

## 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

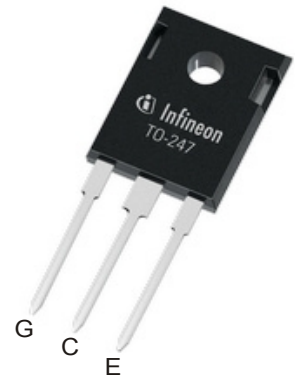
### Product validation

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

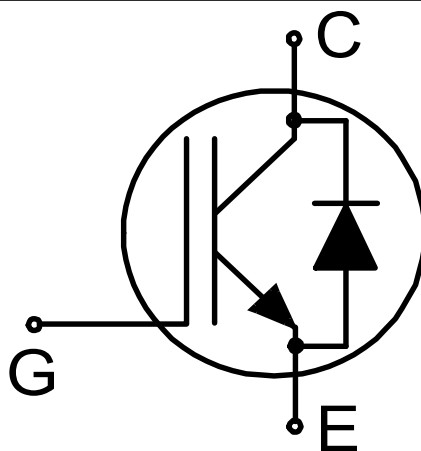
### Description

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 $T_{vjmax}$ <sup>1)</sup>	$I_{Cpuls}$		120	A	
Turn-off safe operating area <sup>2)</sup>		$V_{CE} \leq 650\text{ V}$ , $t_p = 1\text{ }\mu\text{s}$ , $T_{vj} \leq 175\text{ °C}$	120	A	
Gate-emitter voltage	$V_{GE}$		$\pm 20$	V	
Transient gate-emitter voltage	$V_{GE}$	$t_p \leq 10\text{ }\mu\text{s}$ , $D < 0.010$	$\pm 30$	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	$\mu\text{s}$
			$V_{CC} \leq 400\text{ V}$ , $T_{vj} = 150\text{ °C}$	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	$\mu A$
			$T_{vj} = 175\ ^\circ C$		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	$t_{\text{doff}}$	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \text{ } \Omega,$ $R_{\text{Goff}} = 10.0 \text{ } \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ } ^\circ\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	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)	$t_{\text{f}}$	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \text{ } \Omega,$ $R_{\text{Goff}} = 10.0 \text{ } \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ } ^\circ\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	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	$E_{\text{on}}$	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \text{ } \Omega,$ $R_{\text{Goff}} = 10.0 \text{ } \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ } ^\circ\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	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	$E_{\text{off}}$	$V_{\text{CE}} = 400 \text{ V}, V_{\text{GE}} = 15 \text{ V},$ $R_{\text{Gon}} = 10.0 \text{ } \Omega,$ $R_{\text{Goff}} = 10.0 \text{ } \Omega,$ $L_{\sigma} = 32 \text{ nH}, C_{\sigma} = 30 \text{ pF}$	$T_{\text{vj}} = 25 \text{ } ^\circ\text{C},$ $I_{\text{C}} = 40.0 \text{ A}$	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	$\mu\text{A}$
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		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
			$T_{vj} = 25\text{ °C}$ , $I_F = 20.0\text{ A}$ , $-di_F/dt = 2381\text{ A}/\mu\text{s}$		59		
			$T_{vj} = 175\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 1660\text{ A}/\mu\text{s}$		145		
			$T_{vj} = 175\text{ °C}$ , $I_F = 20.0\text{ A}$ , $-di_F/dt = 1881\text{ A}/\mu\text{s}$		105		
Diode reverse recovery charge	$Q_{rr}$	$V_R = 650\text{ V}$	$T_{vj} = 25\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 1779\text{ A}/\mu\text{s}$		0.95		$\mu\text{C}$
			$T_{vj} = 25\text{ °C}$ , $I_F = 20.0\text{ A}$ , $-di_F/dt = 2381\text{ A}/\mu\text{s}$		0.70		
			$T_{vj} = 175\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 1660\text{ A}/\mu\text{s}$		2.80		
			$T_{vj} = 175\text{ °C}$ , $I_F = 20.0\text{ A}$ , $-di_F/dt = 1881\text{ A}/\mu\text{s}$		2.02		
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 650\text{ V}$	$T_{vj} = 25\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 1779\text{ A}/\mu\text{s}$		22.0		A
			$T_{vj} = 25\text{ °C}$ , $I_F = 20.0\text{ A}$ , $-di_F/dt = 2381\text{ A}/\mu\text{s}$		24.5		
			$T_{vj} = 175\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 1660\text{ A}/\mu\text{s}$		35.0		
			$T_{vj} = 175\text{ °C}$ , $I_F = 20.0\text{ A}$ , $-di_F/dt = 1881\text{ A}/\mu\text{s}$		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/ $\mu\text{s}$
			$T_{vj} = 25\text{ °C}$ , $I_F = 20.0\text{ A}$ , $-di_F/dt = 2381\text{ A}/\mu\text{s}$		-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	

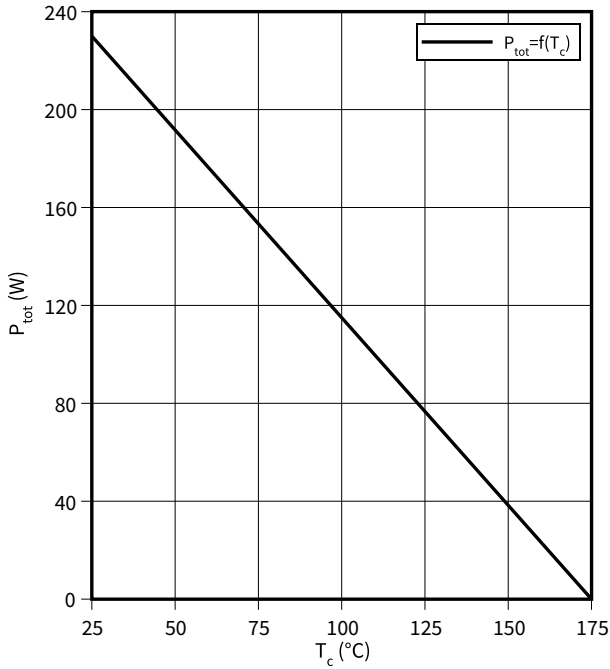
*Note:* For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.



## 4 Characteristics diagrams

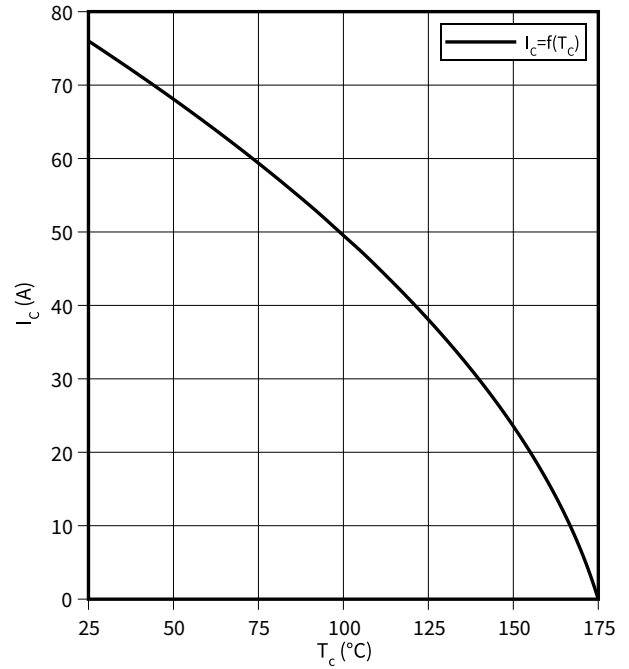
**Power dissipation as a function of case temperature, IGBT**

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



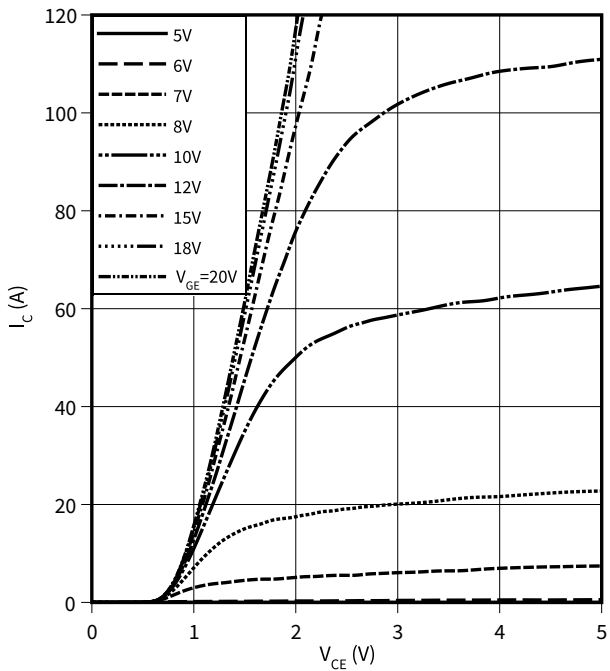
**Collector current as a function of case temperature, IGBT**

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



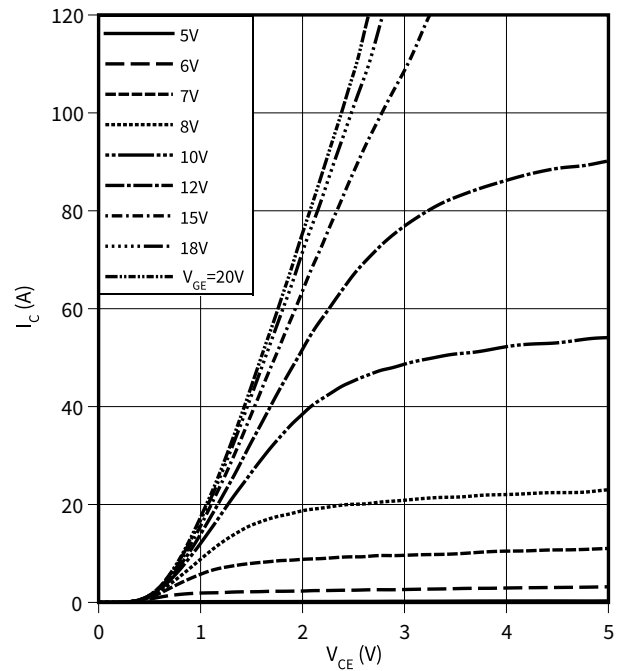
**Typical output characteristic, IGBT**

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



**Typical output characteristic, IGBT**

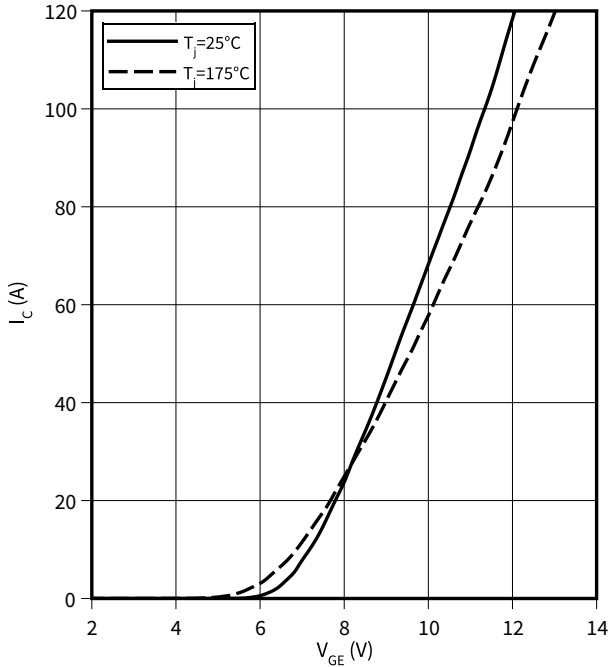
$I_c = f(V_{CE})$   
 $T_{vj} = 175\text{ °C}$



4 Characteristics diagrams

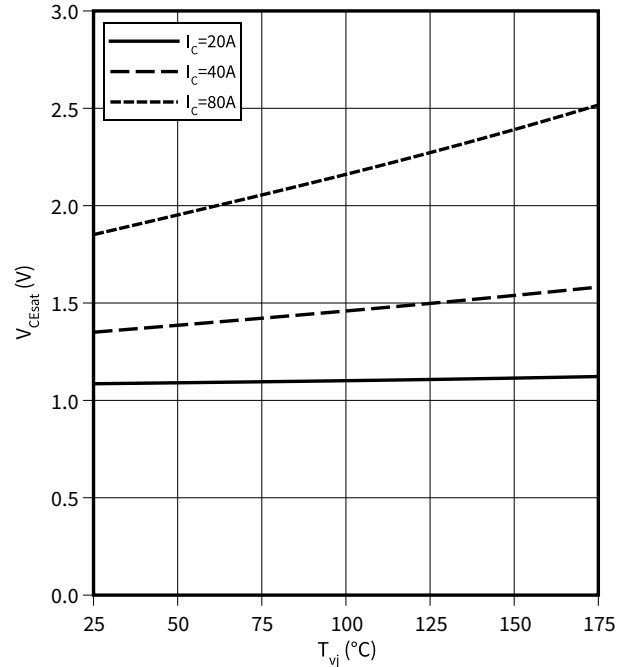
**Typical transfer characteristic, IGBT**

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



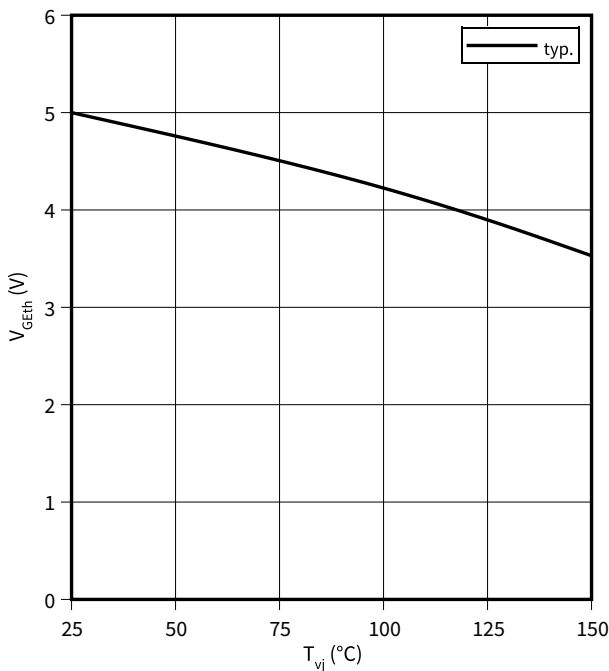
**Typical collector-emitter saturation voltage as a function of junction temperature, IGBT**

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



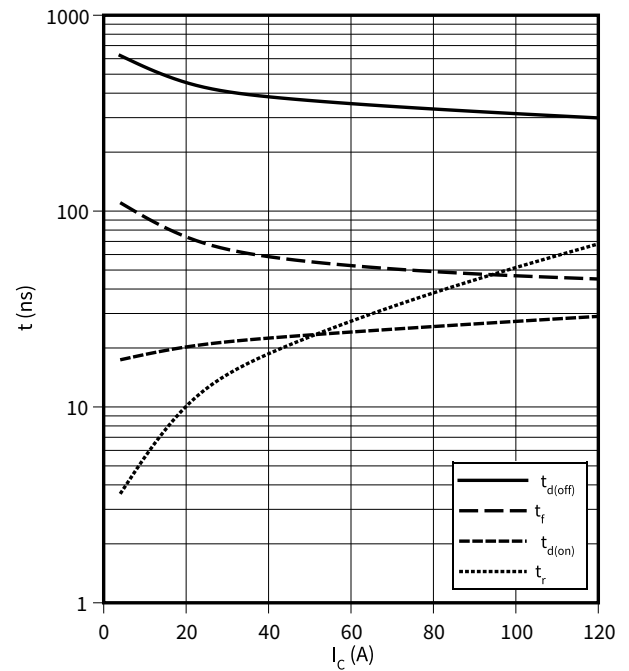
**Gate-emitter threshold voltage as a function of junction temperature, IGBT**

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



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

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

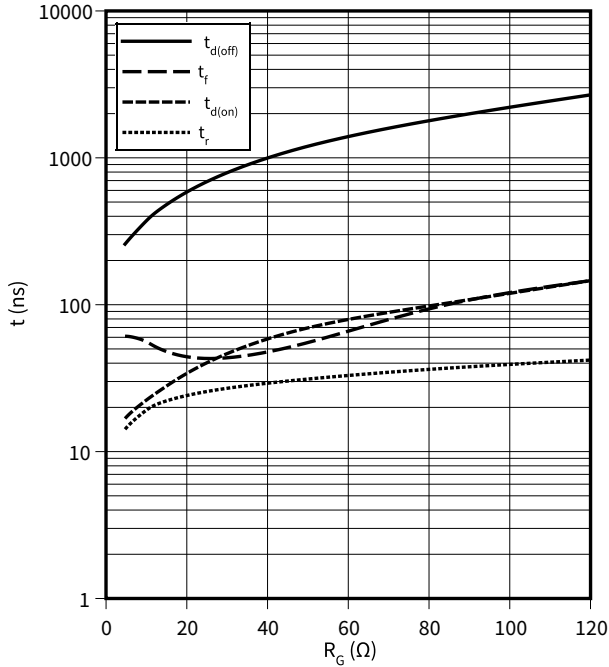


4 Characteristics diagrams

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

$t = f(R_G)$

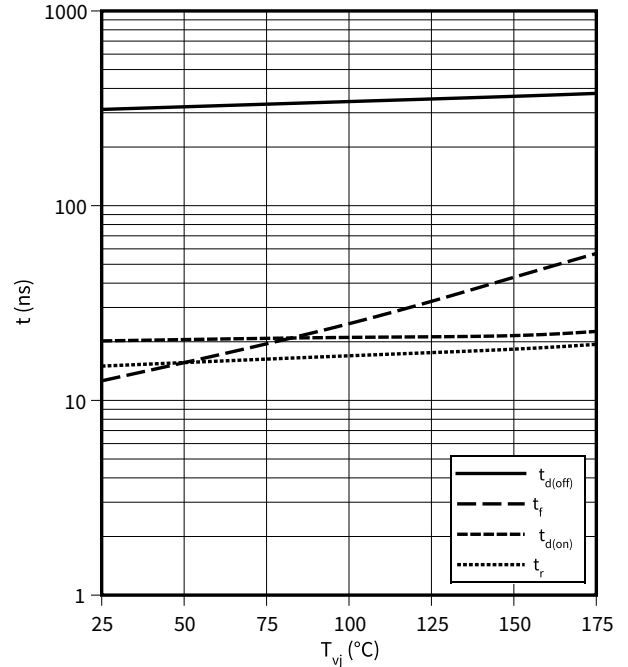
$I_C = 40.0 \text{ A}$ ,  $V_{CE} = 400 \text{ V}$ ,  $T_{vj} = 175 \text{ }^\circ\text{C}$ ,  $V_{GE} = 0/15 \text{ V}$



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

$t = f(T_{vj})$

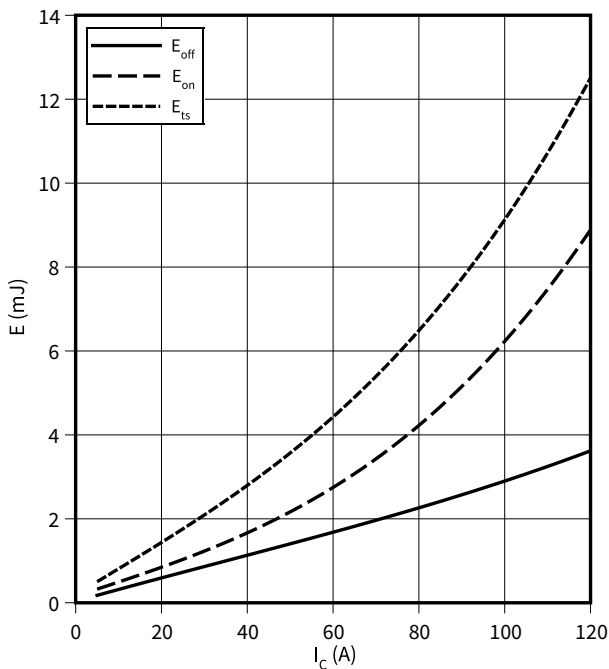
$I_C = 40.0 \text{ A}$ ,  $V_{CE} = 400 \text{ V}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 10 \text{ } \Omega$



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

$E = f(I_C)$

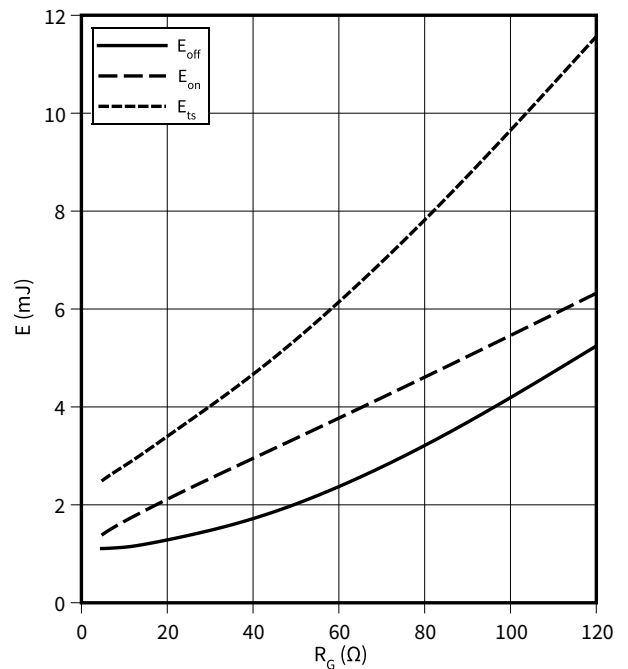
$V_{CE} = 400 \text{ V}$ ,  $T_{vj} = 175 \text{ }^\circ\text{C}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 10 \text{ } \Omega$



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

$E = f(R_G)$

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

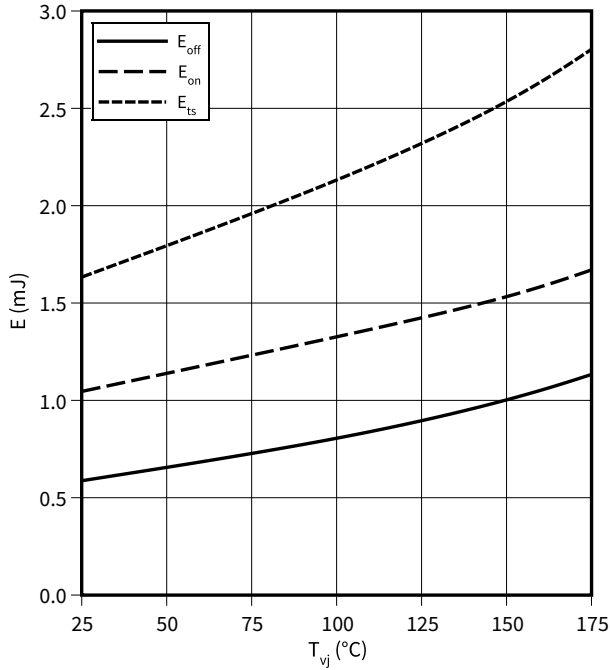


4 Characteristics diagrams

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

$E = f(T_{vj})$

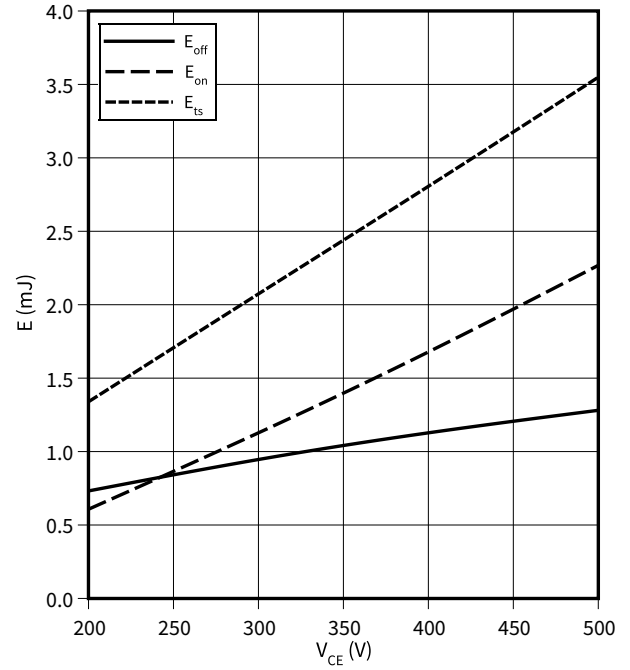
$I_C = 40.0\text{ A}$ ,  $V_{CE} = 400\text{ V}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 10\ \Omega$



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

$E = f(V_{CE})$

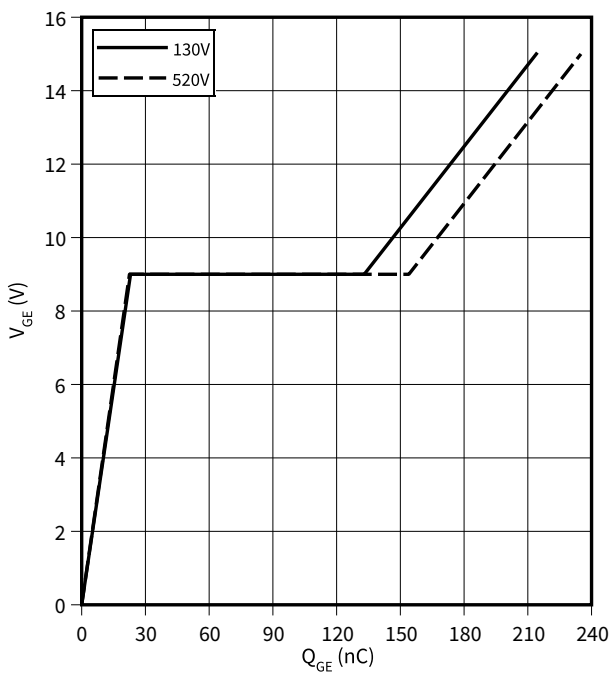
$I_C = 40.0\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 10\ \Omega$



**Typical gate charge, IGBT**

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

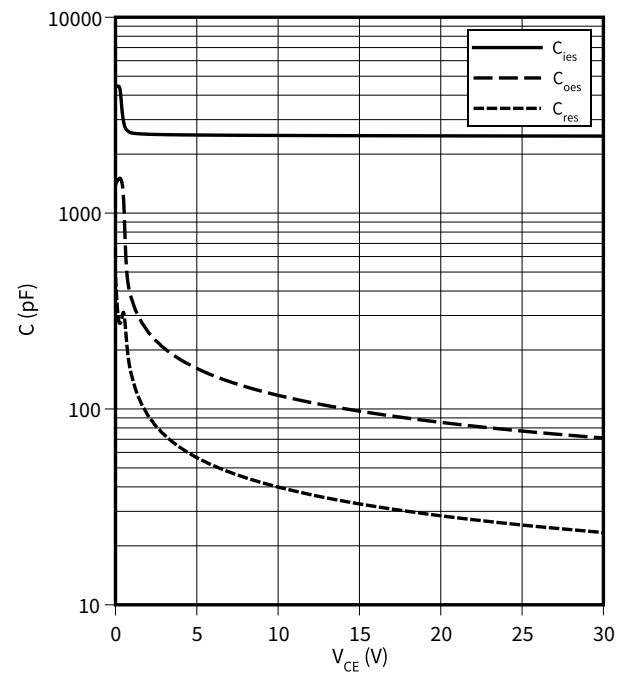
$I_C = 40.0\text{ A}$



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

$C = f(V_{CE})$

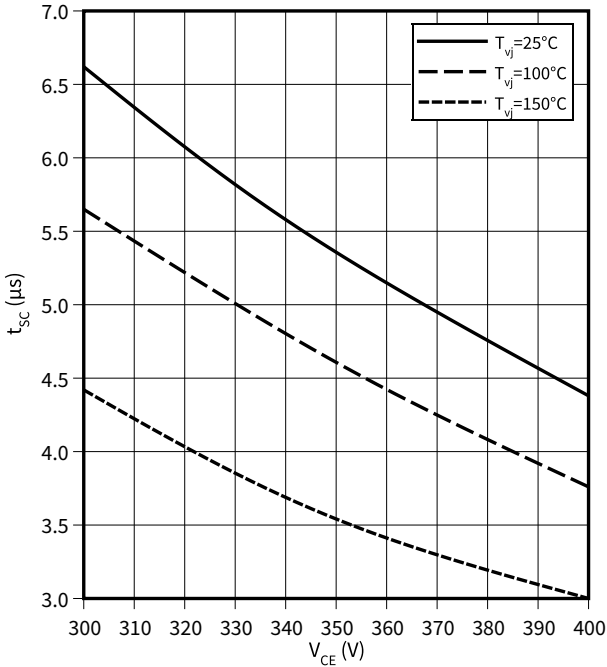
$f = 1000\text{ kHz}$ ,  $V_{GE} = 0\text{ V}$



4 Characteristics diagrams

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

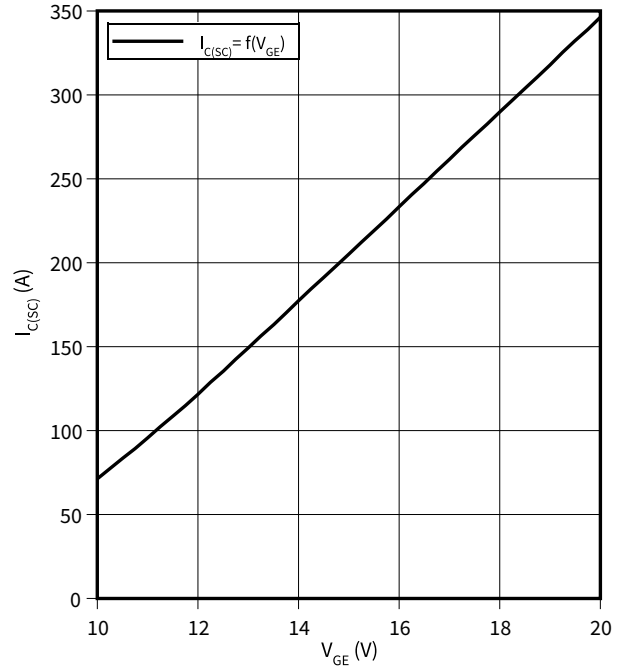
$t_{SC} = f(V_{CE})$



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

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

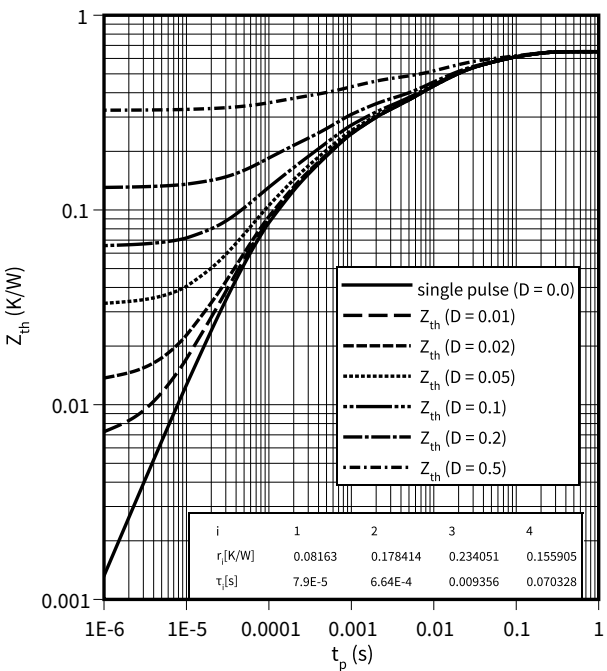
V<sub>CE</sub> = 400 V, T<sub>vj</sub> = 150 °C



**IGBT transient thermal resistance, IGBT**

$Z_{th} = f(t_p)$

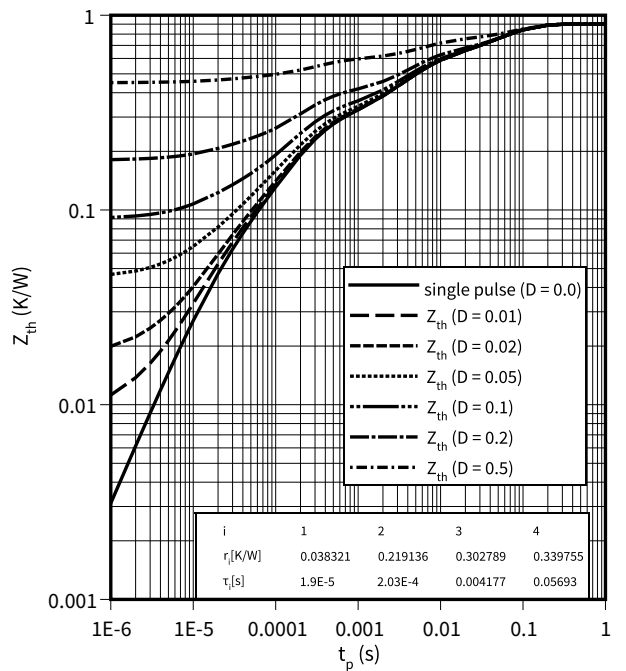
$D = t_p/T$



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

$Z_{th} = f(t_p)$

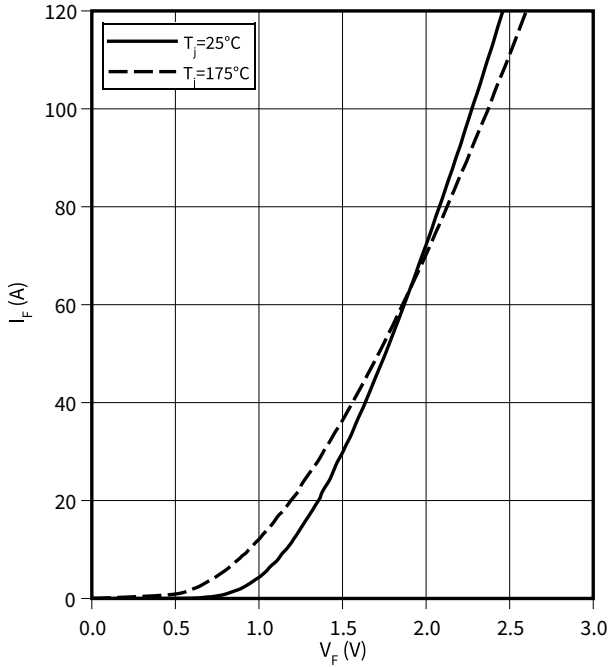
$D = t_p/T$



4 Characteristics diagrams

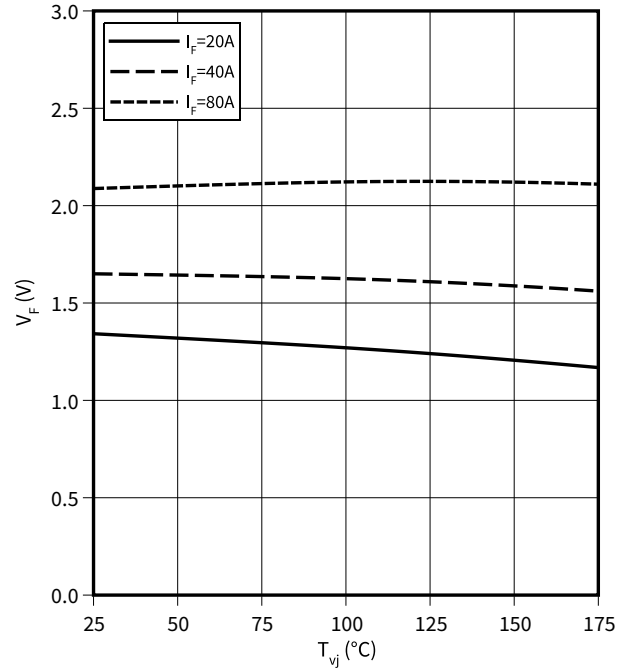
**Typical diode forward current as a function of forward voltage, Diode**

$I_F = f(V_F)$



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

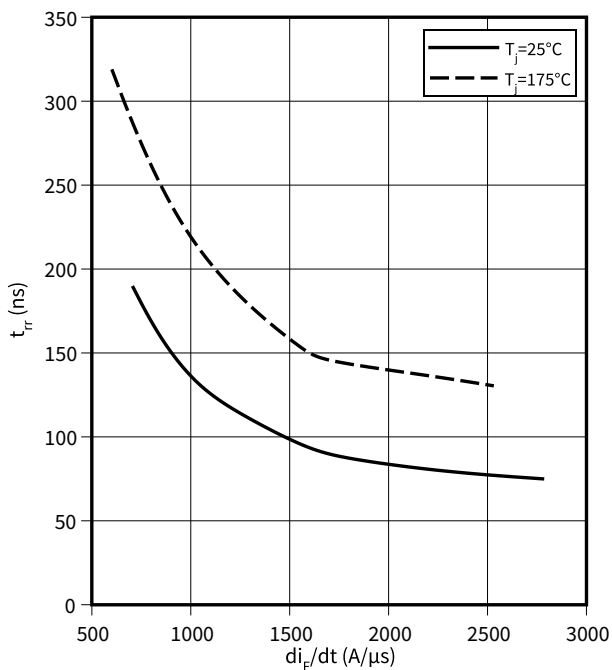
$V_F = f(T_{vj})$



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

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

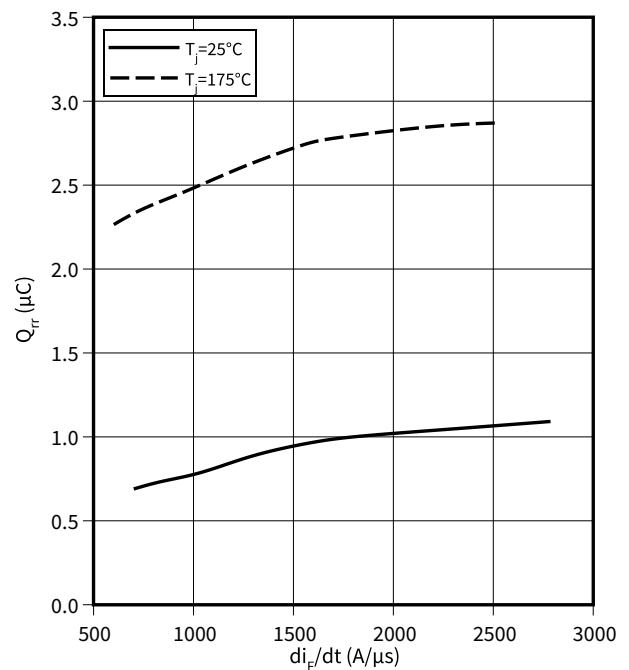
$V_R = 400\text{ V}, I_F = 40\text{ A}$



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

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

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

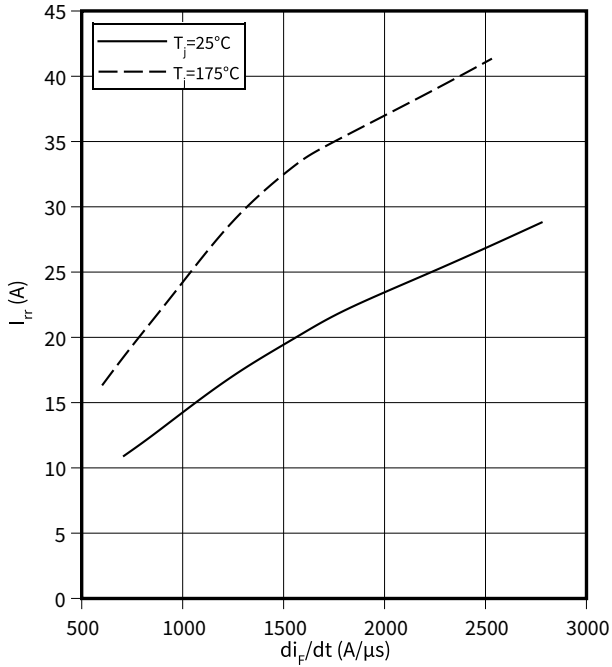


4 Characteristics diagrams

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

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

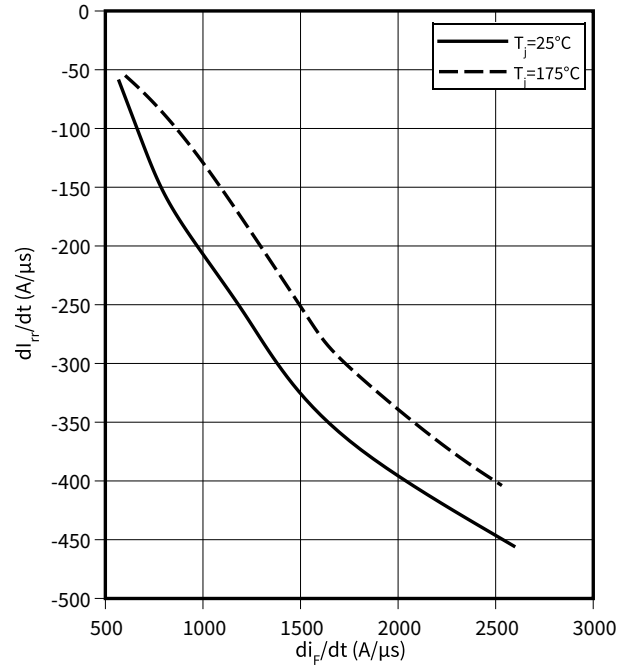
$V_R = 400\text{ V}$ ,  $I_F = 40\text{ A}$



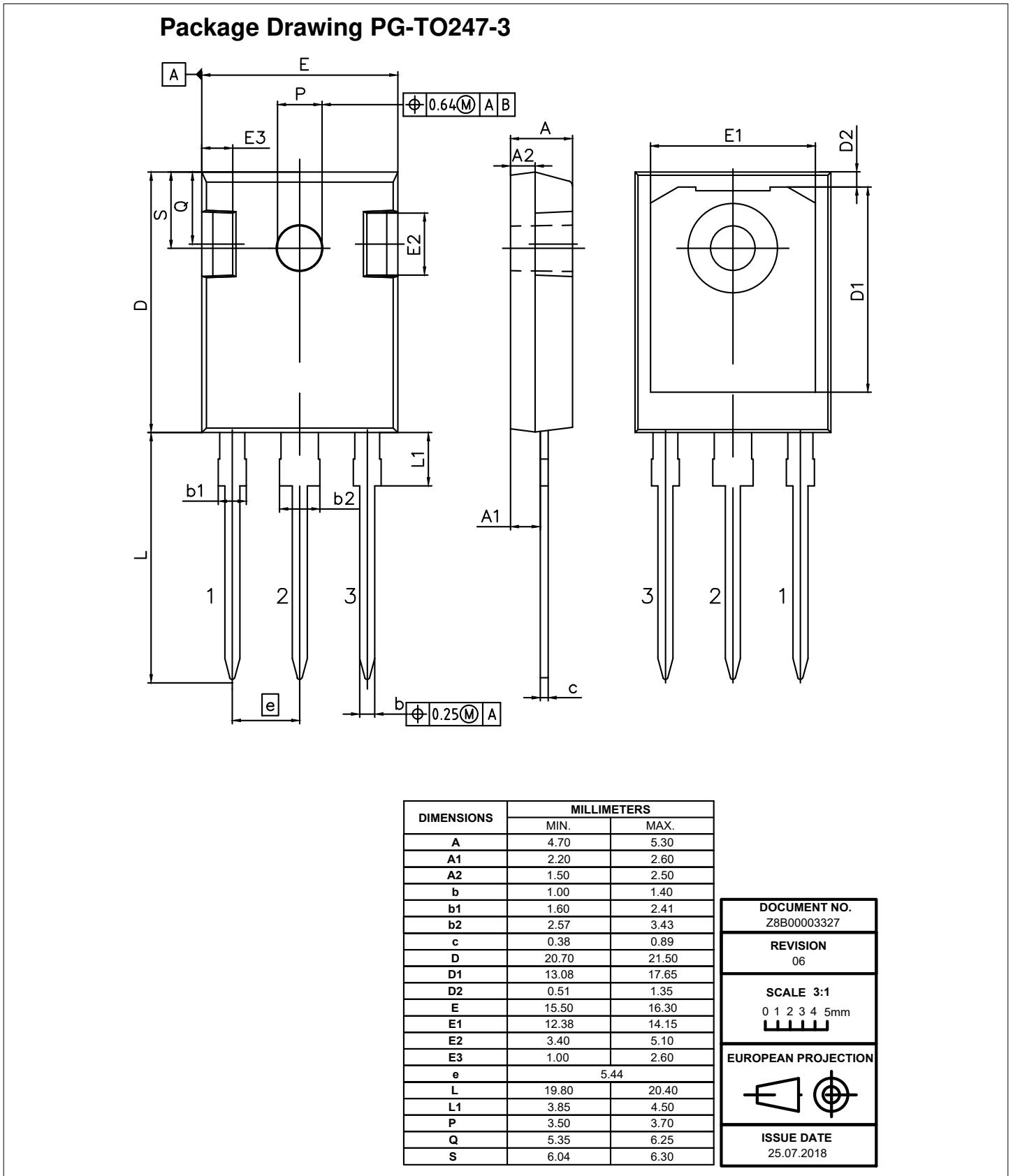
**Typical diode peak rate of fall of reverse recovery current as a function of diode current slope, Diode**

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

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



**5 Package outlines**



**Figure 6**



## 6 Testing conditions

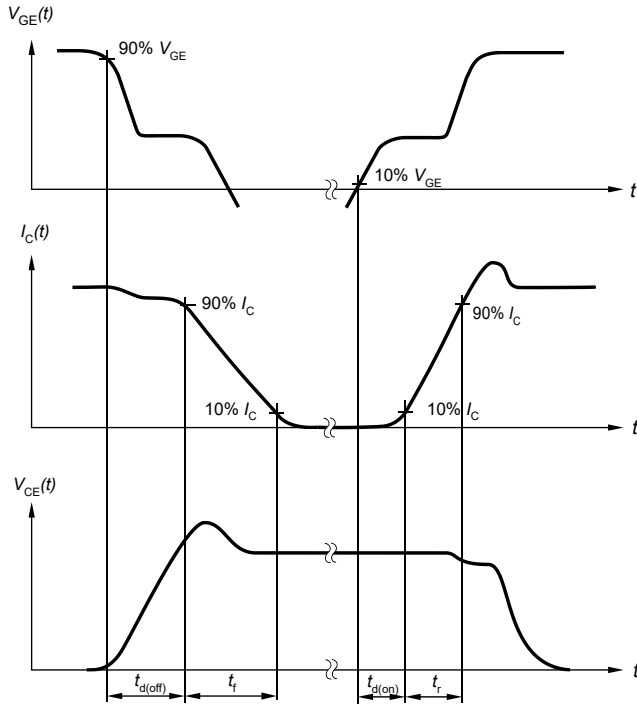


Figure A. Definition of switching times

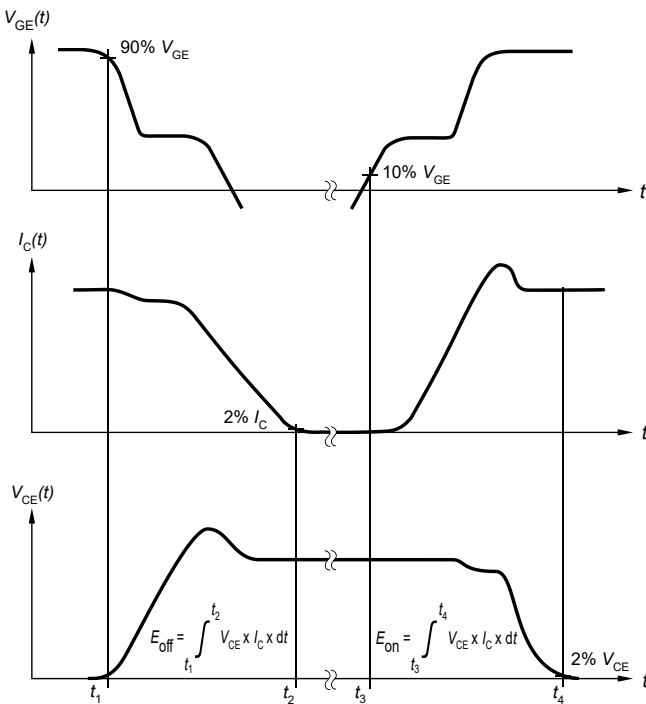


Figure B. Definition of switching losses

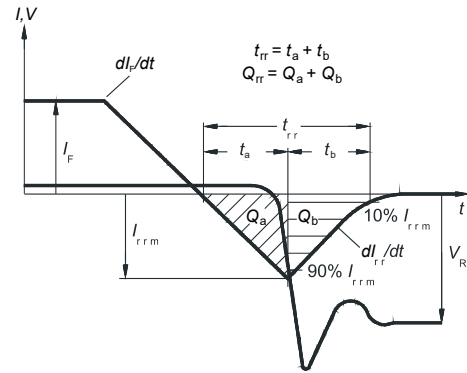


Figure C. Definition of diode switching characteristics

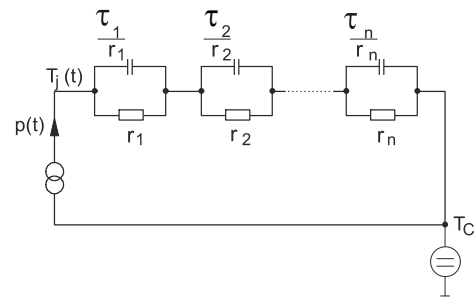


Figure D. Thermal equivalent circuit

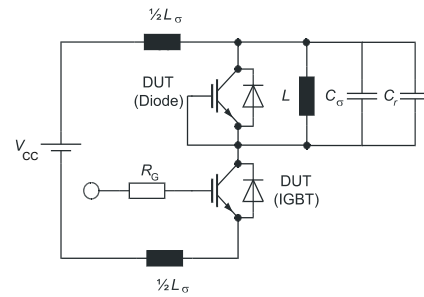


Figure E. Dynamic test circuit  
 Parasitic inductance  $L_{\sigma}$ ,  
 parasitic capacitor  $C_{\sigma}$ ,  
 relief capacitor  $C_r$ ,  
 (only for ZVT switching)

Figure 7

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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 $V_{CE}$ )