

### PrimePACK™3+ B-series module with TRENCHSTOP™ IGBT7 and emitter controlled 7 diode and NTC

#### Features

- Electrical features
  - $V_{CES} = 1200\text{ V}$
  - $I_{C\text{nom}} = 2400\text{ A} / I_{CRM} = 4800\text{ A}$
  - High current density
  - Low inductive design
  - Low  $V_{CE,sat}$
  - $T_{vj,op} = 150^{\circ}\text{C}$
  - Overload operation up to  $175^{\circ}\text{C}$
- Mechanical features
  - 4 kV AC 1 min insulation
  - High creepage and clearance distances
  - High power density



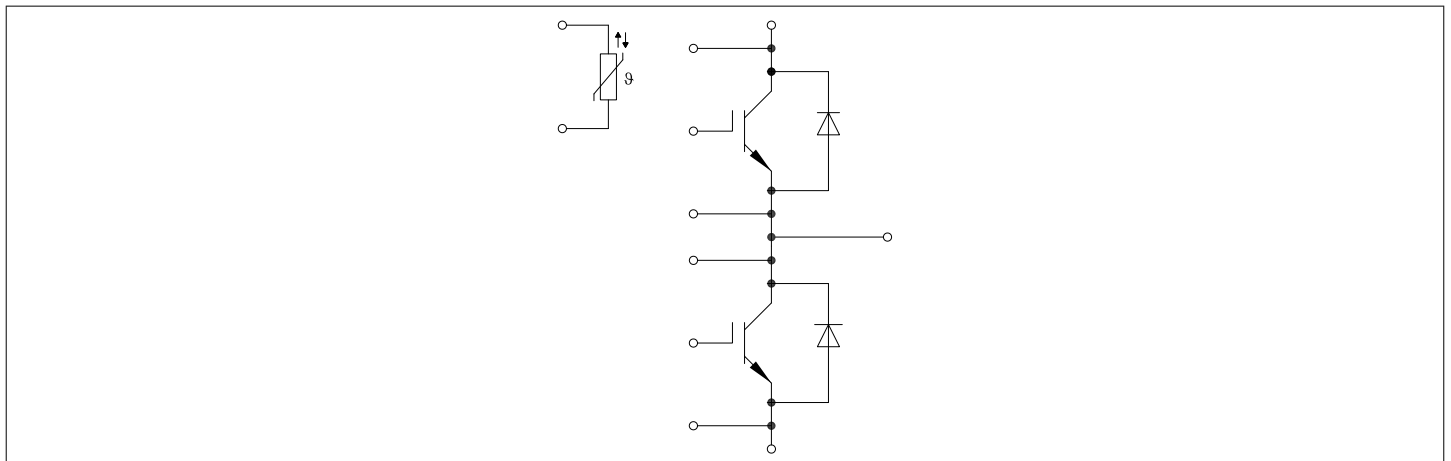
#### Potential applications

- Motor drives

#### 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, $f = 50 \text{ Hz}$ , $t = 60 \text{ s}$	4.0	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	36.0	mm
Creepage distance	$d_{Creep}$	terminal to terminal	28.0	mm
Clearance	$d_{Clear}$	terminal to heatsink	21.0	mm
Clearance	$d_{Clear}$	terminal to terminal	19.0	mm
Comparative tracking index	$CTI$		> 400	

**Table 2** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Stray inductance module	$L_{SCE}$			10		nH	
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C = 25 \text{ °C}$ , per switch		0.1		mΩ	
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25 \text{ °C}$ , per switch		0.135		mΩ	
Current slope at AC-terminals	$ di/dt_{AC} $	Valid if AC-terminals are permanently part of commutation path			100	A/μs	
Storage temperature	$T_{stg}$		-40		150	°C	
Maximum baseplate operation temperature	$T_{BPmax}$				150	°C	
Mounting torque for module mounting	$M$	- Mounting according to valid application note	M5, Screw	3		6	Nm
Terminal connection torque	$M$	- Mounting according to valid application note	M4, Screw	1.8		2.1	Nm
			M8, Screw	8		10	
Weight	$G$			1400		g	

## 2 IGBT, Inverter

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	$V_{CES}$	$T_{Vj} = 25 \text{ °C}$	1200	V

(table continues...)

**Table 3 (continued) Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Implemented collector current	$I_{CN}$		2400	A
Continuous DC collector current	$I_{CDC}$	$T_{vj\ max} = 175\ ^\circ\text{C}$ $T_C = 95\ ^\circ\text{C}$	2400	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{vj\ op}$	4800	A
Gate-emitter peak voltage	$V_{GES}$		$\pm 20$	V

**Table 4 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\ sat}$	$I_C = 2400\ \text{A}, V_{GE} = 15\ \text{V}$	$T_{vj} = 25\ ^\circ\text{C}$	1.27	1.79	V
			$T_{vj} = 125\ ^\circ\text{C}$	1.37	1.82	
			$T_{vj} = 175\ ^\circ\text{C}$	1.43	1.85	
Gate threshold voltage	$V_{GEth}$	$I_C = 48\ \text{mA}, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ\text{C}$	5.15	5.80	6.45	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\ \text{V}, V_{CC} = 600\ \text{V}$		38.1		$\mu\text{C}$
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\ ^\circ\text{C}$		0.33		$\Omega$
Input capacitance	$C_{ies}$	$f = 100\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$		325		nF
Reverse transfer capacitance	$C_{res}$	$f = 100\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$		1.92		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 1200\ \text{V}, V_{GE} = 0\ \text{V}$ $T_{vj} = 25\ ^\circ\text{C}$			5	mA
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\ \text{V}, V_{GE} = 20\ \text{V}, T_{vj} = 25\ ^\circ\text{C}$			400	nA
Turn-on delay time (inductive load)	$t_{don}$	$I_C = 2400\ \text{A}, V_{CC} = 600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 0.2\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	0.790		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	0.840		
			$T_{vj} = 175\ ^\circ\text{C}$	0.870		
Rise time (inductive load)	$t_r$	$I_C = 2400\ \text{A}, V_{CC} = 600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 0.2\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	0.120		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	0.140		
			$T_{vj} = 175\ ^\circ\text{C}$	0.150		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 2400\ \text{A}, V_{CC} = 600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 0.4\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	0.940		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	1.060		
			$T_{vj} = 175\ ^\circ\text{C}$	1.120		
Fall time (inductive load)	$t_f$	$I_C = 2400\ \text{A}, V_{CC} = 600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 0.4\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	0.230		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	0.430		
			$T_{vj} = 175\ ^\circ\text{C}$	0.530		

(table continues...)

**Table 4 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on energy loss per pulse	$E_{on}$	$I_C = 2400\text{ A}$ , $V_{CC} = 600\text{ V}$ , $L_\sigma = 20\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Gon} = 0.2\ \Omega$ , $di/dt =$ $15500\text{ A}/\mu\text{s}$ ( $T_{vj} = 175\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	200		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	295		
			$T_{vj} = 175\text{ }^\circ\text{C}$	380		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 2400\text{ A}$ , $V_{CC} = 600\text{ V}$ , $L_\sigma = 20\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Goff} = 0.4\ \Omega$ , $dv/dt =$ $2200\text{ V}/\mu\text{s}$ ( $T_{vj} = 175\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	355		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	510		
			$T_{vj} = 175\text{ }^\circ\text{C}$	570		
SC data	$I_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 800\text{ V}$ , $V_{CEmax} = V_{CES} - L_{sCE} * di/dt$	$t_p = 6\ \mu\text{s}$ , $T_{vj} = 150\text{ }^\circ\text{C}$	8500		A
			$t_p = 6\ \mu\text{s}$ , $T_{vj} = 175\text{ }^\circ\text{C}$	8000		
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			17.9	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{K})$		12.9		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-40		175	$^\circ\text{C}$

Note: Maximum RMS module DC-terminal current according to application note AN2009-08.  
 $T_{vj\ op} > 150\text{ }^\circ\text{C}$  is only allowed for operation at overload conditions. For detailed specifications please refer to AN2018-14.

### 3 Diode, Inverter

**Table 5 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1200	V	
Continuous DC forward current	$I_F$		2400	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	4800	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}$ , $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	455	kA <sup>2</sup> s
			$T_{vj} = 175\text{ }^\circ\text{C}$	420	

**Table 6** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	$V_F$	$I_F = 2400 \text{ A}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		1.70	2.03	V
			$T_{vj} = 125 \text{ °C}$		1.65	1.96	
			$T_{vj} = 175 \text{ °C}$		1.55	1.91	
Peak reverse recovery current	$I_{RM}$	$V_{CC} = 600 \text{ V}, I_F = 2400 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 15500 \text{ A}/\mu\text{s} (T_{vj} = 175 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		1410		A
			$T_{vj} = 125 \text{ °C}$		1720		
			$T_{vj} = 175 \text{ °C}$		1850		
Recovered charge	$Q_r$	$V_{CC} = 600 \text{ V}, I_F = 2400 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 15500 \text{ A}/\mu\text{s} (T_{vj} = 175 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		265		$\mu\text{C}$
			$T_{vj} = 125 \text{ °C}$		455		
			$T_{vj} = 175 \text{ °C}$		585		
Reverse recovery energy	$E_{rec}$	$V_{CC} = 600 \text{ V}, I_F = 2400 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 15500 \text{ A}/\mu\text{s} (T_{vj} = 175 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		110		mJ
			$T_{vj} = 125 \text{ °C}$		200		
			$T_{vj} = 175 \text{ °C}$		250		
Thermal resistance, junction to case	$R_{thJC}$	per diode				34.1	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot\text{K})$			14.7		K/kW
Temperature under switching conditions	$T_{vj\text{op}}$		-40			175	°C

Note:  $T_{vj\text{op}} > 150 \text{ °C}$  is only allowed for operation at overload conditions. For detailed specifications please refer to AN2018-14.

## 4 NTC-Thermistor

**Table 7** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	$R_{25}$	$T_{NTC} = 25 \text{ °C}$		5		k $\Omega$
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

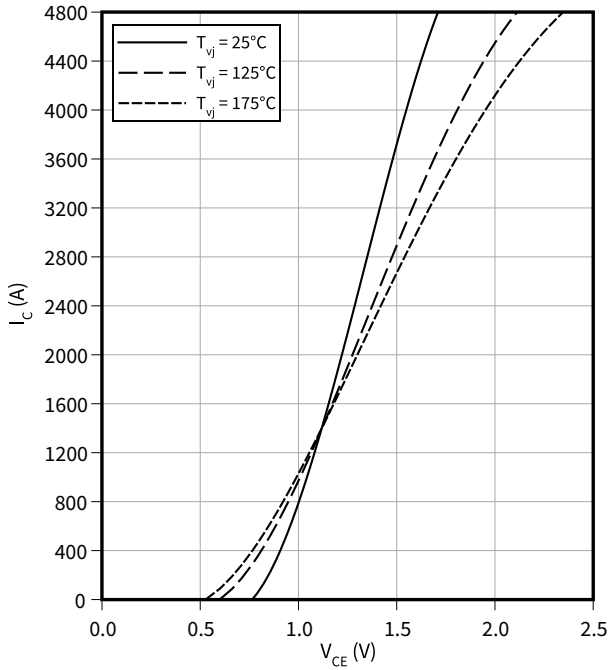
Note: For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4

## 5 Characteristics diagrams

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

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

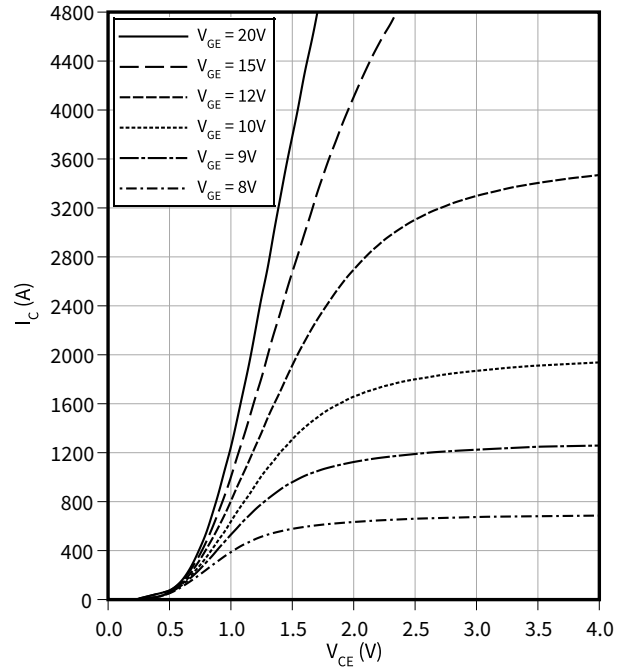
$$V_{GE} = 15 \text{ V}$$



**Output characteristic field (typical), IGBT, Inverter**

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

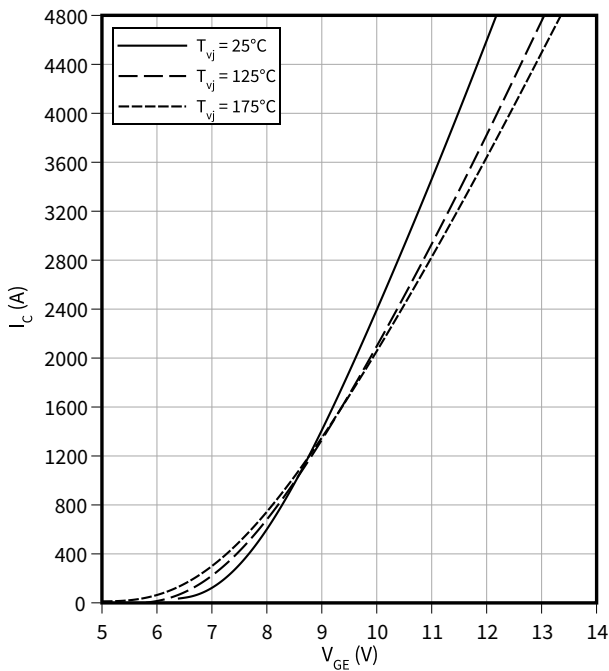
$$T_{vj} = 175 \text{ °C}$$



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

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

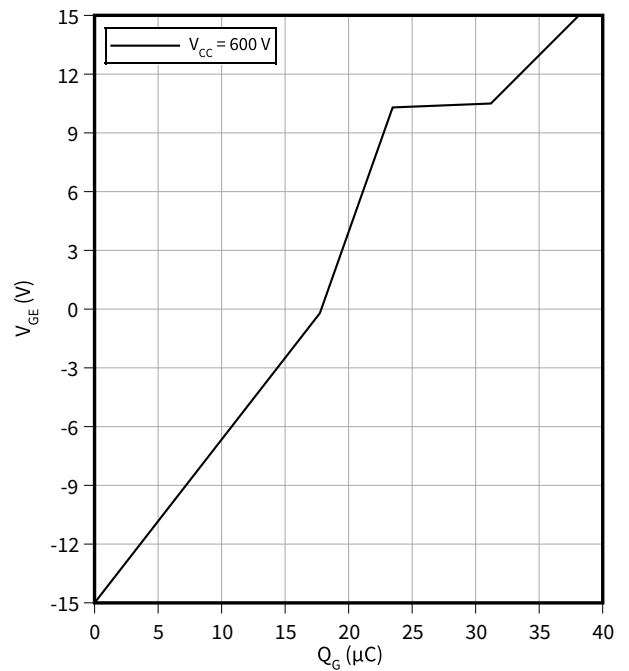
$$V_{CE} = 20 \text{ V}$$



**Gate charge characteristic (typical), IGBT, Inverter**

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

$$I_C = 2400 \text{ A}, T_{vj} = 25 \text{ °C}$$

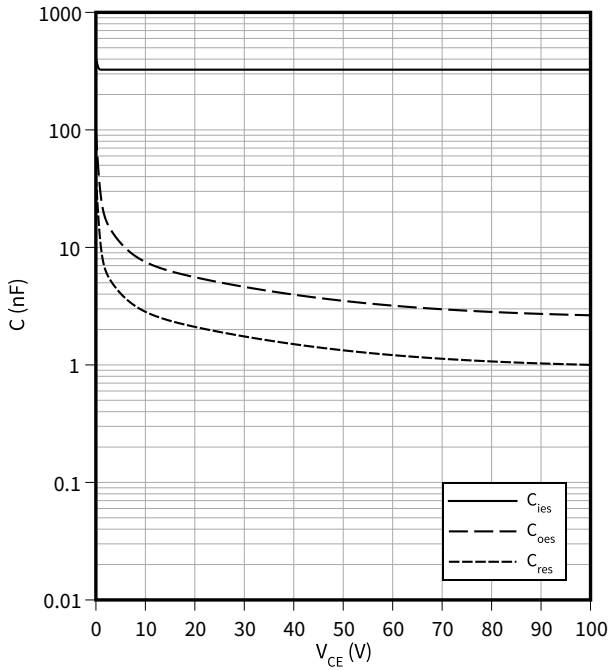


5 Characteristics diagrams

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

$C = f(V_{CE})$

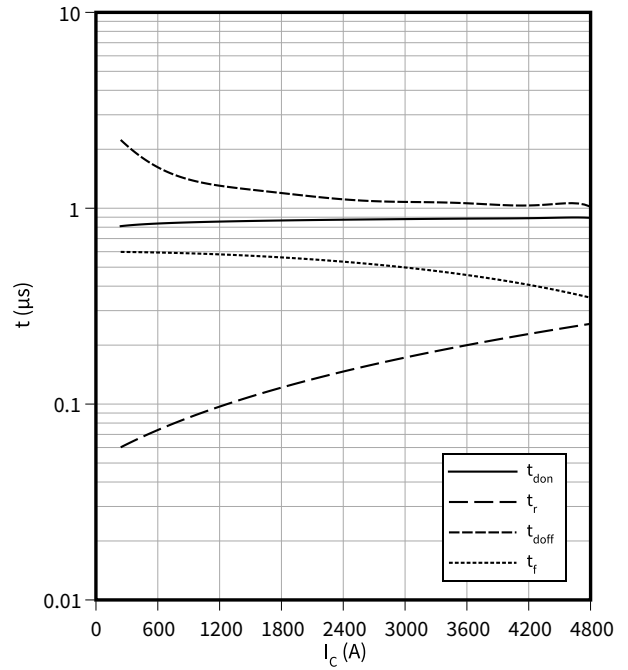
$f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}, T_{vj} = 25 \text{ }^\circ\text{C}$



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

$t = f(I_C)$

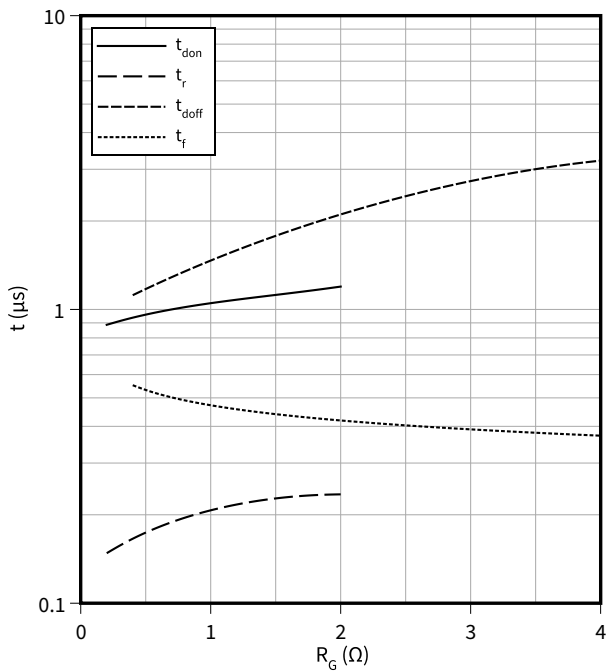
$R_{Goff} = 0.4 \text{ } \Omega, R_{Gon} = 0.2 \text{ } \Omega, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}$



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

$t = f(R_G)$

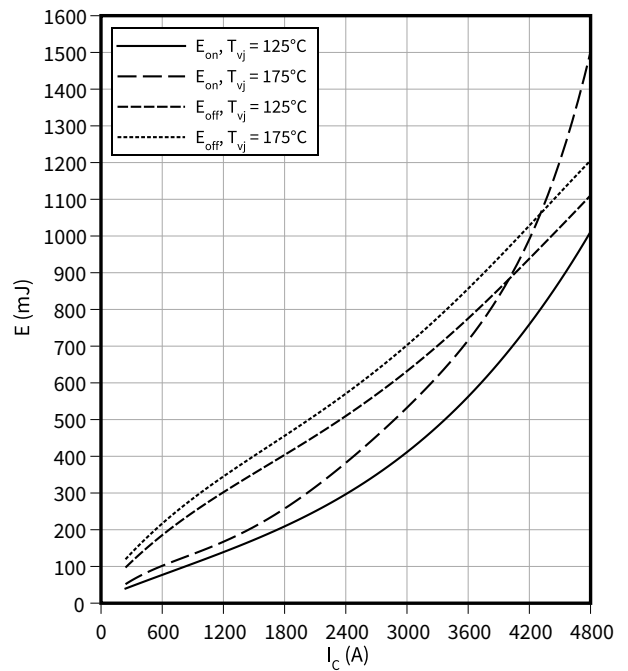
$I_C = 2400 \text{ A}, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}$



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

$E = f(I_C)$

$R_{Goff} = 0.4 \text{ } \Omega, R_{Gon} = 0.2 \text{ } \Omega, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}$



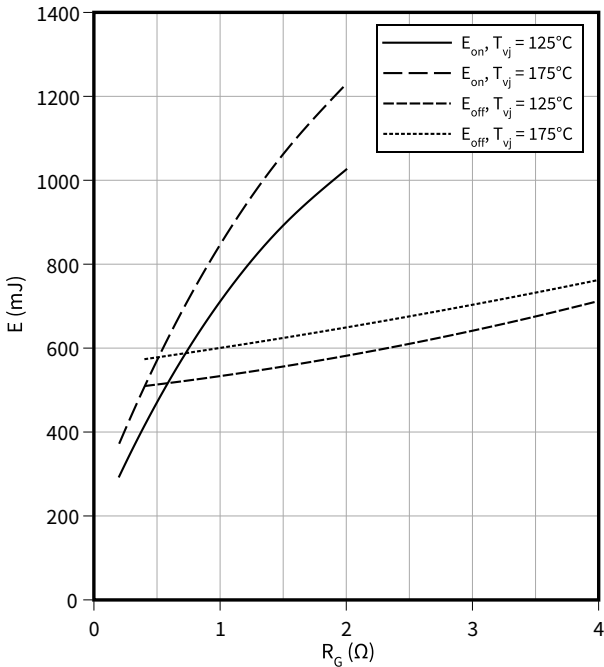


5 Characteristics diagrams

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

$E = f(R_G)$

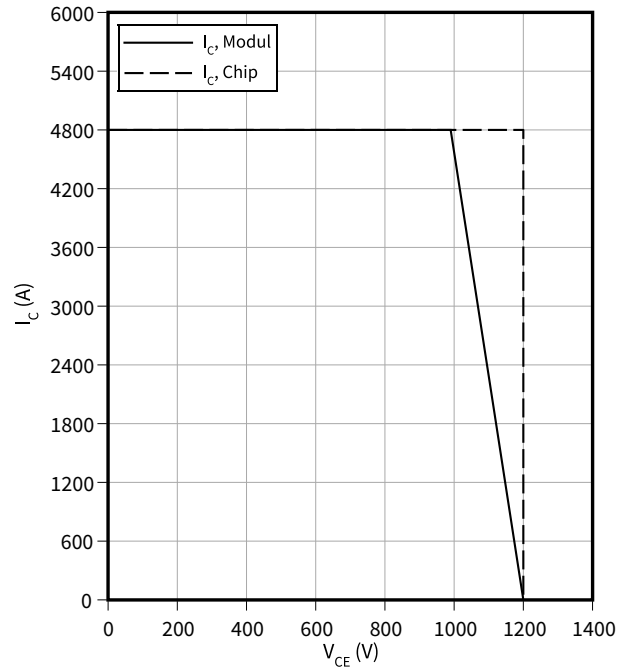
$I_C = 2400 \text{ A}$ ,  $V_{CC} = 600 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$



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

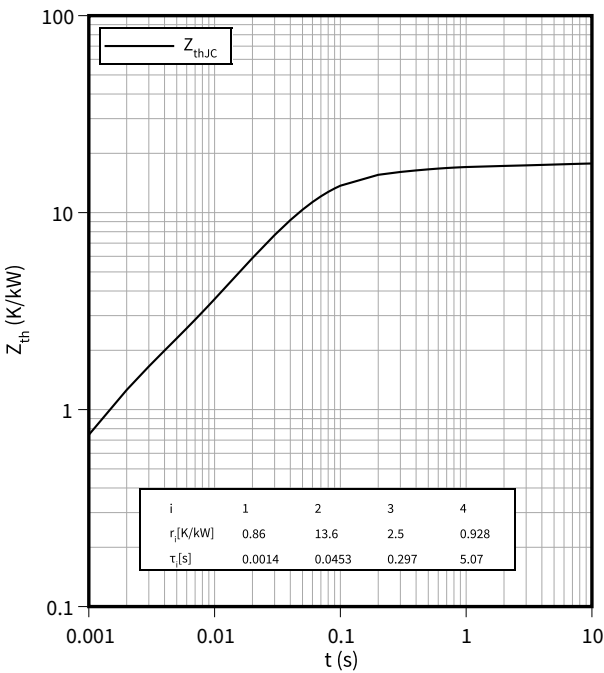
$I_C = f(V_{CE})$

$R_{Goff} = 0.4 \Omega$ ,  $V_{GE} = 15 \text{ V}$ ,  $T_{vj} = 175 \text{ °C}$



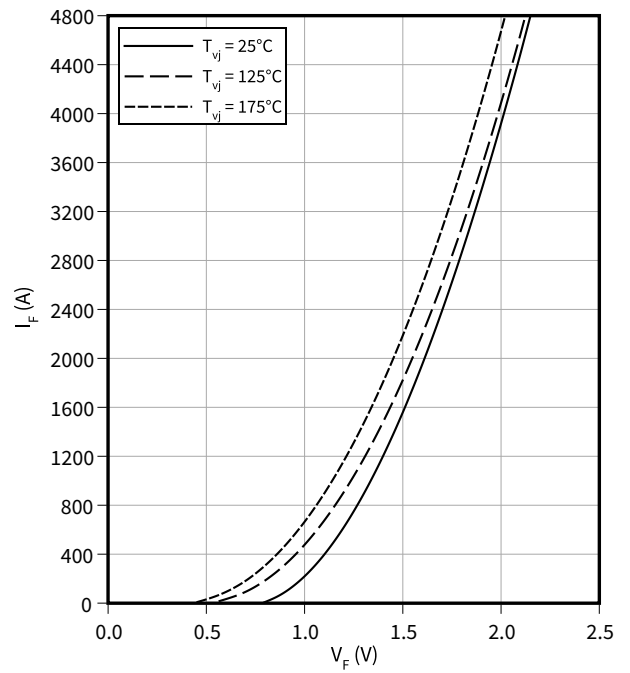
**Transient thermal impedance, IGBT, Inverter**

$Z_{th} = f(t)$



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

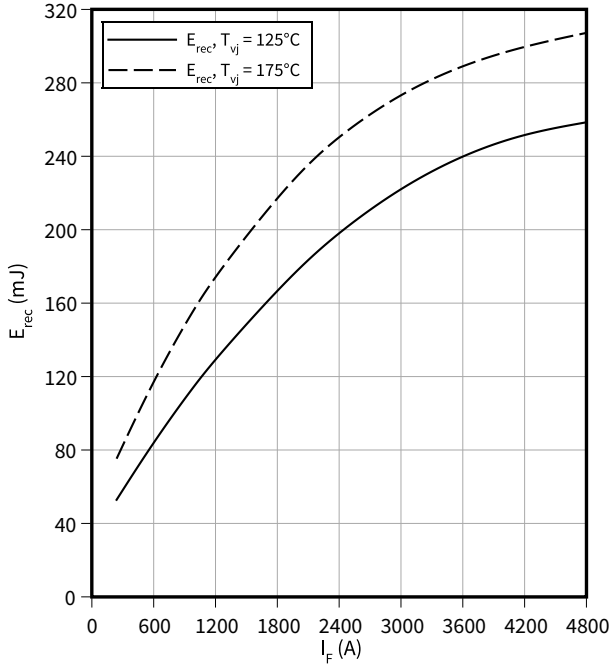
$I_F = f(V_F)$



5 Characteristics diagrams

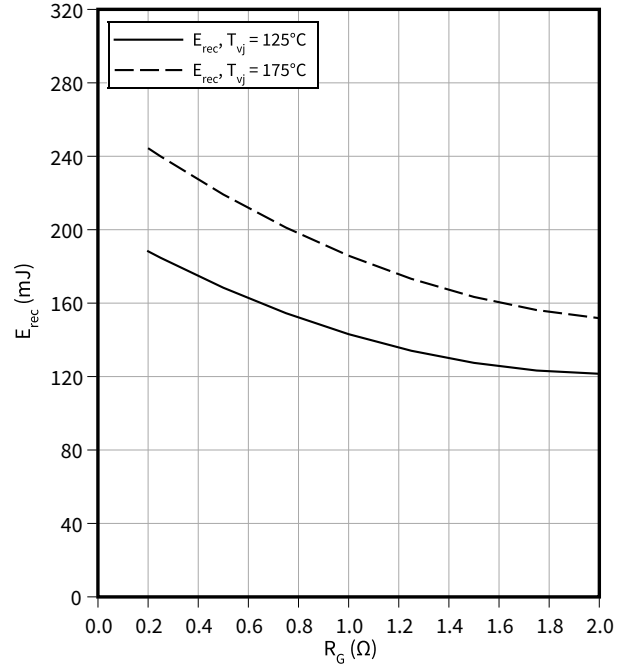
**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(I_F)$   
 $V_{CE} = 600\text{ V}, R_{Gon} = R_{Gon}(IGBT)$



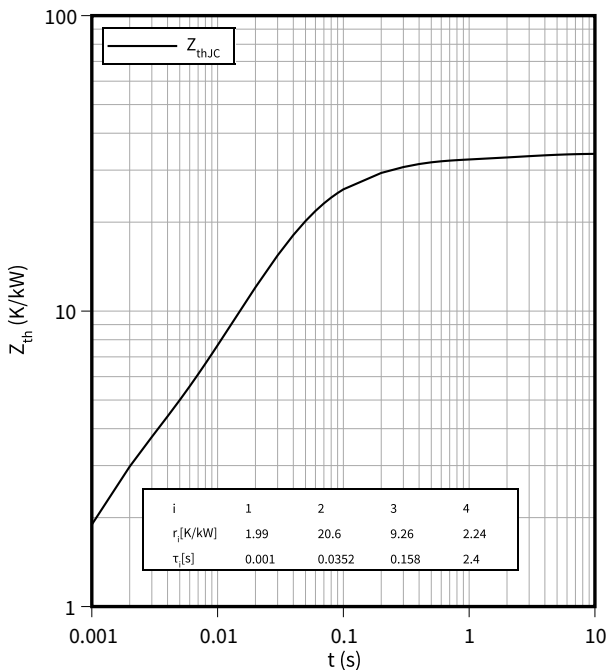
**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(R_G)$   
 $V_{CE} = 600\text{ V}, I_F = 2400\text{ A}$



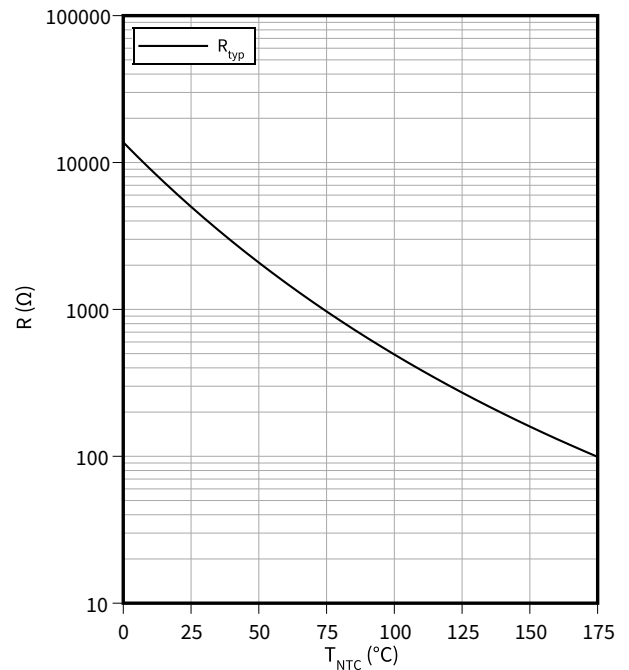
**Transient thermal impedance, Diode, Inverter**

$Z_{th} = f(t)$



**Temperature characteristic (typical), NTC-Thermistor**

$R = f(T_{NTC})$



6 Circuit diagram

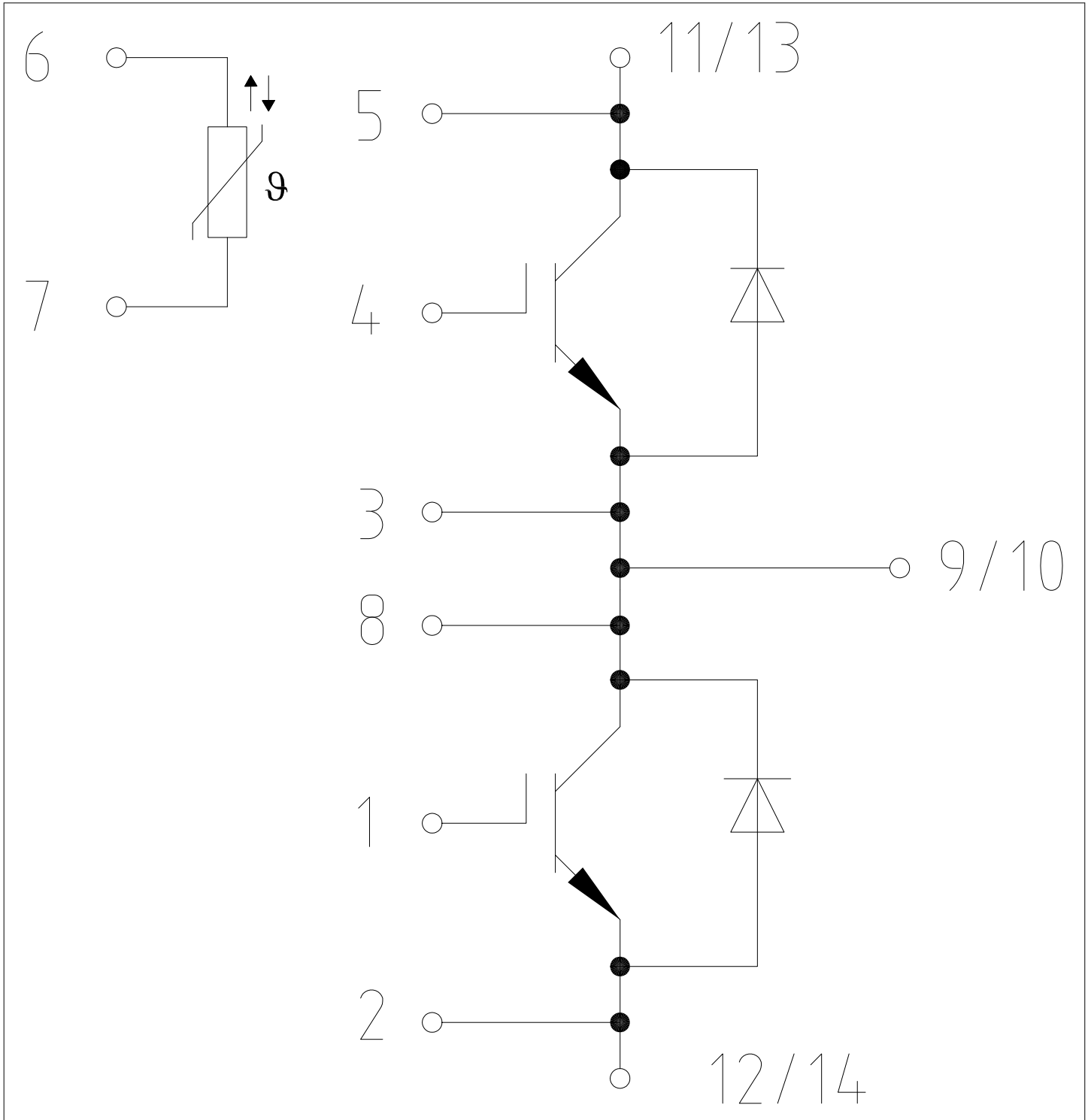


Figure 1

## 7 Package outlines

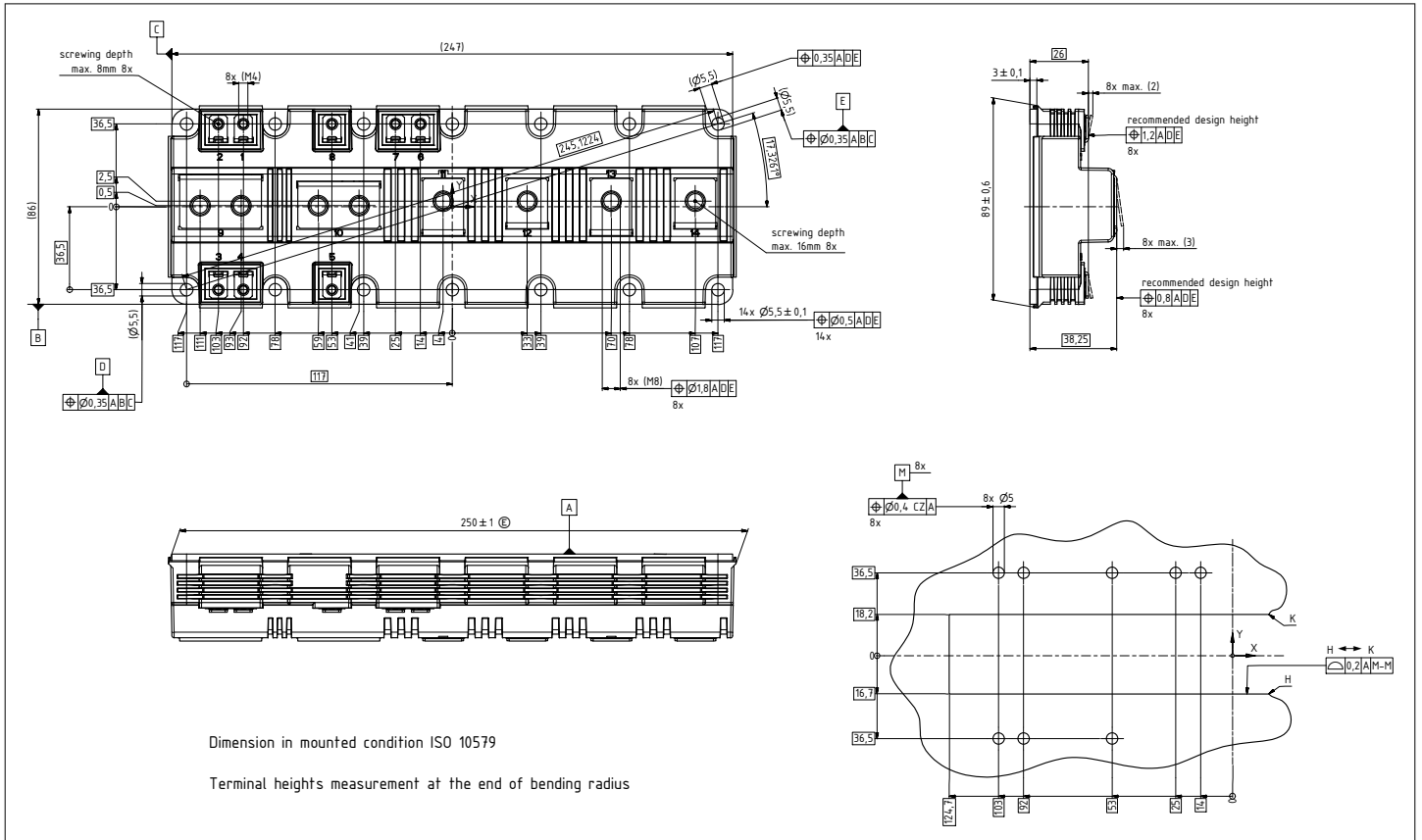

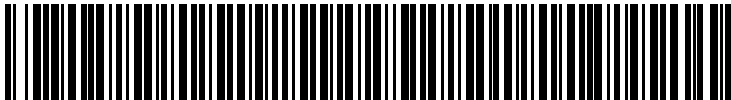


Figure 2

## 8 Module label code

Module label code			
Code format	Data Matrix	Barcode Code128	
Encoding	ASCII text	Code Set A	
Symbol size	16x16	23 digits	
Standard	IEC24720 and IEC16022	IEC8859-1	
Code content	<i>Content</i>	<i>Digit</i>	<i>Example</i>
	Module serial number	1 - 5	71549
	Module material number	6 - 11	142846
	Production order number	12 - 19	55054991
	Date code (production year)	20 - 21	15
	Date code (production week)	22 - 23	30
Example	 		
	71549142846550549911530		71549142846550549911530

**Figure 3**

## Revision history

Document revision	Date of release	Description of changes
0.10	2021-11-09	Initial version
0.20	2022-10-28	Target datasheet
1.00	2023-06-09	Final datasheet

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