

## XHP™3 module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode

### Features

- Electrical features
  - $V_{CES} = 3300\text{ V}$
  - $I_{C\text{nom}} = 450\text{ A} / I_{CRM} = 900\text{ A}$
  - High DC stability
  - High short-circuit capability
  - Low switching losses
  - Low  $V_{CE,sat}$
  - $T_{vj,op} = 150^{\circ}\text{C}$
  - Unbeatable robustness
- Mechanical features
  - ALSiC base plate for increased thermal cycling capability
  - Isolated base plate
  - Package with CTI > 600
  - Package with enhanced insulation of 10.4 kV AC 60 s



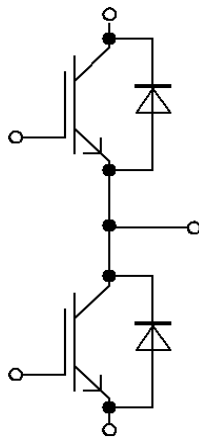
### Potential applications

- Traction drives
- Medium-voltage converters
- 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, $f = 50$ Hz, $t = 60$ s	10.4	kV
Partial discharge extinction voltage	$V_{isol}$	RMS, $f = 50$ Hz, $Q_{PD}$ typ. 10 pC	5.1	kV
Material of module baseplate			AlSiC	
Creepage distance	$d_{Creep}$	terminal to heatsink	53.0	mm
Creepage distance	$d_{Creep}$	terminal to terminal	53.0	mm
Clearance	$d_{Clear}$	terminal to heatsink	36.0	mm
Clearance	$d_{Clear}$	terminal to terminal	26.0	mm
Comparative tracking index	$CTI$		> 600	

**Table 2** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Stray inductance module	$L_{SCE}$			25		nH	
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C=25^\circ\text{C}$ , per switch		0.31		mΩ	
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C=25^\circ\text{C}$ , per switch		0.41		mΩ	
Storage temperature	$T_{stg}$		-40		150	°C	
Mounting torque for module mounting	$M$	- Mounting according to valid application note	M6, Screw	4.25		5.75	Nm
Terminal connection torque	$M$	- Mounting according to valid application note	M3, Screw	0.9		1.1	Nm
			M8, Screw	8		10	
Weight	$G$			700		g	

## 2 IGBT, Inverter

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Collector-emitter voltage	$V_{CES}$		$T_{vj} = -40^\circ\text{C}$	3300	V
			$T_{vj} = 150^\circ\text{C}$	3300	
Continuous DC collector current	$I_{CDC}$	$T_{vj\ max} = 150^\circ\text{C}$	$T_C = 100^\circ\text{C}$	450	A

(table continues...)

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

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{vj\ op}$	900	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	$V_{CE\ sat}$	$I_C = 450\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	2.50	2.75	V
			$T_{vj} = 125\ ^\circ C$	2.90		
			$T_{vj} = 150\ ^\circ C$	3.00	3.30	
Gate threshold voltage	$V_{GEth}$	$I_C = 12\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.20	5.80	6.40	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\ V, V_{CE} = 1800\ V$		12.5		$\mu C$
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\ ^\circ C$		1.3		$\Omega$
Input capacitance	$C_{ies}$	$f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		84		nF
Reverse transfer capacitance	$C_{res}$	$f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		2		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 3300\ V, V_{GE} = 0\ V$			5	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)	$t_{don}$	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.530		$\mu s$
			$T_{vj} = 125\ ^\circ C$	0.570		
			$T_{vj} = 150\ ^\circ C$	0.580		
Rise time (inductive load)	$t_r$	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.100		$\mu s$
			$T_{vj} = 125\ ^\circ C$	0.130		
			$T_{vj} = 150\ ^\circ C$	0.130		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$	1.710		$\mu s$
			$T_{vj} = 125\ ^\circ C$	1.860		
			$T_{vj} = 150\ ^\circ C$	1.920		
Fall time (inductive load)	$t_f$	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.130		$\mu s$
			$T_{vj} = 125\ ^\circ C$	0.240		
			$T_{vj} = 150\ ^\circ C$	0.270		
Turn-on time (resistive load)	$t_{on\_R}$	$I_C = 500\ A, V_{CE} = 2000\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	1.15			$\mu s$

**(table continues...)**

**Table 4 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on energy loss per pulse	$E_{on}$	$I_C = 450\text{ A}, V_{CE} = 1800\text{ V}, L_\sigma = 85\text{ nH}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 0.7\ \Omega, di/dt = 3650\text{ A}/\mu\text{s} (T_{vj} = 150\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	500		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	765		
			$T_{vj} = 150\text{ }^\circ\text{C}$	845		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 450\text{ A}, V_{CE} = 1800\text{ V}, L_\sigma = 85\text{ nH}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 3.3\ \Omega, dv/dt = 2850\text{ V}/\mu\text{s} (T_{vj} = 150\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	415		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	610		
			$T_{vj} = 150\text{ }^\circ\text{C}$	670		
SC data	$I_{SC}$	$V_{GE} \leq 15\text{ V}, V_{CC} = 2500\text{ V}, V_{CEmax} = V_{CES} - L_{sCE} * di/dt$	$t_p \leq 10\ \mu\text{s}, T_{vj} \leq 150\text{ }^\circ\text{C}$	1800		A
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			28.4	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$		17.4		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-40		150	$^\circ\text{C}$

### 3 Diode, Inverter

**Table 5 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$		$T_{vj} = -40\text{ }^\circ\text{C}$	3300	V
			$T_{vj} = 150\text{ }^\circ\text{C}$	3300	
Continuous DC forward current	$I_F$		450	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	900	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}, V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	82.9	kA <sup>2</sup> s
			$T_{vj} = 150\text{ }^\circ\text{C}$	68	
Maximum power dissipation	$P_{RQM}$		$T_{vj} = 150\text{ }^\circ\text{C}$	1000	kW
Minimum turn-on time	$t_{onmin}$			10	$\mu\text{s}$

**Table 6** Characteristic values

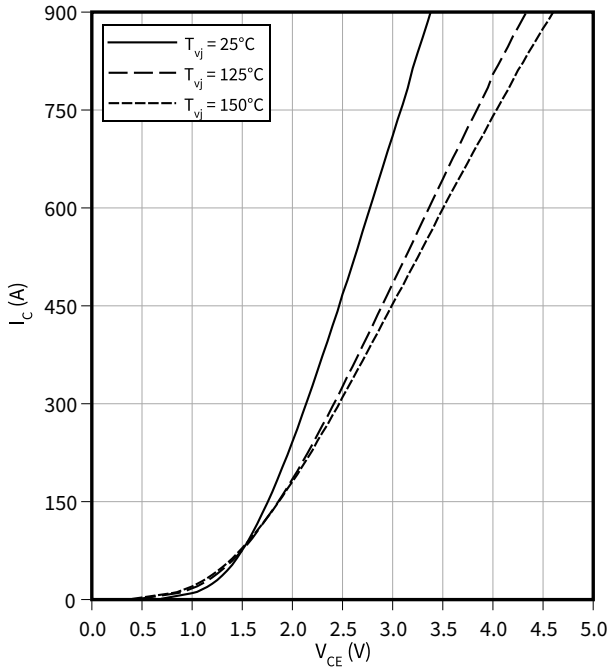
Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	$V_F$	$I_F = 450 \text{ A}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		3.10	3.50	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$		2.75		
			$T_{vj} = 150 \text{ }^\circ\text{C}$		2.65	2.95	
Peak reverse recovery current	$I_{RM}$	$V_R = 1800 \text{ V}, I_F = 450 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 3650 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ }^\circ\text{C})$	$T_{vj} = 25 \text{ }^\circ\text{C}$		680		A
			$T_{vj} = 125 \text{ }^\circ\text{C}$		680		
			$T_{vj} = 150 \text{ }^\circ\text{C}$		680		
Recovered charge	$Q_r$	$V_R = 1800 \text{ V}, I_F = 450 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 3650 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ }^\circ\text{C})$	$T_{vj} = 25 \text{ }^\circ\text{C}$		230		$\mu\text{C}$
			$T_{vj} = 125 \text{ }^\circ\text{C}$		445		
			$T_{vj} = 150 \text{ }^\circ\text{C}$		525		
Reverse recovery energy	$E_{rec}$	$V_R = 1800 \text{ V}, I_F = 450 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 3650 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ }^\circ\text{C})$	$T_{vj} = 25 \text{ }^\circ\text{C}$		220		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$		490		
			$T_{vj} = 150 \text{ }^\circ\text{C}$		595		
Thermal resistance, junction to case	$R_{thJC}$	per diode				45.5	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 1 \text{ W}/(\text{m}^*\text{K})$			19.3		K/kW
Temperature under switching conditions	$T_{vj op}$			-40		150	$^\circ\text{C}$

## 4 Characteristics diagrams

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

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

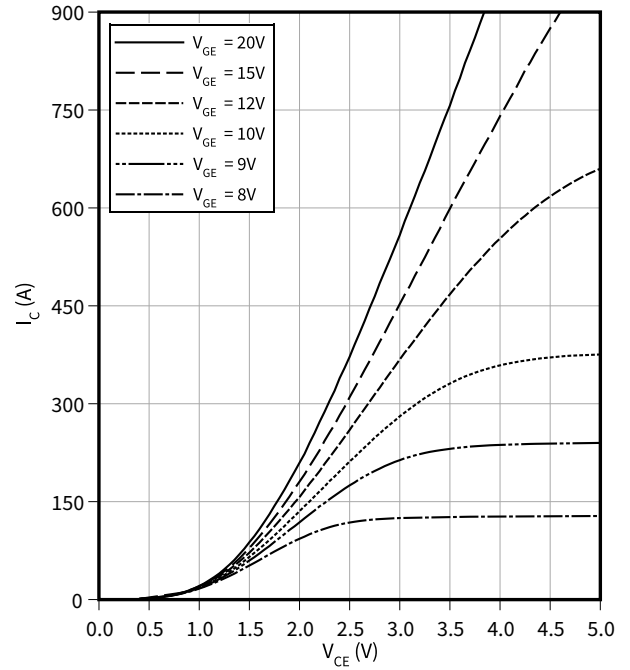
$$V_{GE} = 15 \text{ V}$$



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

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

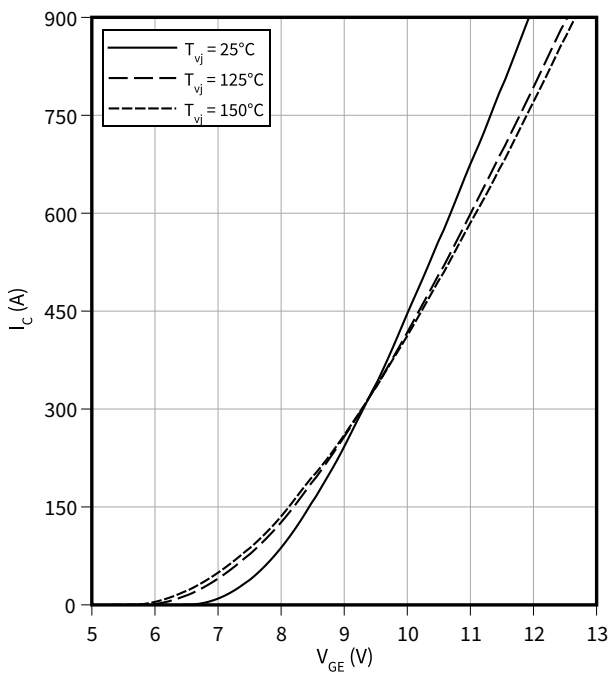
$$T_{vj} = 150 \text{ °C}$$



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

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

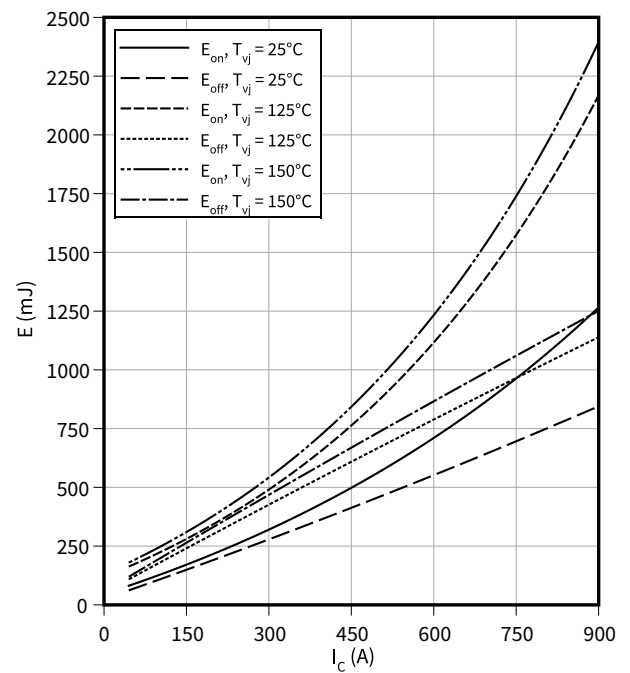
$$V_{CE} = 20 \text{ V}$$



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

$$E = f(I_C)$$

$$R_{Goff} = 3.3 \text{ } \Omega, R_{Gon} = 0.7 \text{ } \Omega, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}$$

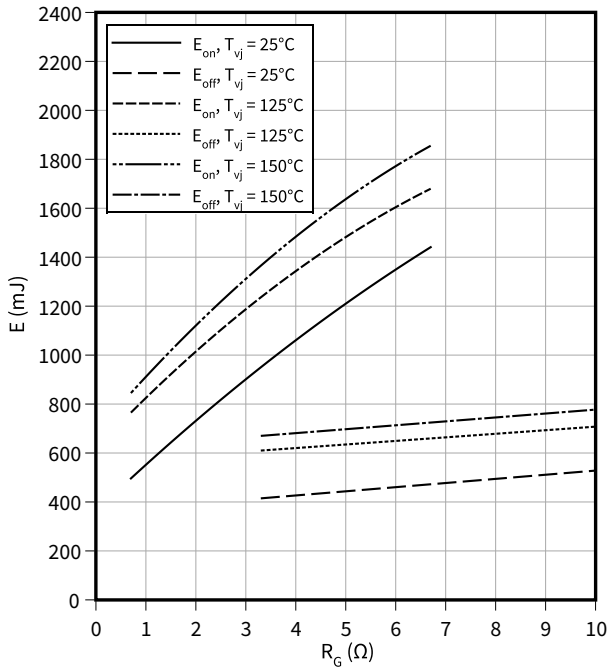


4 Characteristics diagrams

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

$E = f(R_G)$

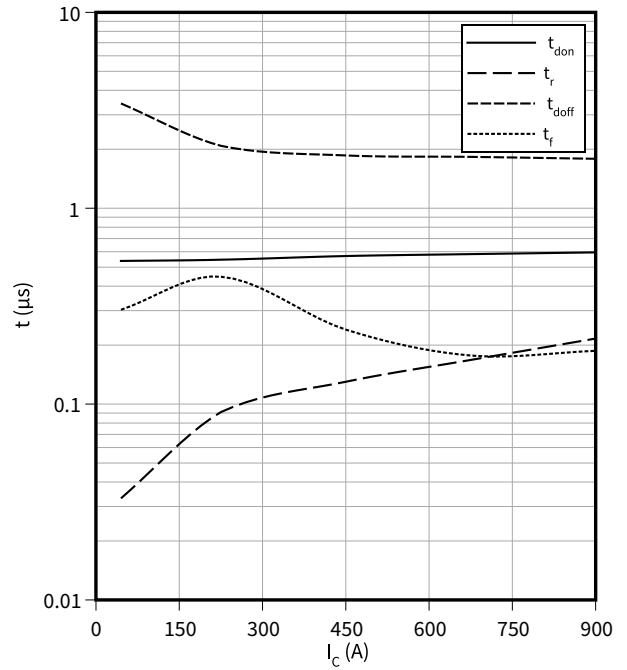
$I_C = 450 \text{ A}, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}$



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

$t = f(I_C)$

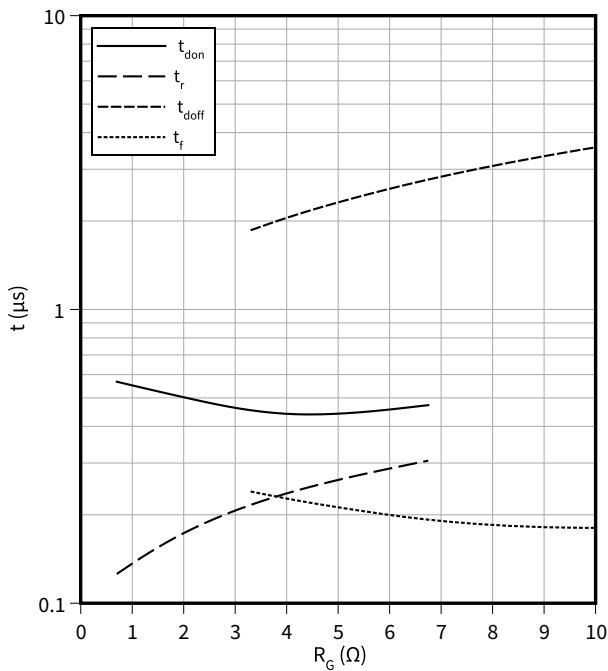
$R_{Goff} = 3.3 \Omega, R_{Gon} = 0.7 \Omega, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 150 \text{ °C}$



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

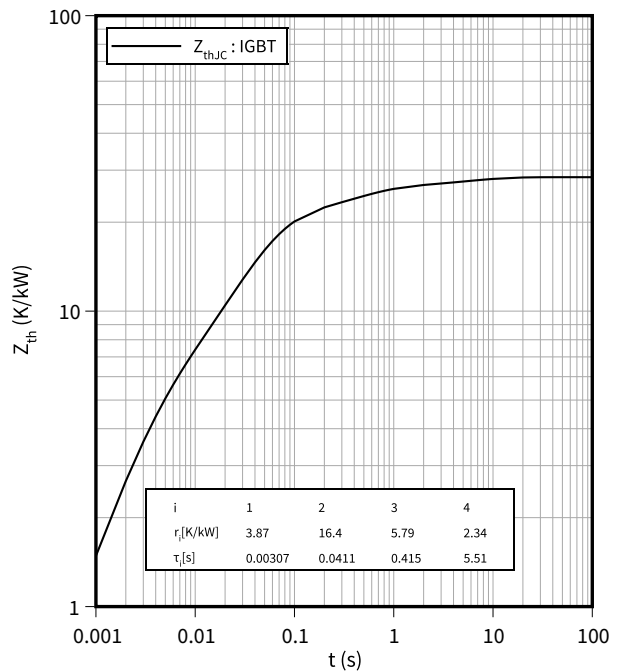
$t = f(R_G)$

$I_C = 450 \text{ A}, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 150 \text{ °C}$



**Transient thermal impedance, IGBT, Inverter**

$Z_{th} = f(t)$



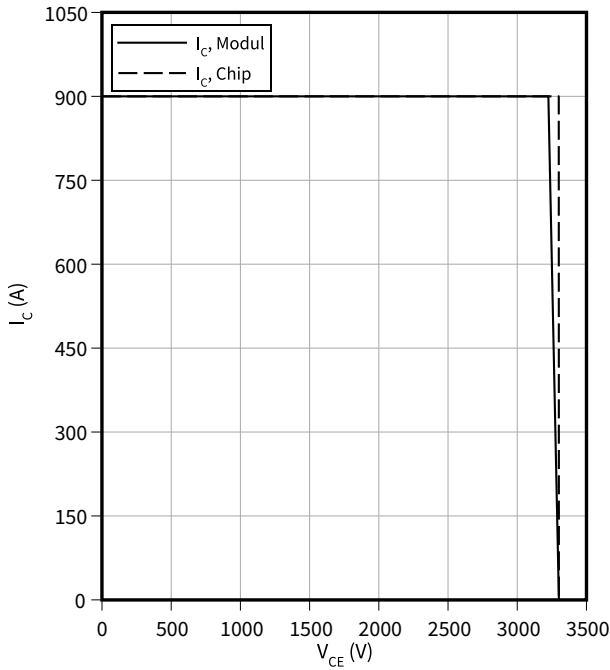


4 Characteristics diagrams

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

$I_C = f(V_{CE})$

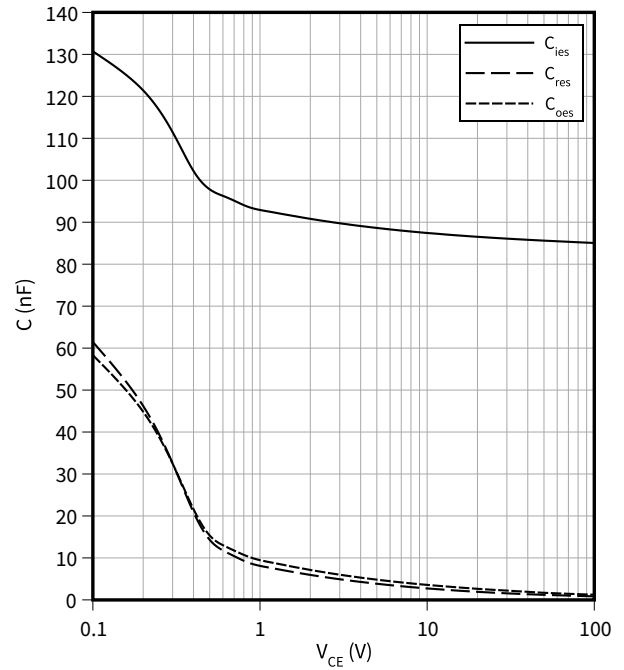
$R_{Goff} = 3.3 \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $T_{vj} = 150 \text{ }^\circ\text{C}$



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

$C = f(V_{CE})$

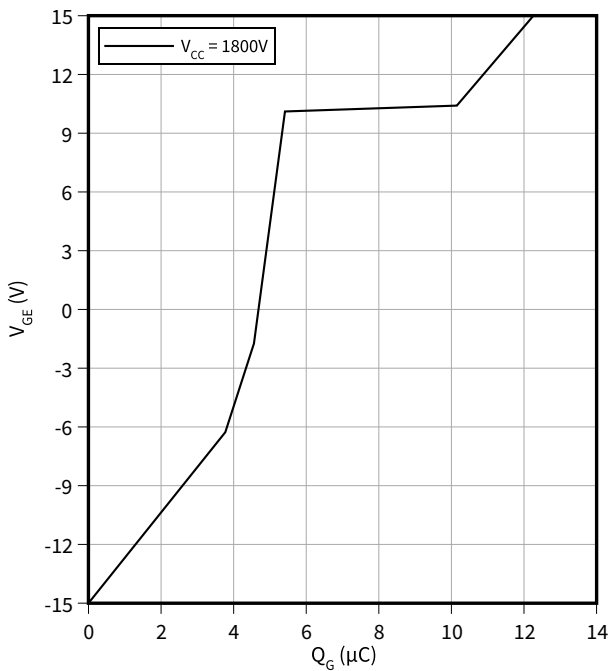
$f = 1000 \text{ kHz}$ ,  $V_{GE} = 0 \text{ V}$ ,  $T_{vj} = 25 \text{ }^\circ\text{C}$



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

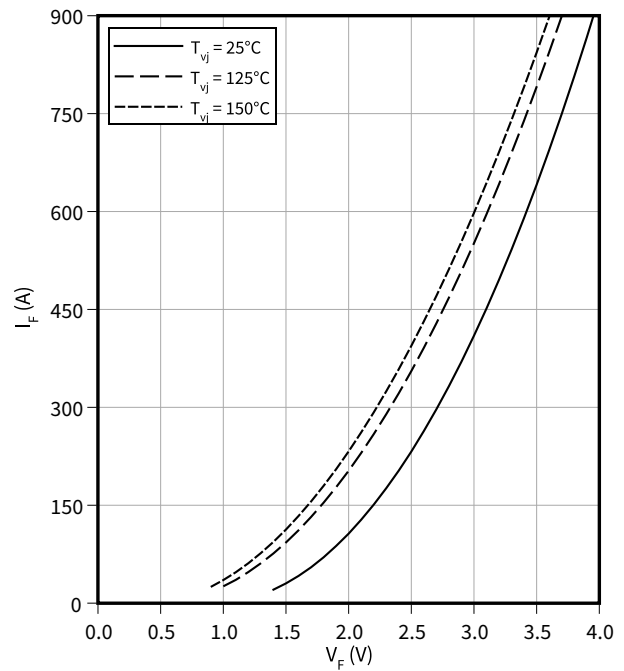
$V_{GE} = f(Q_G)$

$I_C = 450 \text{ A}$ ,  $T_{vj} = 25 \text{ }^\circ\text{C}$



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

$I_F = f(V_F)$

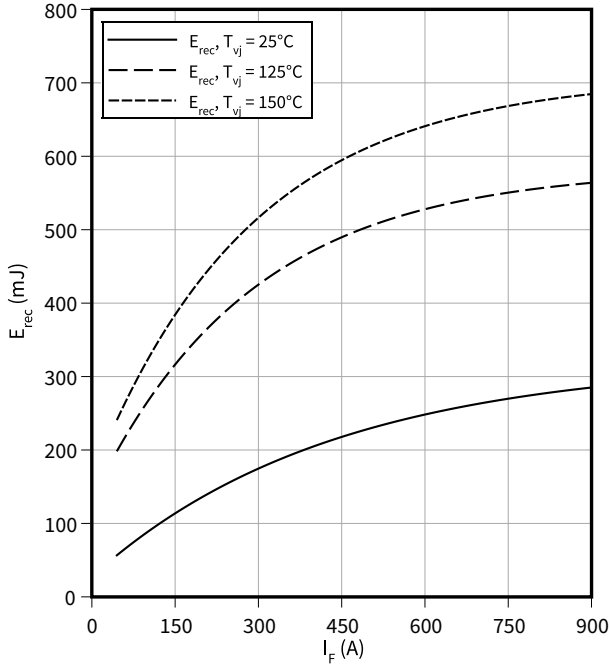


4 Characteristics diagrams

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

$E_{rec} = f(I_F)$

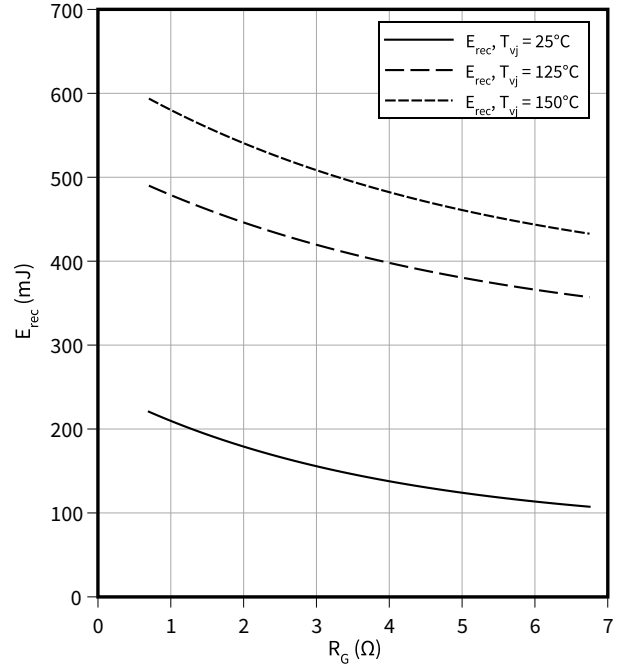
$V_{CE} = 1800\text{ V}$ ,  $R_{Gon} = R_{Gon}(IGBT)$



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

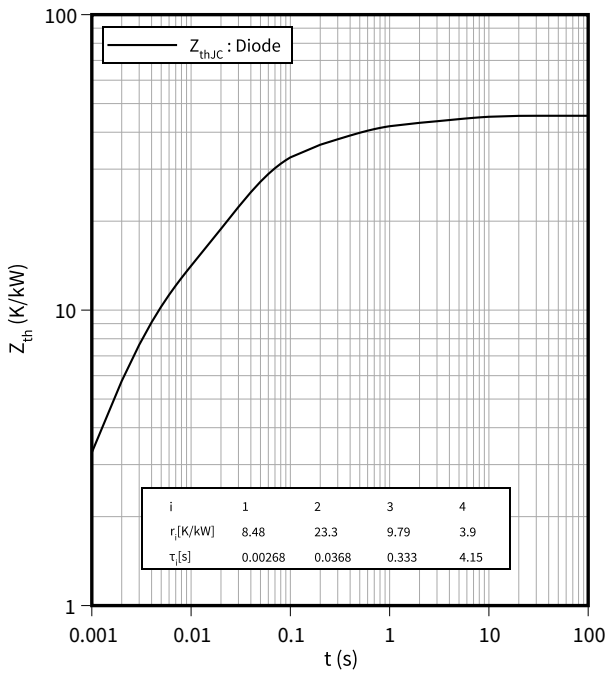
$E_{rec} = f(R_G)$

$V_{CE} = 1800\text{ V}$ ,  $I_F = 450\text{ A}$



**Transient thermal impedance, Diode, Inverter**

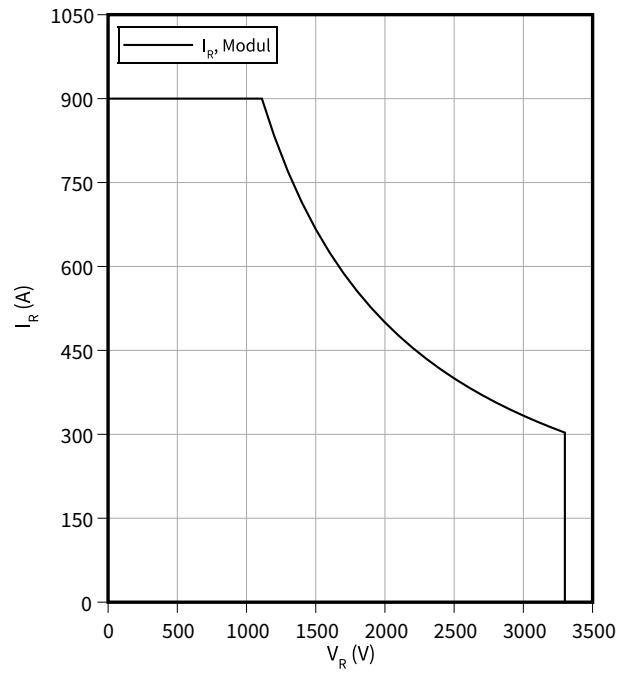
$Z_{th} = f(t)$



**Safe operating area (SOA), Diode, Inverter**

$I_R = f(V_R)$

$T_{vj} = 150\text{ °C}$



## 5 Circuit diagram

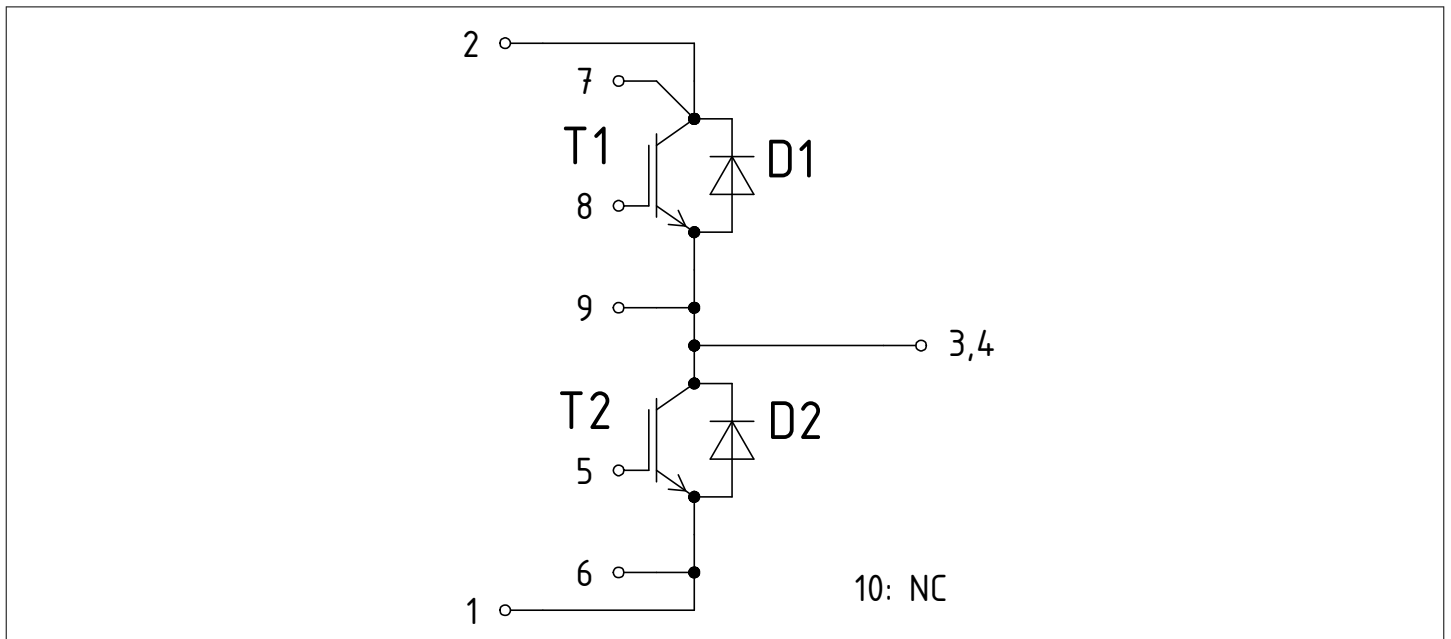


Figure 1

## 6 Package outlines

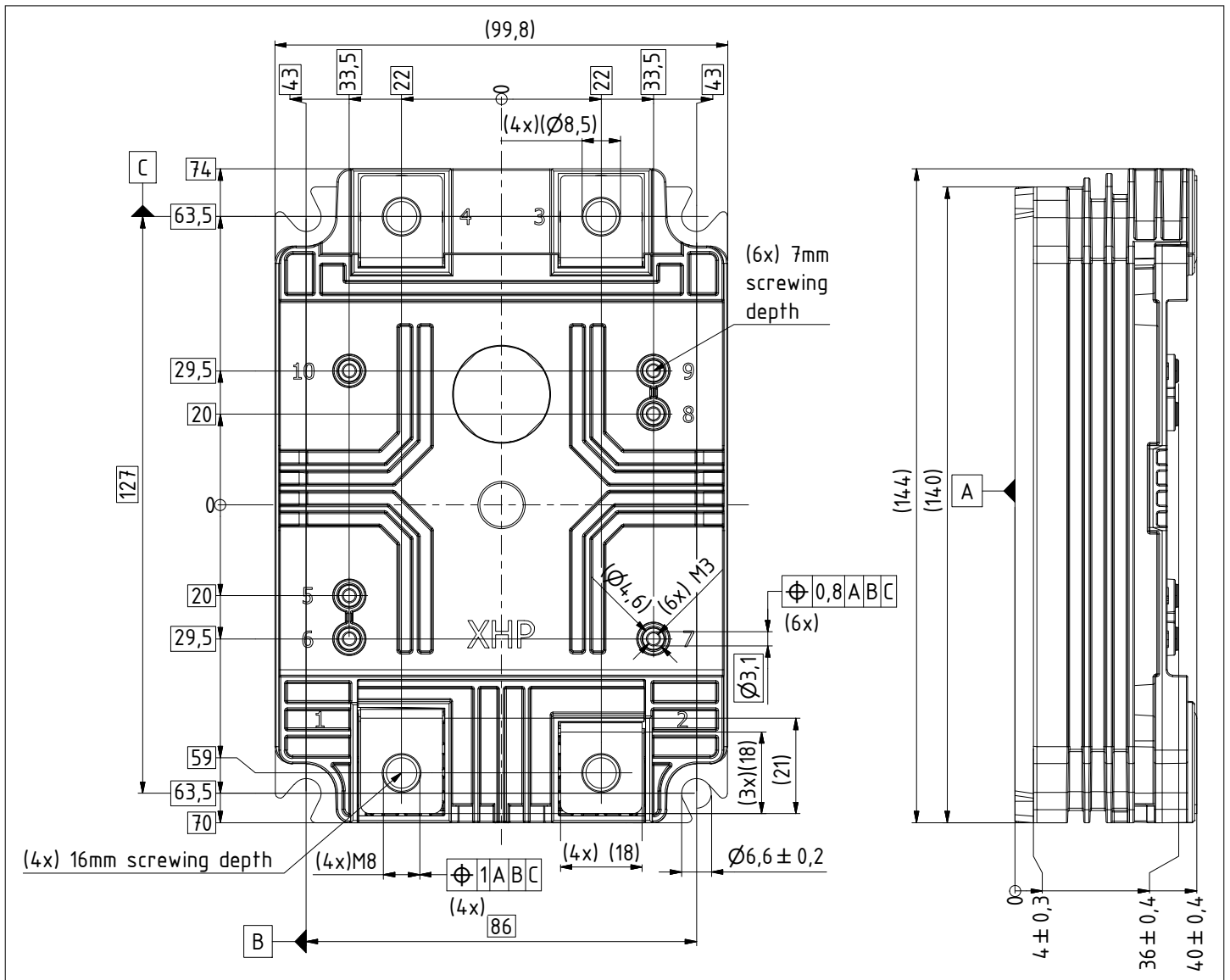


Figure 2

## 7 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
V2.0	2018-10-08	Preliminary datasheet
V3.0	2019-01-28	Final datasheet
V3.1	2020-01-27	Final datasheet
n/a	2020-09-01	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.10	2021-11-04	Final datasheet
1.20	2022-04-06	Final datasheet

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