

## EDT2 IGBT and emitter controlled diode in TO247PLUS package

### Features

- $V_{CE} = 750\text{ V}$
- $I_C = 120\text{ A}$
- 750 V collector-emitter blocking voltage capability
- Suitable for 470 V  $V_{DC}$  systems and increase overvoltage margin for 400 V  $V_{DC}$  systems
- Very low  $V_{CE(sat)}$ , 1.30 V at  $I_{Cnom} = 120\text{ A}$ ,  $25^\circ\text{C}$
- Short circuit robust  $t_{sc} = 5\text{ }\mu\text{s}$  at  $V_{CE} = 470\text{ V}$ ,  $V_{GE} = 15\text{ V}$
- Self limiting current under short circuit condition
- Positive thermal coefficient and very tight parameter distribution for easy paralleling
- Drop-in replacement for previous generation devices  $I_C = 120\text{ A}$ ,  $T_C = 100^\circ\text{C}$
- Excellent current sharing in parallel operation
- Smooth switching characteristics, low EMI signature
- Low gate charge  $Q_G$
- Simple gate drive design
- Co-packed with fast soft recovery emitter controlled 3 diode
- TO247PLUS package with high creepage distance
- High reliability

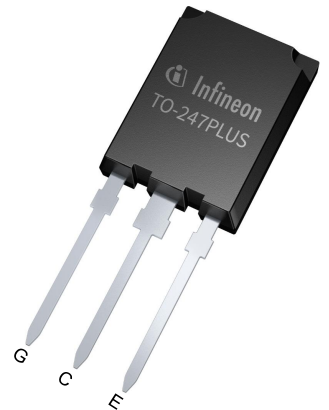
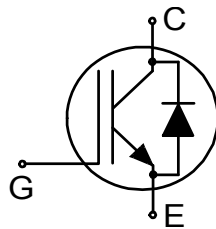
### Potential applications

- xEV traction inverter
- DC-link discharge switch
- Automotive aux-drives

### Product validation

- Qualified for automotive applications
- Qualified according to AEC-Q101

### Description



Type	Package	Marking
AIKQ120N75CP2	PG-TO247PLUS-3	AKQ12FCP

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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
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	$V_{CE}$		750	V
DC collector current, limited by $T_{vjmax}$	$I_C$	$T_c = 25\text{ °C}$	150	A
		$T_c = 100\text{ °C}$	120	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpulse}$		360	A
Turn-off safe operating area		$V_{CE} \leq 750\text{ V}$ , $t_p = 1\text{ }\mu\text{s}$ , $T_{vj} \leq 175\text{ °C}$	360	A
Gate-emitter voltage	$V_{GE}$		$\pm 20$	V
Transient gate-emitter voltage	$V_{GE}$	$t_p < 0.1\text{ }\mu\text{s}$ , $D < 0.01$	$\pm 30$	V
Short-circuit withstand time	$t_{SC}$	$V_{CC} \leq 470\text{ V}$ , $V_{GE} = 15\text{ V}$ , Allowed number of short circuits $< 1000$ , Time between short circuits $\geq 1.0\text{ s}$ , $T_{vj} = 25\text{ °C}$	5	$\mu\text{s}$
Power dissipation	$P_{tot}$	$T_c = 25\text{ °C}$	682	W
		$T_c = 100\text{ °C}$	341	

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Collector-emitter saturation voltage	$V_{CEsat}$	$I_C = 120\text{ A}$ , $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.3	1.5	V
			$T_{vj} = 175\text{ °C}$		1.53		
Gate-emitter threshold voltage	$V_{GEth}$	$I_C = 1.6\text{ mA}$ , $V_{CE} = V_{GE}$ , $T_{vj} = 25\text{ °C}$	5	5.8	6.5	V	

**(table continues...)**

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 750 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$			200	$\mu\text{A}$
			$T_{vj} = 175 \text{ }^\circ\text{C}$		4000		
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}, V_{GE} = 20 \text{ V}$				100	nA
Transconductance	$g_{fs}$	$I_C = 120 \text{ A}, V_{CE} = 20 \text{ V}$		90			S
Short-circuit collector current	$I_{SC}$	$V_{CC} \leq 470 \text{ V}, V_{GE} = 15 \text{ V}, t_{SC} \leq 5 \mu\text{s}$ , Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0 \text{ s}$ , $T_{vj} = 25 \text{ }^\circ\text{C}$		750			A
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$		13125			pF
Output capacitance	$C_{oes}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$		337			pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$		59			pF
Gate charge	$Q_G$	$I_C = 120 \text{ A}, V_{GE} = 15 \text{ V}, V_{CC} = 600 \text{ V}, V_{CE} = 600 \text{ V}$		731			nC
Turn-on delay time	$t_{don}$	$V_{CE} = 470 \text{ V}, V_{GE} = -8/15 \text{ V}, R_{Gon} = 5 \Omega, R_{Goff} = 5 \Omega, L_\sigma = 50 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		71		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		50		
Rise time (inductive load)	$t_r$	$V_{CE} = 470 \text{ V}, V_{GE} = -8/15 \text{ V}, R_{Gon} = 5 \Omega, R_{Goff} = 5 \Omega, L_\sigma = 50 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		69		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		68		
Turn-off delay time	$t_{doff}$	$V_{CE} = 470 \text{ V}, V_{GE} = -8/15 \text{ V}, R_{Gon} = 5 \Omega, R_{Goff} = 5 \Omega, L_\sigma = 50 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		244		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		226		
Fall time (inductive load)	$t_f$	$V_{CE} = 470 \text{ V}, V_{GE} = -8/15 \text{ V}, R_{Gon} = 5 \Omega, R_{Goff} = 5 \Omega, L_\sigma = 50 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		50.5		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		67		
Turn-on energy <sup>1)</sup>	$E_{on}$	$V_{CE} = 470 \text{ V}, V_{GE} = -8/15 \text{ V}, R_{Gon} = 5 \Omega, R_{Goff} = 5 \Omega, L_\sigma = 50 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		6.82		mJ
			$T_{vj} = 175 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		7.3		
Turn-off energy	$E_{off}$	$V_{CE} = 470 \text{ V}, V_{GE} = -8/15 \text{ V}, R_{Gon} = 5 \Omega, R_{Goff} = 5 \Omega, L_\sigma = 50 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		3.8		mJ
			$T_{vj} = 175 \text{ }^\circ\text{C}, I_C = 120 \text{ A}$		4.7		

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	$E_{ts}$	$V_{CE} = 470\text{ V}, V_{GE} = -8/15\text{ V},$ $R_{Gon} = 5\ \Omega, R_{Goff} = 5\ \Omega,$ $L_{\sigma} = 50\text{ nH}, C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 120\text{ A}$		10.3		mJ
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 120\text{ A}$		12.1		
IGBT thermal resistance, junction to case <sup>2)</sup>	$R_{thjc}$			0.17	0.22	K/W	
Operating junction temperature	$T_{vj}$		-40		175	$^{\circ}\text{C}$	

1) Includes reverse recovery losses

2) Not subject to production test - specified by simulation.

### 3 Diode

**Table 4 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
Diode forward current, limited by $T_{vjmax}$	$I_F$		$T_c = 25\text{ }^{\circ}\text{C}$	150	A
			$T_c = 100\text{ }^{\circ}\text{C}$	120	
Diode pulsed current, limited by $T_{vjmax}$	$I_{Fpulse}$		360	A	
Power dissipation	$P_{tot}$		$T_c = 25\text{ }^{\circ}\text{C}$	375	W
			$T_c = 100\text{ }^{\circ}\text{C}$	170	

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	$V_F$	$I_F = 120\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		1.7	1.95	V
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		1.74		
Diode reverse recovery charge	$Q_{rr}$	$V_R < 470\text{ V}, R_{Gon} = 4.8\ \Omega$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_F = 120\text{ A},$ $-di_F/dt = 1070\text{ A}/\mu\text{s}$		3.6		$\mu\text{C}$
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_F = 120\text{ A},$ $-di_F/dt = 1055\text{ A}/\mu\text{s}$		5.3		

(table continues...)

**Table 5 (continued) Characteristic values**

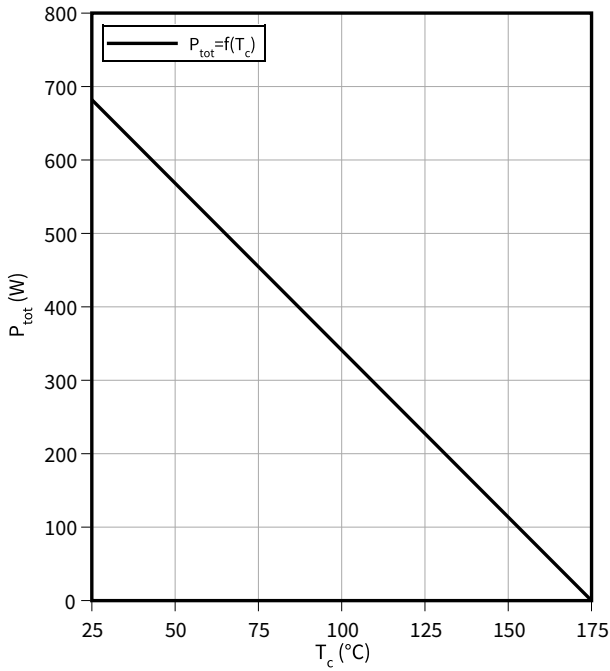
Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode peak reverse recovery current	$I_{rrm}$	$V_R < 470 \text{ V}$ , $R_{Gon} = 4.8 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$ , $I_F = 120 \text{ A}$ , $-di_F/dt = 1070 \text{ A}/\mu\text{s}$		33		A
			$T_{vj} = 175 \text{ }^\circ\text{C}$ , $I_F = 120 \text{ A}$ , $-di_F/dt = 1055 \text{ A}/\mu\text{s}$		43		
Reverse recovery energy	$E_{rec}$	$V_R < 470 \text{ V}$ , $V_{GE} = -8/15 \text{ V}$ , $R_{Gon} = 4.8 \Omega$ , $L_\sigma = 50 \text{ nH}$ , $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$ , $I_F = 120 \text{ A}$ , $-di_F/dt = 1070 \text{ A}/\mu\text{s}$		1.2		mJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$ , $I_F = 120 \text{ A}$ , $-di_F/dt = 1055 \text{ A}/\mu\text{s}$		1.6		
Diode thermal resistance, junction to case <sup>1)</sup>	$R_{thjc}$			0.31	0.4	K/W	
Operating junction temperature	$T_{vj}$		-40		175	$^\circ\text{C}$	

<sup>1)</sup> Note subject to test

## 4 Characteristics diagrams

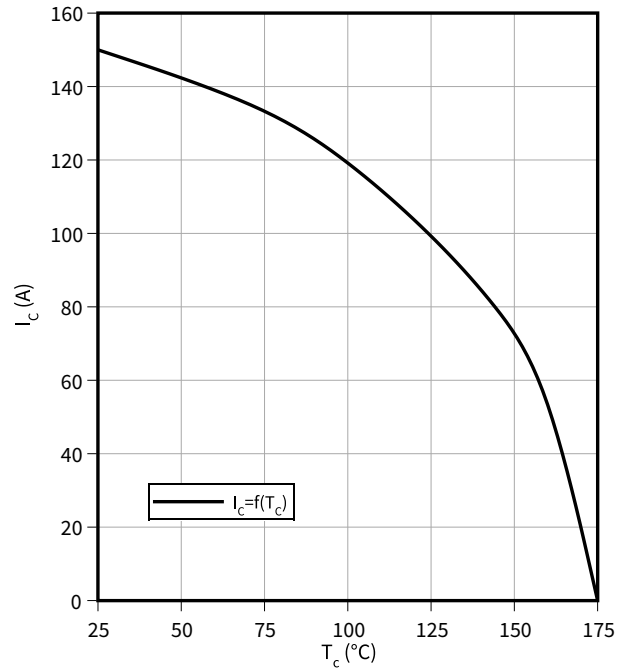
### Power dissipation as a function of case temperature, IGBT

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



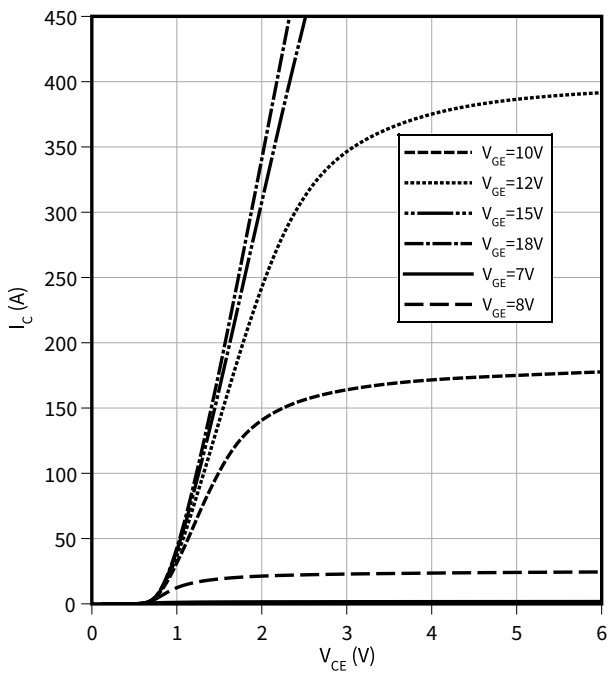
### Collector current as a function of case temperature, IGBT

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



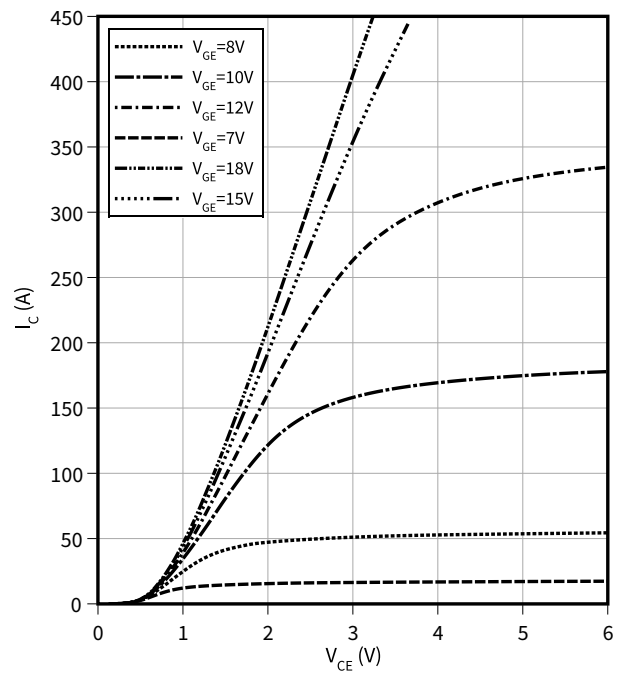
### Typical output characteristic, IGBT

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



### Typical output characteristic, IGBT

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

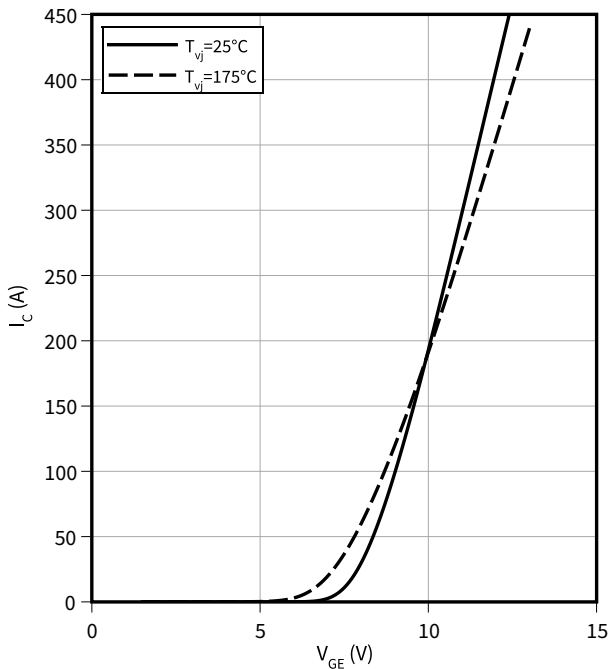


4 Characteristics diagrams

**Typical transfer characteristic, IGBT**

$I_C = f(V_{GE})$

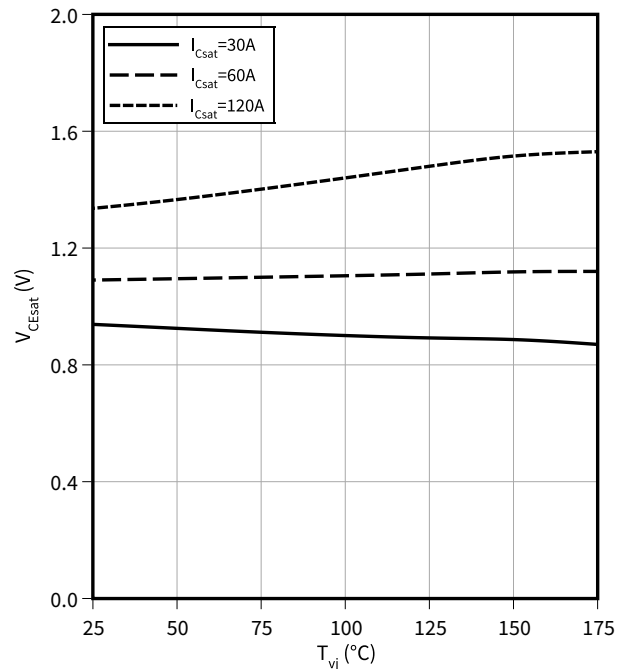
$V_{CE} = 20\text{ V}$



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

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

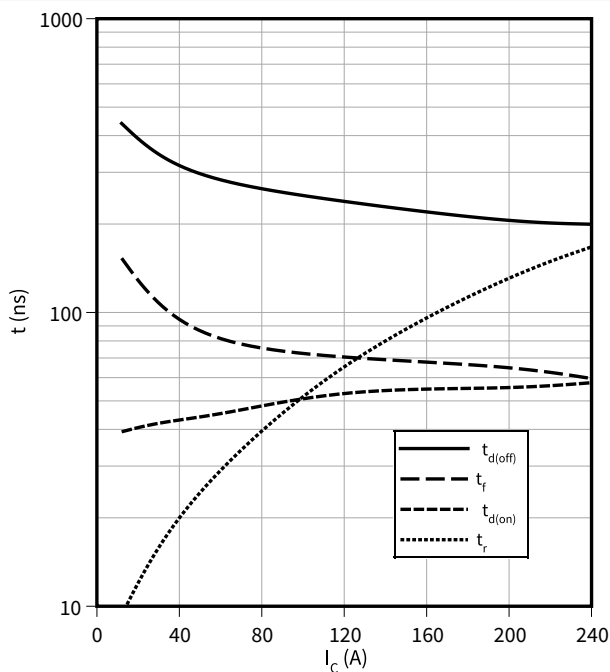
$V_{GE} = 15\text{ V}$



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

$t = f(I_C)$

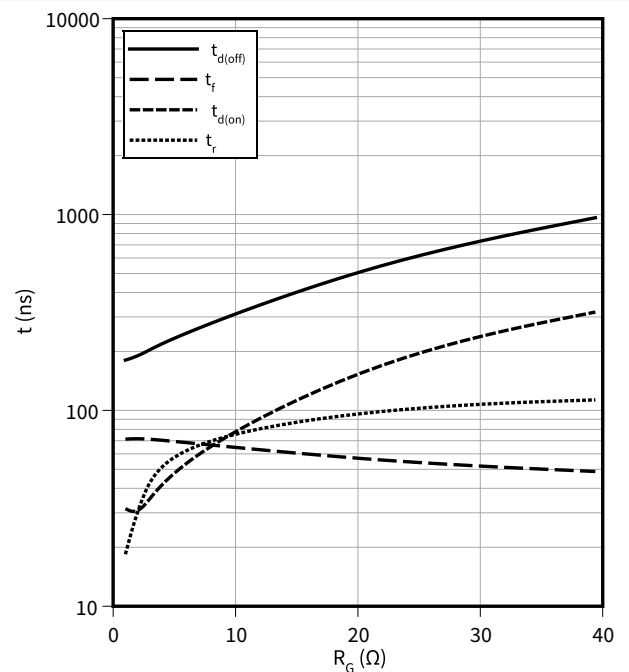
$R_{Goff} = 5.0\ \Omega$ ,  $V_{CE} = 470\text{ V}$ ,  $T_{vj} = 175^\circ\text{C}$ ,  $V_{GE} = -8/15\text{ V}$ ,  $R_{Gon} = 5\ \Omega$



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

$t = f(R_G)$

$I_C = 120.0\text{ A}$ ,  $V_{CE} = 470\text{ V}$ ,  $T_{vj} = 175^\circ\text{C}$ ,  $V_{GE} = -8/15\text{ V}$



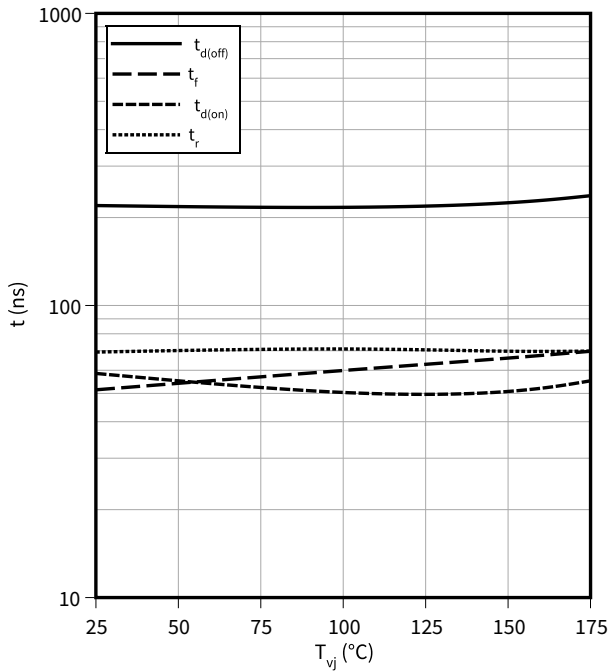


4 Characteristics diagrams

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

$t = f(T_{vj})$

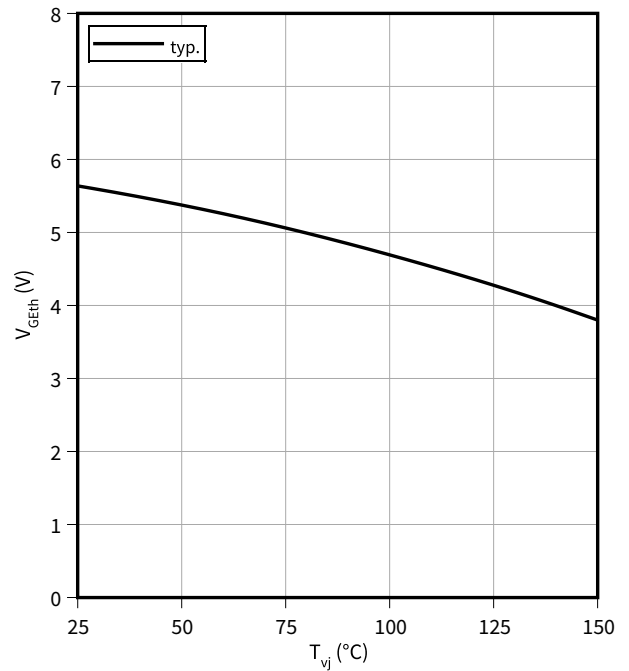
$I_C = 120.0 \text{ A}$ ,  $R_{Goff} = 5.0 \ \Omega$ ,  $V_{CE} = 470 \text{ V}$ ,  $V_{GE} = -8/15 \text{ V}$ ,  $R_{Gon} = 5 \ \Omega$



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

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

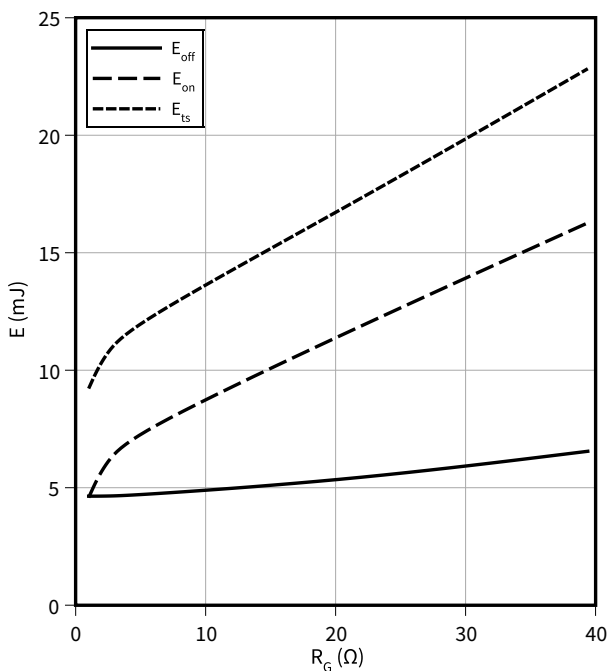
$I_C = 1.60 \text{ mA}$



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

$E = f(R_G)$

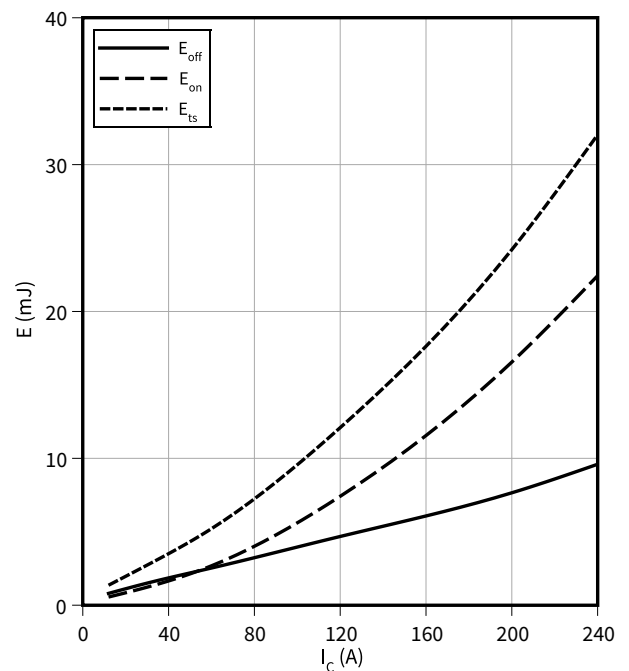
$I_C = 120.0 \text{ A}$ ,  $V_{CE} = 470 \text{ V}$ ,  $T_{vj} = 175 \text{ °C}$ ,  $V_{GE} = -8/15 \text{ V}$



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

$E = f(I_C)$

$R_{Goff} = 5.0 \ \Omega$ ,  $V_{CE} = 470 \text{ V}$ ,  $T_{vj} = 175 \text{ °C}$ ,  $V_{GE} = -8/15 \text{ V}$ ,  $R_{Gon} = 5 \ \Omega$

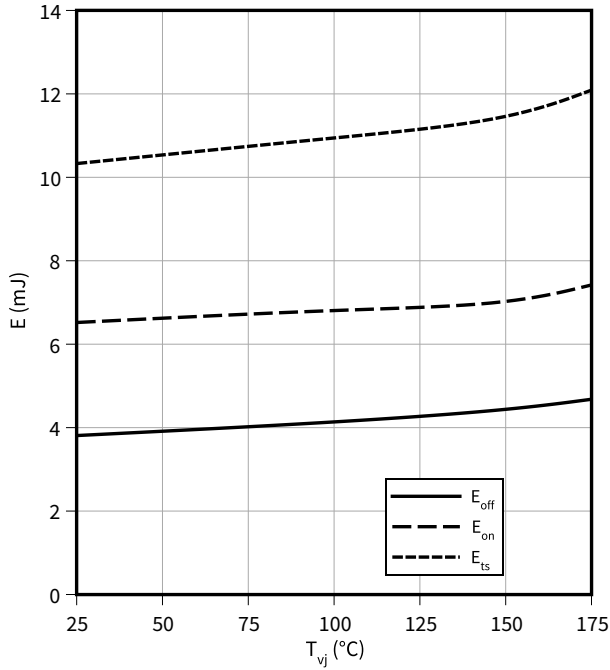


4 Characteristics diagrams

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

$E = f(T_{vj})$

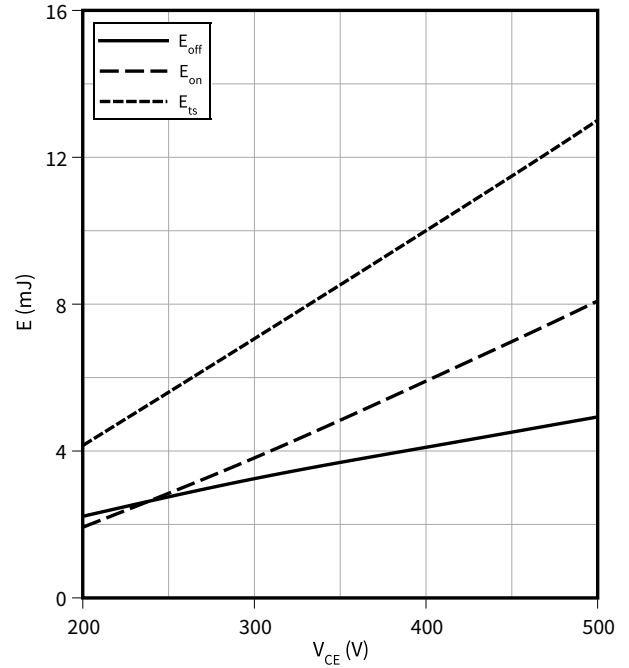
$I_C = 120.0 \text{ A}$ ,  $R_{Goff} = 5.0 \text{ } \Omega$ ,  $V_{CE} = 470 \text{ V}$ ,  $V_{GE} = -8/15 \text{ V}$ ,  $R_{Gon} = 5 \text{ } \Omega$



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

$E = f(V_{CE})$

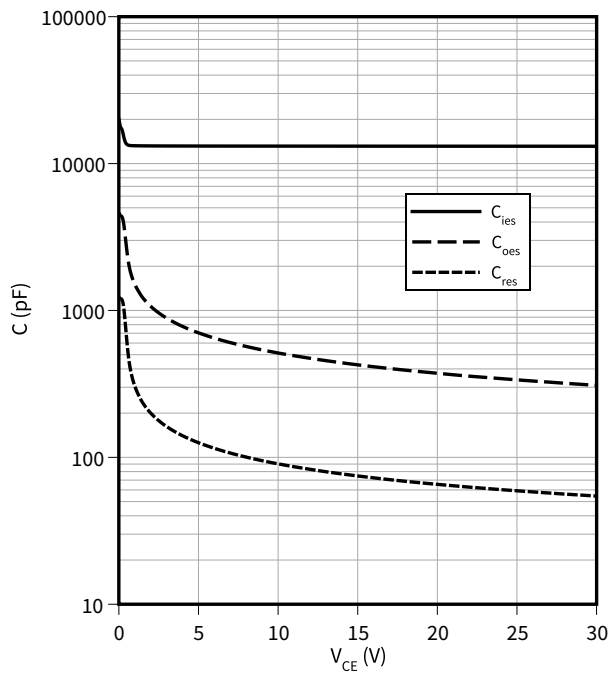
$I_C = 120 \text{ A}$ ,  $R_{Goff} = 5 \text{ } \Omega$ ,  $T_{vj} \leq 175 \text{ } ^\circ\text{C}$ ,  $V_{GE} = -8/15 \text{ V}$ ,  $R_{Gon} = 5 \text{ } \Omega$



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

$C = f(V_{CE})$

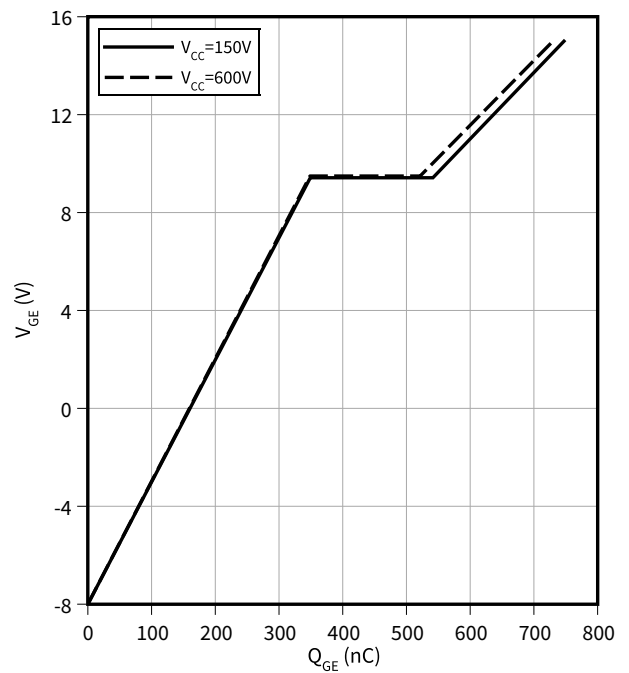
$f = 100 \text{ kHz}$ ,  $V_{GE} = 0 \text{ V}$



**Typical gate charge, IGBT**

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

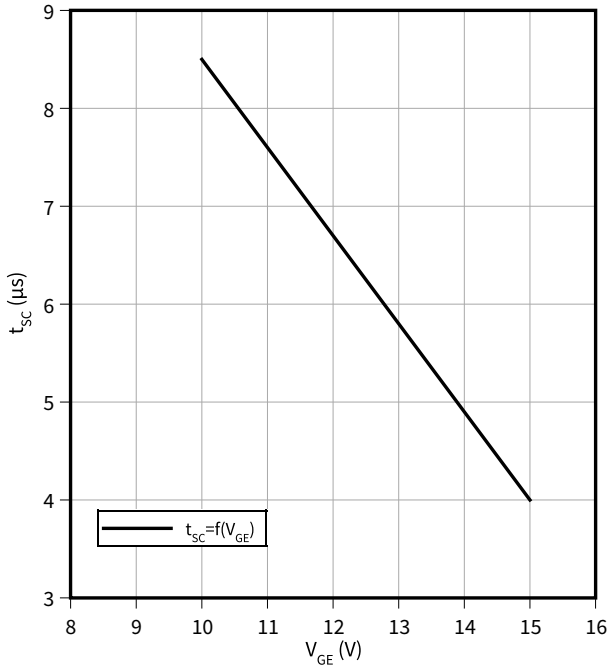
$I_C = 120.0 \text{ A}$



4 Characteristics diagrams

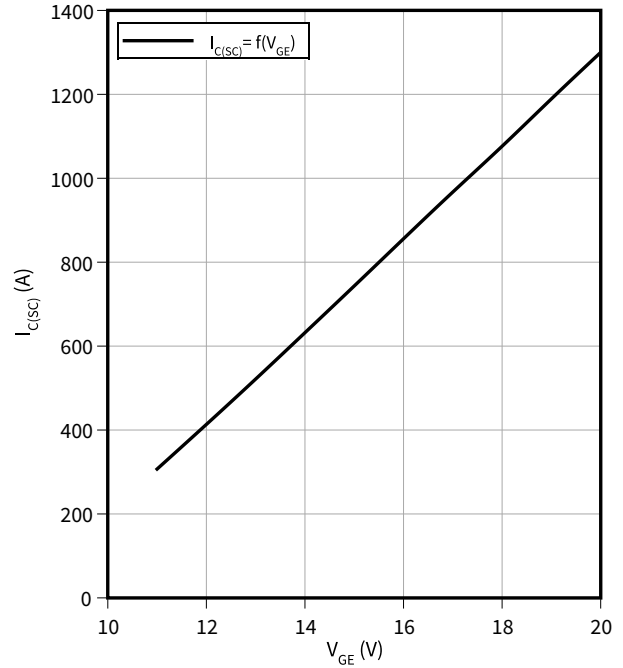
**Typical Short circuit withstand time as a function of gate-emitter voltage, IGBT**

$t_{SC} = f(V_{GE})$   
 $T_{vj} \leq 175\text{ }^{\circ}\text{C}, V_{CC} \leq 470\text{ V}$



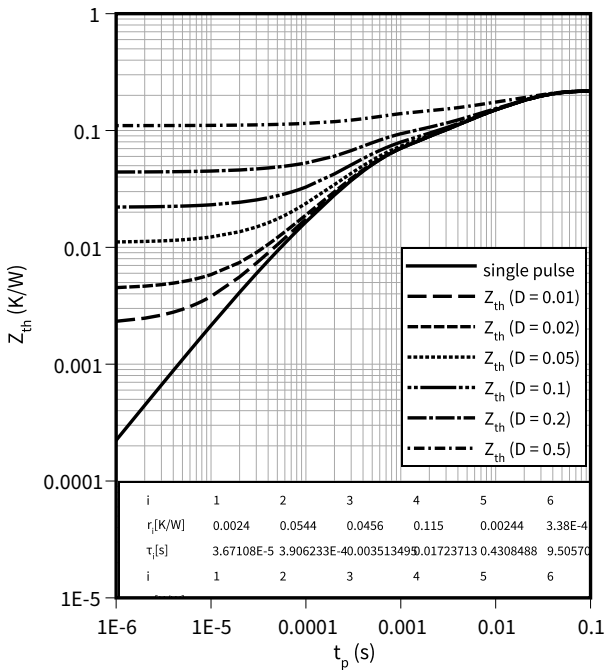
**Typical short circuit collector current as a function of gate-emitter voltage, IGBT**

$I_{C(SC)} = f(V_{GE})$   
 $T_{vj} \leq 175\text{ }^{\circ}\text{C}, V_{CC} \leq 470\text{ V}$



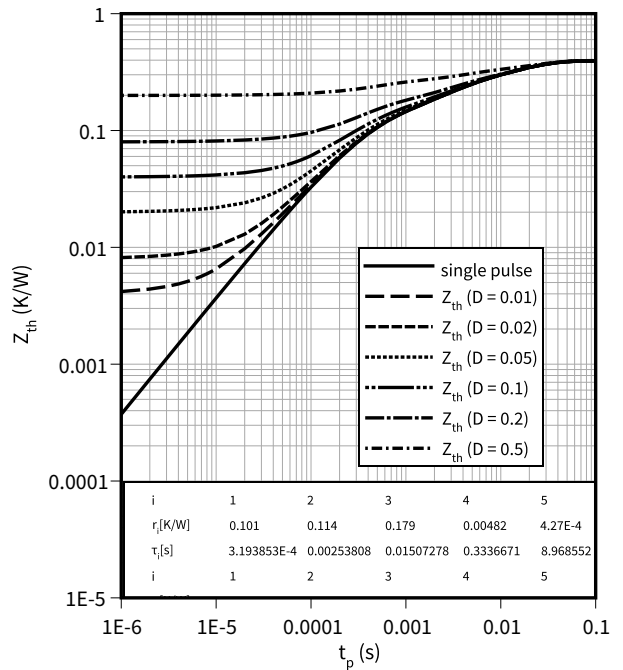
**IGBT transient thermal impedance as a function of pulse width, IGBT**

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



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

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

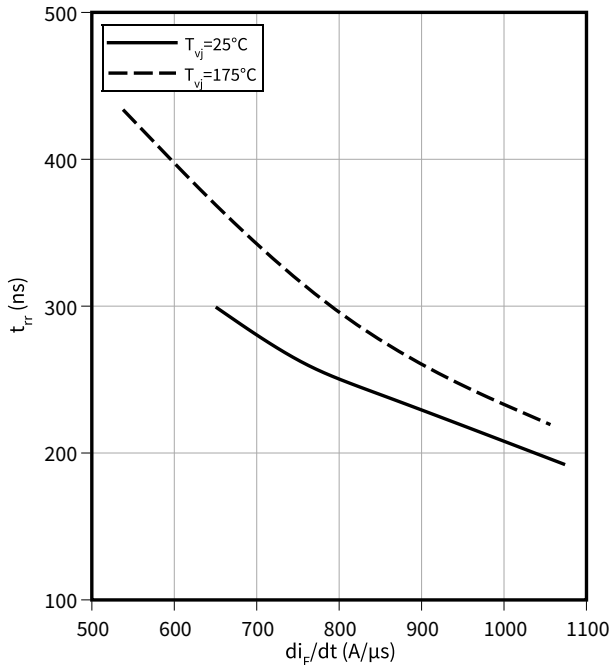


4 Characteristics diagrams

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

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

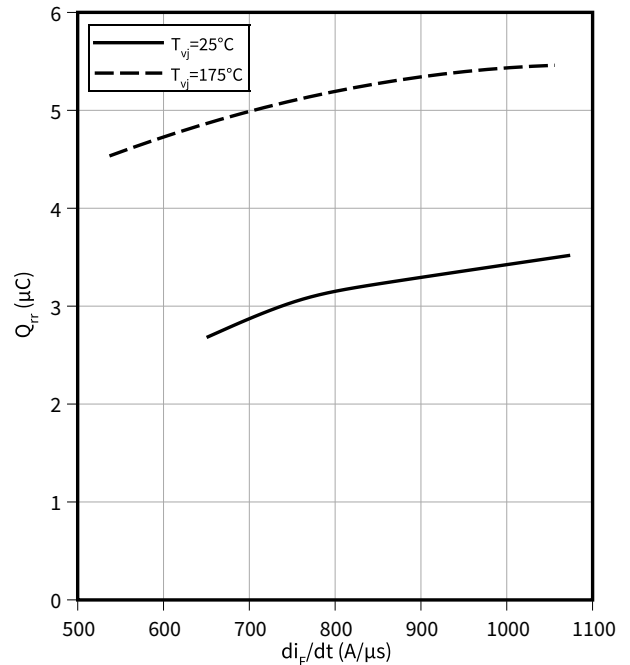
$V_R = 470 \text{ V}, I_F = 120.0 \text{ A}$



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

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

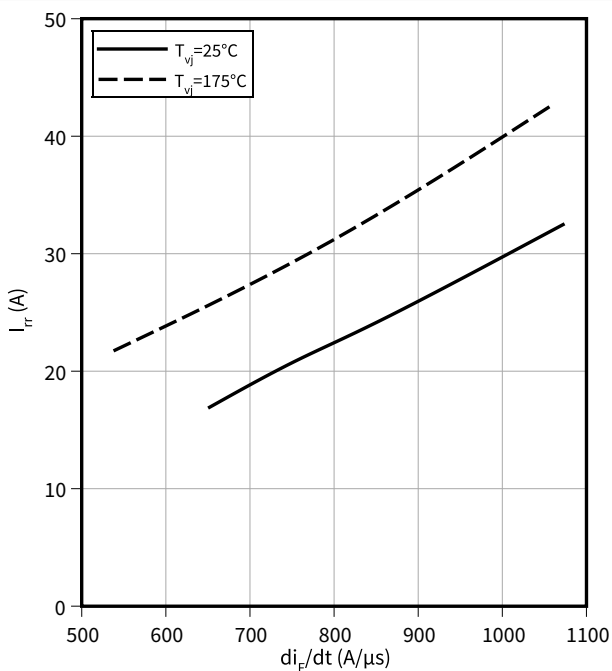
$V_R = 470 \text{ V}, I_F = 120.0 \text{ A}$



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

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

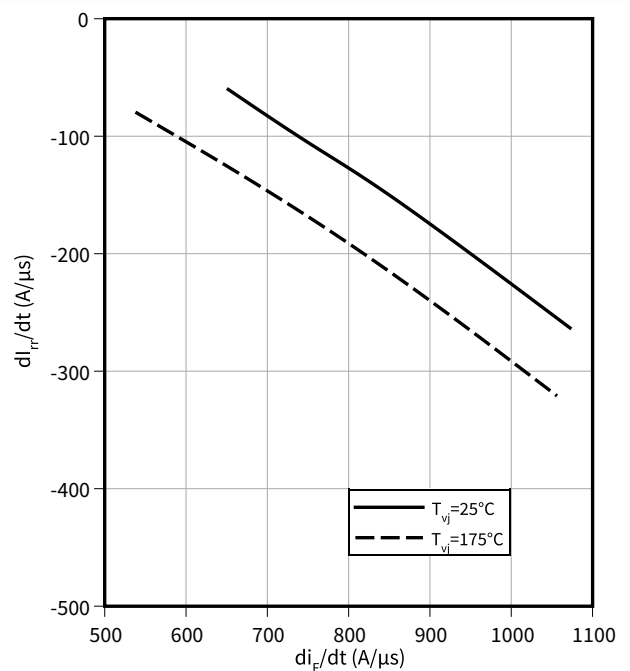
$V_R = 470 \text{ V}, I_F = 120.0 \text{ A}$



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

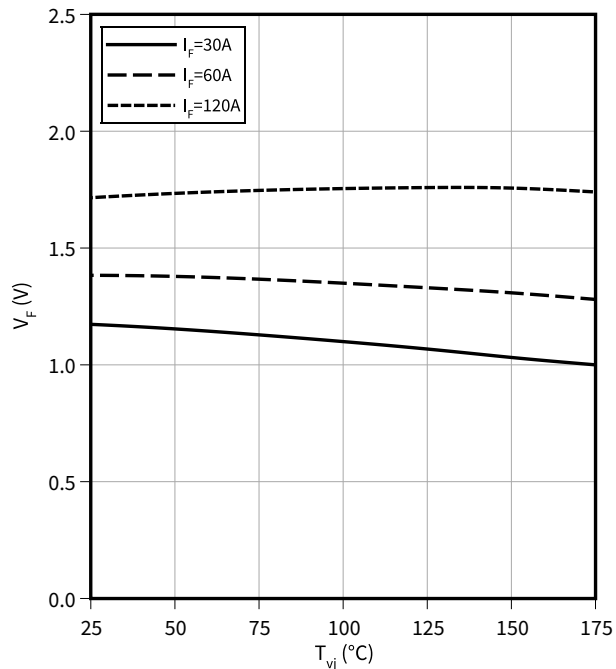
$dI_{rr}/dt = f(di_F/dt)$

$V_R = 470 \text{ V}, I_F = 120.0 \text{ A}$



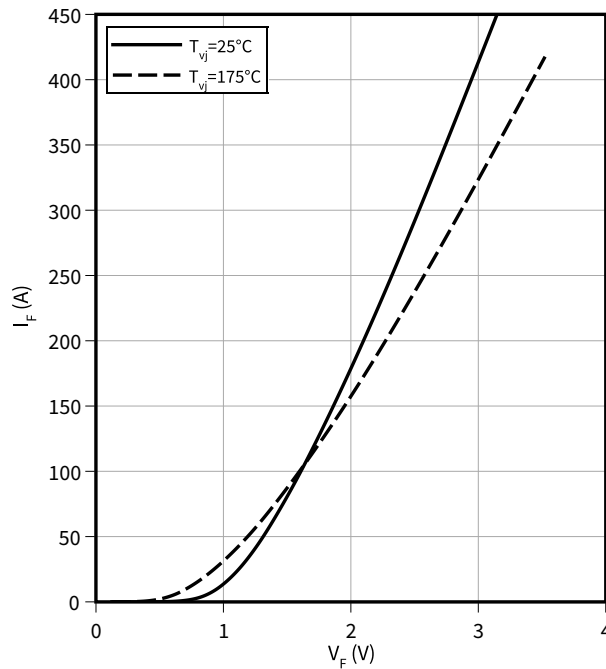
**Typical diode forward voltage as a function of junction temperature, Diode**

$V_F = f(T_{vj})$



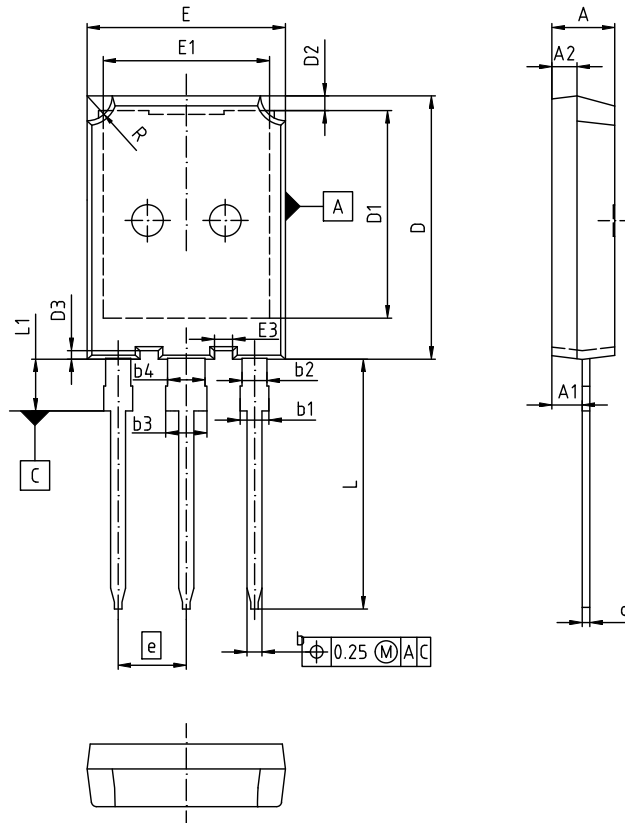
**Typical diode forward current as a function of forward voltage, Diode**

$I_F = f(V_F)$



5 Package outlines

Package Drawing PG-TO247PLUS-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
b	1.16	1.26	0.046	0.050
b1	1.96	2.25	0.077	0.089
b2	1.96	2.06	0.077	0.081
c	0.59	0.66	0.023	0.026
D	20.90	21.10	0.823	0.831
D1	16.25	16.85	0.640	0.663
D2	1.05	1.35	0.041	0.053
D3	0.58	0.78	0.023	0.031
E	15.70	15.90	0.618	0.626
E1	13.10	13.50	0.516	0.531
E3	1.35	1.55	0.053	0.061
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.10	0.780	0.791
L1	-	4.30	-	0.169
R	1.90	2.10	0.075	0.083

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REVISION  
01

Figure 1

## Revision history

Document revision	Date of release	Description of changes
1.00	2022-02-16	Final datasheet
1.10	2022-03-16	Updated VF and Rthjc

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