

## Final datasheet

### XHP™2 module with Trench/Fieldstop IGBT5, emitter controlled 5 diode and NTC

#### Features

- Electrical features
  - $V_{CES} = 1700\text{ V}$
  - $I_{C\text{ nom}} = 1800\text{ A} / I_{CRM} = 3600\text{ A}$
  - Extended operating temperature  $T_{vj\text{ op}}$
  - High current density
  - Low switching losses
  - Low  $V_{CE,\text{sat}}$
  - $T_{vj,\text{op}} = 175^\circ\text{C}$
- Mechanical features
  - High creepage and clearance distances
  - High power and thermal cycling capability
  - High power density
  - Package with CTI > 600



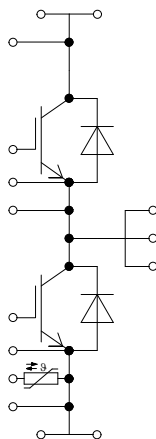
#### Potential applications

- Motor drives
- Traction drives
- Wind turbines
- High-power 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, $f = 50$ Hz	4.0	kV
Material of module baseplate			Cu	
Creepage distance	$d_{Creep}$	terminal to heatsink	40.0	mm
Creepage distance	$d_{Creep}$	terminal to terminal	34.0	mm
Clearance	$d_{Clear}$	terminal to heatsink	31.0	mm
Clearance	$d_{Clear}$	terminal to terminal	8.0	mm
Comparative tracking index	$CTI$		> 600	

**Table 2** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray inductance module	$L_{sCE}$			10		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C = 25$ °C, per switch		0.25		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25$ °C, per switch		0.3		mΩ
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	M6, Screw	3	6	Nm
Terminal connection torque	$M$	- Mounting according to valid application note	M3, Screw	0.9	1.1	Nm
			M8, Screw	8	10	
Weight	$G$			1020		g

## 2 IGBT, Inverter

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	$V_{CES}$	$T_{vj} = 25$ °C	1700	V
Implemented collector current	$I_{CN}$		1800	A
Continuous DC collector current	$I_{CDC}$	$T_{vj\ max} = 175$ °C $T_C = 60$ °C	1800	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 $T_{vj\ op}$	3600	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	$V_{CE\ sat}$	$I_C = 1800\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.80	2.25	V
			$T_{vj} = 125\ ^\circ C$	2.20	2.75	
			$T_{vj} = 175\ ^\circ C$	2.40	3.00	
Gate threshold voltage	$V_{GEth}$	$I_C = 58\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.35	5.80	6.25	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\ V, V_{CC} = 900\ V$		8.25		μC
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\ ^\circ C$		0.5		Ω
Input capacitance	$C_{ies}$	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		84		nF
Reverse transfer capacitance	$C_{res}$	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		3		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 1700\ V, V_{GE} = 0\ V$			10	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)	$t_{don}$	$I_C = 1800\ A, V_{CC} = 900\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.190		μs
			$T_{vj} = 125\ ^\circ C$	0.200		
			$T_{vj} = 175\ ^\circ C$	0.210		
Rise time (inductive load)	$t_r$	$I_C = 1800\ A, V_{CC} = 900\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.110		μs
			$T_{vj} = 125\ ^\circ C$	0.125		
			$T_{vj} = 175\ ^\circ C$	0.130		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 1800\ A, V_{CC} = 900\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3\ \Omega$	$T_{vj} = 25\ ^\circ C$	1.060		μs
			$T_{vj} = 125\ ^\circ C$	1.160		
			$T_{vj} = 175\ ^\circ C$	1.220		
Fall time (inductive load)	$t_f$	$I_C = 1800\ A, V_{CC} = 900\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.160		μs
			$T_{vj} = 125\ ^\circ C$	0.370		
			$T_{vj} = 175\ ^\circ C$	0.510		
Turn-on energy loss per pulse	$E_{on}$	$I_C = 1800\ A, V_{CC} = 900\ V, L_\sigma = 20\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 0.5\ \Omega, di/dt = 14500\ A/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	330		mJ
			$T_{vj} = 125\ ^\circ C$	490		
			$T_{vj} = 175\ ^\circ C$	615		

(table continues...)

**Table 4** (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off energy loss per pulse	$E_{off}$	$I_C = 1800\text{ A}$ , $V_{CC} = 900\text{ V}$ , $L_\sigma = 20\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Goff} = 3\ \Omega$ , $dv/dt = 1800\text{ V}/\mu\text{s}$ ( $T_{vj} = 175\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	550		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	707		
			$T_{vj} = 175\text{ }^\circ\text{C}$	800		
SC data	$I_{SC}$	$V_{GE} \leq 15\text{ V}$ , $V_{CC} = 1000\text{ V}$ , $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_p \leq 10\ \mu\text{s}$ , $T_{vj} = 175\text{ }^\circ\text{C}$	7100		A
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			20.6	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{K})$		14.2		K/kW
Temperature under switching conditions	$T_{vjop}$		-40		175	$^\circ\text{C}$

### 3 Diode, Inverter

**Table 5** **Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1700	V	
Continuous DC forward current	$I_F$		1800	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	3600	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}$ , $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	730	kA <sup>2</sup> s
			$T_{vj} = 175\text{ }^\circ\text{C}$	650	
Maximum power dissipation	$P_{RQM}$	$T_{vj} = 175\text{ }^\circ\text{C}$	1800	kW	

**Table 6** **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$I_F = 1800\text{ A}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1.75	2.10	V
			$T_{vj} = 125\text{ }^\circ\text{C}$	1.70	2.05	
			$T_{vj} = 175\text{ }^\circ\text{C}$	1.70	2.05	
Peak reverse recovery current	$I_{RM}$	$V_{CC} = 900\text{ V}$ , $I_F = 1800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 14500\text{ A}/\mu\text{s}$ ( $T_{vj} = 175\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	1700		A
			$T_{vj} = 125\text{ }^\circ\text{C}$	2000		
			$T_{vj} = 175\text{ }^\circ\text{C}$	2200		

(table continues...)

**Table 6** (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Recovered charge	$Q_r$	$V_{CC} = 900\text{ V}$ , $I_F = 1800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt =$ $14500\text{ A}/\mu\text{s}$ ( $T_{vj} = 175\text{ °C}$ )	$T_{vj} = 25\text{ °C}$	350		$\mu\text{C}$
			$T_{vj} = 125\text{ °C}$	640		
			$T_{vj} = 175\text{ °C}$	850		
Reverse recovery energy	$E_{rec}$	$V_{CC} = 900\text{ V}$ , $I_F = 1800\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt =$ $14500\text{ A}/\mu\text{s}$ ( $T_{vj} = 175\text{ °C}$ )	$T_{vj} = 25\text{ °C}$	220		mJ
			$T_{vj} = 125\text{ °C}$	410		
			$T_{vj} = 175\text{ °C}$	540		
Thermal resistance, junction to case	$R_{thJC}$	per diode			39.1	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{K})$		20.4		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$		-40		175	$^{\circ}\text{C}$

## 4 NTC-Thermistor

**Table 7** **Characteristic values**

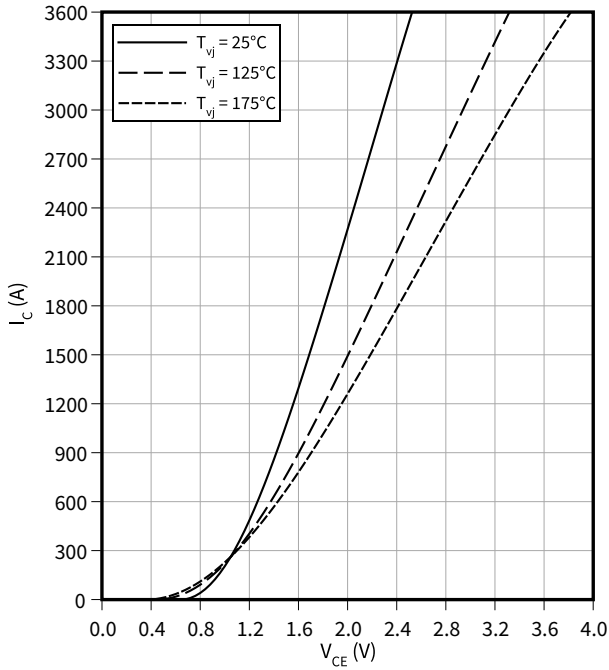
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	$R_{25}$	$T_{NTC} = 25\text{ °C}$		5		k $\Omega$
Deviation of $R_{100}$	$\Delta R/R$	$T_{NTC} = 100\text{ °C}$ , $R_{100} = 493\text{ }\Omega$	-5		5	%
Power dissipation	$P_{25}$	$T_{NTC} = 25\text{ °C}$			20	mW
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**

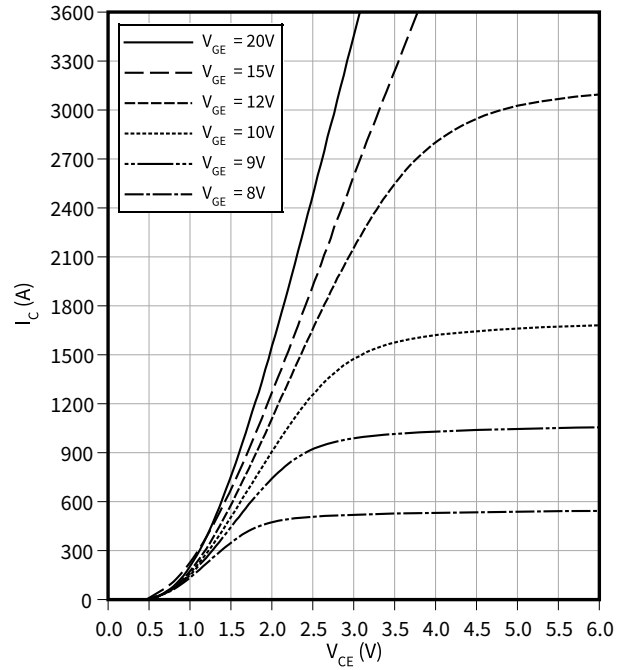
**Output characteristic (typical), IGBT, Inverter**

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



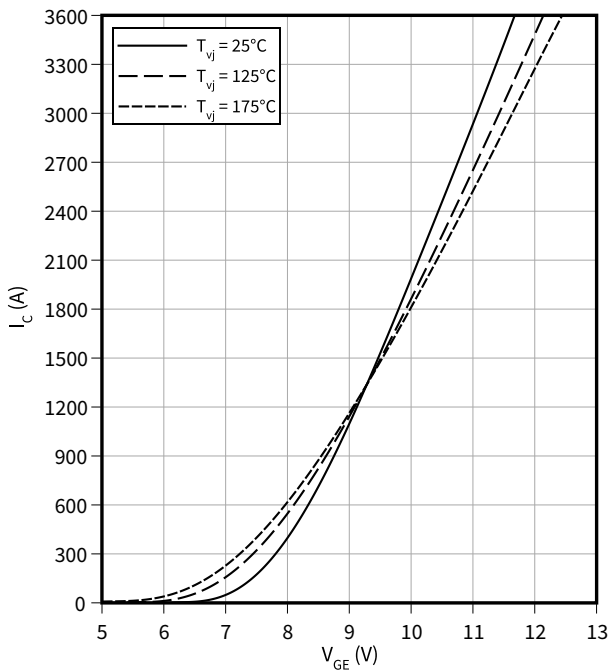
**Output characteristic field (typical), IGBT, Inverter**

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



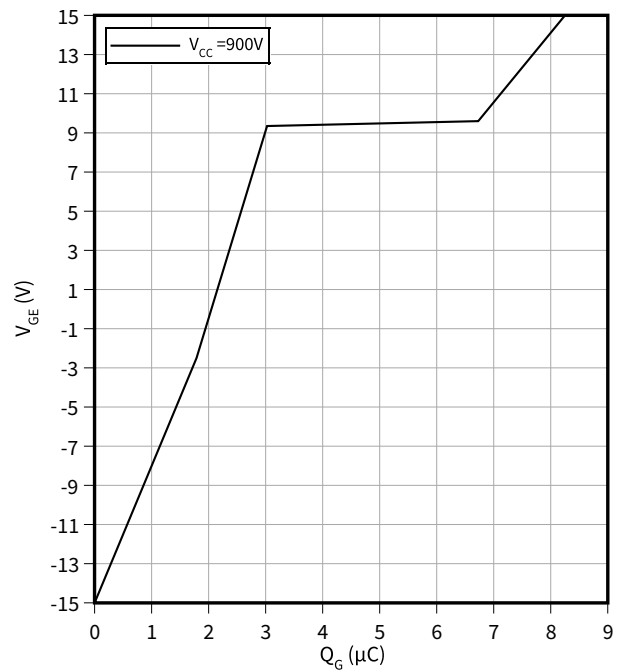
**Transfer characteristic (typical), IGBT, Inverter**

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



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

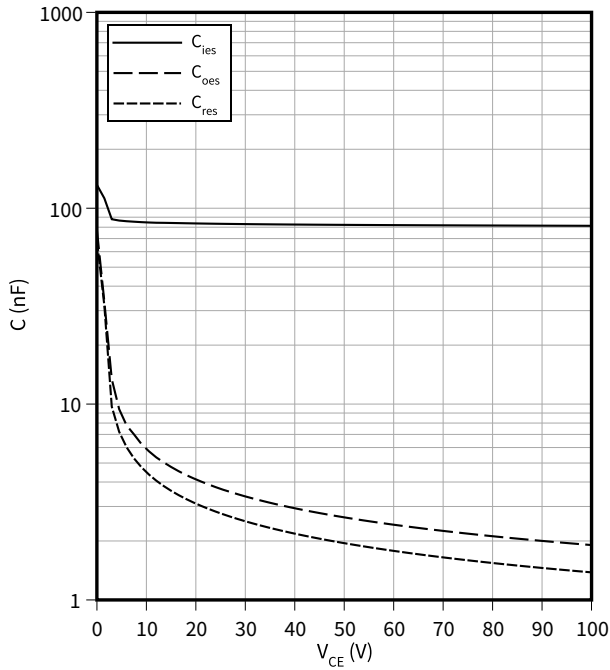
$V_{GE} = f(Q_G)$   
 $I_C = 1800\text{ A}, T_{vj} = 25\text{ °C}$



5 Characteristics diagrams

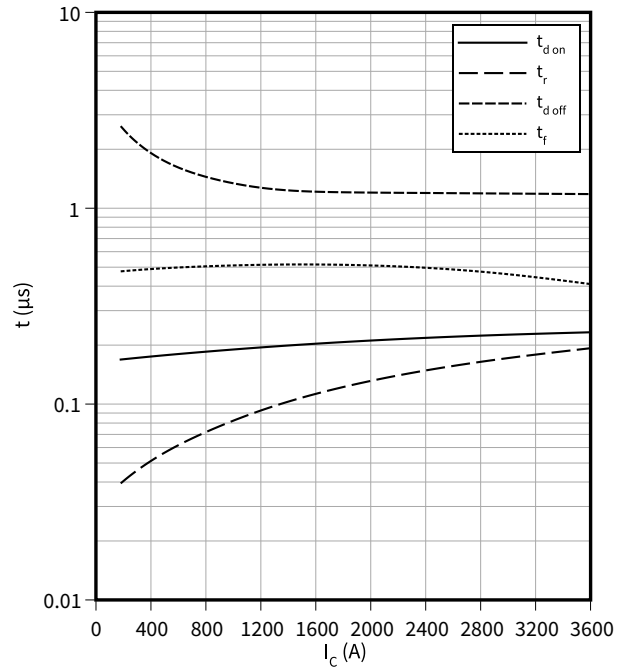
**Capacity characteristic (typical), IGBT, Inverter**

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



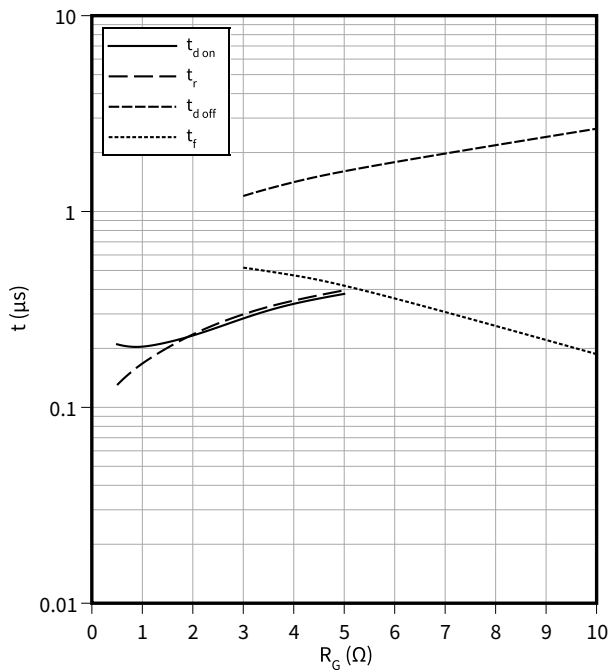
**Switching times (typical), IGBT, Inverter**

$t = f(I_C)$   
 $R_{Goff} = 3 \text{ } \Omega, R_{Gon} = 0.5 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, V_{CC} = 900 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}$



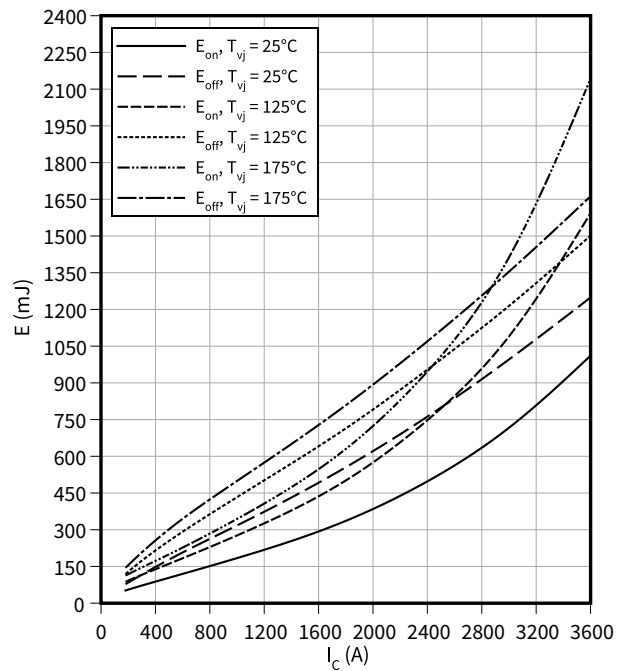
**Switching times (typical), IGBT, Inverter**

$t = f(R_G)$   
 $V_{GE} = \pm 15 \text{ V}, I_C = 1800 \text{ A}, V_{CC} = 900 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}$



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

$E = f(I_C)$   
 $R_{Goff} = 3 \text{ } \Omega, R_{Gon} = 0.5 \text{ } \Omega, V_{CC} = 900 \text{ V}, V_{GE} = \pm 15 \text{ V}$

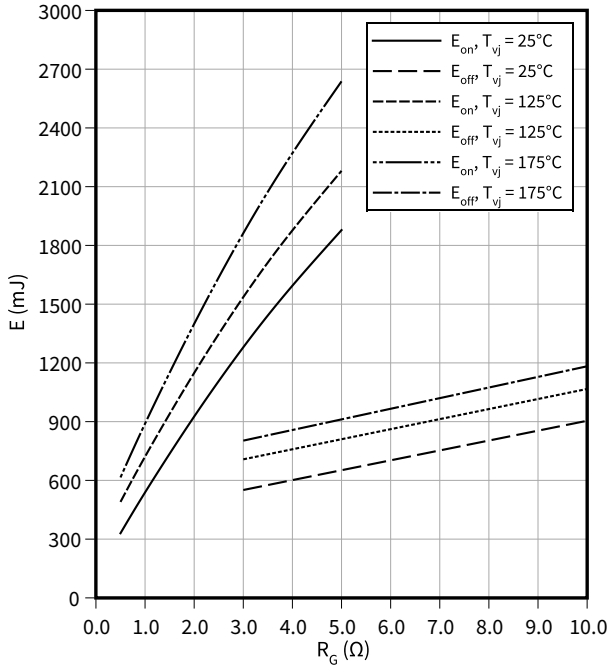


**5 Characteristics diagrams**

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

$E = f(R_G)$

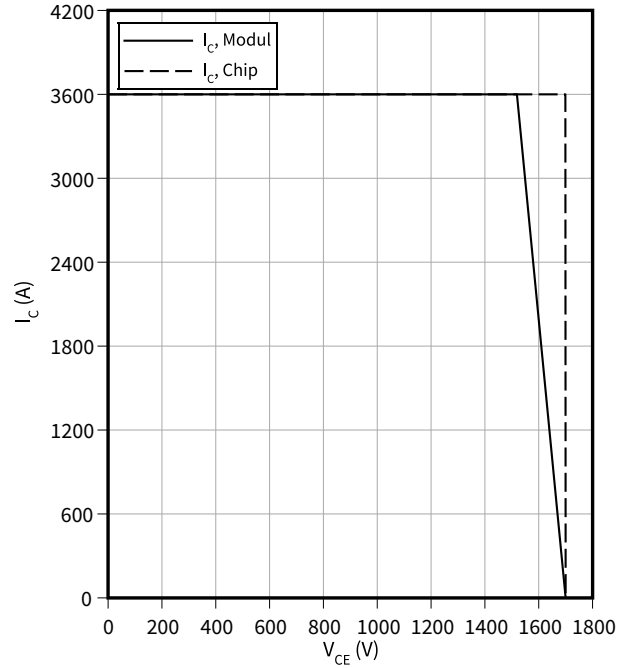
$I_C = 1800 \text{ A}$ ,  $V_{CC} = 900 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$



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

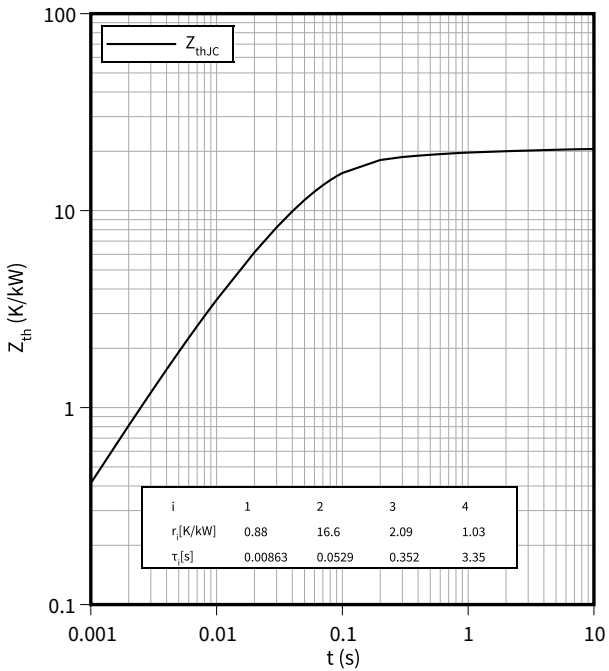
$I_C = f(V_{CE})$

$R_{Goff} \geq 3 \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $T_{vj} = 175 \text{ °C}$



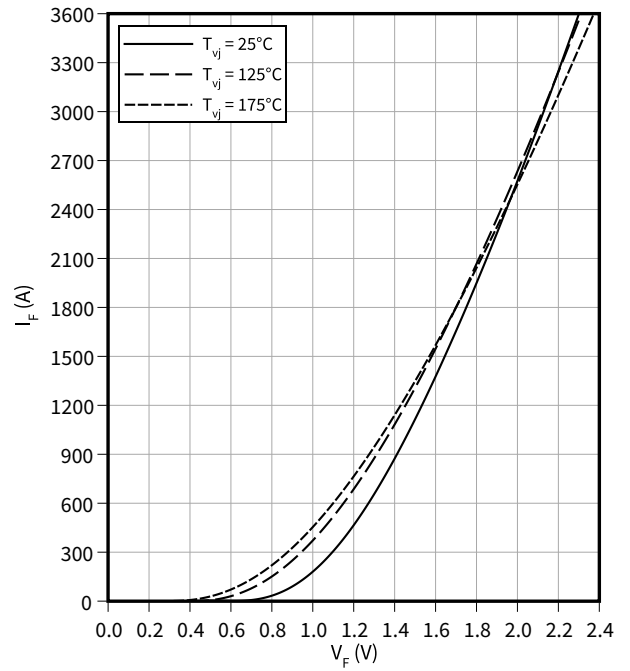
**Transient thermal impedance, IGBT, Inverter**

$Z_{th} = f(t)$



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

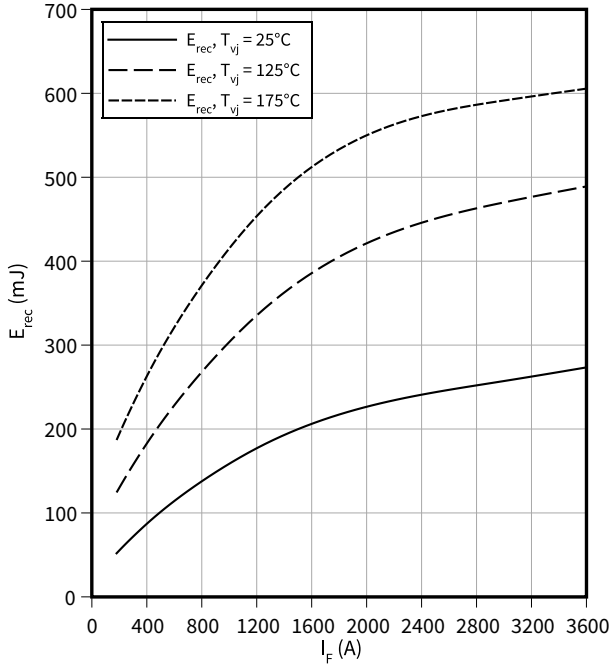
$I_F = f(V_F)$



**5 Characteristics diagrams**

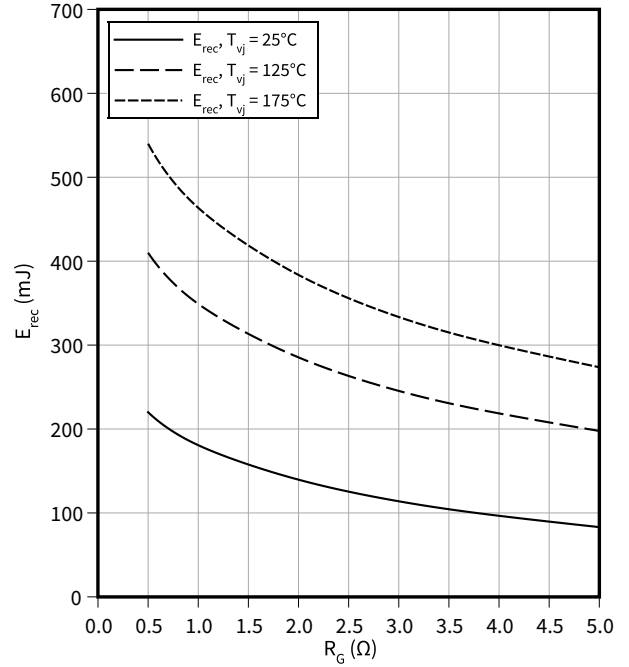
**Switching losses (typical), Diode, Inverter**

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



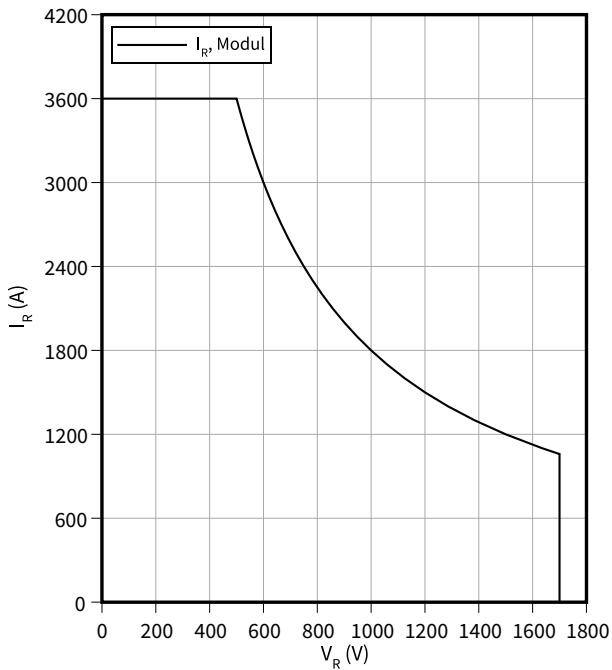
**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(R_G)$   
 $V_{CE} = 900\text{ V}, I_F = 1800\text{ A}$



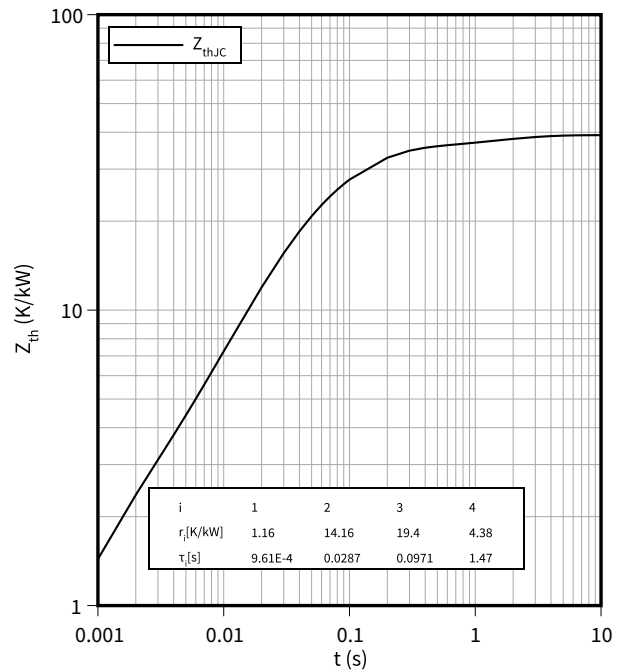
**Safe operating area (SOA), Diode, Inverter**

$I_R = f(V_R)$   
 $T_{vj} = 175\text{ °C}$



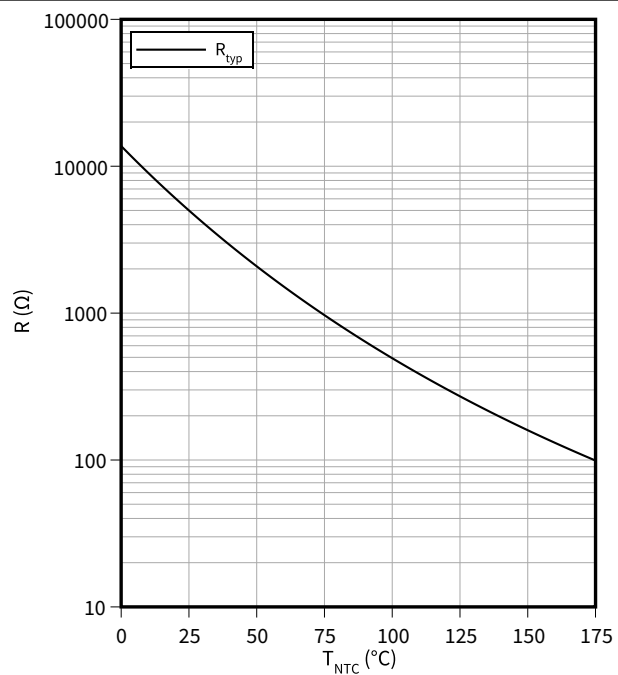
**Transient thermal impedance, Diode, Inverter**

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$$R = f(T_{NTC})$$



## 6 Circuit diagram

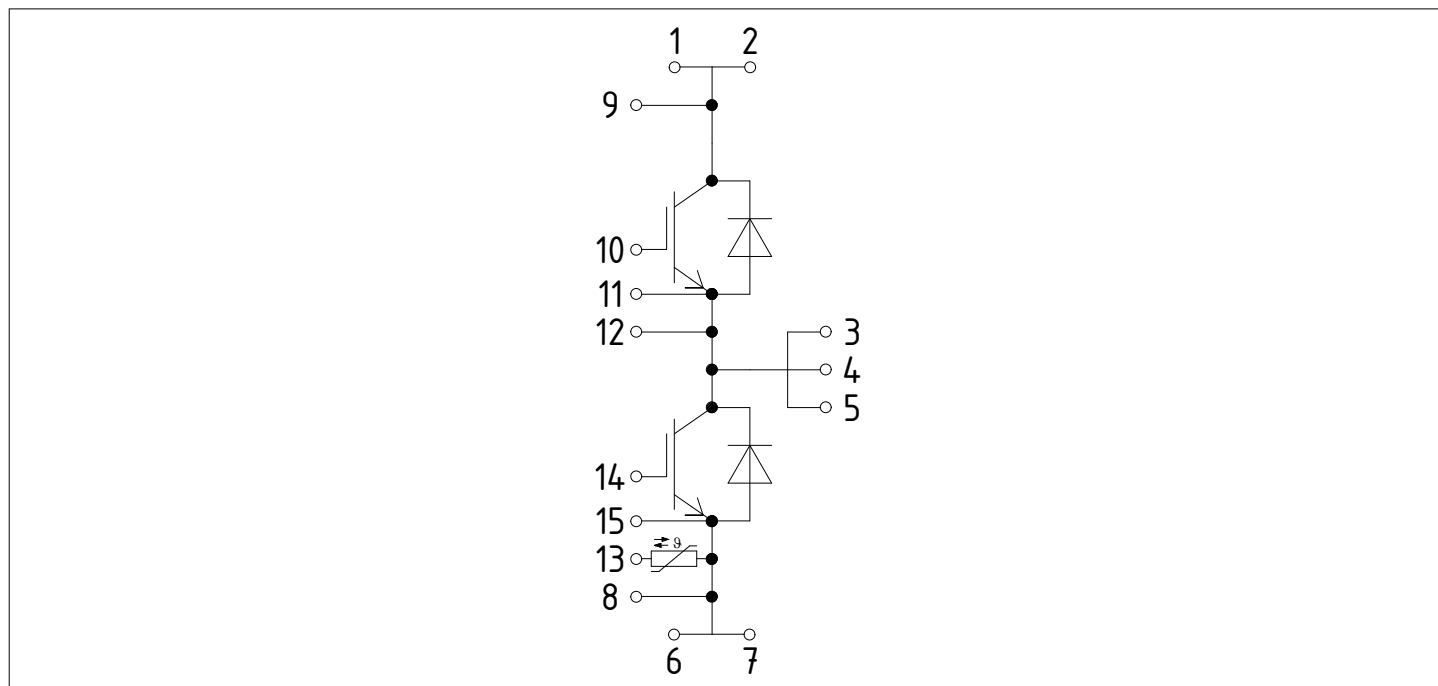


Figure 1

## 7 Package outlines

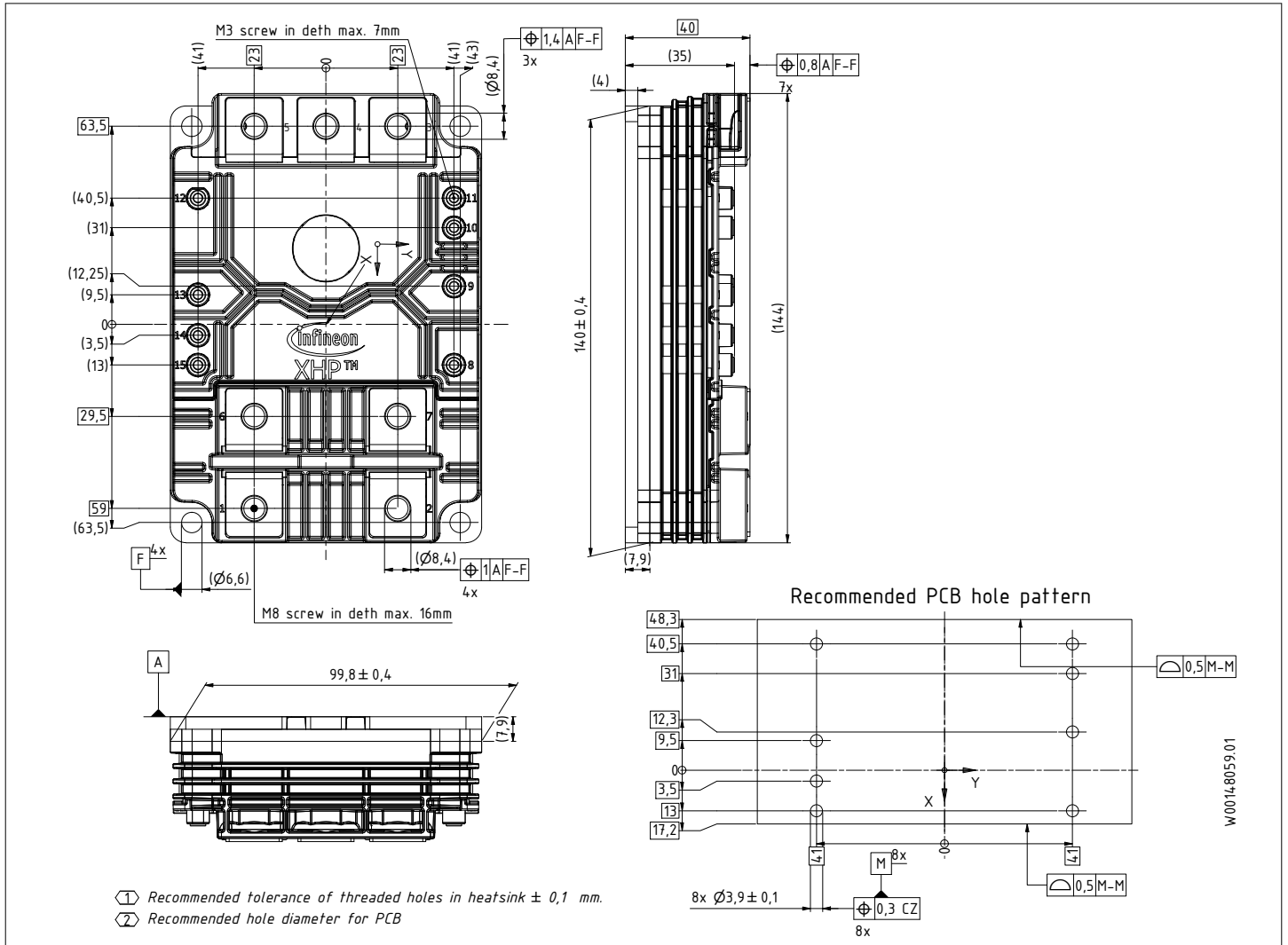

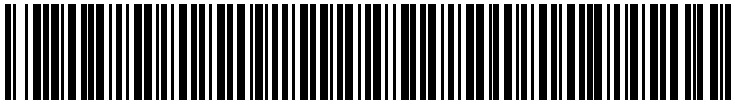


Figure 2

## 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
V1.0	2019-02-07	Target datasheet
V1.1	2020-04-02	Target 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
0.10	2021-04-29	Target datasheet
0.20	2022-11-03	Preliminary datasheet
1.00	2023-10-30	Final datasheet

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