

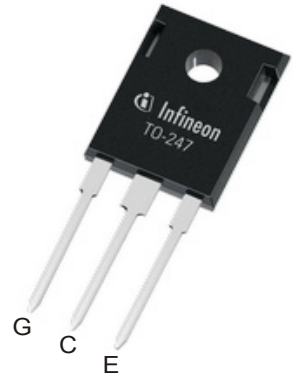
## High speed DuoPack: IGBT in Trench and Fieldstop technology with soft, fast recovery antiparallel diode

### Features

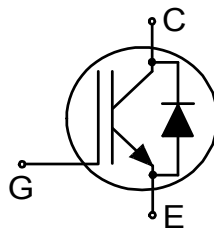
- $V_{CE} = 1200\text{ V}$
- $I_C = 40\text{ A}$
- Very low  $V_{CE,sat}$
- Low EMI
- Very soft, fast recovery antiparallel diode
- Maximum junction temperature  $T_{vjmax} = 175^\circ\text{C}$
- Qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>

### Potential applications

- Uninterruptible power supplies
- Welding converters
- Converters with high switching frequency



### Description



Type	Package	Marking
IKW40N120H3	PG-TO247-3	K40H1203

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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	$V_{CE}$		1200	V
DC collector current, limited by $T_{vjmax}$	$I_C$	$T_c = 25\text{ °C}$	80	A
		$T_c = 100\text{ °C}$	40	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpuls}$		160	A
Turn-off safe operating area		$V_{CE} \leq 1200\text{ V}$ , $T_{vj} \leq 175\text{ °C}$	160	A
Gate-emitter voltage	$V_{GE}$		$\pm 20$	V
Short circuit withstand time	$t_{SC}$	$V_{CC} \leq 600\text{ V}$ , $V_{GE} = 15\text{ V}$ , Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\text{ s}$ , $T_{vj} = 175\text{ °C}$	10	$\mu\text{s}$
Power dissipation	$P_{tot}$	$T_c = 25\text{ °C}$	483	W
		$T_c = 100\text{ °C}$	220	

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter breakdown voltage	$V_{BRCES}$	$I_C = 0.5\text{ mA}$ , $V_{GE} = 0\text{ V}$	1200			V

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Collector-emitter saturation voltage	$V_{CE\ sat}$	$I_C = 40.0\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$		2.05	2.40	V
			$T_{vj} = 125\ ^\circ C$		2.50		
			$T_{vj} = 175\ ^\circ C$		2.70		
Gate-emitter threshold voltage	$V_{GEth}$	$I_C = 1.00\ mA, V_{CE} = V_{GE}, T_{vj} = 175\ ^\circ C$		5.00	5.80	6.50	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 1200\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$			250	$\mu A$
			$T_{vj} = 175\ ^\circ C$			2500	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\ V, V_{GE} = 20\ V$				600	nA
Transconductance	$g_{fs}$	$I_C = 40.0\ A, V_{CE} = 20\ V$			20.0		S
Short circuit collector current	$I_{SC}$	$V_{CC} \leq 600\ V, V_{GE} = 15\ V, t_{SC} \leq 10\ \mu s$ , Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\ s, T_{vj} = 175\ ^\circ C$			139		A
Input capacitance	$C_{ies}$	$V_{CE} = 25\ V, V_{GE} = 0\ V, f = 1000\ kHz$			2330		pF
Output capacitance	$C_{oes}$	$V_{CE} = 25\ V, V_{GE} = 0\ V, f = 1000\ kHz$			185		pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25\ V, V_{GE} = 0\ V, f = 1000\ kHz$			130		pF
Gate charge	$Q_G$	$I_C = 40.0\ A, V_{GE} = 15\ V, V_{CE} = 960\ V$			185		nC
Turn-on delay time	$t_{don}$	$V_{CE} = 600\ V, V_{GE} = 15\ V, R_{Gon} = 12.0\ \Omega, R_{Goff} = 12.0\ \Omega, L_\sigma = 70\ nH, C_\sigma = 67\ pF$	$T_{vj} = 25\ ^\circ C, I_C = 40.0\ A$		30		ns
			$T_{vj} = 175\ ^\circ C, I_C = 40.0\ A$		29		
Rise time (inductive load)	$t_r$	$V_{CE} = 600\ V, V_{GE} = 15\ V, R_{Gon} = 12.0\ \Omega, R_{Goff} = 12.0\ \Omega, L_\sigma = 70\ nH, C_\sigma = 67\ pF$	$T_{vj} = 25\ ^\circ C, I_C = 40.0\ A$		57		ns
			$T_{vj} = 175\ ^\circ C, I_C = 40.0\ A$		49		
Turn-off delay time	$t_{doff}$	$V_{CE} = 600\ V, V_{GE} = 15\ V, R_{Gon} = 12.0\ \Omega, R_{Goff} = 12.0\ \Omega, L_\sigma = 70\ nH, C_\sigma = 67\ pF$	$T_{vj} = 25\ ^\circ C, I_C = 40.0\ A$		290		ns
			$T_{vj} = 175\ ^\circ C, I_C = 40.0\ A$		366		
Fall time (inductive load)	$t_f$	$V_{CE} = 600\ V, V_{GE} = 15\ V, R_{Gon} = 12.0\ \Omega, R_{Goff} = 12.0\ \Omega, L_\sigma = 70\ nH, C_\sigma = 67\ pF$	$T_{vj} = 25\ ^\circ C, I_C = 40.0\ A$		16		ns
			$T_{vj} = 175\ ^\circ C, I_C = 40.0\ A$		48		
Turn-on energy	$E_{on}$	$V_{CE} = 600\ V, V_{GE} = 15\ V, R_{Gon} = 12.0\ \Omega, R_{Goff} = 12.0\ \Omega, L_\sigma = 70\ nH, C_\sigma = 67\ pF$	$T_{vj} = 25\ ^\circ C, I_C = 40.0\ A$		3.20		mJ
			$T_{vj} = 175\ ^\circ C, I_C = 40.0\ A$		4.40		

**Table 3** Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Turn-off energy	$E_{off}$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V},$ $R_{Gon} = 12.0\ \Omega,$ $R_{Goff} = 12.0\ \Omega,$ $L_{\sigma} = 70\text{ nH}, C_{\sigma} = 67\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 40.0\text{ A}$		1.20		mJ
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 40.0\text{ A}$		2.60		
Total switching energy	$E_{ts}$	$V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V},$ $R_{Gon} = 12.0\ \Omega,$ $R_{Goff} = 12.0\ \Omega,$ $L_{\sigma} = 70\text{ nH}, C_{\sigma} = 67\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 40.0\text{ A}$		4.40		mJ
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 40.0\text{ A}$		7.00		
IGBT thermal resistance, junction-case	$R_{thjc}$				0.31		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	$V_{RRM}$	$T_{vj} \geq 25\text{ }^{\circ}\text{C}$	1200	V	
Diode forward current, limited by $T_{vjmax}$	$I_F$		$T_c = 25\text{ }^{\circ}\text{C}$	40	A
			$T_c = 100\text{ }^{\circ}\text{C}$	20	
Diode pulsed current, limited by $T_{vjmax}$	$I_{Fpuls}$		160	A	

**Table 5** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	$V_F$	$I_F = 20.0\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		1.80	2.35	V
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		1.85		
Diode forward voltage	$V_F$	$I_F = 40.0\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		2.40	3.05	V
			$T_{vj} = 125\text{ }^{\circ}\text{C}$		2.60		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		2.60		
Reverse leakage current	$I_R$	$V_R = 1200\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$			250	$\mu\text{A}$
			$T_{vj} = 175\text{ }^{\circ}\text{C}$			2500	

**Table 5** Characteristic values (continued)

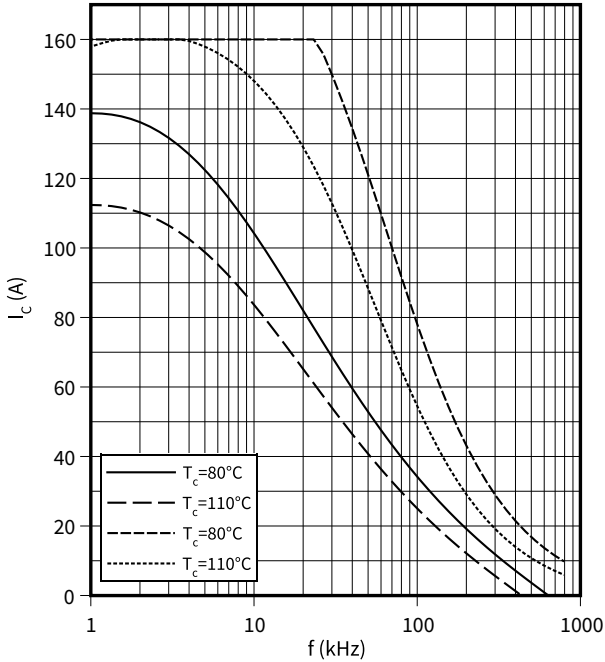
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery time	$t_{rr}$	$V_R = 600\text{ V}$	$T_{vj} = 25\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		355		ns
			$T_{vj} = 175\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		639		
Diode reverse recovery charge	$Q_{rr}$	$V_R = 600\text{ V}$	$T_{vj} = 25\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		1.90		$\mu\text{C}$
			$T_{vj} = 175\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		4.30		
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 600\text{ V}$	$T_{vj} = 25\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		12.8		A
			$T_{vj} = 175\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		16.0		
Diode peak rate off fall of reverse recovery current	$di_{rr}/dt$	$V_R = 600\text{ V}$	$T_{vj} = 25\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		-105		$\text{A}/\mu\text{s}$
			$T_{vj} = 175\text{ °C}$ , $I_F = 40.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		-84		
Diode thermal resistance, junction-case	$R_{thjc}$				1.11		K/W
Operating junction temperature	$T_{vj}$			-40		175	$^{\circ}\text{C}$

## 4 Characteristics diagrams

### Collector current as a function of switching frequency, IGBT

$$I_C = f(f)$$

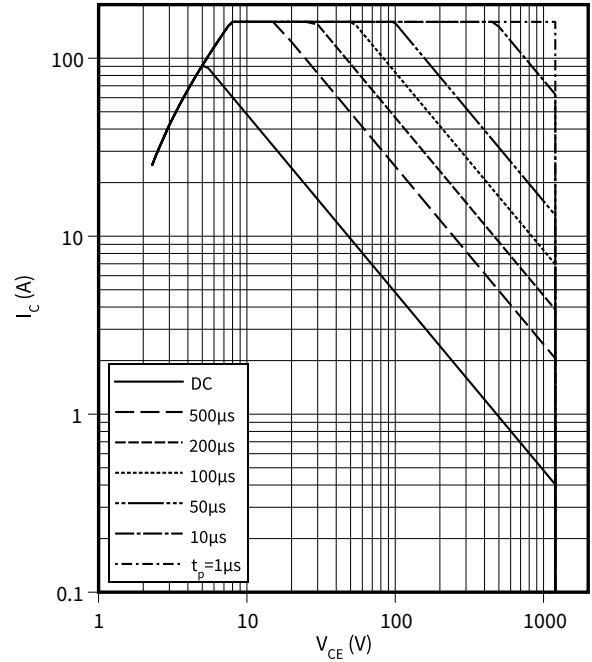
$D = 0.5, V_{CE} = 600 \text{ V}, T_{vj} \leq 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$



### Forward bias safe operating area, IGBT

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

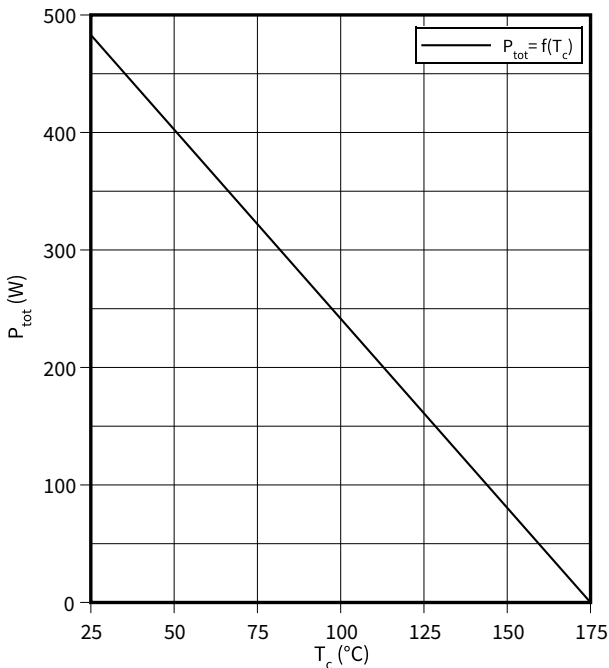
$D = 0, T_{vj} \leq 175 \text{ }^\circ\text{C}, V_{GE} = 15 \text{ V}, T_c = 25 \text{ }^\circ\text{C}$



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

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

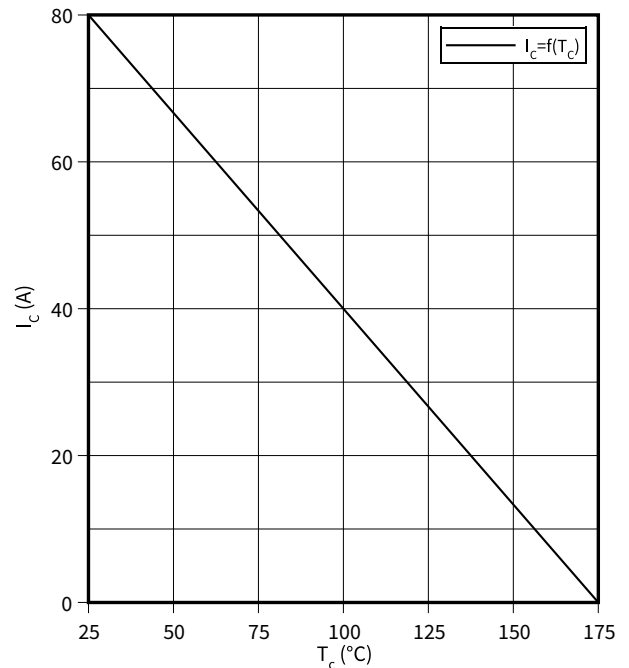
$T_{vj} \leq 175 \text{ }^\circ\text{C}$



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

$$I_C = f(T_c)$$

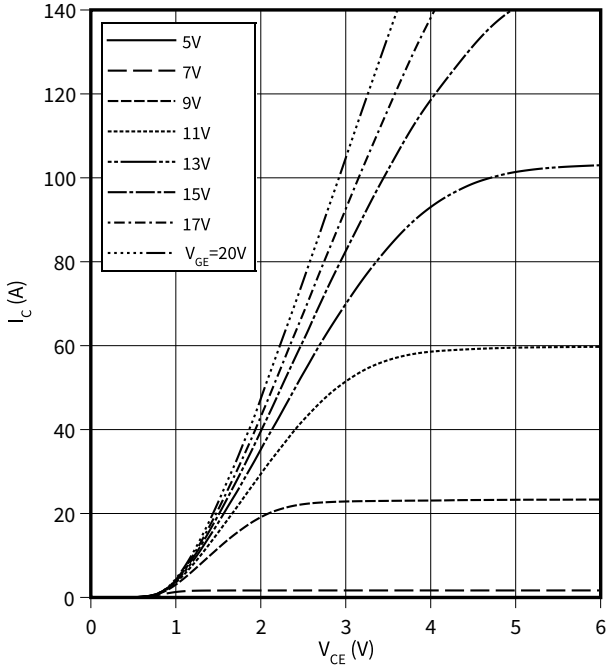
$T_{vj} \leq 175 \text{ }^\circ\text{C}, V_{GE} \geq 15 \text{ V}$



4 Characteristics diagrams

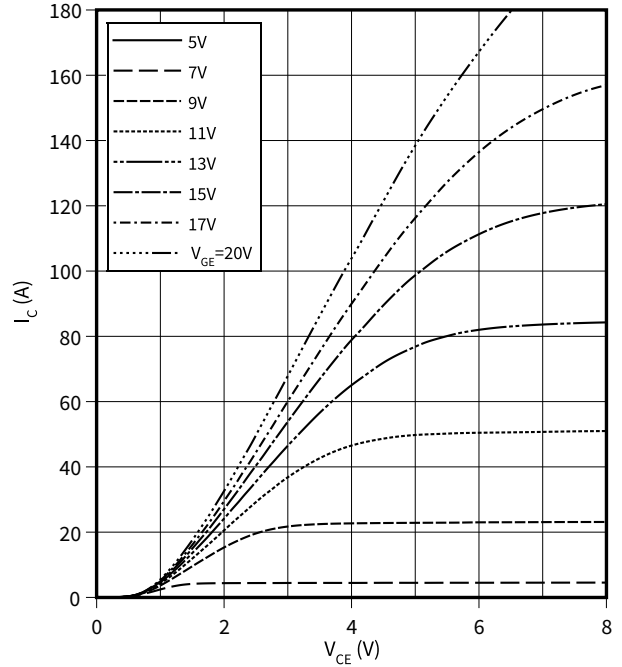
**Typical output characteristic, IGBT**

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



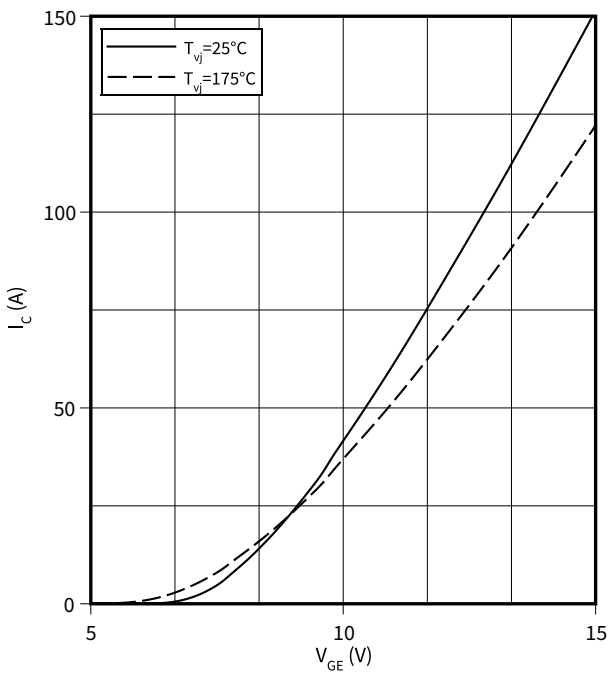
**Typical output characteristic, IGBT**

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



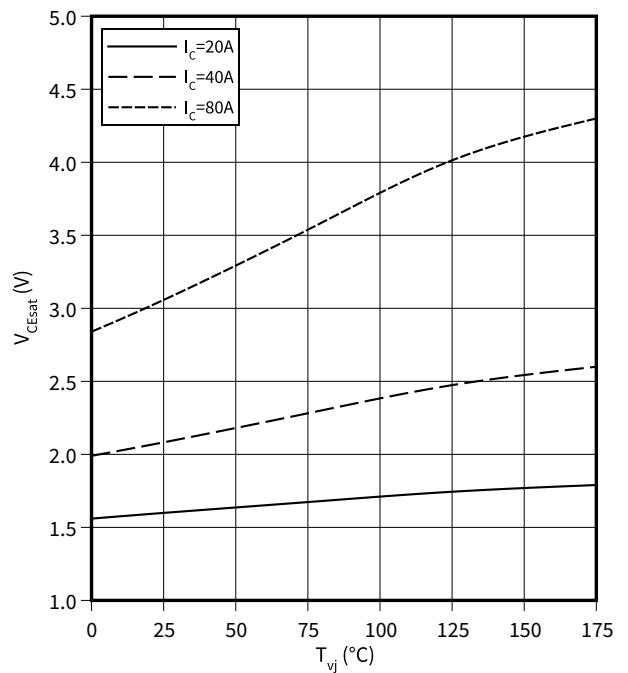
**Typical transfer characteristic, IGBT**

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



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

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

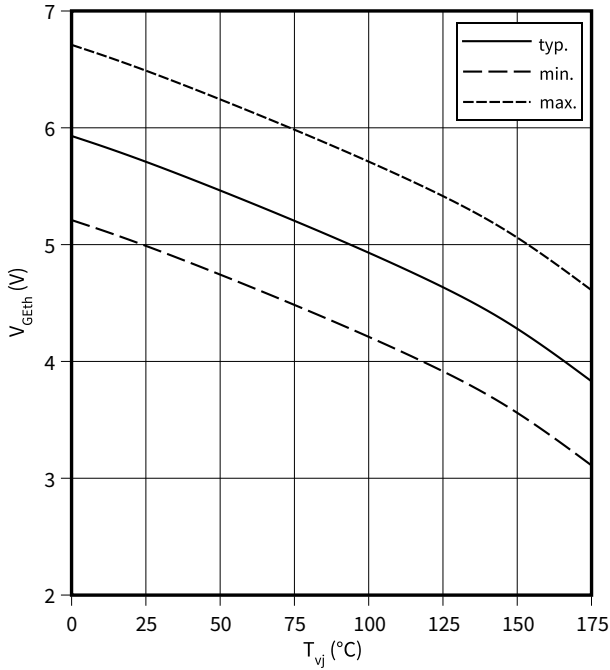




4 Characteristics diagrams

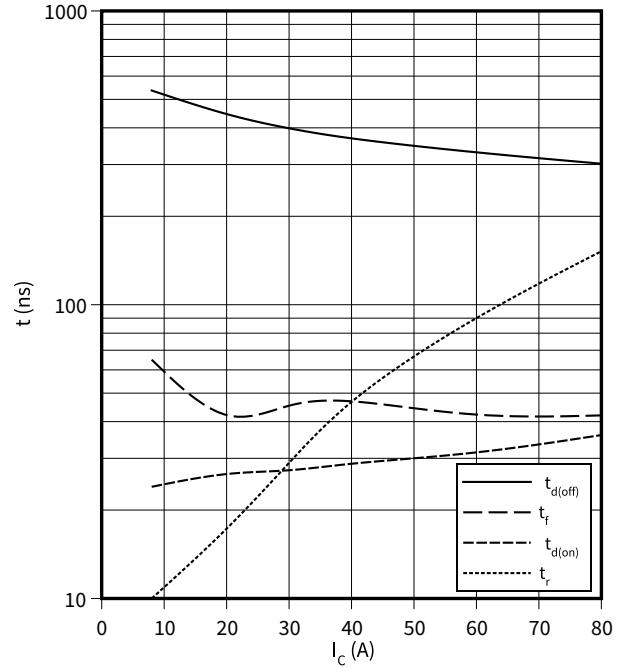
**Gate-emitter threshold voltage as a function of junction temperature, IGBT**

$V_{GEth} = f(T_{vj})$   
 $I_C = 1.00 \text{ mA}$



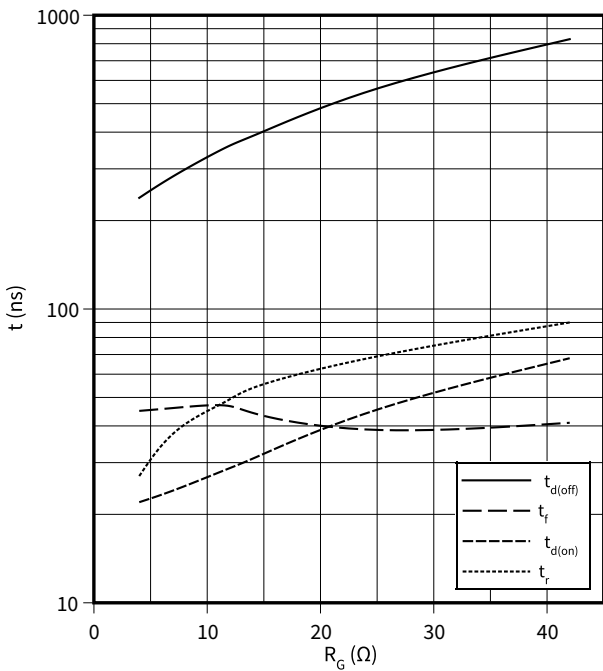
**Typical switching times as a function of collector current, IGBT**

$t = f(I_C)$   
 $V_{CE} = 600 \text{ V}, T_{vj} = 175 \text{ °C}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$



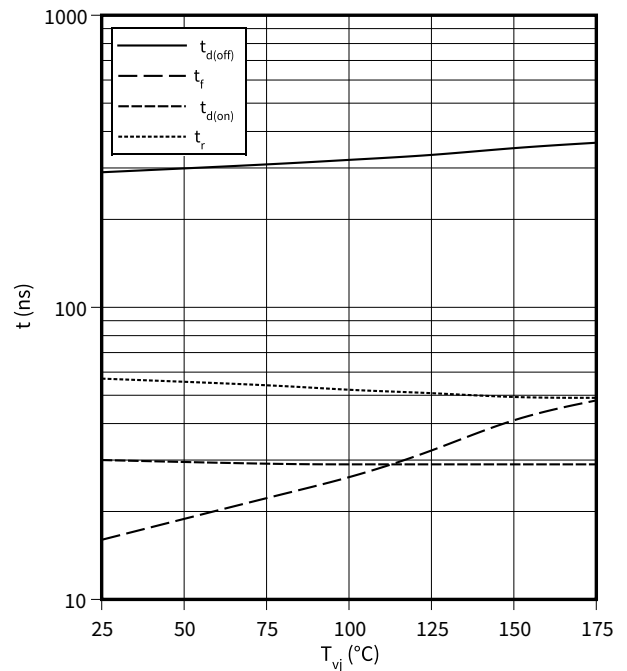
**Typical switching times as a function of gate resistance, IGBT**

$t = f(R_G)$   
 $I_C = 40.0 \text{ A}, V_{CE} = 600 \text{ V}, T_{vj} = 175 \text{ °C}, V_{GE} = 0/15 \text{ V}$



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

$t = f(T_{vj})$   
 $I_C = 40.0 \text{ A}, V_{CE} = 600 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$

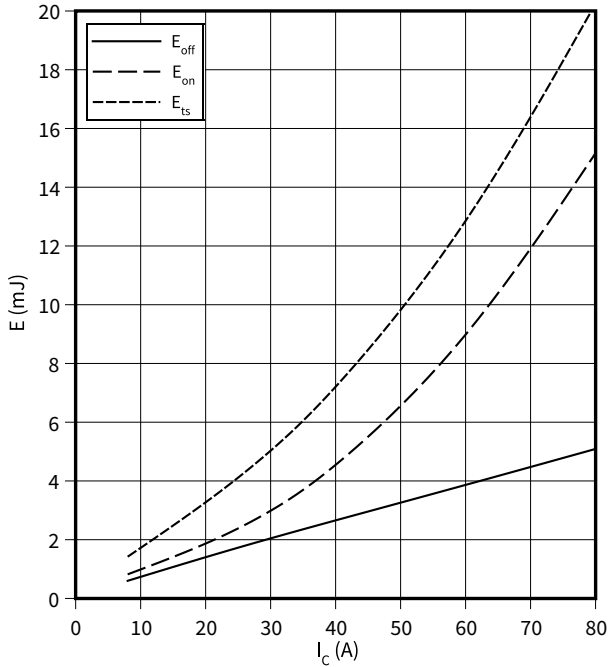


4 Characteristics diagrams

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

$E = f(I_C)$

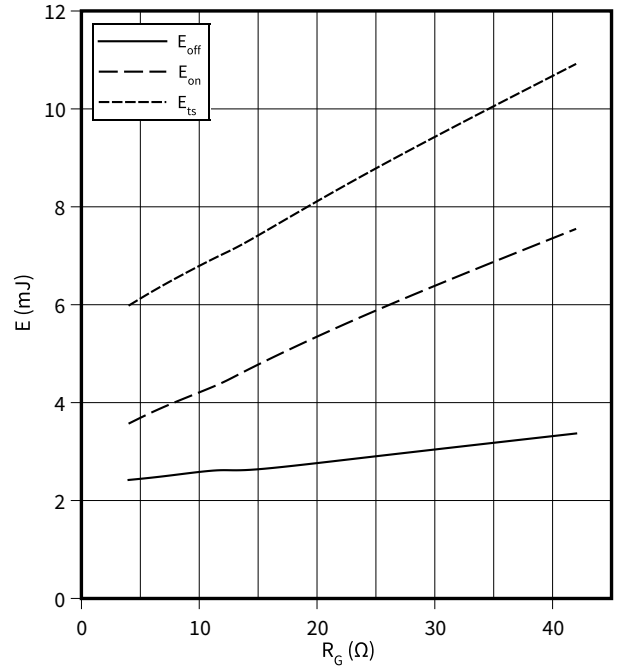
$V_{CE} = 600\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 12\text{ }\Omega$



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

$E = f(R_G)$

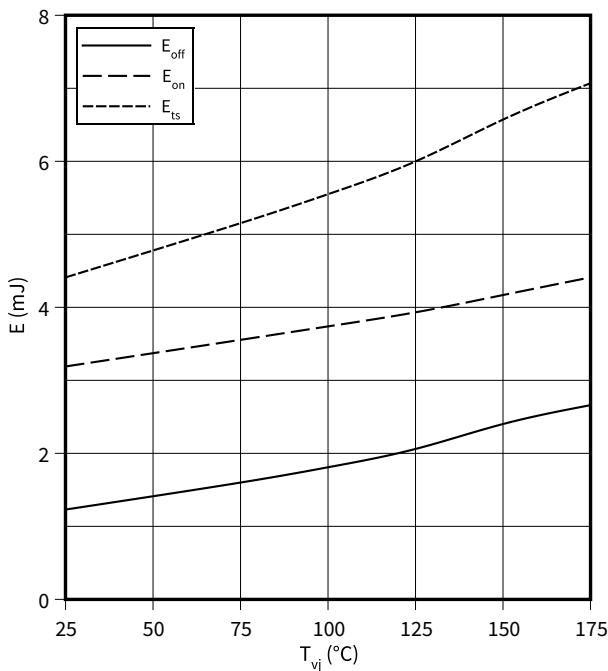
$I_C = 40.0\text{ A}, V_{CE} = 600\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}$



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

$E = f(T_{vj})$

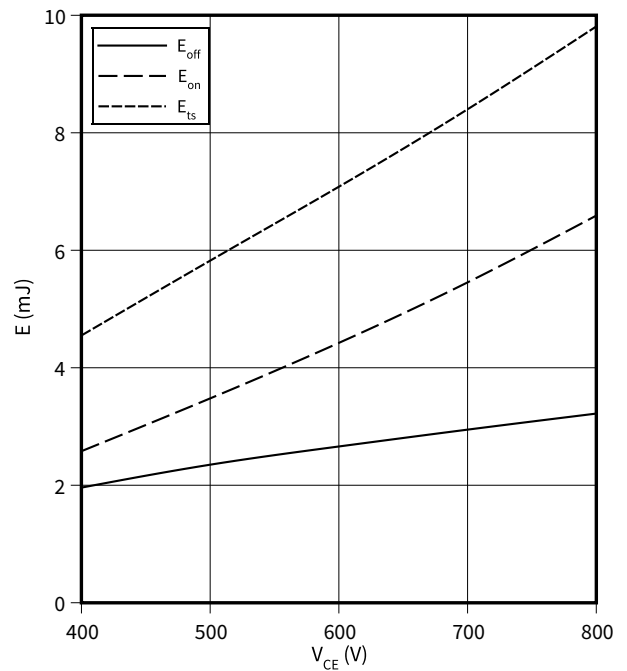
$I_C = 40.0\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 12\text{ }\Omega$



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

$E = f(V_{CE})$

$I_C = 40.0\text{ A}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 12\text{ }\Omega$

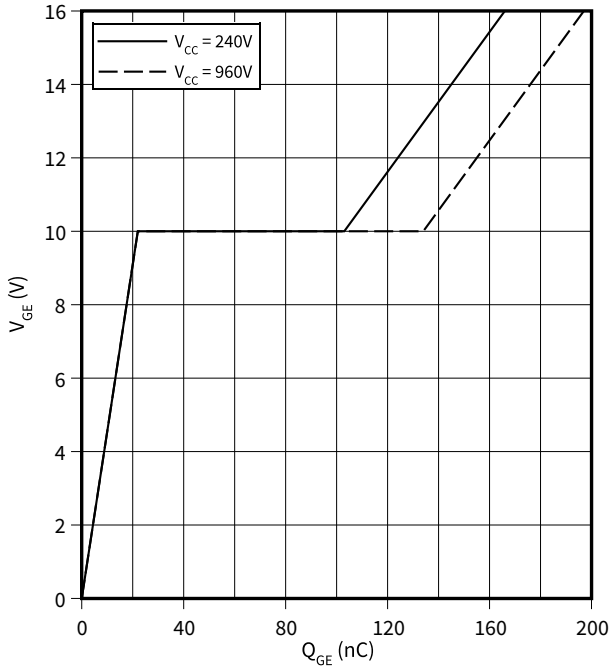


**4 Characteristics diagrams**

**Typical gate charge, IGBT**

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

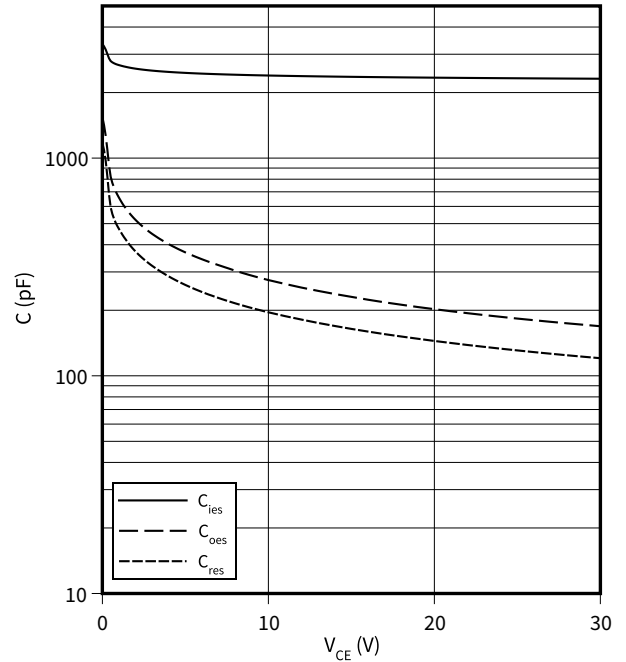
$I_C = 40.0 \text{ A}$



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

$C = f(V_{CE})$

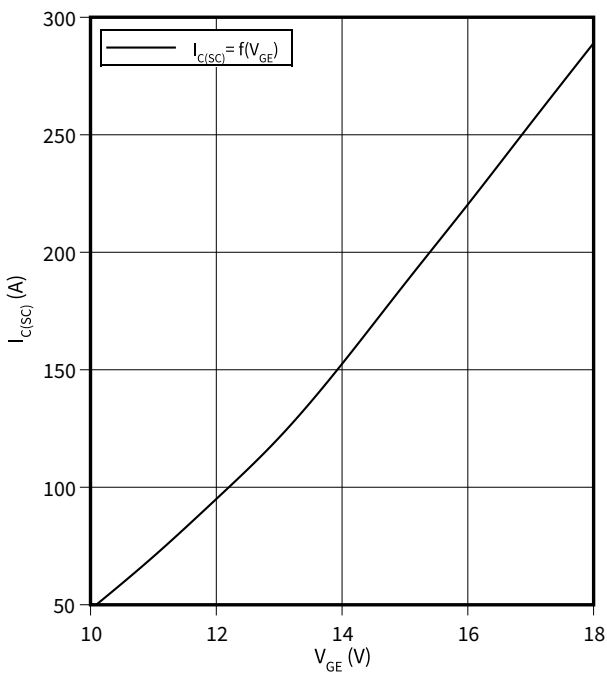
$f = 1000 \text{ kHz}, V_{GE} = 0 \text{ V}$



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

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

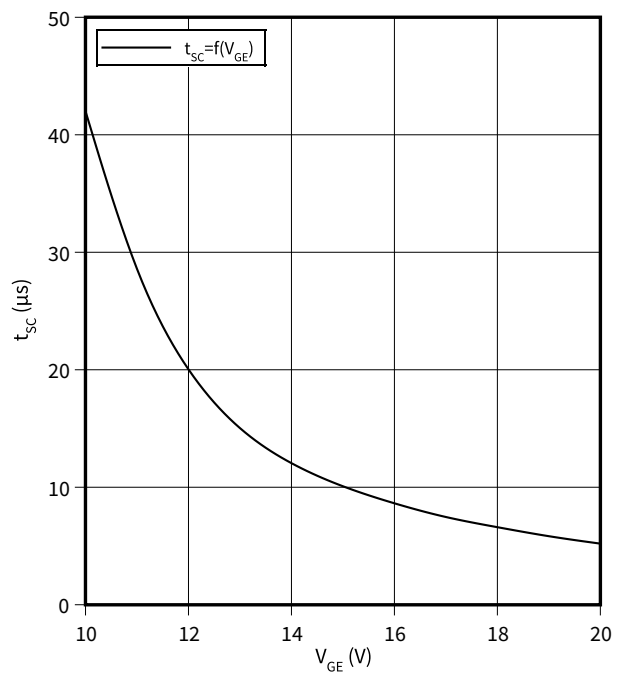
$V_{CE} \leq 600 \text{ V}, T_{vj, start} = 25 \text{ }^\circ\text{C}$



**Short circuit withstand time as a function of gate-emitter voltage, IGBT**

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

$T_{vj} \leq 175 \text{ }^\circ\text{C}, V_{CC} \leq 600 \text{ V}$

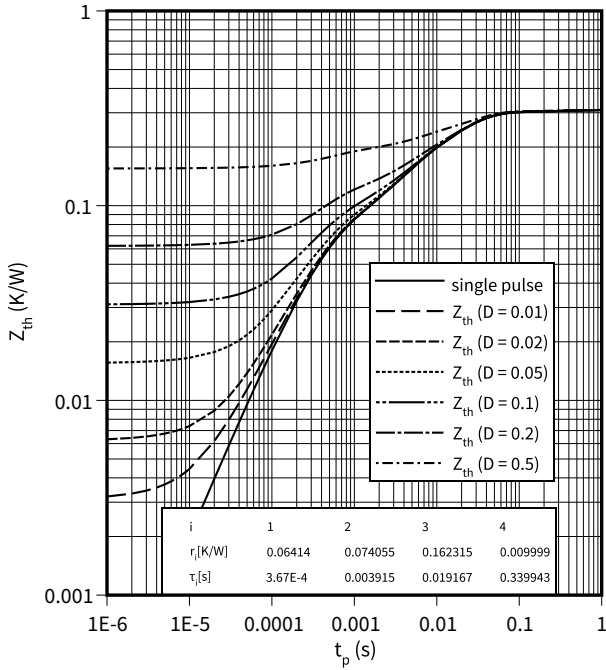


**4 Characteristics diagrams**

**IGBT transient thermal impedance, IGBT**

$Z_{th} = f(t_p)$

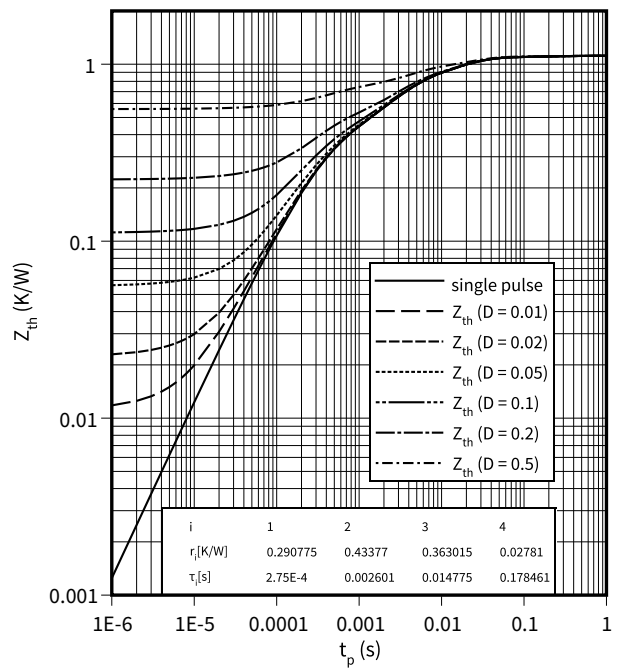
$D = t_p/T$



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

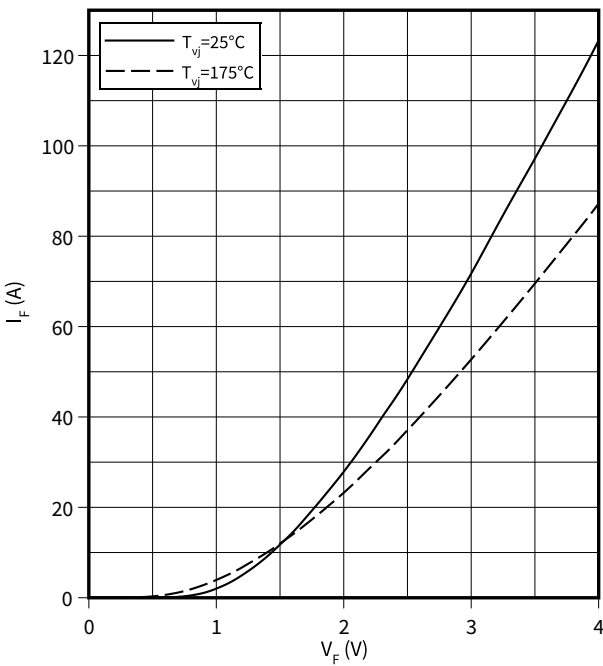
$Z_{th} = f(t_p)$

$D = t_p/T$



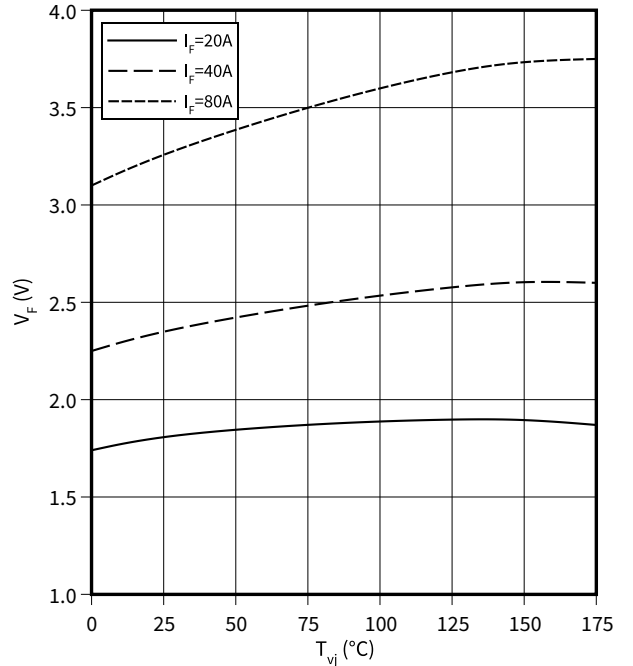
**Typical diode forward current as a function of forward voltage, Diode**

$I_F = f(V_F)$



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

$V_F = f(T_{vj})$

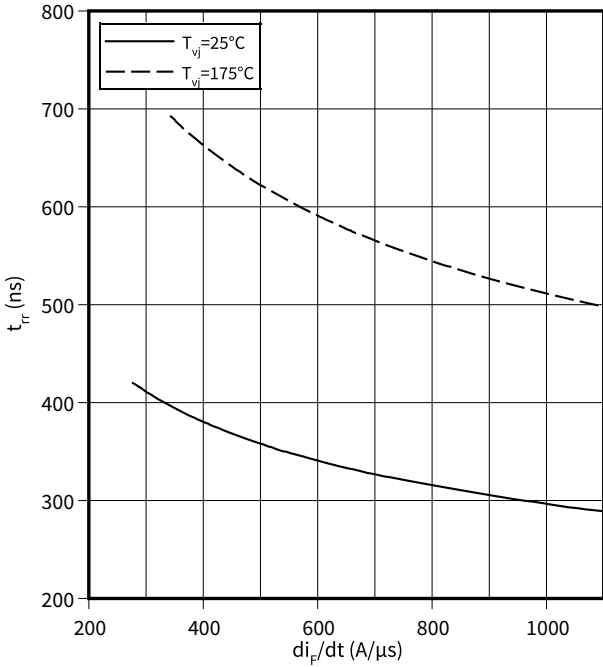


4 Characteristics diagrams

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

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

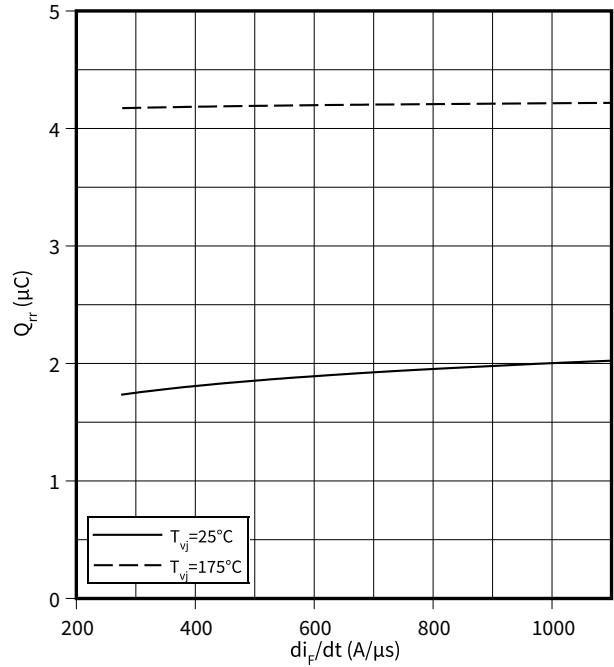
$V_R = 600\text{ V}, I_F = 40\text{ A}$



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

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

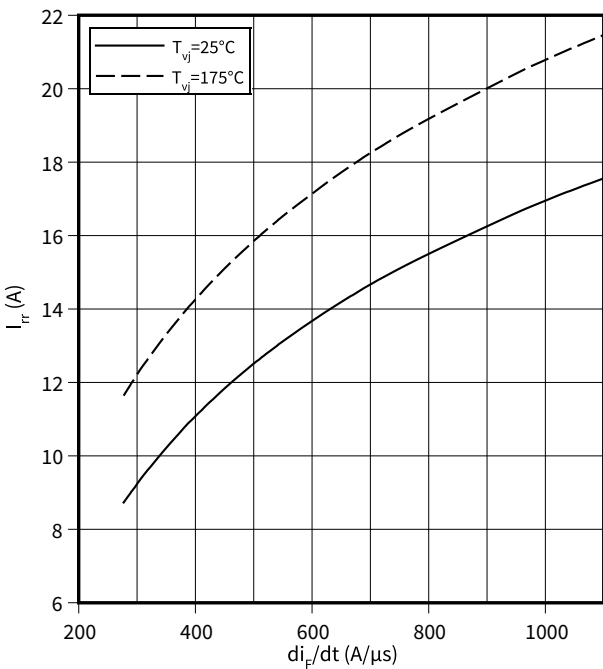
$V_R = 600\text{ V}, I_F = 40\text{ A}$



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

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

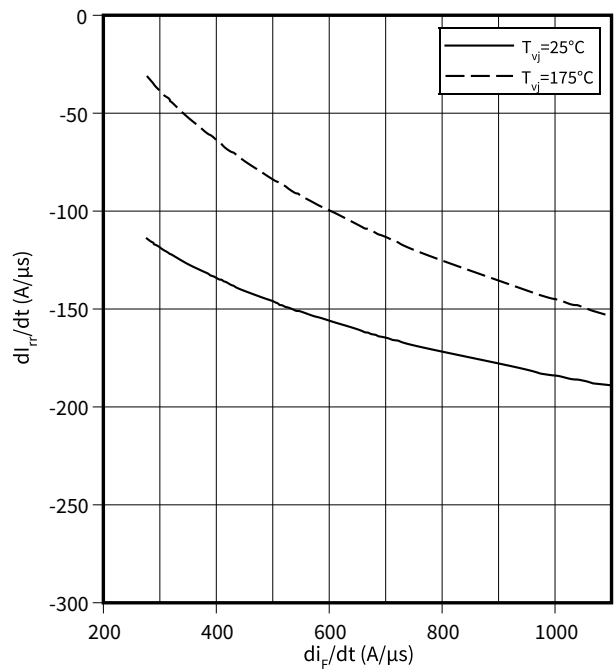
$V_R = 600\text{ V}, I_F = 40\text{ A}$



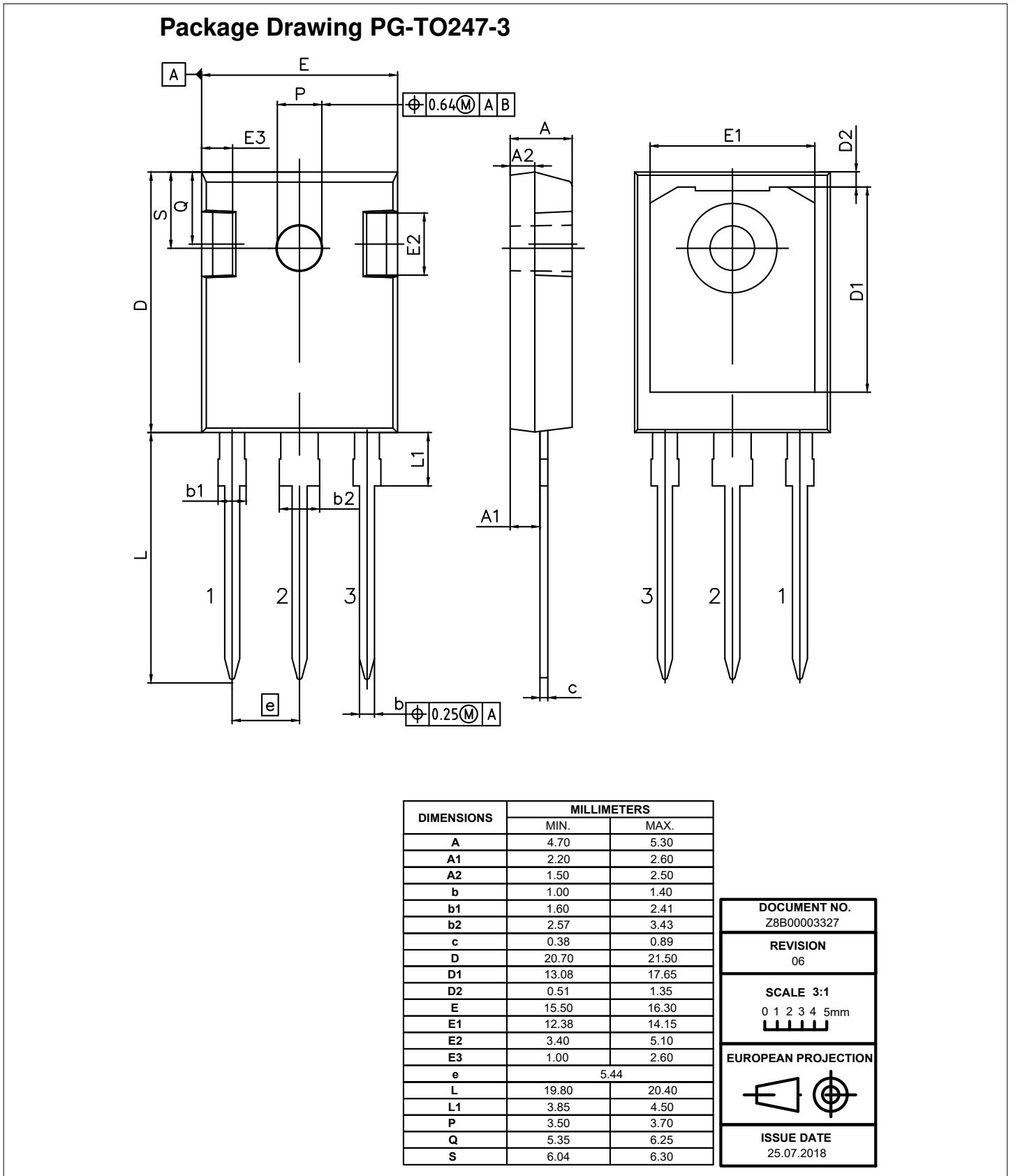
**Typical diode peak rate of fall of reverse recovery current as a function of diode current slope, Diode**

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

$V_R = 600\text{ V}, I_F = 40\text{ A}$



**5 Package outlines**



**Figure 6**

## 6 Testing conditions

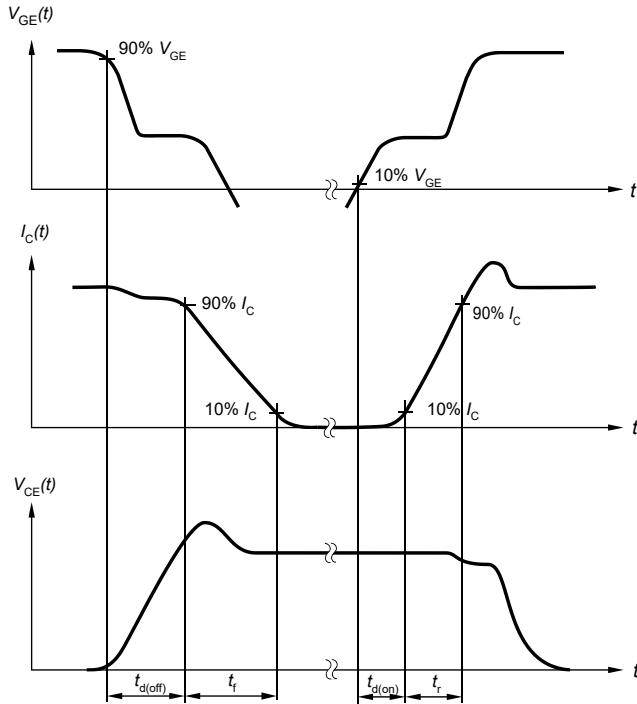


Figure A. Definition of switching times

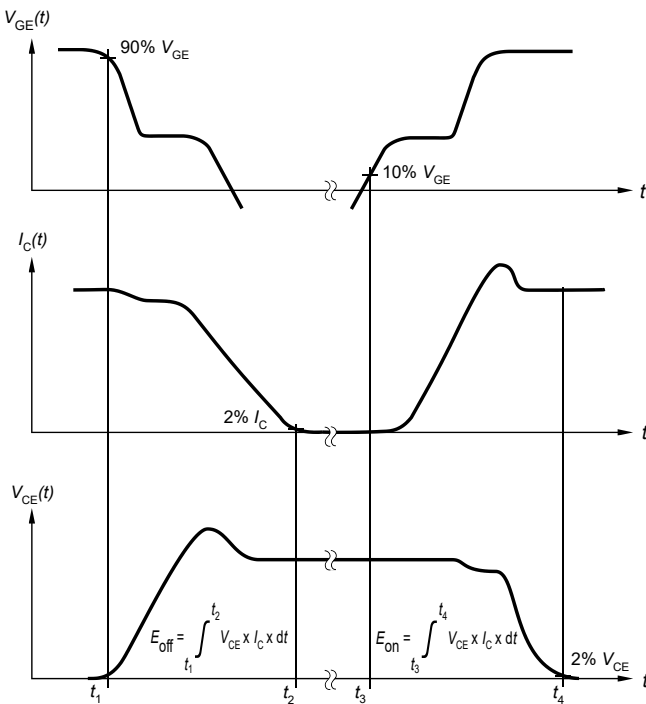


Figure B. Definition of switching losses

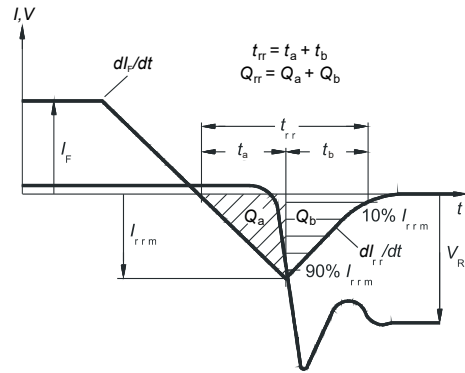


Figure C. Definition of diode switching characteristics

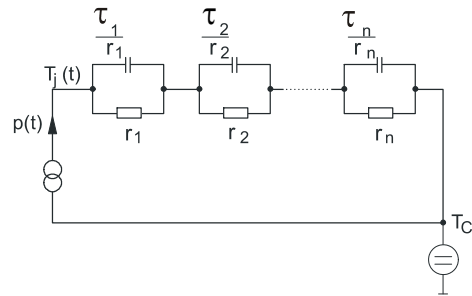


Figure D. Thermal equivalent circuit

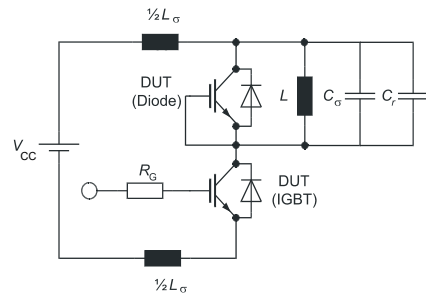


Figure E. **Dynamic test circuit**  
 Parasitic inductance  $L_{\sigma}$ ,  
 parasitic capacitor  $C_{\sigma}$ ,  
 relief capacitor  $C_r$ ,  
 (only for ZVT switching)

Figure 7

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**Revision history****Revision history**

<b>Document revision</b>	<b>Date of release</b>	<b>Description of changes</b>
V1.1	2009-12-03	
V1.2	2010-02-10	
V2.1	2014-11-26	Final data sheet
V2.2		Minor change figure 28
1.10	2021-09-08	Update of legend at the diagram $V_F = f(T_{vj})$



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**Document reference**

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