

## Final datasheet

### XHP™2 module with TRENCHSTOP™ IGBT7 and emitter controlled 7 diode and NTC

#### Features

- Electrical features
  - $V_{CES} = 2300\text{ V}$
  - $I_{C\text{ nom}} = 1400\text{ A} / I_{CRM} = 2800\text{ A}$
  - $T_{vj,op} = 175^{\circ}\text{C}$
  - Low  $V_{CE,sat}$
  - Low switching losses
  - High current density
  - Low inductive design
- Mechanical features
  - High power density
  - High creepage and clearance distances
  - Package with CTI > 600
  - 6kV AC insulation



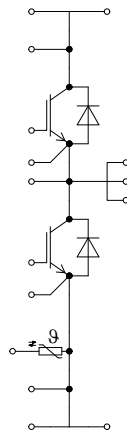
#### Potential applications

- High-power converters
- Motor drives
- Wind turbines

#### Product validation

- Qualified for commercial applications based on the test conditions in 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	6.0	kV
Partial discharge extinction voltage	$V_{isol}$	RMS, $f = 50$ Hz, $Q_{PD} < 10$ pC	2.6	kV
Material of module baseplate			AlSiC	
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	
Main emitter inductance 1	$L_{s(E1-E1m)}$			1.5		nH	
Main emitter inductance 2	$L_{s(E2-E2m)}$			3.5		nH	
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C = 25$ °C, per switch		0.33		mΩ	
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25$ °C, per switch		0.38		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	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	$G$			720		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	2300	V
Implemented collector current	$I_{CN}$			1400	A
Continuous DC collector current	$I_{CDC}$	$T_{vj\ max} = 175$ °C	$T_C = 80$ °C	1150	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 $T_{vj\ op}$	2800	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	$V_{CE\ sat}$	$I_C = 1400\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.85	2.30	V
			$T_{vj} = 125\ ^\circ C$	2.25	3.05	
			$T_{vj} = 175\ ^\circ C$	2.50	3.50	
Gate threshold voltage	$V_{GEth}$	$I_C = 36\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.15	5.80	6.45	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\ V, V_{CC} = 1500\ V$		10.5		μC
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\ ^\circ C$		0.67		Ω
Input capacitance	$C_{ies}$	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		162		nF
Reverse transfer capacitance	$C_{res}$	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		0.39		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 2300\ V, V_{GE} = 0\ V$			30	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)	$t_{don}$	$I_C = 1400\ A, V_{CC} = 1500\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.380		μs
			$T_{vj} = 125\ ^\circ C$	0.420		
			$T_{vj} = 175\ ^\circ C$	0.450		
Rise time (inductive load)	$t_r$	$I_C = 1400\ A, V_{CC} = 1500\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.055		μs
			$T_{vj} = 125\ ^\circ C$	0.065		
			$T_{vj} = 175\ ^\circ C$	0.075		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 1400\ A, V_{CC} = 1500\ V, V_{GE} = \pm 15\ V, R_{Goff} = 18\ \Omega$	$T_{vj} = 25\ ^\circ C$	3.550		μs
			$T_{vj} = 125\ ^\circ C$	3.600		
			$T_{vj} = 175\ ^\circ C$	3.650		
Fall time (inductive load)	$t_f$	$I_C = 1400\ A, V_{CC} = 1500\ V, V_{GE} = \pm 15\ V, R_{Goff} = 18\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.340		μs
			$T_{vj} = 125\ ^\circ C$	0.710		
			$T_{vj} = 175\ ^\circ C$	0.880		
Turn-on time (resistive load)	$t_{on\_R}$	$I_C = 500\ A, V_{CC} = 2000\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.5\ \Omega$	0.66			μs

**(table continues...)**

**Table 4** (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on energy loss per pulse	$E_{on}$	$I_C = 1400\text{ A}, V_{CC} = 1500\text{ V}, L_\sigma = 20\text{ nH}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 0.5\ \Omega, di/dt = 17000\text{ A}/\mu\text{s} (T_{vj} = 175\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	495		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	795		
			$T_{vj} = 175\text{ }^\circ\text{C}$	1100		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 1400\text{ A}, V_{CC} = 1500\text{ V}, L_\sigma = 20\text{ nH}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 18\ \Omega, dv/dt = 2350\text{ V}/\mu\text{s} (T_{vj} = 175\text{ }^\circ\text{C})$	$T_{vj} = 25\text{ }^\circ\text{C}$	990		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	1240		
			$T_{vj} = 175\text{ }^\circ\text{C}$	1400		
SC data	$I_{SC}$	$V_{GE} \leq 15\text{ V}, V_{CC} = 1200\text{ V}, V_{CEmax} = V_{CES} - L_{SCE} * di/dt$	$t_p = 7\ \mu\text{s}, T_{vj} = 150\text{ }^\circ\text{C}$	5800		A
SC data	$I_{SC}$	$V_{GE} \leq 15\text{ V}, V_{CC} = 1500\text{ V}, V_{CEmax} = V_{CES} - L_{SCE} * di/dt$	$t_p = 5\ \mu\text{s}, T_{vj} = 175\text{ }^\circ\text{C}$	5600		A
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			27.2	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 5\text{ W}/(\text{m}\cdot\text{K})$		8.20		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-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	$V_{RRM}$	$T_{vj} = 25\text{ }^\circ\text{C}$	2300	V	
Continuous DC forward current	$I_F$		1400	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	2800	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}, V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	160	$\text{kA}^2\text{s}$
			$T_{vj} = 175\text{ }^\circ\text{C}$	135	
Maximum power dissipation	$P_{RQM}$	$T_{vj} = 175\text{ }^\circ\text{C}$	2400	kW	

**Table 6** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	$V_F$	$I_F = 1400 \text{ A}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		3.05	3.45	V
			$T_{vj} = 125 \text{ °C}$		2.80	3.10	
			$T_{vj} = 175 \text{ °C}$		2.60	2.85	
Peak reverse recovery current	$I_{RM}$	$V_{CC} = 1500 \text{ V}, I_F = 1400 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 17000 \text{ A}/\mu\text{s} (T_{vj} = 175 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		1750		A
			$T_{vj} = 125 \text{ °C}$		1850		
			$T_{vj} = 175 \text{ °C}$		1880		
Recovered charge	$Q_r$	$V_{CC} = 1500 \text{ V}, I_F = 1400 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 17000 \text{ A}/\mu\text{s} (T_{vj} = 175 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		310		$\mu\text{C}$
			$T_{vj} = 125 \text{ °C}$		570		
			$T_{vj} = 175 \text{ °C}$		790		
Reverse recovery energy	$E_{rec}$	$V_{CC} = 1500 \text{ V}, I_F = 1400 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 17000 \text{ A}/\mu\text{s} (T_{vj} = 175 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		305		mJ
			$T_{vj} = 125 \text{ °C}$		565		
			$T_{vj} = 175 \text{ °C}$		785		
Thermal resistance, junction to case	$R_{thJC}$	per diode				45.9	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 5 \text{ W}/(\text{m}\cdot\text{K})$			10.8		K/kW
Temperature under switching conditions	$T_{vj op}$			-40		175	°C

## 4 NTC-Thermistor

**Table 7** Characteristic values

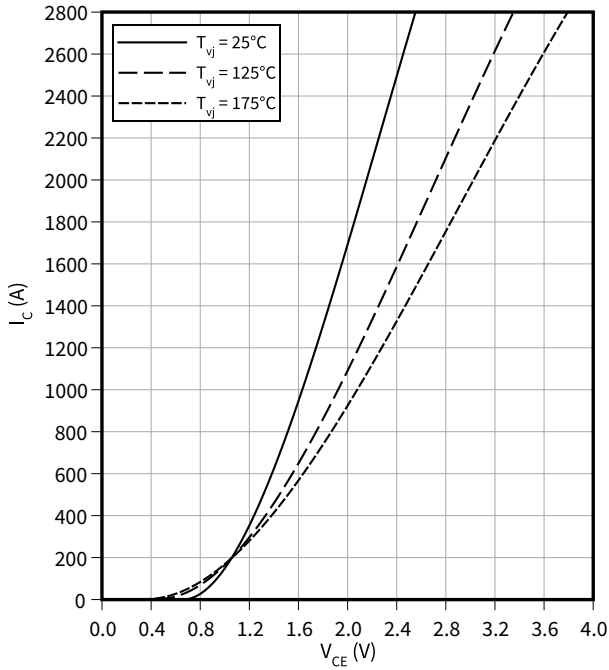
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	$R_{25}$	$T_{NTC} = 25 \text{ °C}$		5		k $\Omega$
Deviation of $R_{100}$	$\Delta R/R$	$T_{NTC} = 100 \text{ °C}, R_{100} = 493 \text{ }\Omega$	-5		5	%
Power dissipation	$P_{25}$	$T_{NTC} = 25 \text{ °C}$			20	mW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

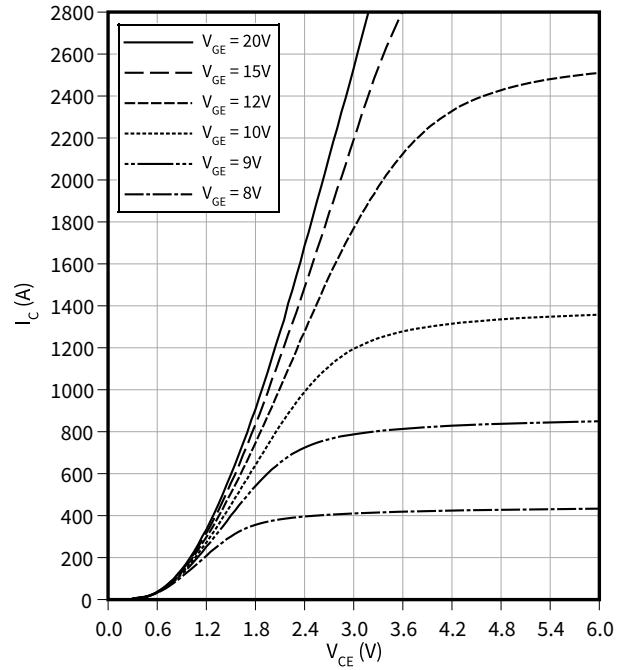
**Output characteristic (typical), IGBT, Inverter**

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



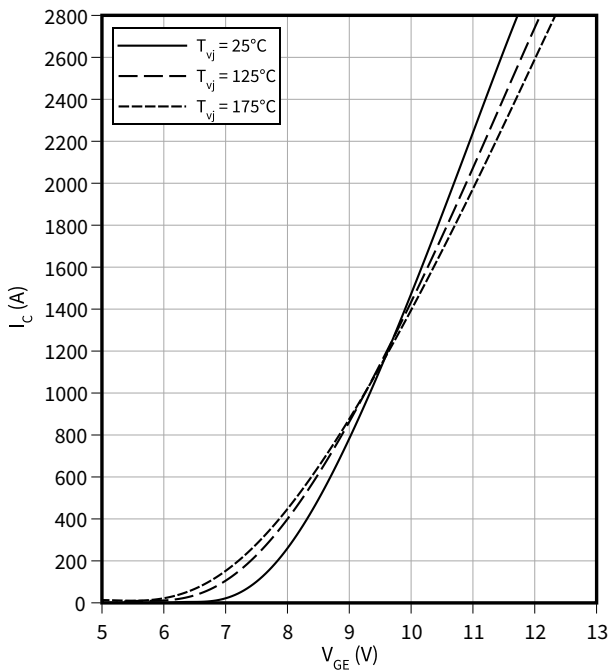
**Output characteristic field (typical), IGBT, Inverter**

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



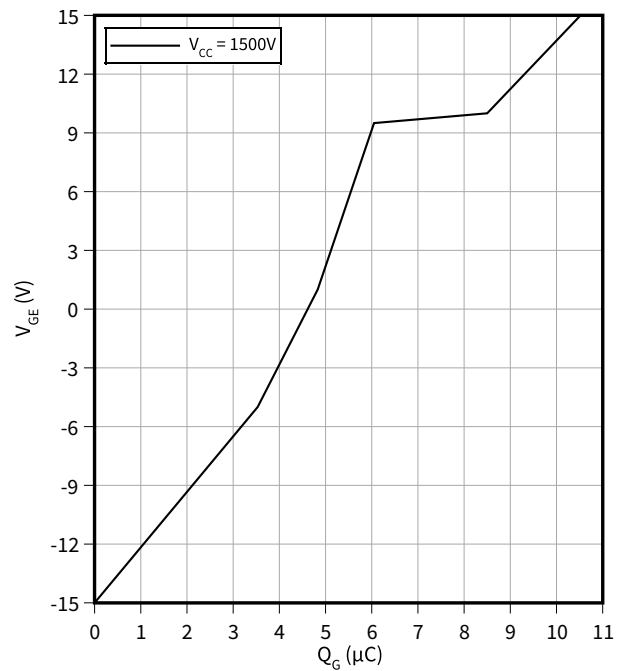
**Transfer characteristic (typical), IGBT, Inverter**

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



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

$V_{GE} = f(Q_G)$   
 $I_C = 1400\text{ A}, T_{vj} = 25\text{ °C}$

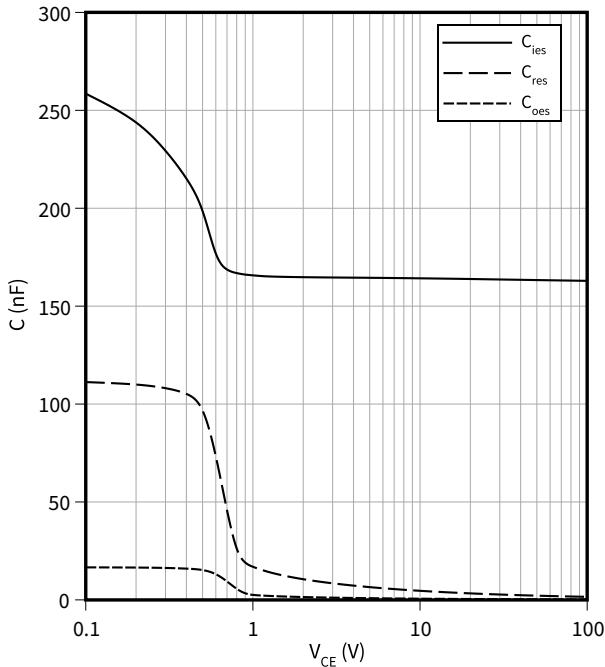


**5 Characteristics diagrams**

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

$C = f(V_{CE})$

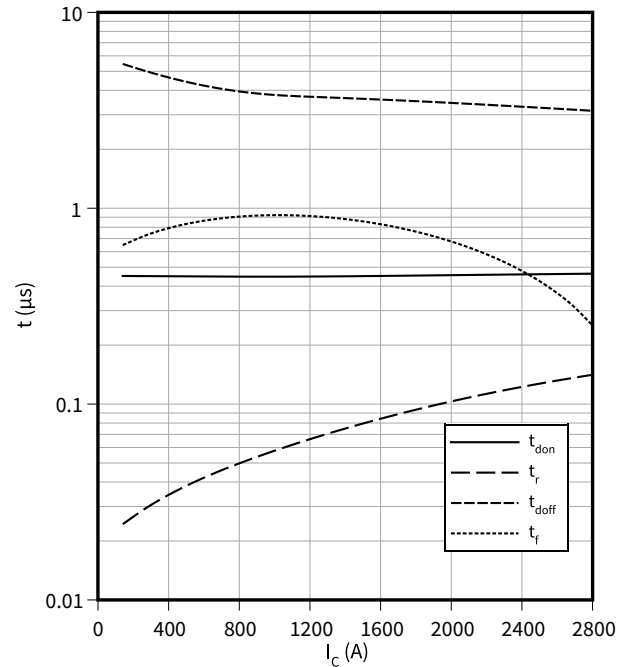
$V_{GE} = 0\text{ V}$ ,  $f = 100\text{ kHz}$ ,  $T_{vj} = 25\text{ °C}$



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

$t = f(I_C)$

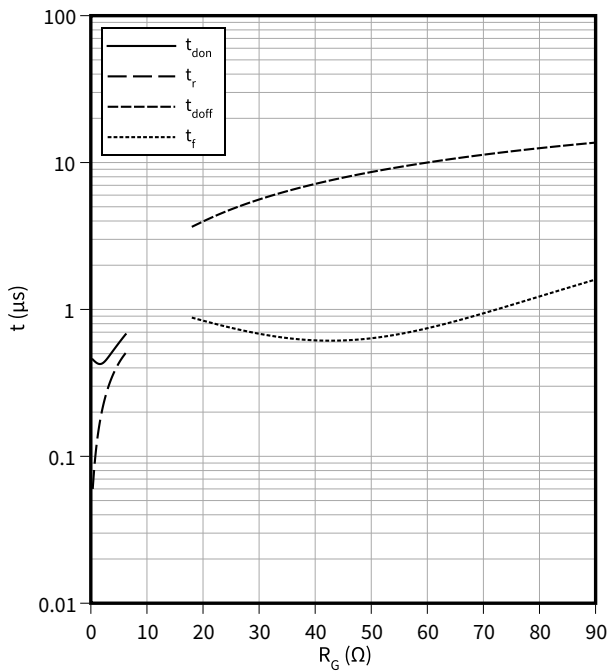
$R_{Goff} = 18\ \Omega$ ,  $R_{Gon} = 0.5\ \Omega$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $V_{CC} = 1500\text{ V}$ ,  $T_{vj} = 175\text{ °C}$



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

$t = f(R_G)$

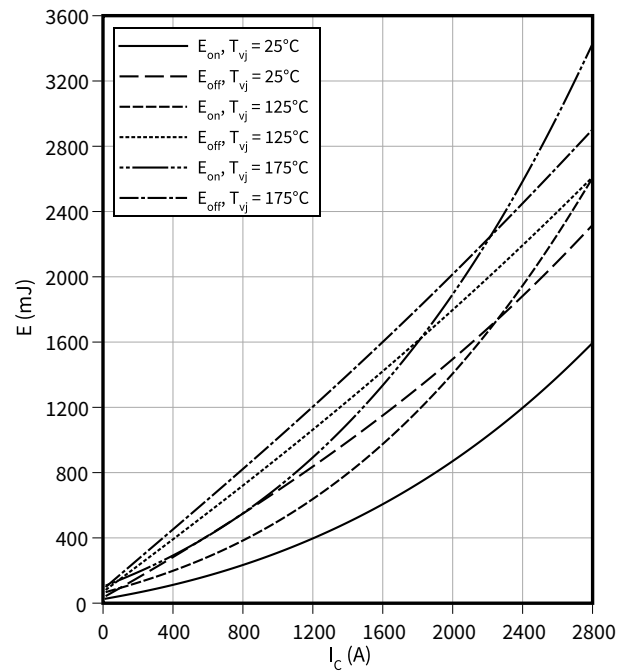
$V_{GE} = \pm 15\text{ V}$ ,  $I_C = 1400\text{ A}$ ,  $V_{CC} = 1500\text{ V}$ ,  $T_{vj} = 175\text{ °C}$



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

$E = f(I_C)$

$R_{Goff} = 18\ \Omega$ ,  $R_{Gon} = 0.5\ \Omega$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $V_{CC} = 1500\text{ V}$

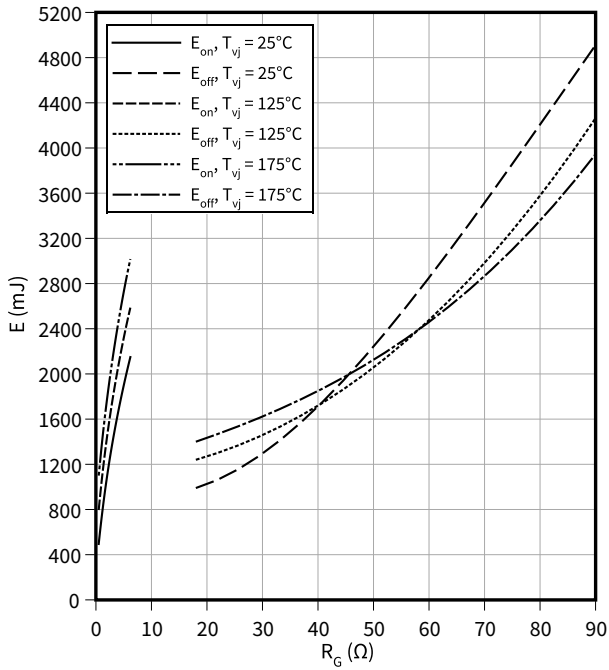


**5 Characteristics diagrams**

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

$E = f(R_G)$

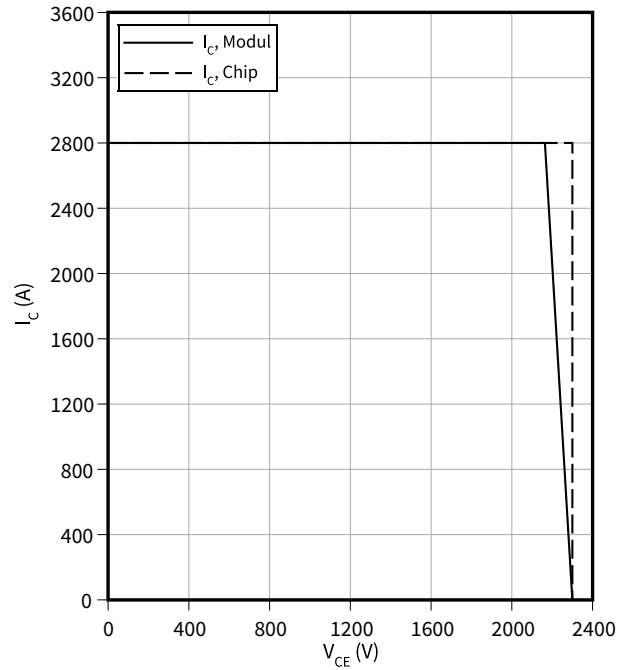
$V_{GE} = \pm 15\text{ V}$ ,  $I_C = 1400\text{ A}$ ,  $V_{CC} = 1500\text{ V}$



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

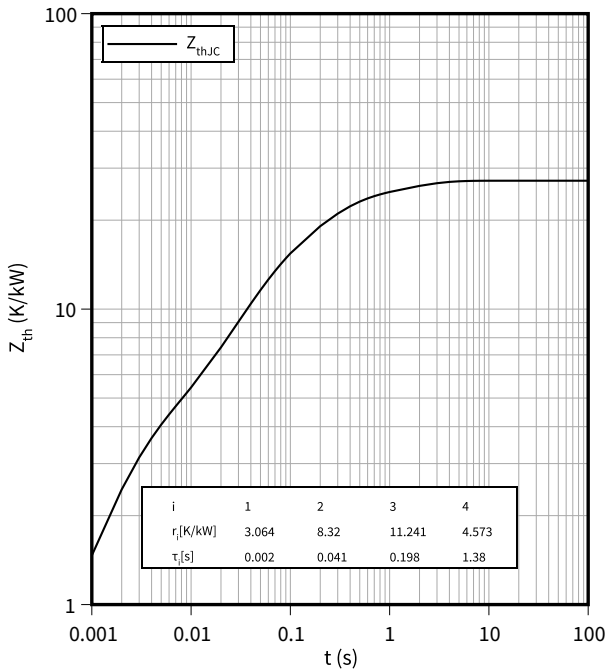
$I_C = f(V_{CE})$

$R_{Goff} = 18\ \Omega$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $T_{vj} = 175\text{ °C}$



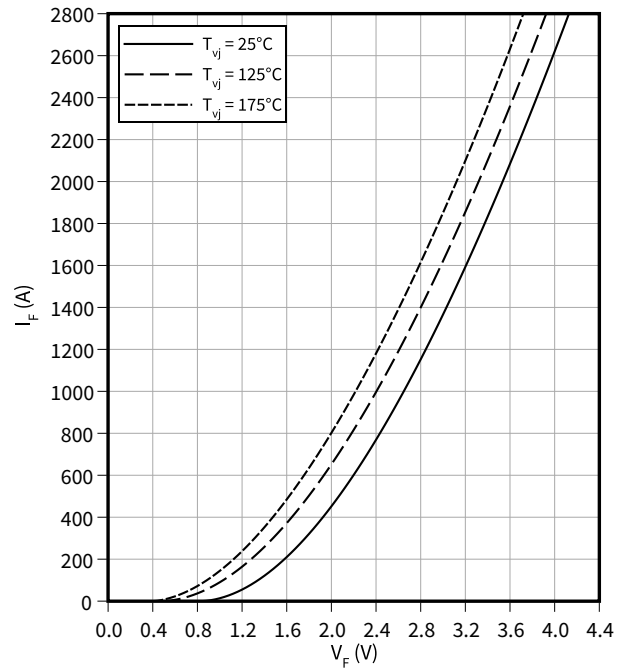
**Transient thermal impedance, IGBT, Inverter**

$Z_{th} = f(t)$



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

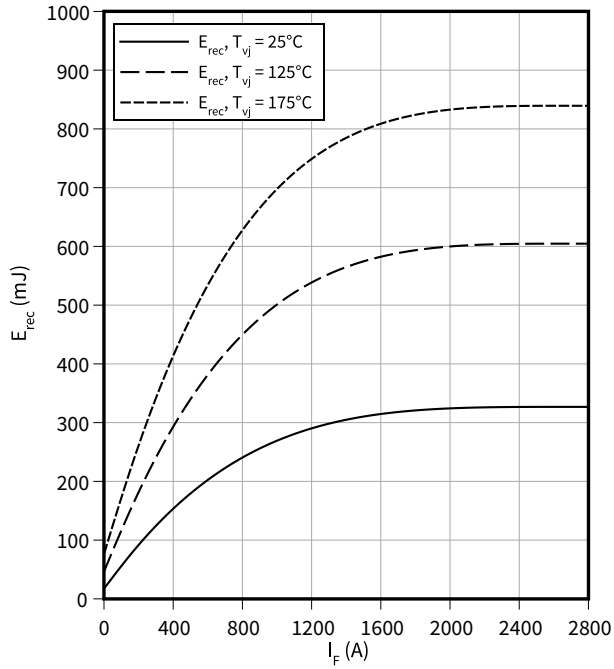
$I_F = f(V_F)$



**5 Characteristics diagrams**

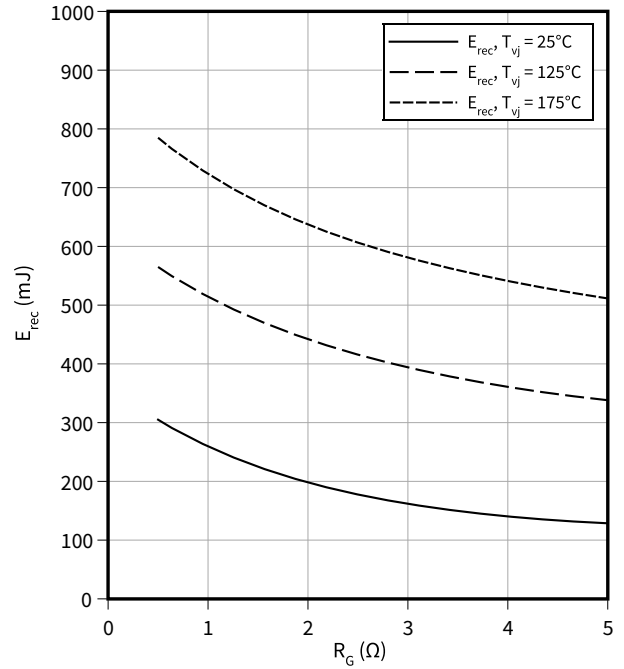
**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(I_F)$   
 $V_{CE} = 1500\text{ V}$ ,  $R_{Gon} = R_{Gon}(IGBT)$



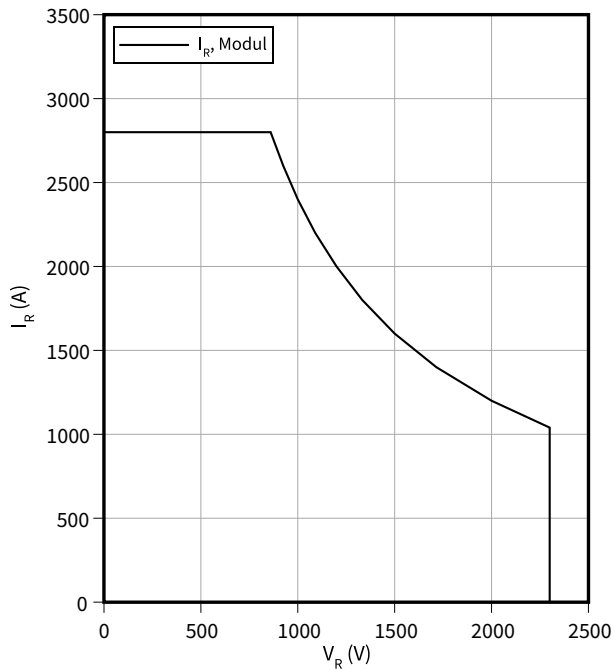
**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(R_G)$   
 $V_{CE} = 1500\text{ V}$ ,  $I_F = 1400\text{ A}$



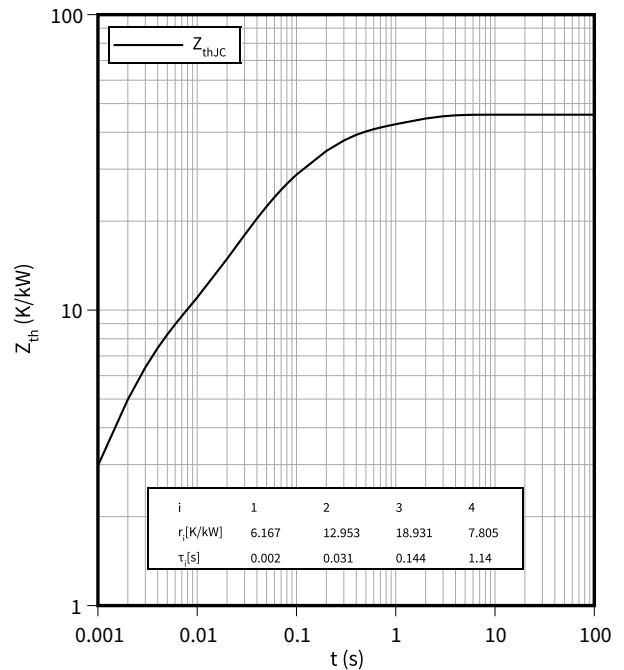
**Safe operating area (SOA), Diode, Inverter**

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



**Transient thermal impedance, Diode, Inverter**

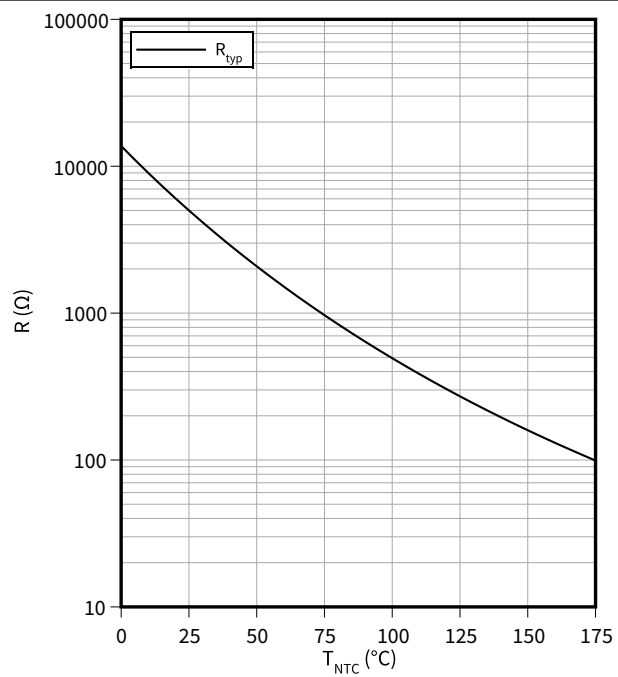
$Z_{th} = f(t)$



i	1	2	3	4
$f_i$ [K/kW]	6.167	12.953	18.931	7.805
$\tau_i$ [s]	0.002	0.031	0.144	1.14

Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



## 6 Circuit diagram

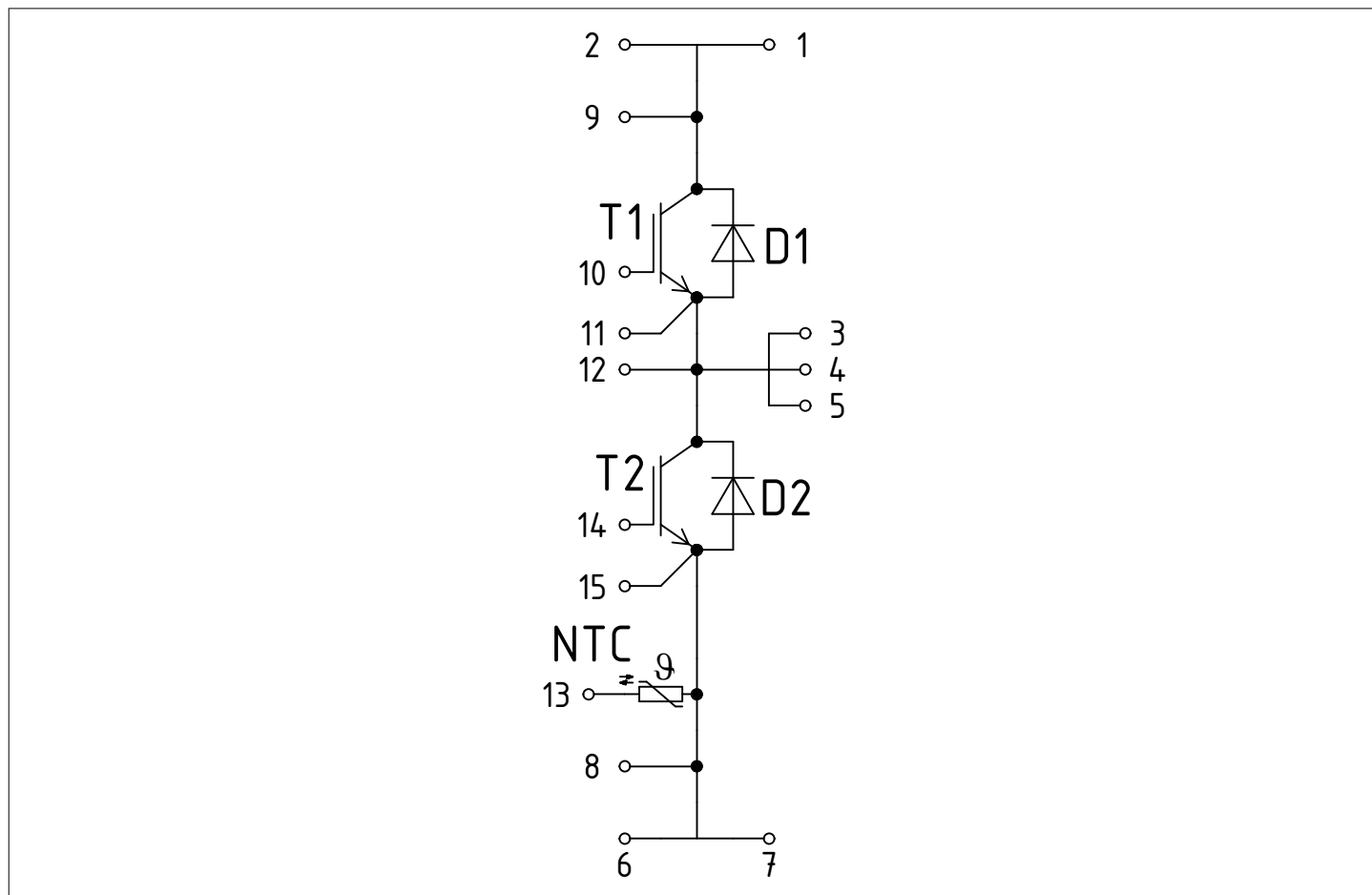


Figure 1



## 8 Module label code


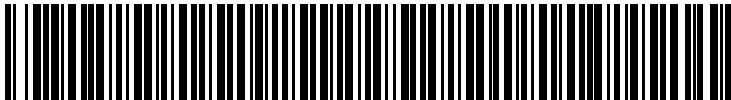
Module label code			
Code format	Data Matrix	Barcode Code128	
Encoding	ASCII text	Code Set A	
Symbol size	16x16	23 digits	
Standard	IEC24720 and IEC16022	IEC8859-1	
Code content	Content	Digit	Example
	Module serial number	1 - 5	71549
	Module material number	6 - 11	142846
	Production order number	12 - 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	2024-10-09	Datasheet for customer sample
0.20	2024-10-14	Target datasheet
0.30	2025-04-25	Preliminary datasheet
1.00	2025-07-01	Final datasheet
1.10	2025-07-29	Final datasheet

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