

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

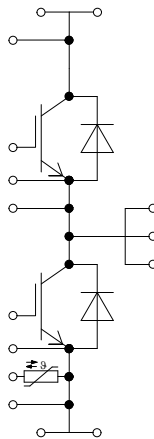


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1 Package

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	$R_{AA'+CC'}$	$T_C = 25\text{ }^{\circ}\text{C}$, per switch			0.25		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25\text{ }^{\circ}\text{C}$, 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}	$V_{CE} = 1700\ V, V_{GE} = 0\ V$	$T_{vj} = 125\ ^\circ C$		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}	$I_C = 1800\text{ A}$, $V_{CC} = 900\text{ V}$, $L_\sigma = 20\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Goff} = 3\ \Omega$, $dv/dt = 1800\text{ V}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	550		mJ
			$T_{vj} = 125\text{ °C}$	707		
			$T_{vj} = 175\text{ °C}$	800		
SC data	I_{SC}	$V_{GE} \leq 15\text{ V}$, $V_{CC} = 1000\text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq 10\ \mu\text{s}$, $T_{vj} = 175\text{ °C}$	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	$T_{vj\text{ op}}$		-40		175	°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		1800	A
Repetitive peak forward current	I_{FRM}	$t_P = 1\text{ ms}$	3600	A
I^2t - value	I^2t	$t_P = 10\text{ ms}$, $V_R = 0\text{ V}$	$T_{vj} = 125\text{ °C}$	kA ² s
			$T_{vj} = 175\text{ °C}$	
Maximum power dissipation	P_{RQM}	$T_{vj} = 175\text{ °C}$	1800	kW

Table 6 Characteristic values

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

(table continues...)

Table 6 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Recovered charge	Q_r	$V_{CC} = 900 \text{ V}$, $I_F = 1800 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 14500 \text{ A}/\mu\text{s}$ ($T_{vj} = 175 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$	350		μC
			$T_{vj} = 125 \text{ }^\circ\text{C}$	640		
			$T_{vj} = 175 \text{ }^\circ\text{C}$	850		
Reverse recovery energy	E_{rec}	$V_{CC} = 900 \text{ V}$, $I_F = 1800 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 14500 \text{ A}/\mu\text{s}$ ($T_{vj} = 175 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$	220		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	410		
			$T_{vj} = 175 \text{ }^\circ\text{C}$	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}	$T_{NTC} = 25 \text{ }^\circ\text{C}$		5		k Ω
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 100 \text{ }^\circ\text{C}$, $R_{100} = 493 \text{ } \Omega$	-5		5	%
Power dissipation	P_{25}	$T_{NTC} = 25 \text{ }^\circ\text{C}$			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

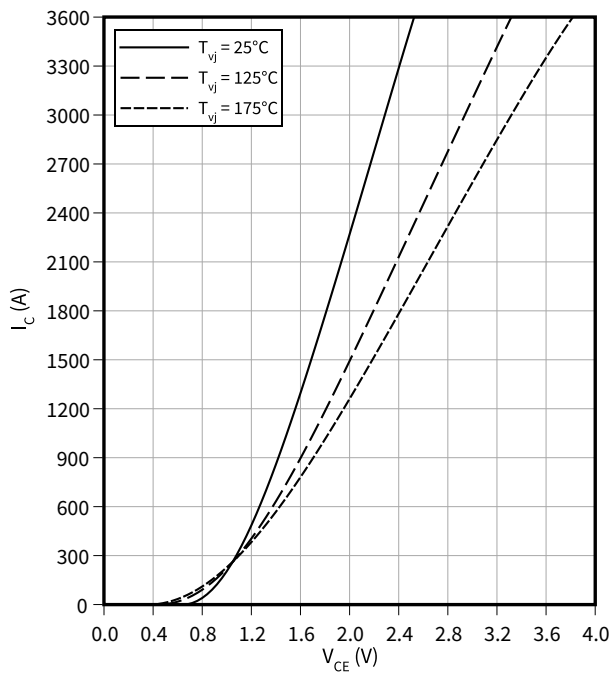
Note: For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4

5 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

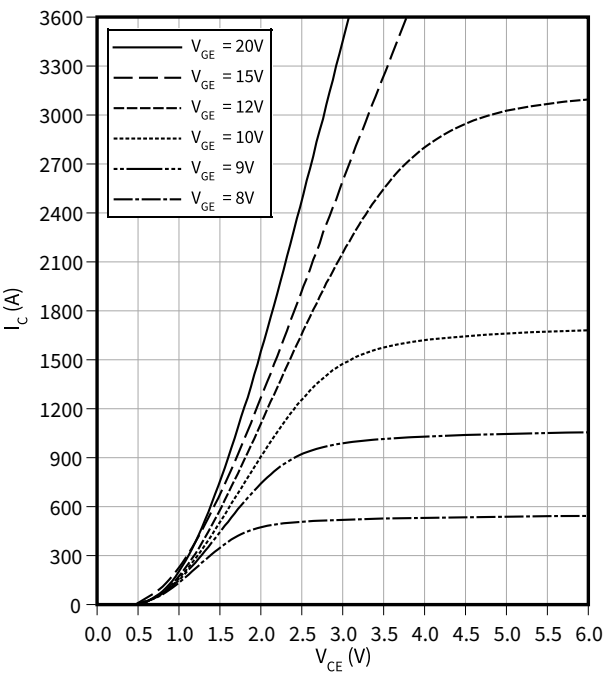
$V_{GE} = 15\text{ V}$



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

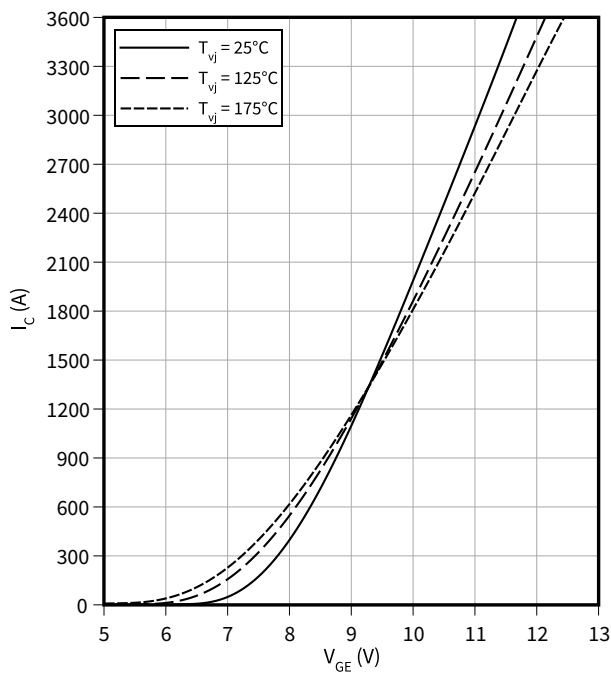
$T_{vj} = 175^\circ\text{C}$



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

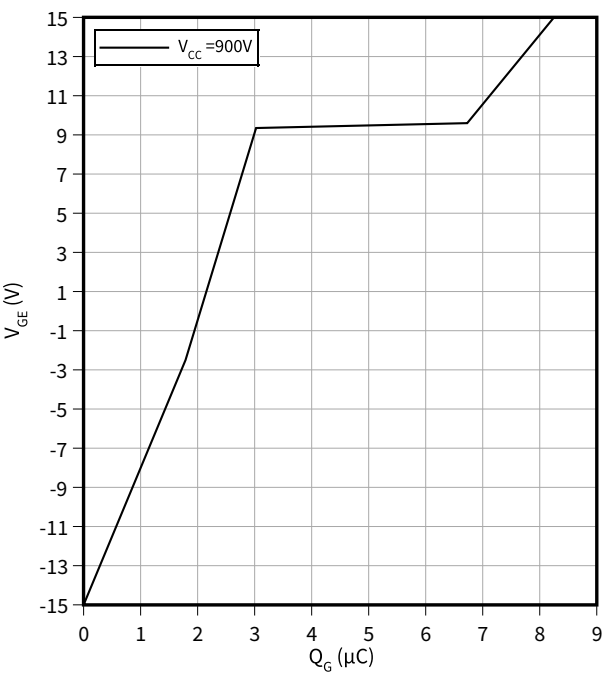
$V_{CE} = 20\text{ V}$



Gate charge characteristic (typical), IGBT, Inverter

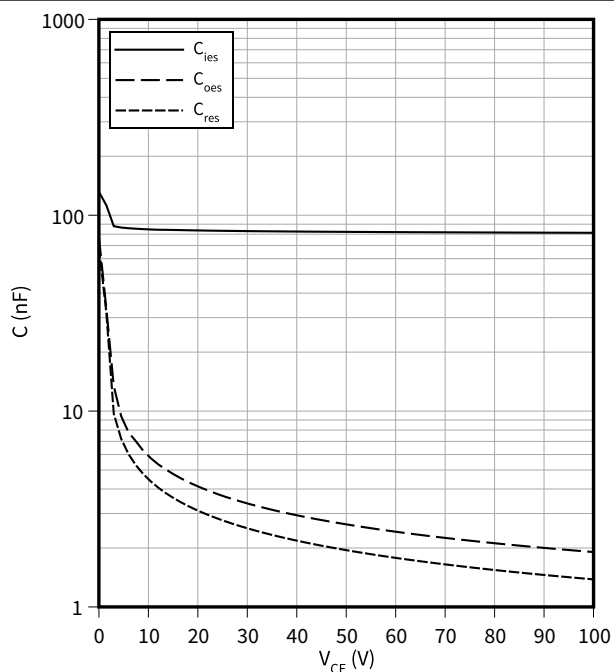
$V_{GE} = f(Q_G)$

$I_C = 1800\text{ A}, T_{vj} = 25^\circ\text{C}$

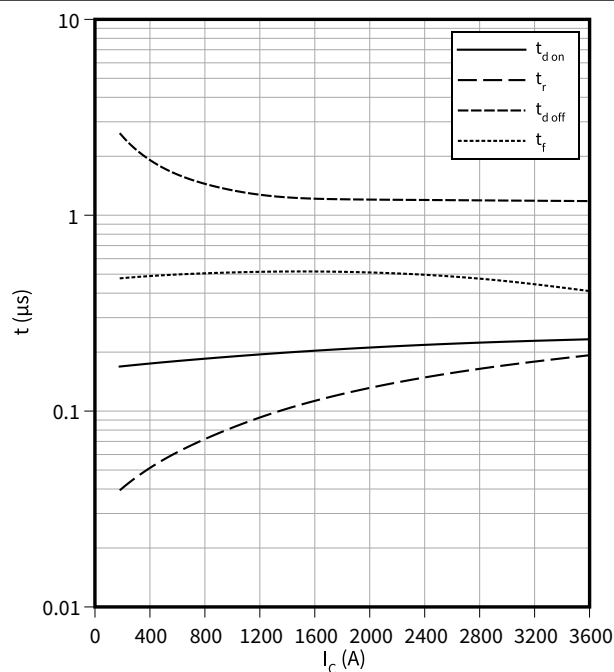


Capacity characteristic (typical), IGBT, Inverter

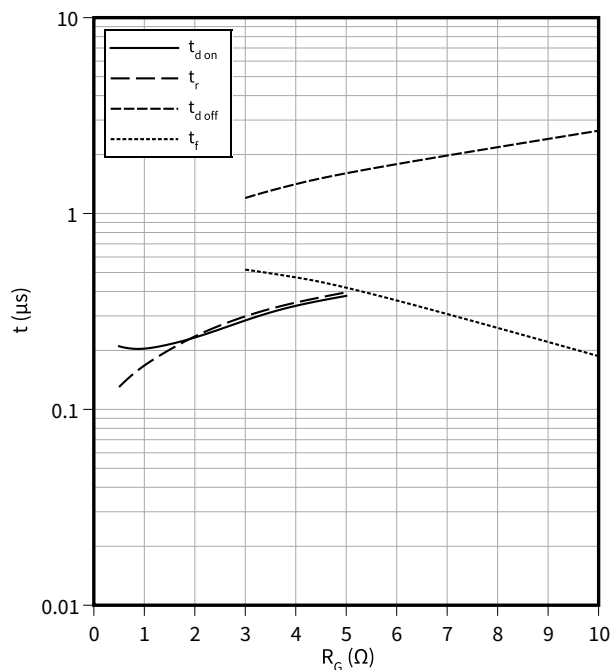
$$C = f(V_{CE})$$

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

Switching times (typical), IGBT, Inverter

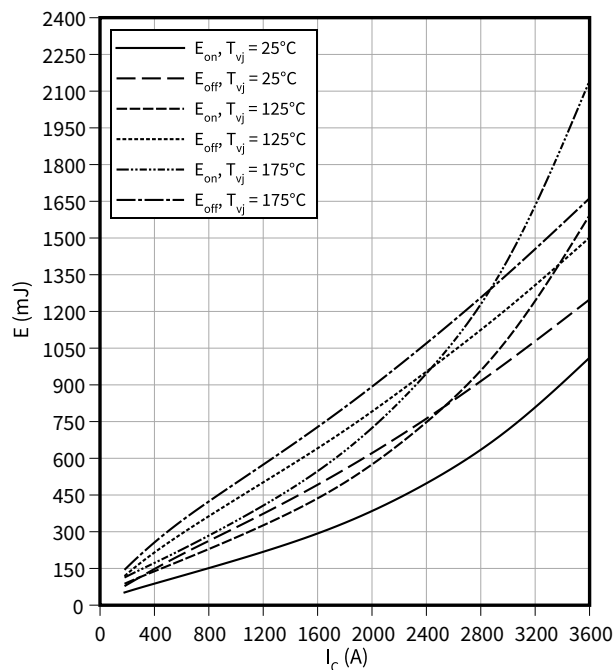
$$t = f(I_C)$$

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

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

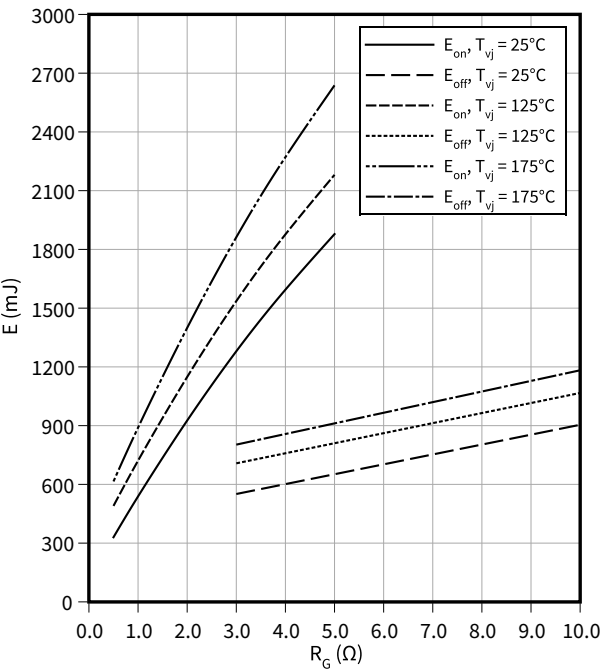
$$E = f(I_C)$$

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


5 Characteristics diagrams

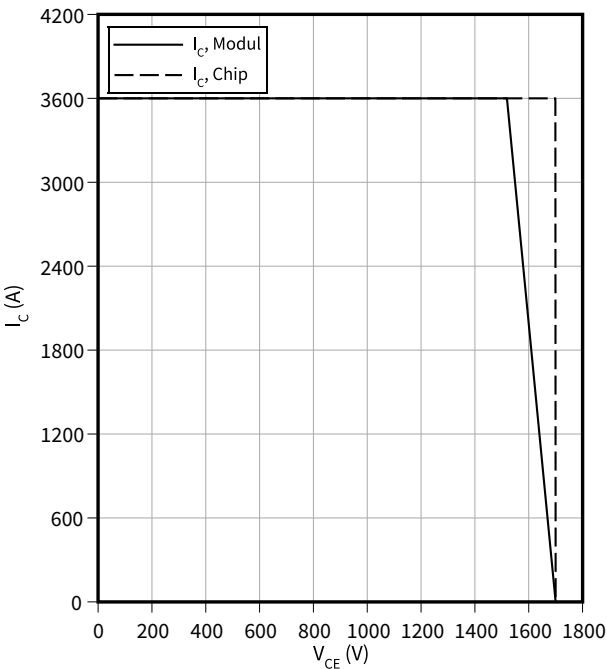
Switching losses (typical), IGBT, Inverter

$E = f(R_G)$
 $I_C = 1800\text{ A}$, $V_{CC} = 900\text{ V}$, $V_{GE} = \pm 15\text{ V}$



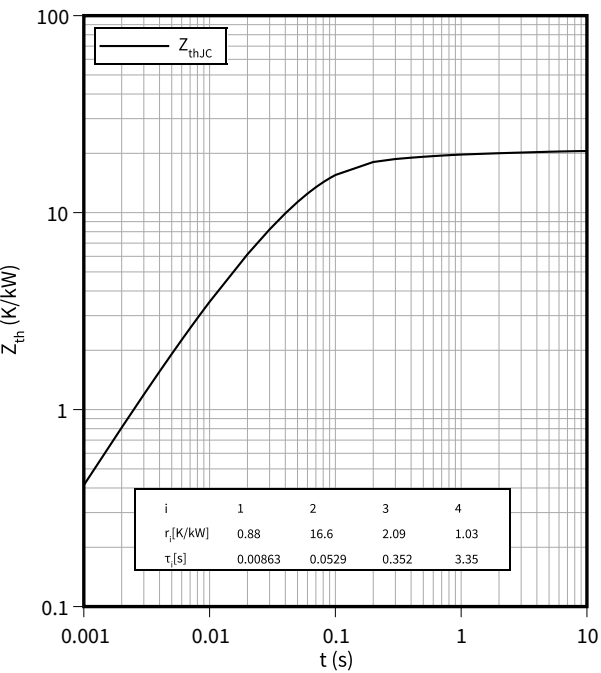
Reverse bias safe operating area (RBSOA), IGBT, Inverter

$I_C = f(V_{CE})$
 $R_{Goff} \geq 3\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 175^\circ\text{C}$



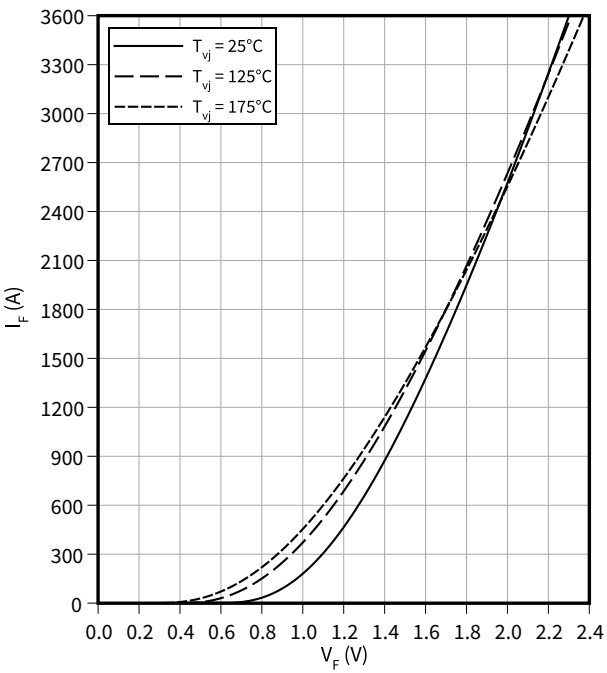
Transient thermal impedance, IGBT, Inverter

$Z_{th} = f(t)$



Forward characteristic (typical), Diode, Inverter

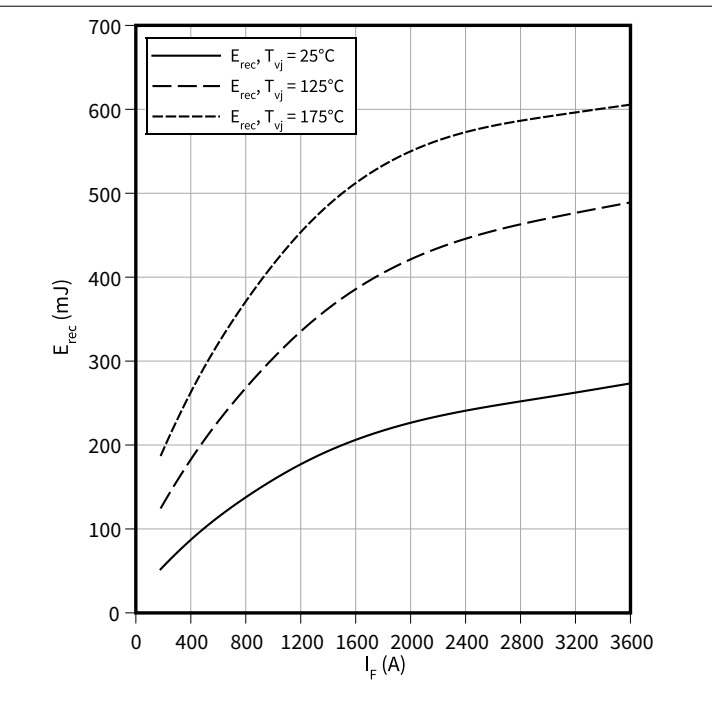
$I_F = f(V_F)$



5 Characteristics diagrams

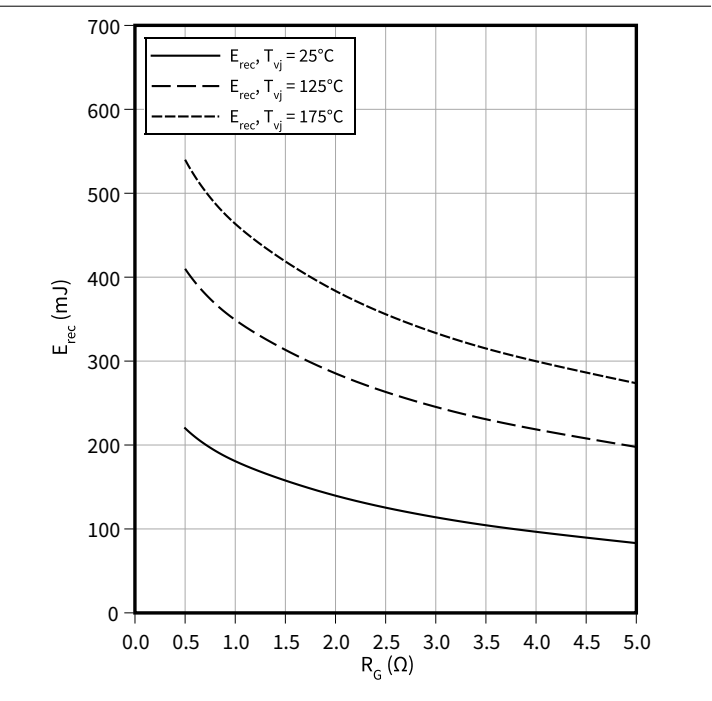
Switching losses (typical), Diode, Inverter

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



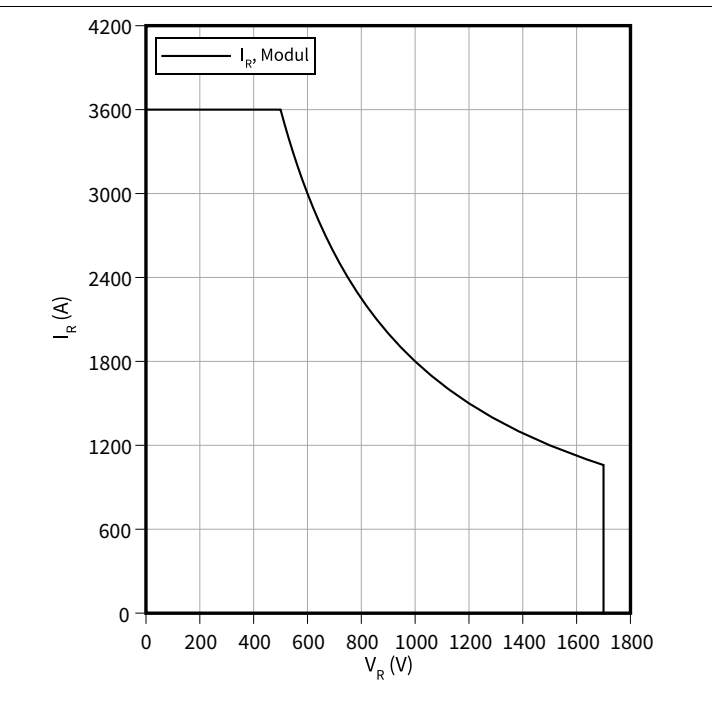
Switching losses (typical), Diode, Inverter

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



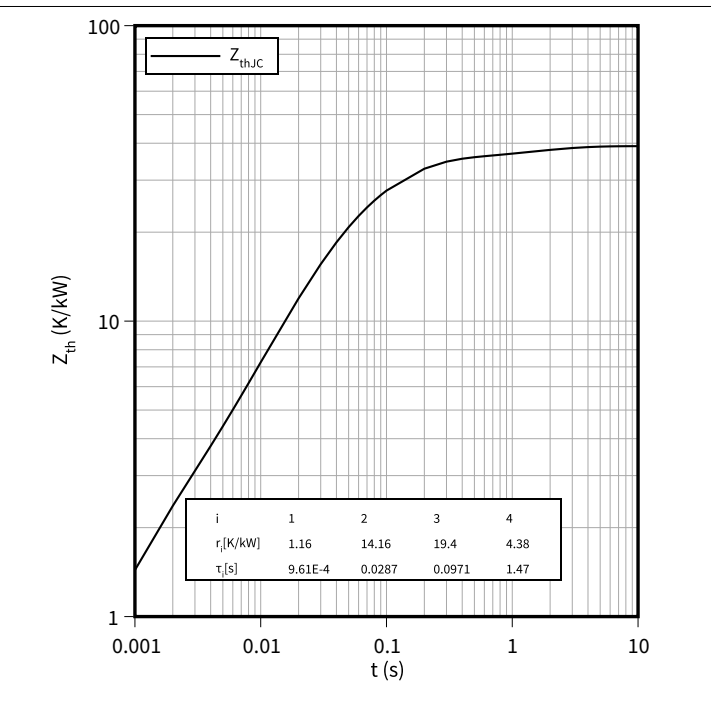
Safe operating area (SOA), Diode, Inverter

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



Transient thermal impedance, Diode, Inverter

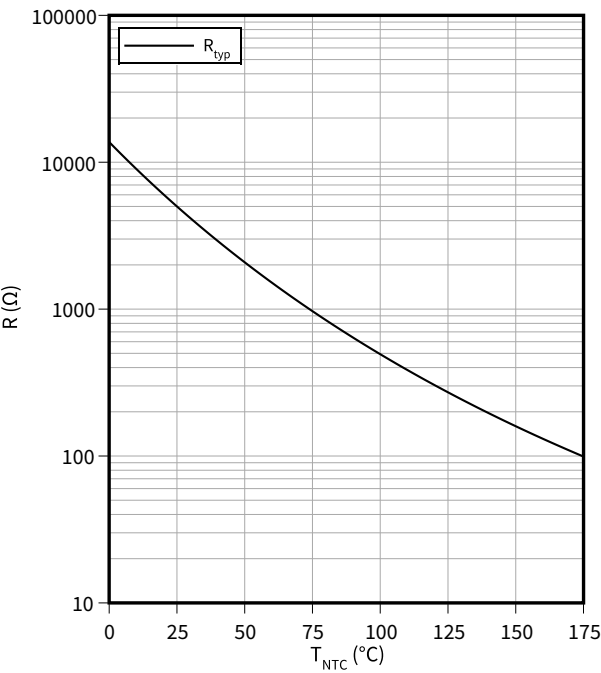
$Z_{th} = f(t)$



5 Characteristics diagrams

Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

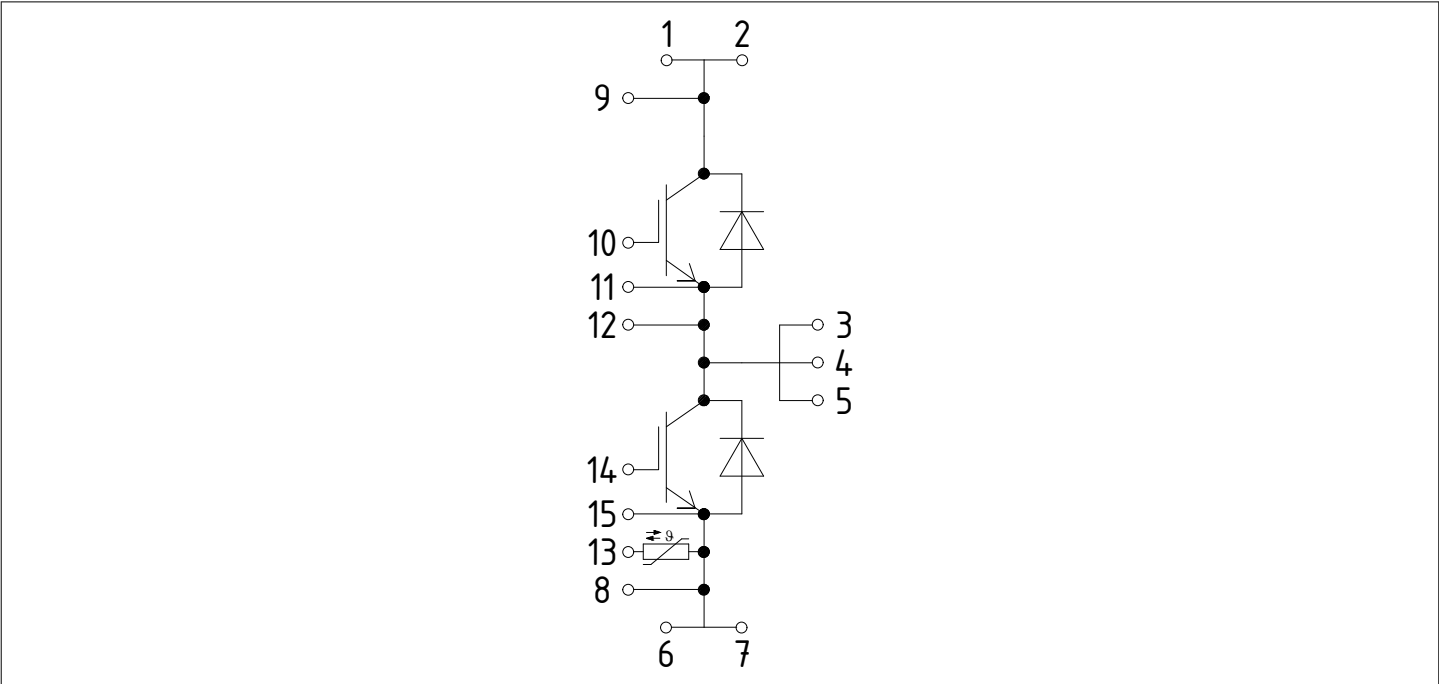
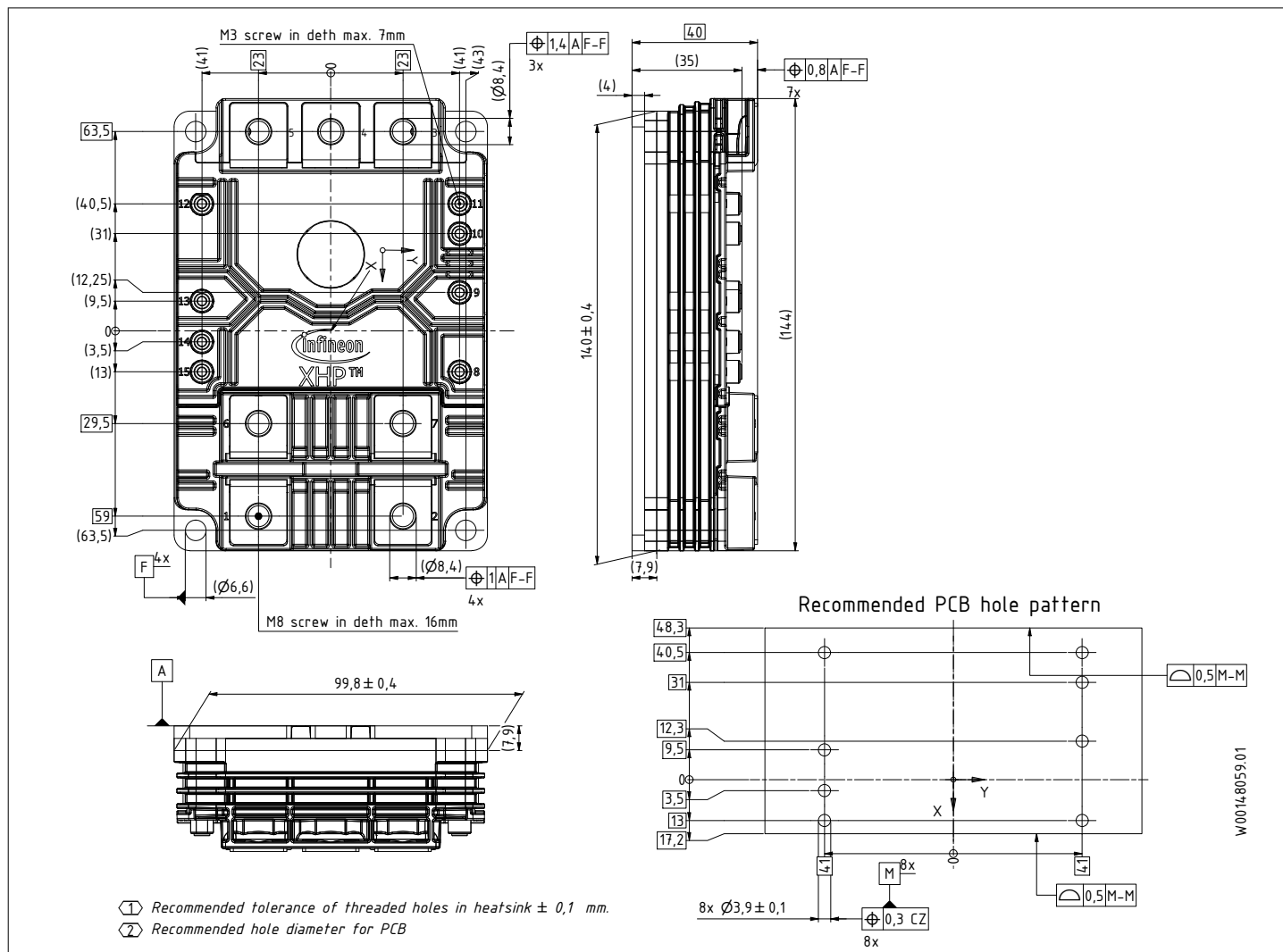


Figure 1



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	<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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Edition 2023-10-30

Published by

Infineon Technologies AG
81726 Munich, Germany

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Document reference
IFX-AA151-005

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