

**EconoPACK™3 module with Trench/Fieldstop IGBT4 and Emitter Controlled diode and NTC**

**Features**

- Electrical features
  - $V_{CES} = 1700\text{ V}$
  - $I_{C\text{nom}} = 100\text{ A} / I_{CRM} = 200\text{ A}$
  - LOW  $V_{CESat}$
  - $T_{vj\text{op}} = 150\text{ °C}$
  - Trench IGBT 4
  - $V_{CESat}$  with positive temperature coefficient
- Mechanical features
  - Integrated NTC temperature sensor
  - Standard housing
  - Solder contact technology
  - Isolated base plate



Typical appearance

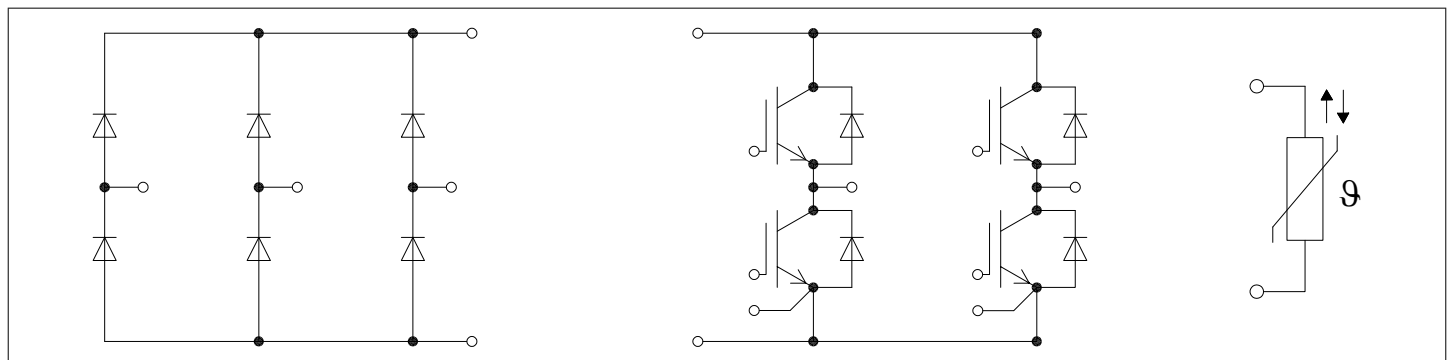
**Potential applications**

- High power converters
- Medium voltage converters

**Product validation**

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

**Description**



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## 1 Package

**Table 1** Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	$V_{ISOL}$	RMS, $f = 50 \text{ Hz}$ , $t = 1 \text{ min}$	3.4	kV
Material of module baseplate			Cu	
Internal Isolation		basic insulation (class 1, IEC 61140)	$\text{Al}_2\text{O}_3$	
Creepage distance	$d_{Creep}$	terminal to heatsink	10.0	mm
Clearance	$d_{Clear}$	terminal to heatsink	7.5	mm
Comparative tracking index	$CTI$		> 225	
RTI Elec.	$RTI$	housing	140	°C

**Table 2** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray inductance module	$L_{SCE}$			33		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C = 25^\circ\text{C}$ , per switch		4		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25^\circ\text{C}$ , per switch		3		mΩ
Storage temperature	$T_{stg}$		-40		125	°C
Mounting torque for modul mounting	$M$	- Mounting according to valid application note	M5, Screw	3	6	Nm
Weight	$G$			300		g

## 2 IGBT, Inverter

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	$V_{CES}$	$T_{vj} = 25^\circ\text{C}$	1700	V
Continous DC collector current	$I_{CDC}$	$T_{vj \text{ max}} = 175^\circ\text{C}$ $T_C = 95^\circ\text{C}$	100	A
Repetitive peak collector current	$I_{CRM}$	$t_p = 1 \text{ ms}$	200	A
Gate-emitter peak voltage	$V_{GES}$		±20	V

**Table 4** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\ sat}$	$I_C = 100\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.90	2.25	V
			$T_{vj} = 125\ ^\circ C$	2.30		
			$T_{vj} = 150\ ^\circ C$	2.40		
Gate threshold voltage	$V_{GEth}$	$I_C = 4\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.35	5.80	6.25	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\ V$		1.2		$\mu C$
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\ ^\circ C$		7.5		$\Omega$
Input capacitance	$C_{ies}$	$f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		9		nF
Reverse transfer capacitance	$C_{res}$	$f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		0.29		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 1700\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$		1	mA
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\ V, V_{GE} = 20\ V, T_{vj} = 25\ ^\circ C$			400	nA
Turn-on delay time (inductive load)	$t_{don}$	$I_C = 100\ A, V_{CE} = 900\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.91\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.191		$\mu s$
			$T_{vj} = 125\ ^\circ C$	0.213		
			$T_{vj} = 150\ ^\circ C$	0.218		
Rise time (inductive load)	$t_r$	$I_C = 100\ A, V_{CE} = 900\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.91\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.052		$\mu s$
			$T_{vj} = 125\ ^\circ C$	0.056		
			$T_{vj} = 150\ ^\circ C$	0.058		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 100\ A, V_{CE} = 900\ V, V_{GE} = \pm 15\ V, R_{Goff} = 0.91\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.409		$\mu s$
			$T_{vj} = 125\ ^\circ C$	0.562		
			$T_{vj} = 150\ ^\circ C$	0.599		
Fall time (inductive load)	$t_f$	$I_C = 100\ A, V_{CE} = 900\ V, V_{GE} = \pm 15\ V, R_{Goff} = 0.91\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.289		$\mu s$
			$T_{vj} = 125\ ^\circ C$	0.507		
			$T_{vj} = 150\ ^\circ C$	0.556		
Turn-on energy loss per pulse	$E_{on}$	$I_C = 100\ A, V_{CE} = 900\ V, L_\sigma = 35\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 0.91\ \Omega, di/dt = 1050\ A/\mu s (T_{vj} = 150\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	27.9		mJ
			$T_{vj} = 125\ ^\circ C$	38.2		
			$T_{vj} = 150\ ^\circ C$	40.9		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 100\ A, V_{CE} = 900\ V, L_\sigma = 35\ nH, V_{GE} = \pm 15\ V, R_{Goff} = 0.91\ \Omega, dv/dt = 3050\ V/\mu s (T_{vj} = 150\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	19		mJ
			$T_{vj} = 125\ ^\circ C$	31.1		
			$T_{vj} = 150\ ^\circ C$	34.9		
SC data	$I_{SC}$	$V_{GE} \leq 15\ V, V_{CC} = 1000\ V, V_{CEmax} = V_{CES} - L_{sCE} * di/dt$	$t_p \leq 10\ \mu s, T_{vj} = 150\ ^\circ C$	460		A
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			0.267	K/W

**Table 4** Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, case to heatsink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 1 \text{ W/(m}^2\text{K)}$		0.0680		K/W
Temperature under switching conditions	$T_{vjop}$		-40		150	°C

### 3 Diode, Inverter

**Table 5** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25 \text{ °C}$	1700	V	
Continuous DC forward current	$I_F$		100	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1 \text{ ms}$	200	A	
$I^2t$ - value	$I^2t$	$t_p = 10 \text{ ms}, V_R = 0 \text{ V}$	$T_{vj} = 125 \text{ °C}$	1130	$A^2s$
			$T_{vj} = 150 \text{ °C}$	1100	

**Table 6** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	$V_F$	$I_F = 100 \text{ A}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		1.80	2.35	V
			$T_{vj} = 125 \text{ °C}$		1.90		
			$T_{vj} = 150 \text{ °C}$		1.95		
Peak reverse recovery current	$I_{RM}$	$V_R = 900 \text{ V}, I_F = 100 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 1050 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		71.4		A
			$T_{vj} = 125 \text{ °C}$		77.9		
			$T_{vj} = 150 \text{ °C}$		79.9		
Recovered charge	$Q_r$	$V_R = 900 \text{ V}, I_F = 100 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 1050 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		23.2		$\mu\text{C}$
			$T_{vj} = 125 \text{ °C}$		40.5		
			$T_{vj} = 150 \text{ °C}$		46.1		
Reverse recovery energy	$E_{rec}$	$V_R = 900 \text{ V}, I_F = 100 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 1050 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		11.9		mJ
			$T_{vj} = 125 \text{ °C}$		22.8		
			$T_{vj} = 150 \text{ °C}$		26.4		
Thermal resistance, junction to case	$R_{thJC}$	per diode			0.465	K/W	

**Table 6** Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, case to heatsink	$R_{thCH}$	per diode, $\lambda_{grease} = 1 \text{ W}/(\text{m}^*\text{K})$		0.0700		K/W
Temperature under switching conditions	$T_{vj,op}$		-40		150	°C

## 4 Diode, Rectifier

**Table 7** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25 \text{ °C}$	1800	V	
Maximum RMS forward current per chip	$I_{FRMSM}$	$T_C = 80 \text{ °C}$	100	A	
Maximum RMS current at rectifier output	$I_{RMSM}$	$T_C = 80 \text{ °C}$	150	A	
Surge forward current	$I_{FSM}$	$t_p = 10 \text{ ms}$	$T_{vj} = 25 \text{ °C}$	829	A
			$T_{vj} = 150 \text{ °C}$	705	
$I^2t$ - value	$I^2t$	$t_p = 10 \text{ ms}$	$T_{vj} = 25 \text{ °C}$	3440	A <sup>2</sup> s
			$T_{vj} = 150 \text{ °C}$	2490	

**Table 8** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$T_{vj} = 150 \text{ °C}$ , $I_F = 150 \text{ A}$		1.15		V
Threshold voltage	$V_{(TO)}$	$T_{vj} = 150 \text{ °C}$		0.78		V
Slope resistance	$r_t$	$T_{vj} = 150 \text{ °C}$		2.4		mΩ
Reverse current	$I_r$	$T_{vj} = 150 \text{ °C}$ , $V_R = 1800 \text{ V}$		1		mA
Thermal resistance, junction to case	$R_{thJC}$	per diode			0.552	K/W
Thermal resistance, case to heatsink	$R_{thCH}$	per diode, $\lambda_{Paste} = 1 \text{ W}/(\text{m}^*\text{K})$ / $\lambda_{grease} = 1 \text{ W}/(\text{m}^*\text{K})$		0.0740		K/W
Temperature under switching conditions	$T_{vj,op}$		-40		150	°C

## 5 NTC-Thermistor

**Table 9** Characteristic values

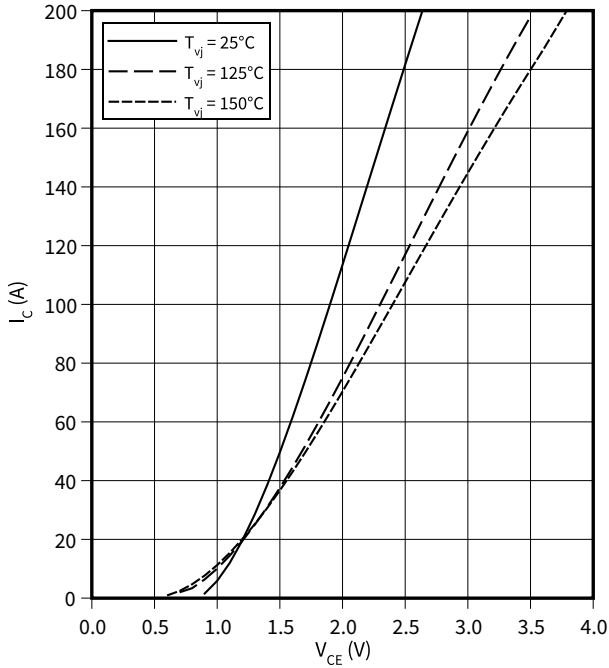
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	$R_{25}$	$T_{NTC} = 25\text{ °C}$		5		kΩ
Deviation of $R_{100}$	$\Delta R/R$	$T_{NTC} = 100\text{ °C}, R_{100} = 493\text{ }\Omega$	-5		5	%
Power dissipation	$P_{25}$	$T_{NTC} = 25\text{ °C}$			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\text{ K}))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15\text{ K}))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\text{ K}))]$		3433		K

Note: Specification according to the valid application note.

## 6 Characteristics diagrams

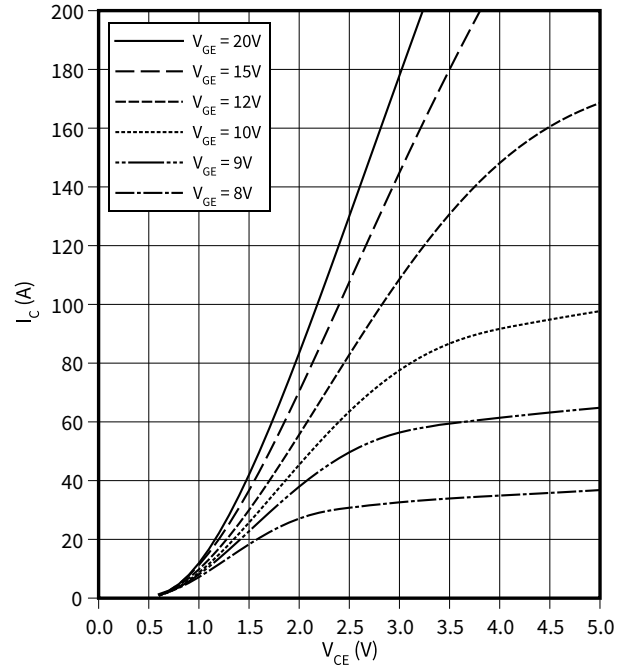
**output characteristic (typical), IGBT, Inverter**

$I_C = f(V_{CE})$   
 $V_{GE} = 15\text{ V}$



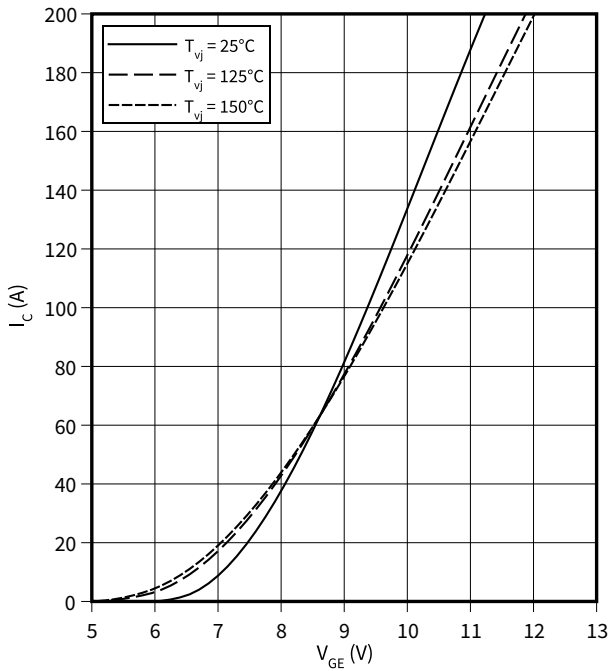
**output characteristic (typical), IGBT, Inverter**

$I_C = f(V_{CE})$   
 $T_{vj} = 150\text{ °C}$



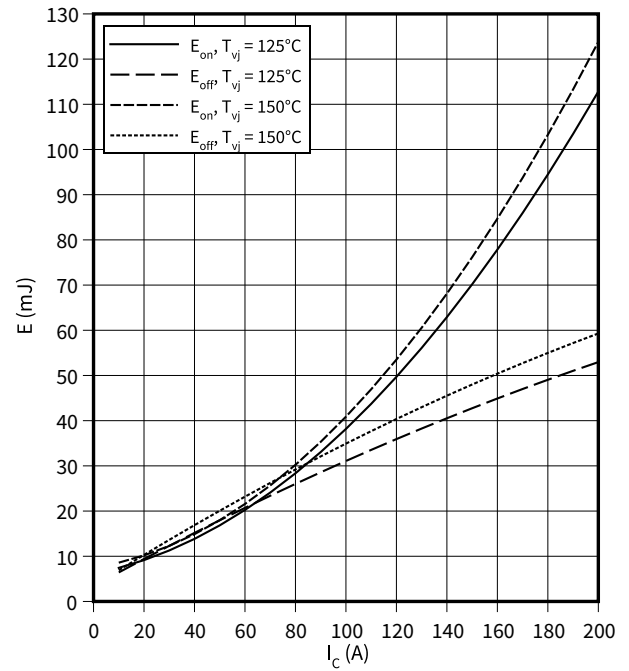
**transfer characteristic (typical), IGBT, Inverter**

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



**switching losses (typical), IGBT, Inverter**

$E = f(I_C)$   
 $R_{Goff} = 0.91\ \Omega$ ,  $R_{Gon} = 0.91\ \Omega$ ,  $V_{CE} = 900\text{ V}$ ,  $V_{GE} = \pm 15\text{ V}$



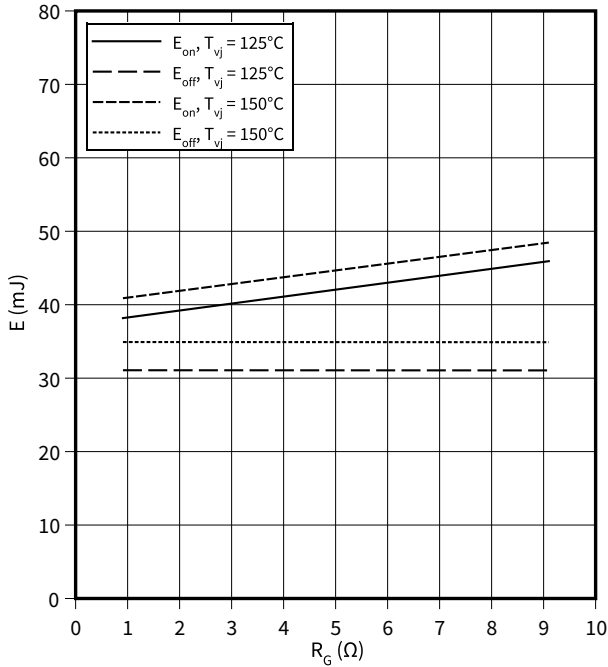


6 Characteristics diagrams

**switching losses (typical), IGBT, Inverter**

$E = f(R_G)$

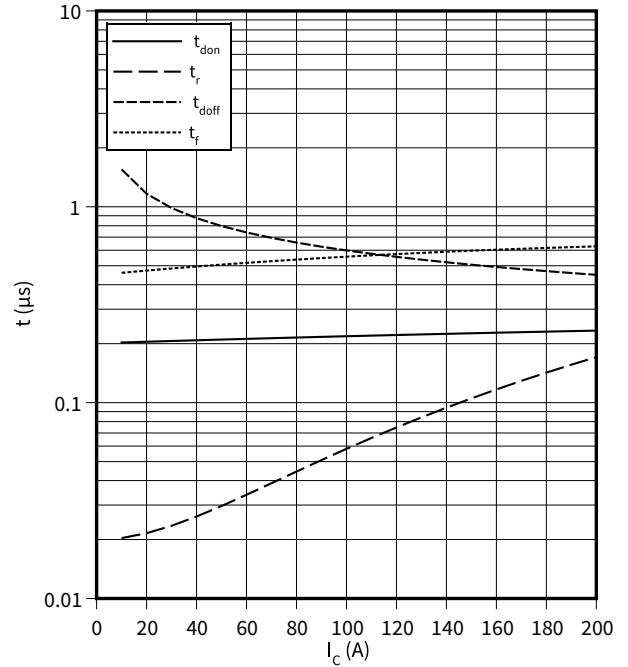
$I_C = 100 \text{ A}$ ,  $V_{CE} = 900 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$



**switching times (typical), IGBT, Inverter**

$t = f(I_C)$

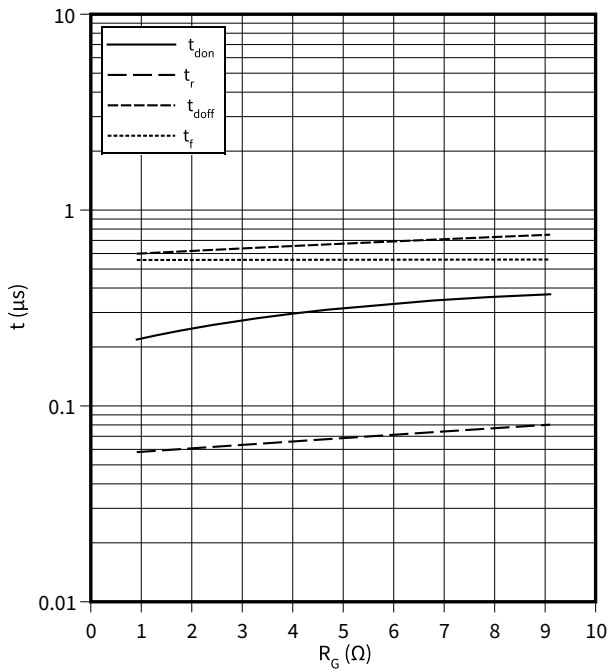
$R_{Goff} = 0.91 \Omega$ ,  $R_{Gon} = 0.91 \Omega$ ,  $V_{CE} = 900 \text{ V}$ ,  $V_{GE} = -15 / 15 \text{ V}$ ,  $T_{vj} = 150 \text{ °C}$



**switching times (typical), IGBT, Inverter**

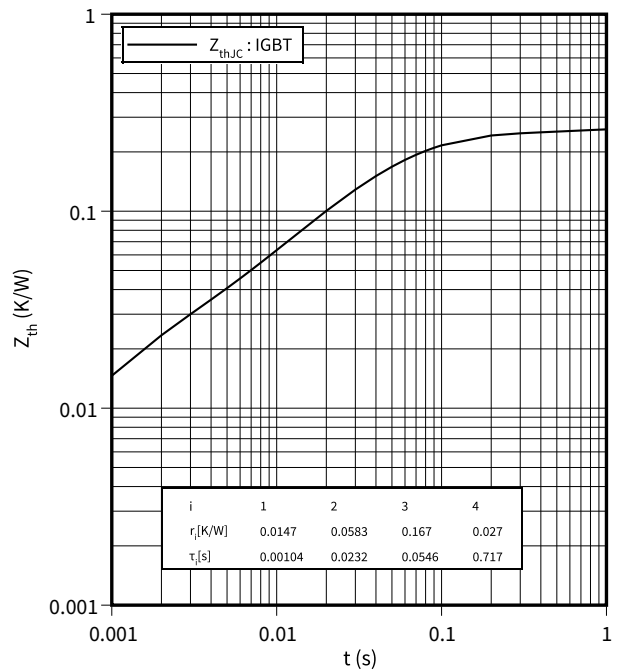
$t = f(R_G)$

$I_C = 100 \text{ A}$ ,  $V_{CE} = 900 \text{ V}$ ,  $V_{GE} = -15 / 15 \text{ V}$ ,  $T_{vj} = 150 \text{ °C}$



**transient thermal impedance , IGBT, Inverter**

$Z_{th} = f(t)$

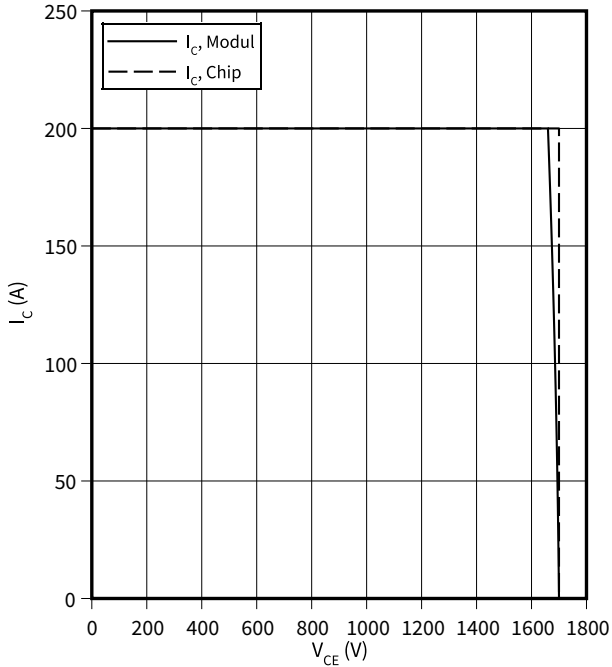


6 Characteristics diagrams

**reverse bias safe operating area (RBSOA), IGBT, Inverter**

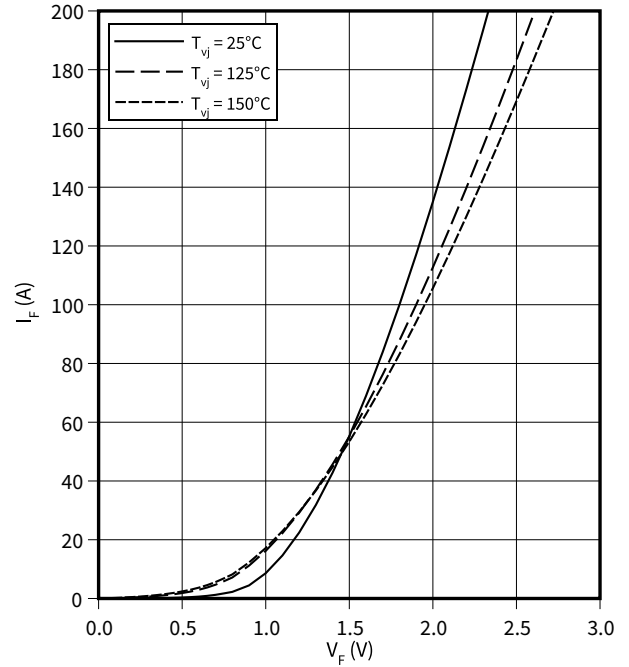
$I_C = f(V_{CE})$

$R_{Goff} = 0.91 \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $T_{vj} = 150 \text{ }^\circ\text{C}$



**forward characteristic (typical), Diode, Inverter**

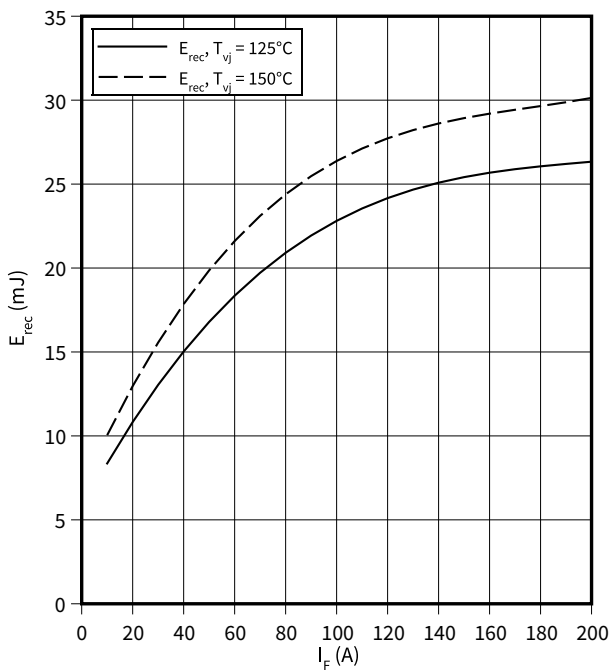
$I_F = f(V_F)$



**switching losses (typical), Diode, Inverter**

$E_{rec} = f(I_F)$

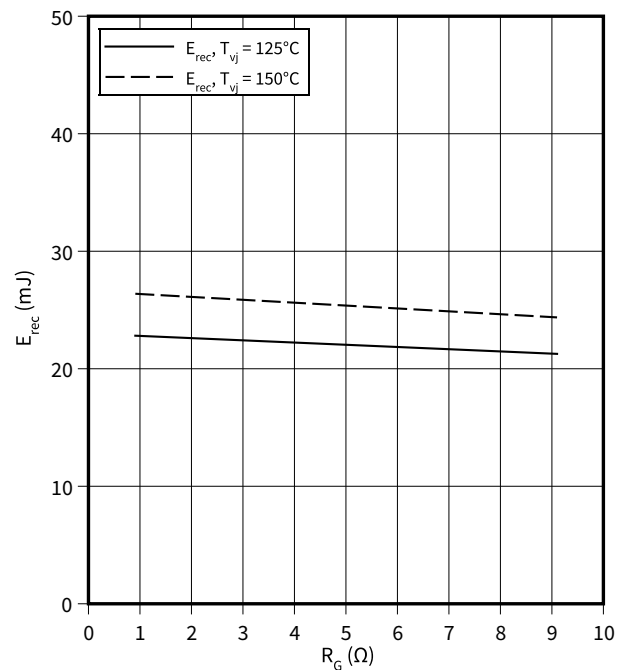
$V_{CE} = 900 \text{ V}$ ,  $R_{Gon} = R_{Gon}(\text{IGBT})$



**switching losses (typical), Diode, Inverter**

$E_{rec} = f(R_G)$

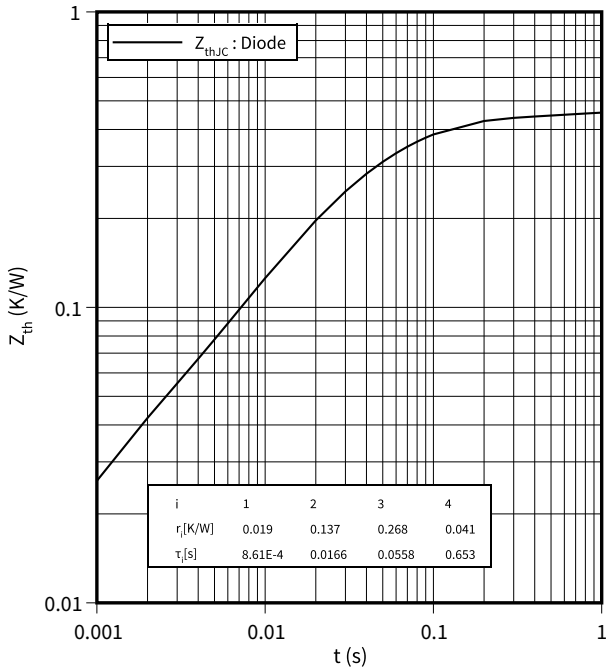
$V_{CE} = 900 \text{ V}$ ,  $I_F = 100 \text{ A}$



6 Characteristics diagrams

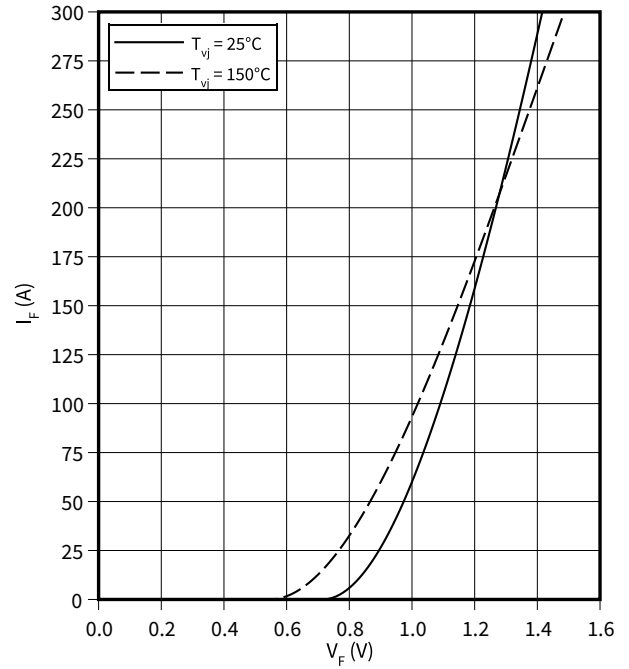
transient thermal impedance , Diode, Inverter

$Z_{th} = f(t)$



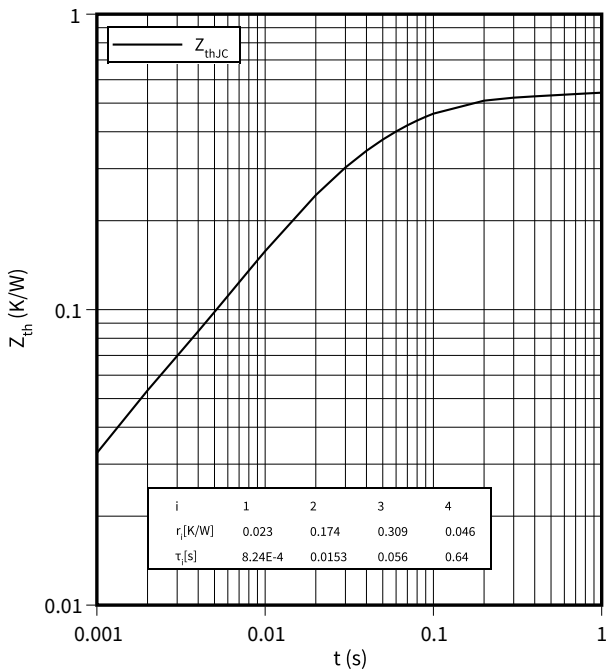
Forward characteristic (typical), Diode, Rectifier

$I_F = f(V_F)$



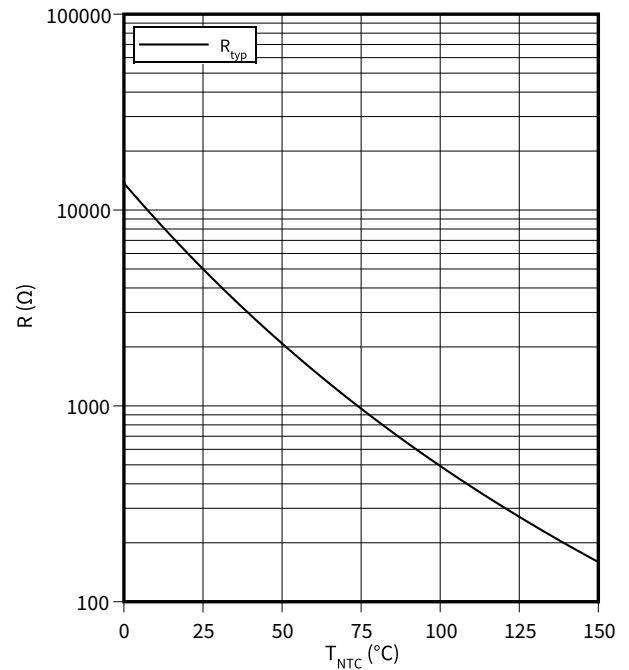
Transient thermal impedance, Diode, Rectifier

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



7 Circuit diagram

7 Circuit diagram

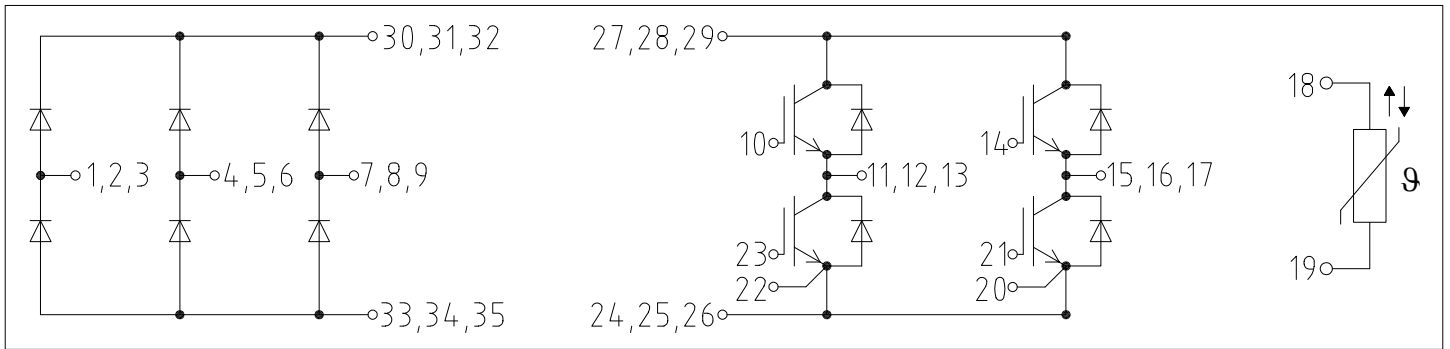


Figure 2

8 Package outlines

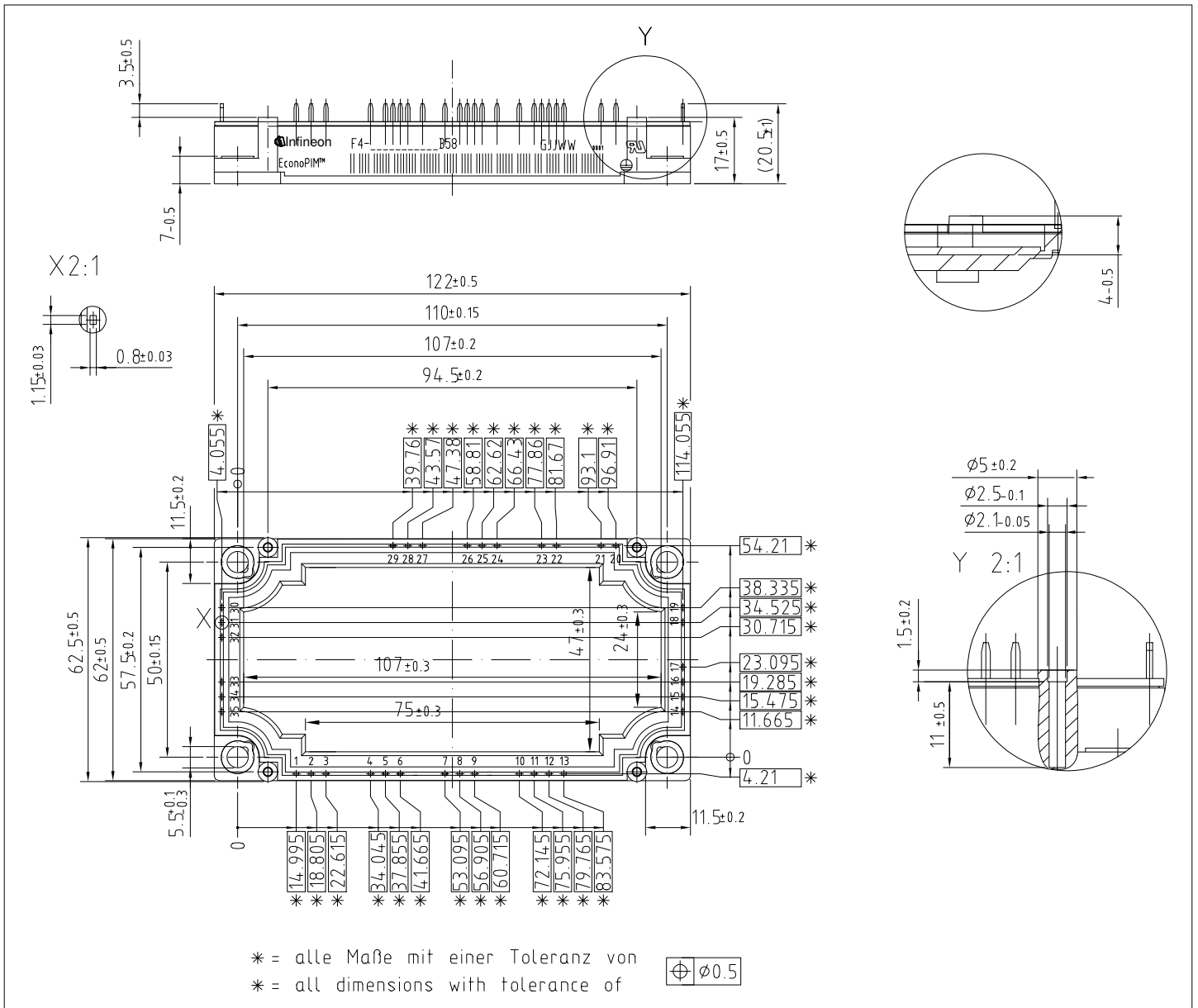


Figure 3

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**Edition 2021-04-16**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**

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