

Low Loss Duopack: IGBT 7 with Trench and Fieldstop technology

Features

- $V_{CE} = 650\text{ V}$
- $I_C = 40\text{ A}$
- Very Low V_{CEsat}
- Low turn-off losses
- Short tail current
- Reduced EMI
- Humidity robust design
- 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

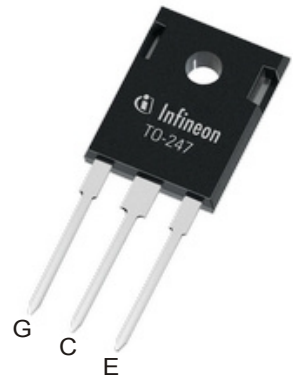
Product validation

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

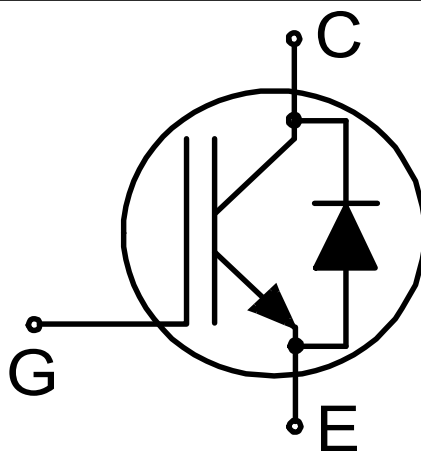
Description

Package pin definition:

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



-  Lead-Free
-  Green
-  Halogen-Free
-  RoHS



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			13.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M				0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	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_{Cpuls}		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}	$t_p \leq 10\text{ }\mu\text{s}$, $D < 0.010$	± 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	$V_{CE\ sat}$	$I_C = 40.0\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.35	1.65	V
			$T_{vj} = 125\ ^\circ C$	1.50		
			$T_{vj} = 175\ ^\circ C$	1.60		
Gate-emitter threshold voltage	V_{GEth}	$I_C = 0.40\ mA, V_{CE} = V_{GE}$	4.30	5.00	5.70	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 650\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$		40	μA
			$T_{vj} = 175\ ^\circ C$		900	
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\ V, V_{GE} = 20\ V$			100	nA
Transconductance	g_{fs}	$I_C = 40.0\ A, V_{CE} = 20\ V$		21		S
Short circuit collector current	I_{SC}	$V_{GE} = 15\ V, t_{SC} \leq 3\ \mu s$, Allowed number of short circuits < 1000 , Time between short circuits $\geq 1.0\ s$		205		A
Input capacitance	C_{ies}	$V_{CE} = 25\ V, V_{GE} = 0\ V, f = 1000\ kHz$		2475		pF
Output capacitance	C_{oes}	$V_{CE} = 25\ V, V_{GE} = 0\ V, f = 1000\ kHz$		77		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25\ V, V_{GE} = 0\ V, f = 1000\ kHz$		25		pF
Gate charge	Q_G	$I_C = 40.0\ A, V_{GE} = 15\ V, V_{CE} = 520\ V$		235		nC
Turn-on delay time	t_{don}	$V_{CE} = 400\ V, V_{GE} = 15\ V,$ $R_{Gon} = 10.0\ \Omega,$ $R_{Goff} = 10.0\ \Omega,$ $L_\sigma = 32\ nH, C_\sigma = 30\ pF$	$T_{vj} = 25\ ^\circ C,$ $I_C = 40.0\ A$	20		ns
			$T_{vj} = 25\ ^\circ C,$ $I_C = 20.0\ A$	19		
			$T_{vj} = 175\ ^\circ C,$ $I_C = 40.0\ A$	23		
			$T_{vj} = 175\ ^\circ C,$ $I_C = 20.0\ A$	21		
Rise time (inductive load)	t_r	$V_{CE} = 400\ V, V_{GE} = 15\ V,$ $R_{Gon} = 10.0\ \Omega,$ $R_{Goff} = 10.0\ \Omega,$ $L_\sigma = 32\ nH, C_\sigma = 30\ pF$	$T_{vj} = 25\ ^\circ C,$ $I_C = 40.0\ A$	15		ns
			$T_{vj} = 25\ ^\circ C,$ $I_C = 20.0\ A$	9		
			$T_{vj} = 175\ ^\circ C,$ $I_C = 40.0\ A$	20		
			$T_{vj} = 175\ ^\circ C,$ $I_C = 20.0\ A$	12		

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off delay time	t_{doff}	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \ \Omega,$ $R_{\text{Goff}} = 10.0 \ \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	310		ns
			$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	330		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	380		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	430		
Fall time (inductive load)	t_{f}	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \ \Omega,$ $R_{\text{Goff}} = 10.0 \ \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	13		ns
			$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	17		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	57		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	70		
Turn-on energy	E_{on}	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \ \Omega,$ $R_{\text{Goff}} = 10.0 \ \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	1.05		mJ
			$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	0.45		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	1.65		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	0.84		
Turn-off energy	E_{off}	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \ \Omega,$ $R_{\text{Goff}} = 10.0 \ \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	0.59		mJ
			$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	0.26		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	1.13		
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C},$ $I_{\text{C}} = 20.0 \text{ A}$	0.59		

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	E_{ts}	$V_{CE} = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $R_{Gon} = 10.0\ \Omega$, $R_{Goff} = 10.0\ \Omega$, $L_{\sigma} = 32\text{ nH}$, $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 40.0\text{ A}$		1.64		mJ
			$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 20.0\text{ A}$		0.71		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 40.0\text{ A}$		2.78		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 20.0\text{ A}$		1.43		
IGBT thermal resistance, junction-case	R_{thjc}				0.65	K/W	
Operating junction temperature	T_{vj}		-40		175	$^{\circ}\text{C}$	

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

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, limited by T_{vjmax}	I_{Fpuls}		120	A	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	V_F	$I_F = 40.0\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		1.65	2.00	V
			$T_{vj} = 125\text{ }^{\circ}\text{C}$		1.60		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		1.55		
Reverse leakage current	I_R	$V_R = 650\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$			40	μA
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		900		

Table 5 Characteristic values (continued)

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery time	t_{rr}	$V_R = 650\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 40.0\text{ A},$ $-di_F/dt = 1779\text{ A}/\mu\text{s}$		85		ns
					59		
					145		
					105		
Diode reverse recovery charge	Q_{rr}	$V_R = 650\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 40.0\text{ A},$ $-di_F/dt = 1779\text{ A}/\mu\text{s}$		0.95		μC
					0.70		
					2.80		
					2.02		
Diode peak reverse recovery current	I_{rrm}	$V_R = 650\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 40.0\text{ A},$ $-di_F/dt = 1779\text{ A}/\mu\text{s}$		22.0		A
					24.5		
					35.0		
					35.0		

Table 5 Characteristic values (continued)

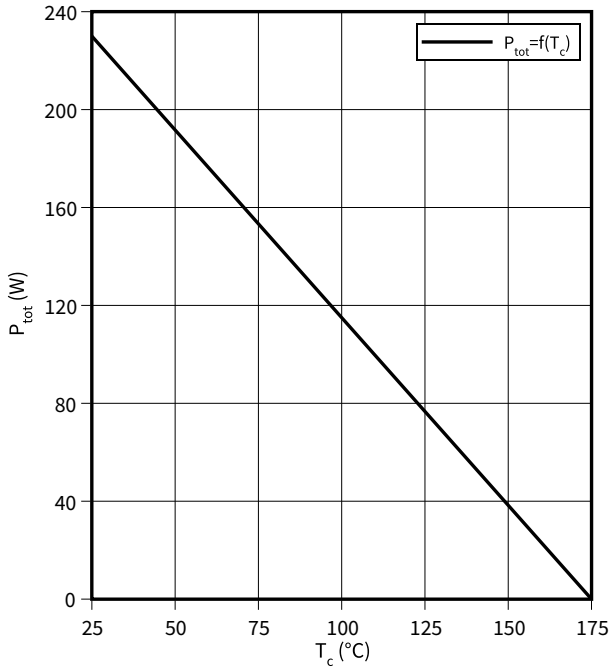
Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode peak rate off fall of reverse recovery current	di_{rr}/dt	$V_R = 650\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 40.0\text{ A},$ $-di_F/dt = 1779\text{ A}/\mu\text{s}$		-380		A/ μs
			$T_{vj} = 25\text{ °C},$ $I_F = 20.0\text{ A},$ $-di_F/dt = 2381\text{ A}/\mu\text{s}$		-520		
			$T_{vj} = 175\text{ °C},$ $I_F = 40.0\text{ A},$ $-di_F/dt = 1660\text{ A}/\mu\text{s}$		-290		
			$T_{vj} = 175\text{ °C},$ $I_F = 20.0\text{ A},$ $-di_F/dt = 1881\text{ A}/\mu\text{s}$		-425		
Diode thermal resistance, junction-case	R_{thjc}				0.90	K/W	
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.

4 Characteristics diagrams

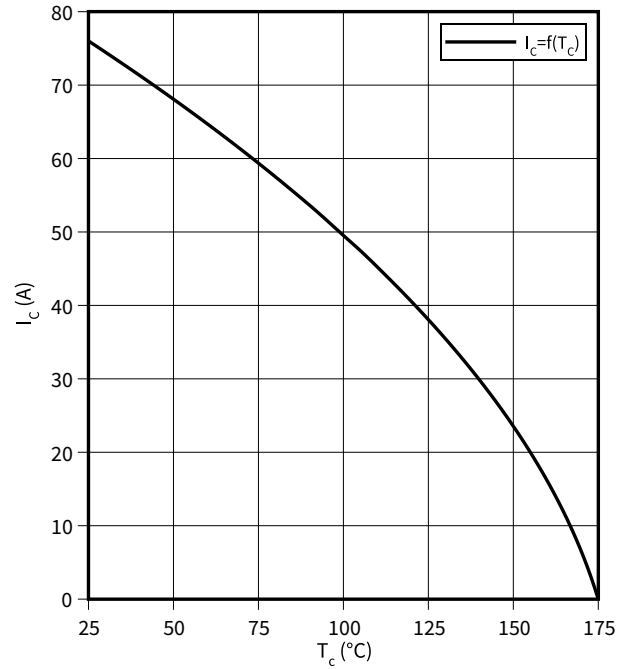
Power dissipation as a function of case temperature, IGBT

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



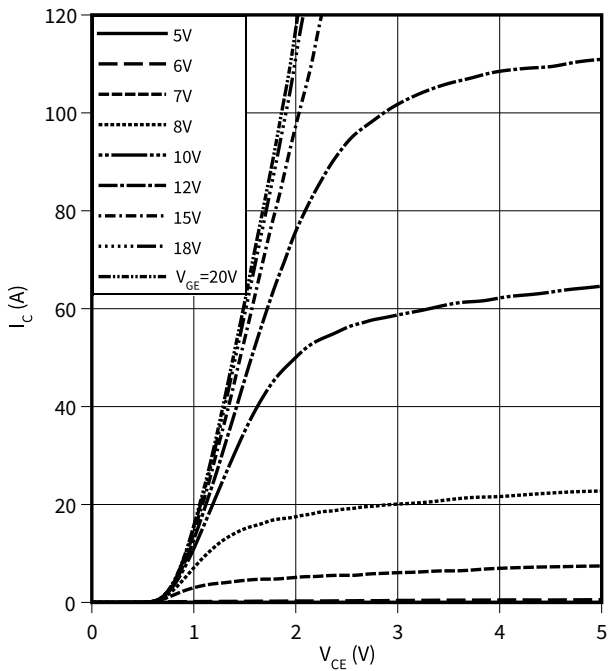
Collector current as a function of case temperature, IGBT

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



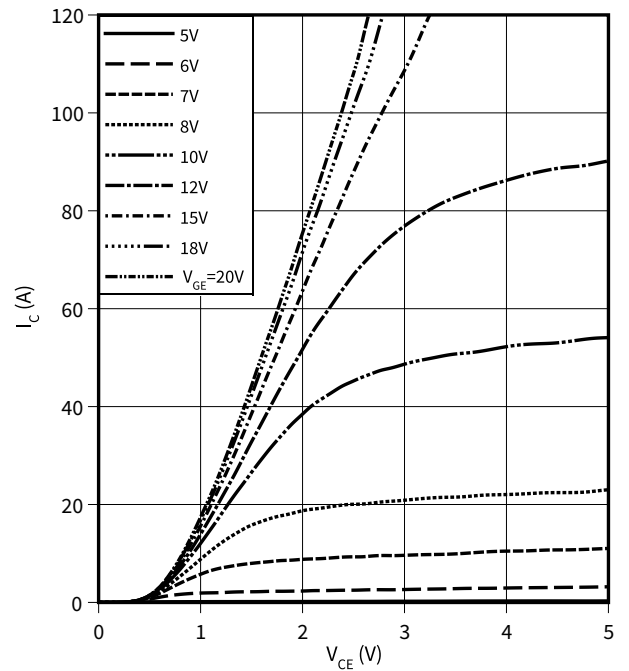
Typical output characteristic, IGBT

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



Typical output characteristic, IGBT

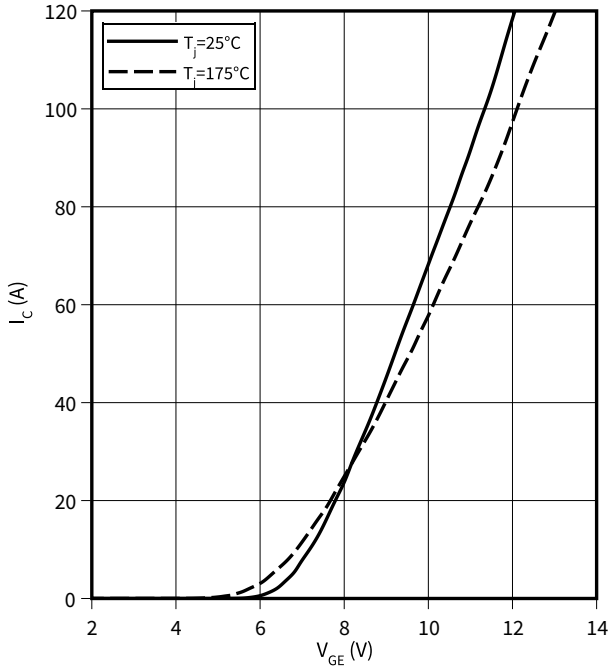
$I_c = f(V_{CE})$
 $T_{vj} = 175\text{ °C}$



4 Characteristics diagrams

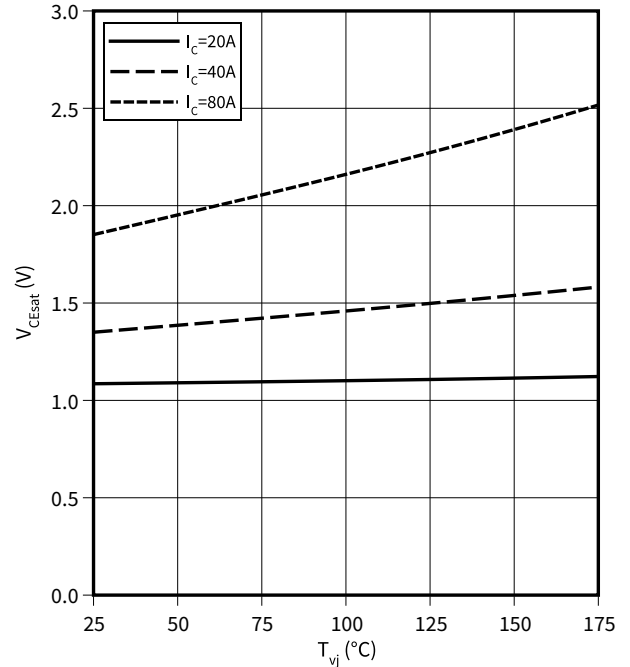
Typical transfer characteristic, IGBT

$I_C = f(V_{GE})$
 $V_{CE} = 20\text{ V}$



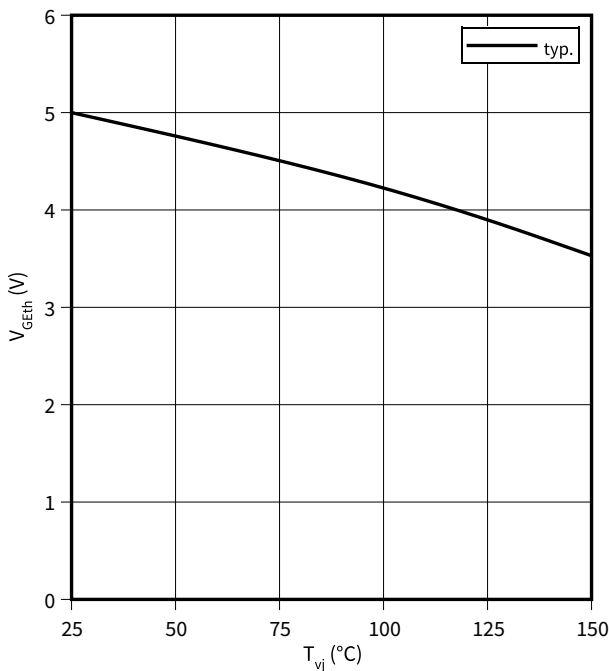
Typical collector-emitter saturation voltage as a function of junction temperature, IGBT

$V_{CEsat} = f(T_{vj})$
 $V_{GE} = 15\text{ V}$



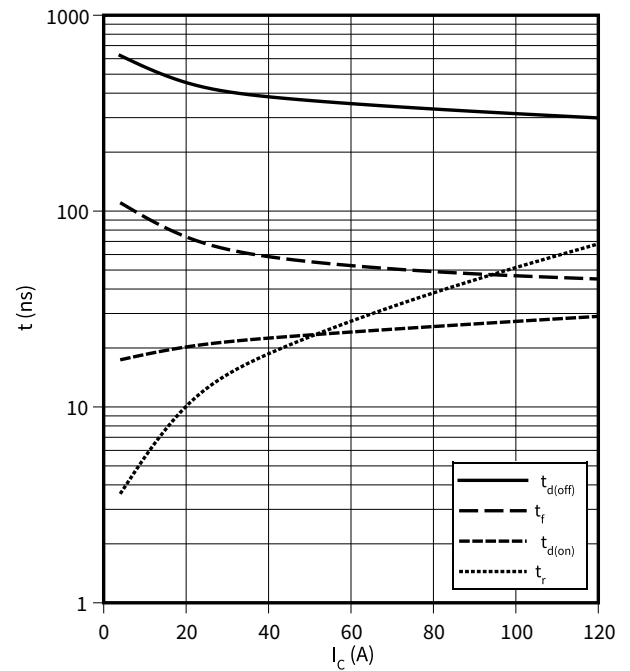
Gate-emitter threshold voltage as a function of junction temperature, IGBT

$V_{GEth} = f(T_{vj})$
 $I_C = 0.40\text{ mA}$



Typical switching times as a function of collector current, IGBT

$t = f(I_C)$
 $V_{CE} = 400\text{ V}, T_{vj} = 175^\circ\text{C}, V_{GE} = 0/15\text{ V}, R_G = 10\ \Omega$

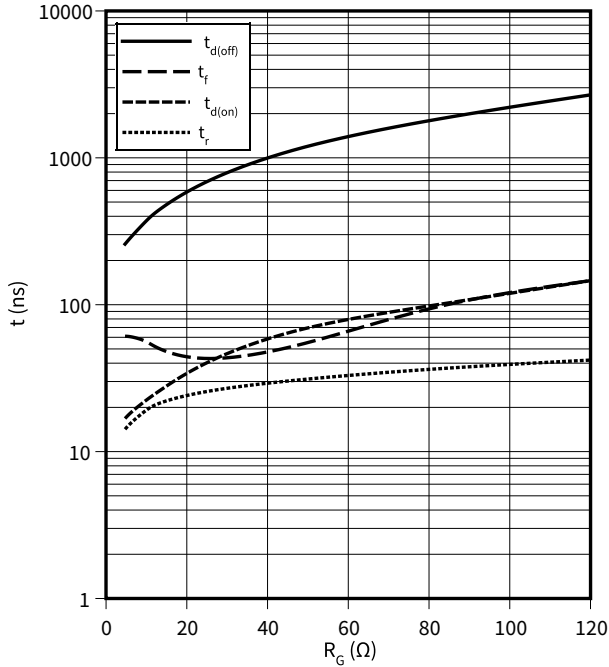


4 Characteristics diagrams

Typical switching times as a function of gate resistor, IGBT

$t = f(R_G)$

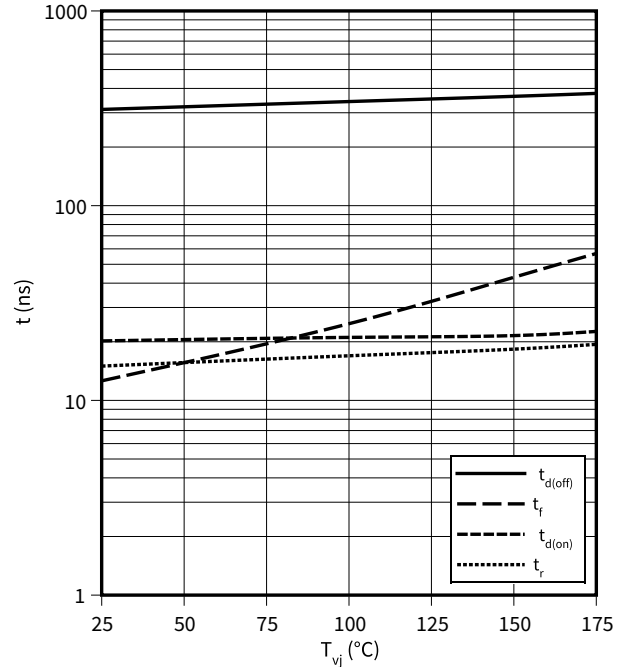
$I_C = 40.0 \text{ A}$, $V_{CE} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$



Typical switching times as a function of junction temperature, IGBT

$t = f(T_{vj})$

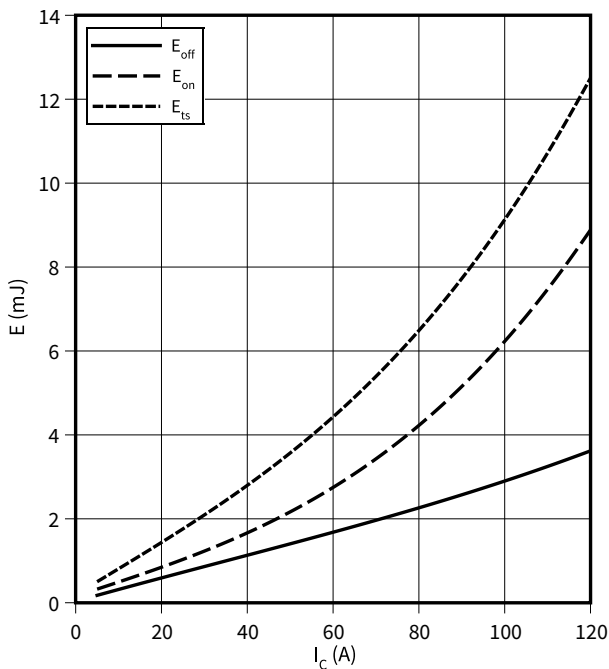
$I_C = 40.0 \text{ A}$, $V_{CE} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 10 \text{ } \Omega$



Typical switching energy losses as a function of collector current, IGBT

$E = f(I_C)$

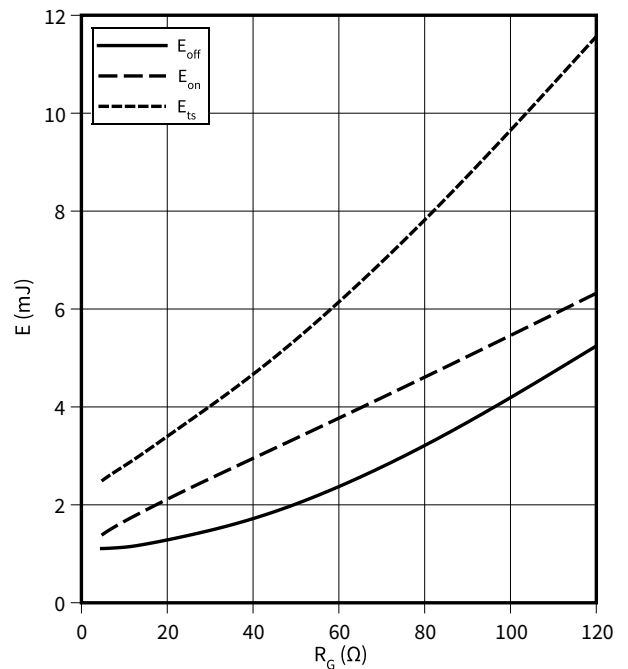
$V_{CE} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 10 \text{ } \Omega$



Typical switching energy losses as a function of gate resistor, IGBT

$E = f(R_G)$

$I_C = 40.0 \text{ A}$, $V_{CE} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$

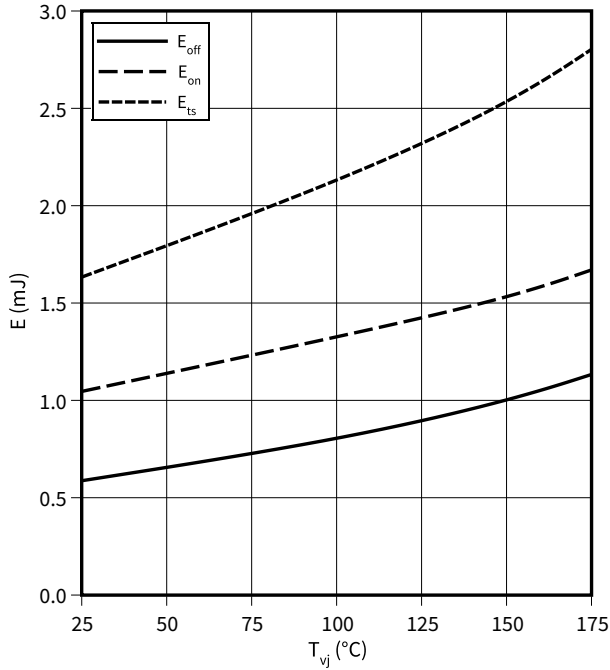


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature, IGBT

$E = f(T_{vj})$

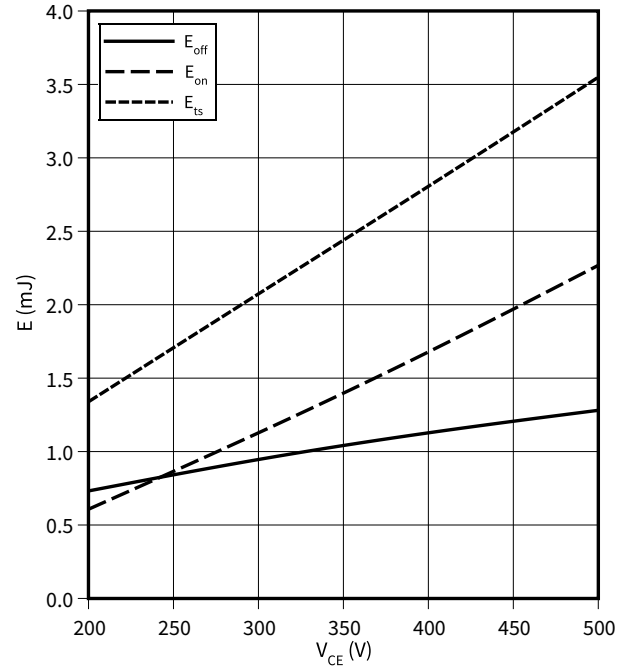
$I_C = 40.0\text{ A}$, $V_{CE} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 10\ \Omega$



Typical switching energy losses as a function of collector emitter voltage, IGBT

$E = f(V_{CE})$

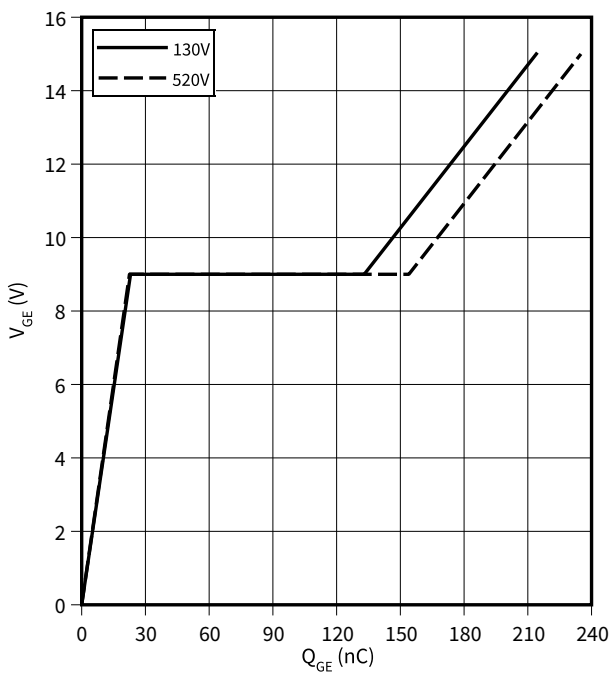
$I_C = 40.0\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{GE} = 0/15\text{ V}$, $R_G = 10\ \Omega$



Typical gate charge, IGBT

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

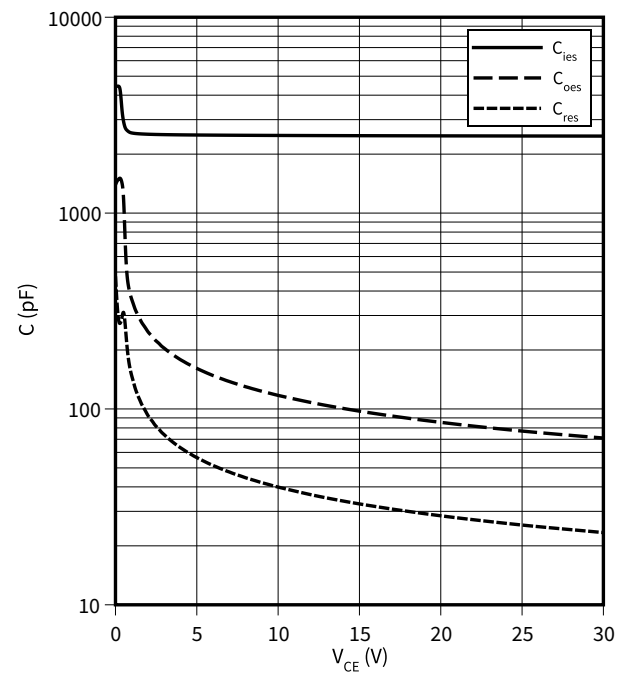
$I_C = 40.0\text{ A}$



Typical capacitance as a function of collector-emitter voltage, IGBT

$C = f(V_{CE})$

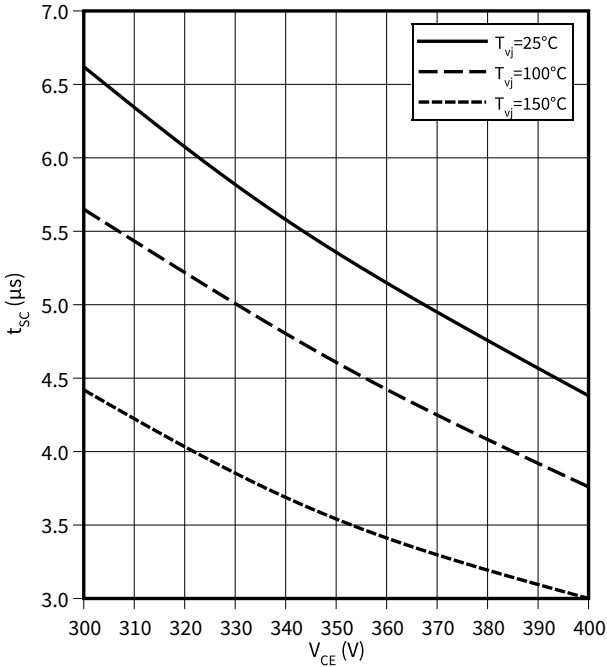
$f = 1000\text{ kHz}$, $V_{GE} = 0\text{ V}$



4 Characteristics diagrams

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

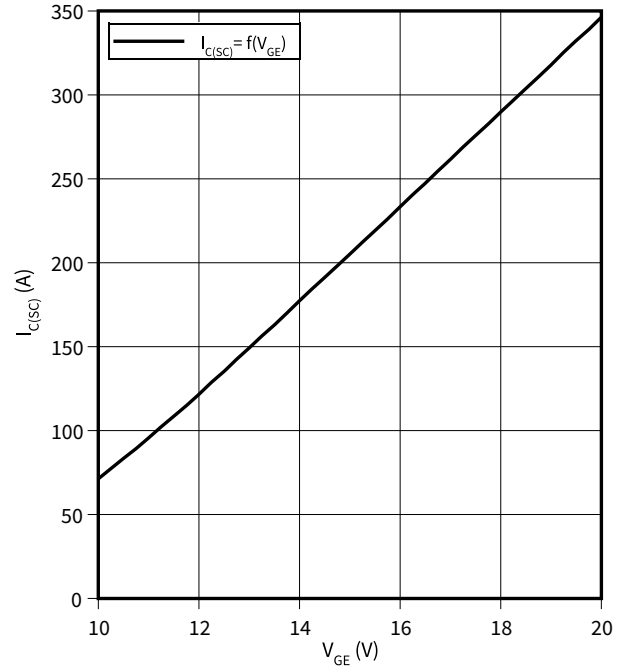
$t_{SC} = f(V_{CE})$



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

$I_{C(SC)} = f(V_{GE})$

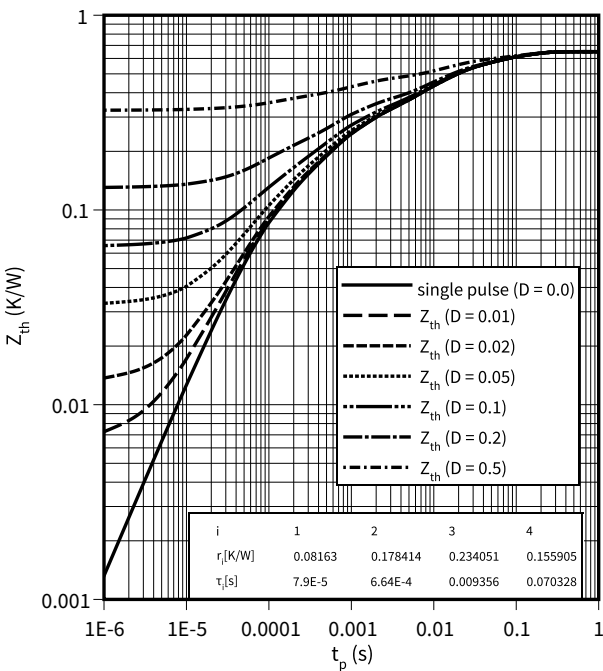
$V_{CE} = 400\text{ V}, T_{vj} = 150\text{ }^{\circ}\text{C}$



IGBT transient thermal resistance, IGBT

$Z_{th} = f(t_p)$

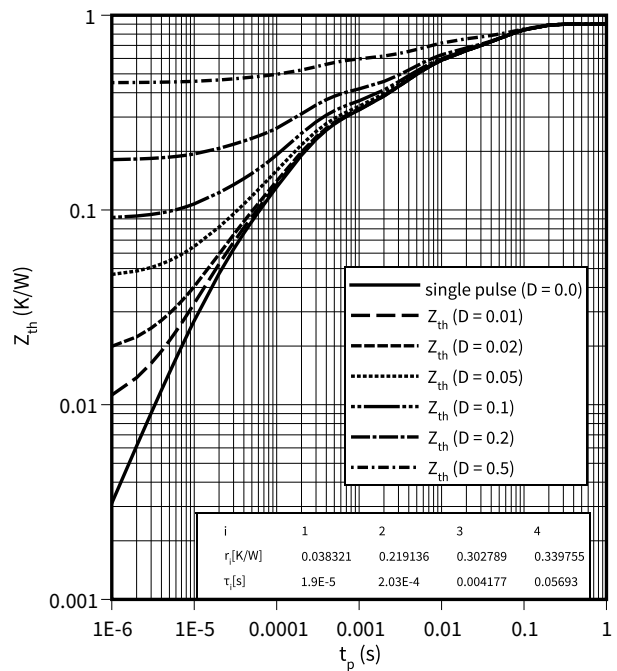
$D = t_p/T$



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

$Z_{th} = f(t_p)$

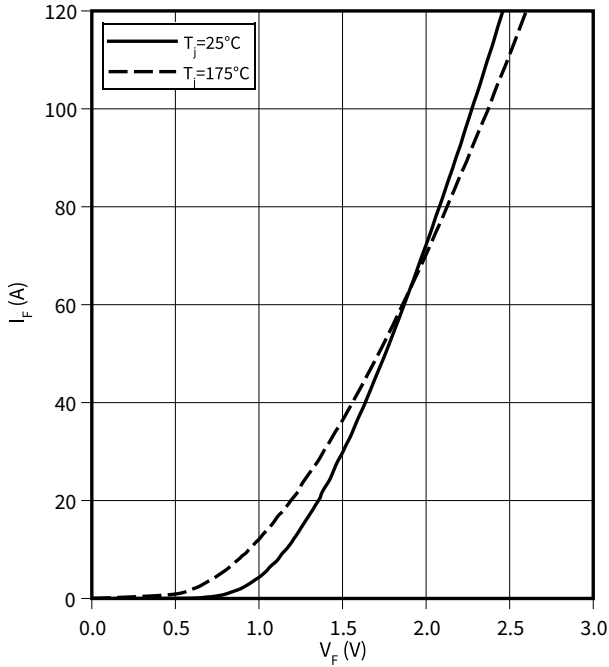
$D = t_p/T$



4 Characteristics diagrams

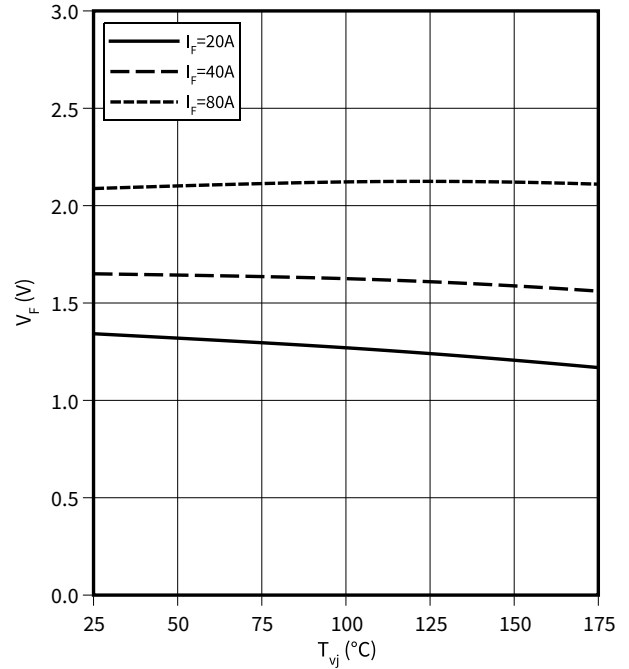
Typical diode forward current as a function of forward voltage, Diode

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature, Diode

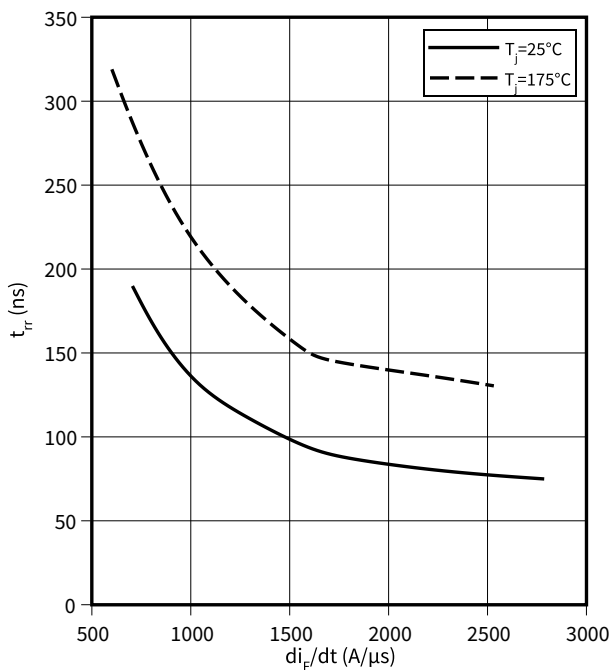
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope, Diode

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

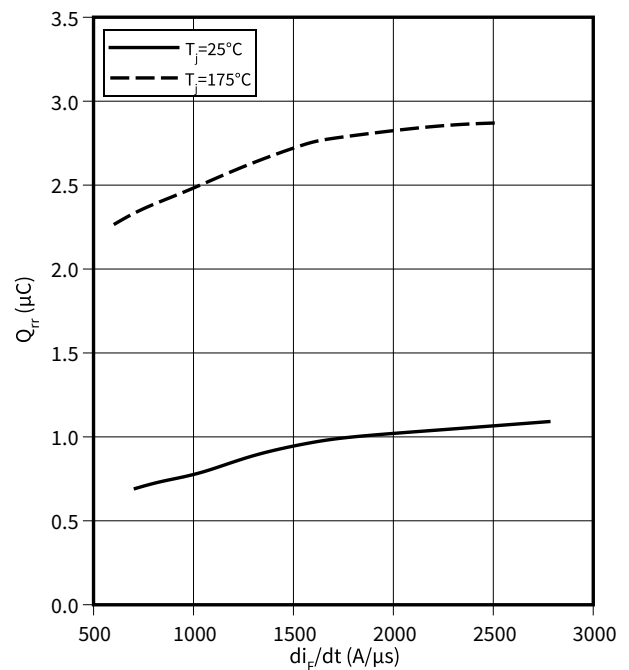
$V_R = 400\text{ V}, I_F = 40\text{ A}$



Typical reverse recovery charge as a function of diode current slope, Diode

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

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

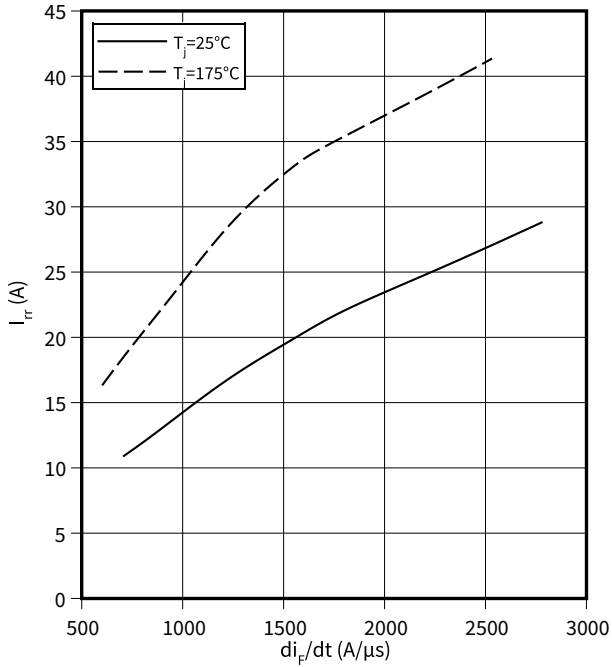


4 Characteristics diagrams

Typical reverse recovery current as a function of diode current slope, Diode

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

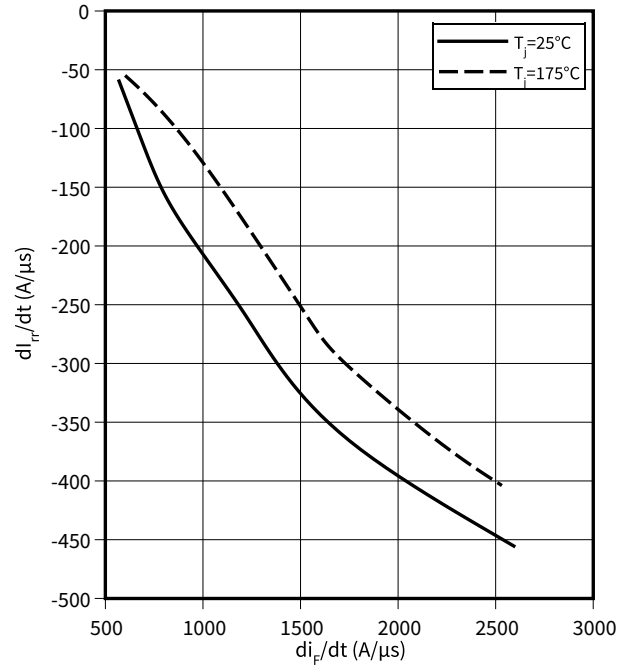
$V_R = 400\text{ V}$, $I_F = 40\text{ A}$



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

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

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



5 Package outlines

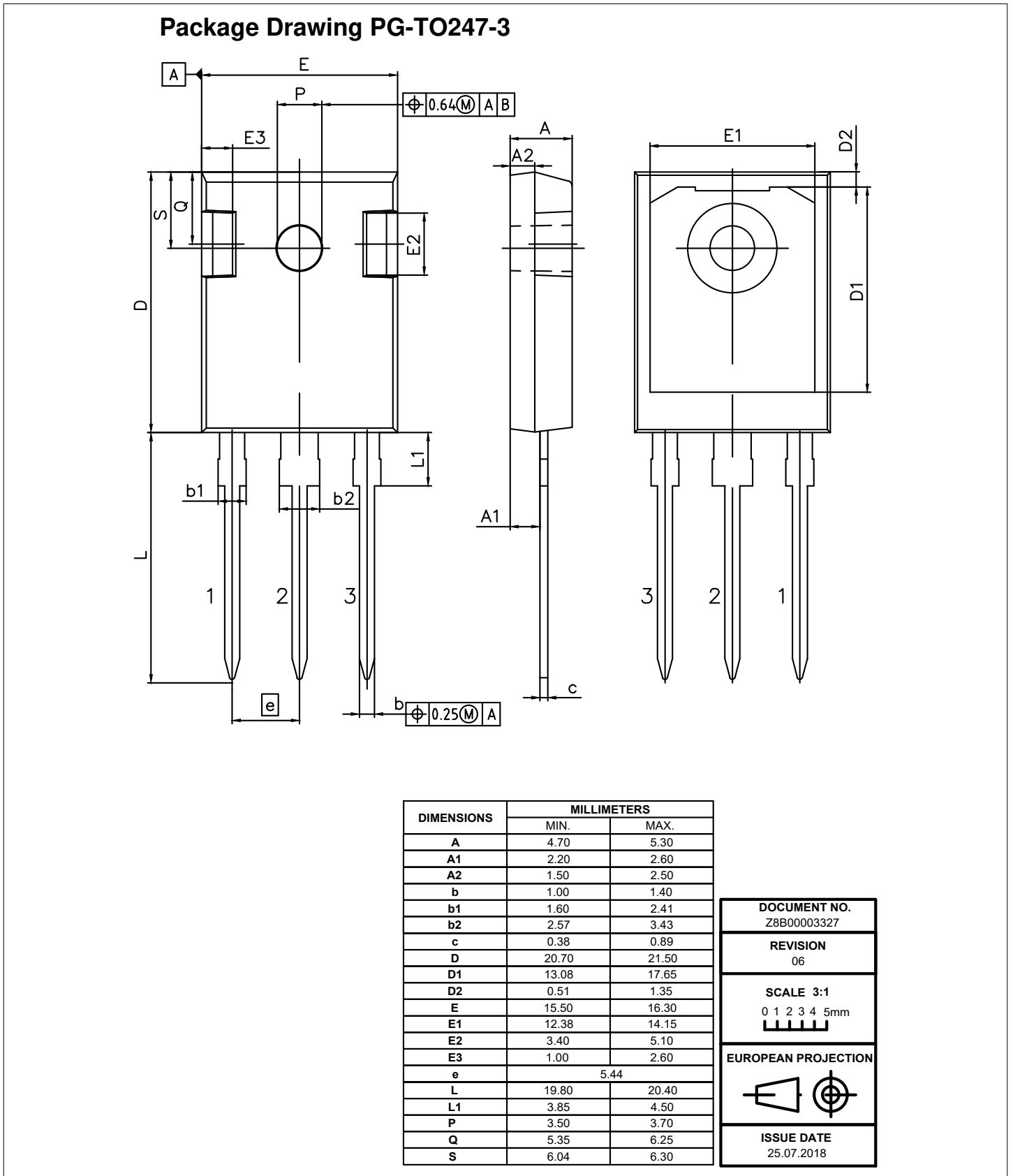


Figure 6

6 Testing conditions

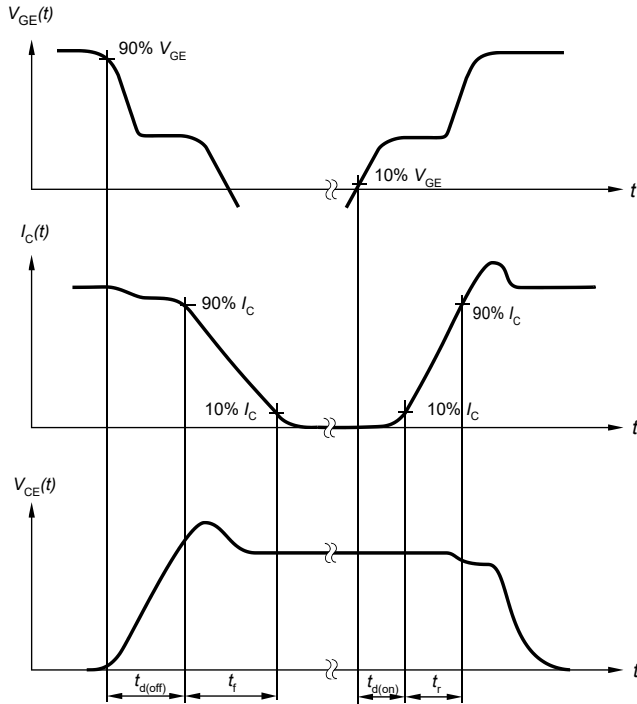


Figure A. Definition of switching times

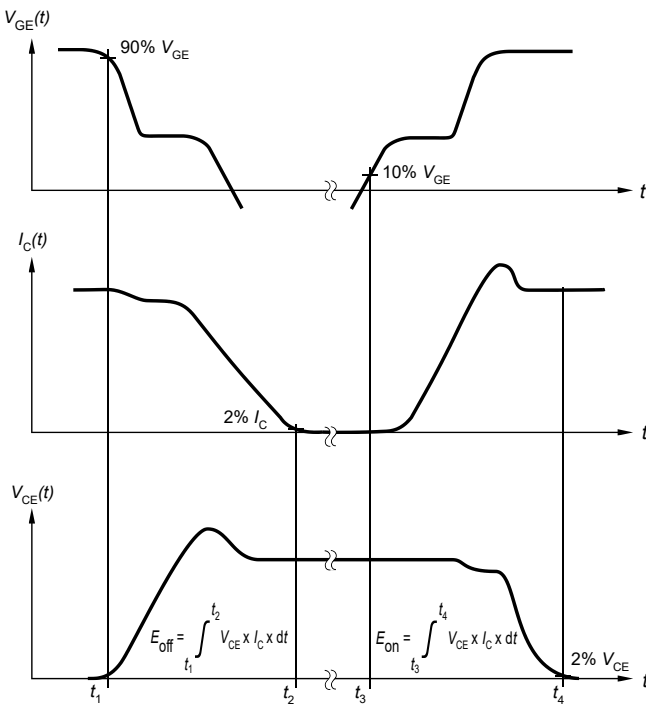


Figure B. Definition of switching losses

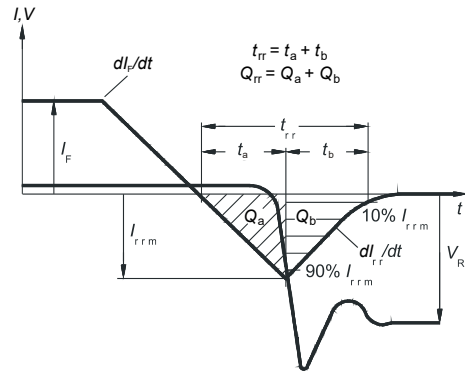


Figure C. Definition of diode switching characteristics

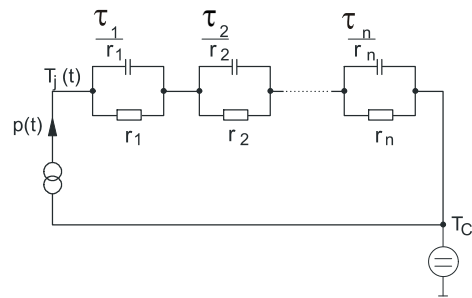


Figure D. Thermal equivalent circuit

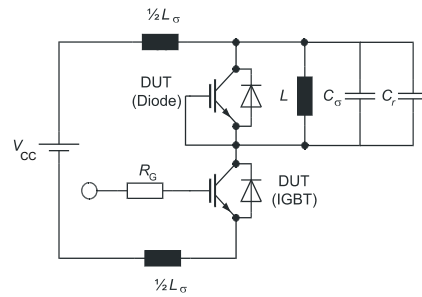


Figure E. Dynamic test circuit
 Parasitic inductance L_σ ,
 parasitic capacitor C_σ ,
 relief capacitor C_r ,
 (only for ZVT switching)

Figure 7

Revision history

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
1.00	2021-06-29	Change of potential applications and new diagram added (t_{SC} as function of V_{CE})

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Edition 2021-06-29

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference

IFX-AAL383-003

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