Final datasheet

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

Features

- Electrical features
  - V_{CES} = 1700 V
  - $I_{C\ nom}$ = 1200 A / I_{CRM} = 2400 A
  - Extended operating temperature $T_{vj\ op}$
  - High current density
  - Low switching losses
  - Low $V_{CE,sat}$
  - $T_{vj,op}$ = 175°C
- Mechanical features
  - High creepage and clearance distances
  - High power and thermal cycling capability
  - High power density
  - Package with CTI > 600

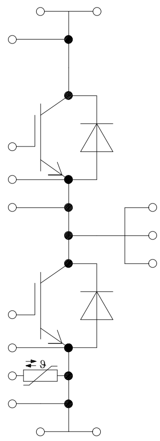
Potential applications

- High-power converters
- Motor drives
- Traction drives
- Wind turbines

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			0.3		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_C = 25 °C, per switch			0.35		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}			1200	A
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_C = 75 °C	1200	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 $T_{vj\,op}$	2400	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 = 1200 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.80	2.25	V
			T_{vj} = 125 °C		2.20	2.75	
			T_{vj} = 175 °C		2.40	3.00	
Gate threshold voltage	V_{GEth}	I_C = 43 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.35	5.80	6.25	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CC} = 900 V			5.5		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0.75		Ω
Input capacitance	C_{ies}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			56		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			2		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 1700 V, V_{GE} = 0 V	T_{vj} = 125 °C			10	mA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V, T_{vj} = 25 °C				400	nA
Turn-on delay time (inductive load)	t_{don}	I_C = 1200 A, V_{CC} = 900 V, V_{GE} = ±15 V, R_{Gon} = 0.5 Ω	T_{vj} = 25 °C		0.173		µs
			T_{vj} = 125 °C		0.180		
			T_{vj} = 175 °C		0.183		
Rise time (inductive load)	t_r	I_C = 1200 A, V_{CC} = 900 V, V_{GE} = ±15 V, R_{Gon} = 0.5 Ω	T_{vj} = 25 °C		0.090		µs
			T_{vj} = 125 °C		0.095		
			T_{vj} = 175 °C		0.105		
Turn-off delay time (inductive load)	t_{doff}	I_C = 1200 A, V_{CC} = 900 V, V_{GE} = ±15 V, R_{Goff} = 4.5 Ω	T_{vj} = 25 °C		1.050		µs
			T_{vj} = 125 °C		1.150		
			T_{vj} = 175 °C		1.210		
Fall time (inductive load)	t_f	I_C = 1200 A, V_{CC} = 900 V, V_{GE} = ±15 V, R_{Goff} = 4.5 Ω	T_{vj} = 25 °C		0.180		µs
			T_{vj} = 125 °C		0.410		
			T_{vj} = 175 °C		0.560		
Turn-on energy loss per pulse	E_{on}	I_C = 1200 A, V_{CC} = 900 V, L_σ = 20 nH, V_{GE} = ±15 V, R_{Gon} = 0.5 Ω, di/dt = 12700 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		220		mJ
			T_{vj} = 125 °C		340		
			T_{vj} = 175 °C		420		

(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 = 1200 A, V_{CC} = 900 V, L_σ = 20 nH, V_{GE} = ±15 V, R_{Goff} = 4.5 Ω, dv/dt = 1800 V/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		355		mJ
			T_{vj} = 125 °C		465		
			T_{vj} = 175 °C		535		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 1000 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 10 µs, T_{vj} = 175 °C		4600		A
Thermal resistance, junction to case	R_{thJC}	per IGBT				26.8	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, λ_{grease} = 1 W/(m·K)			20.1		K/kW
Temperature under switching conditions	$T_{vj\,op}$			-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 °C	1700	V
Continuous DC forward current	I_F			1200	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		2400	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	338	kA^2s
			T_{vj} = 175 °C	276	
Maximum power dissipation	P_{RQM}		T_{vj} = 175 °C	1200	kW

Table 6 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 1200 A, V_{GE} = 0 V	T_{vj} = 25 °C		1.75	2.10	V
			T_{vj} = 125 °C		1.70	2.05	
			T_{vj} = 175 °C		1.70	2.05	
Peak reverse recovery current	I_{RM}	V_{CC} = 900 V, I_F = 1200 A, V_{GE} = -15 V, -di_F/dt = 12700 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		1300		A
			T_{vj} = 125 °C		1500		
			T_{vj} = 175 °C		1600		

(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 V, I_F = 1200 A, V_{GE} = -15 V, -di_F/dt = 12700 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		240		µC
			T_{vj} = 125 °C		455		
			T_{vj} = 175 °C		585		
Reverse recovery energy	E_{rec}	V_{CC} = 900 V, I_F = 1200 A, V_{GE} = -15 V, -di_F/dt = 12700 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		150		mJ
			T_{vj} = 125 °C		290		
			T_{vj} = 175 °C		365		
Thermal resistance, junction to case	R_{thJC}	per diode				51.4	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, λ_{grease} = 1 W/(m·K)			27.1		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 °C		5		kΩ
Deviation of R_{100}	$\Delta R/R$	T_{NTC} = 100 °C, R_{100} = 493 Ω	-5		5	%
Power dissipation	P_{25}	T_{NTC} = 25 °C			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\ K))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15\ K))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\ K))]$		3433		K

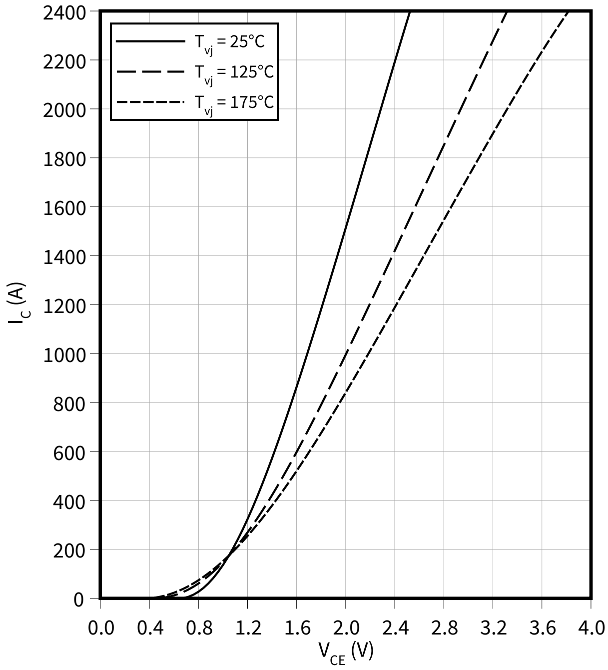
Note: *For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4*

5 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

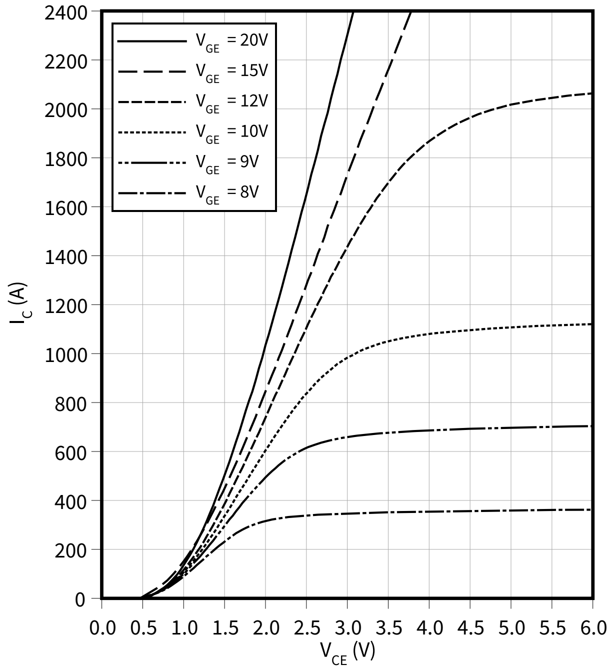
$V_{GE} = 15\ V$



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

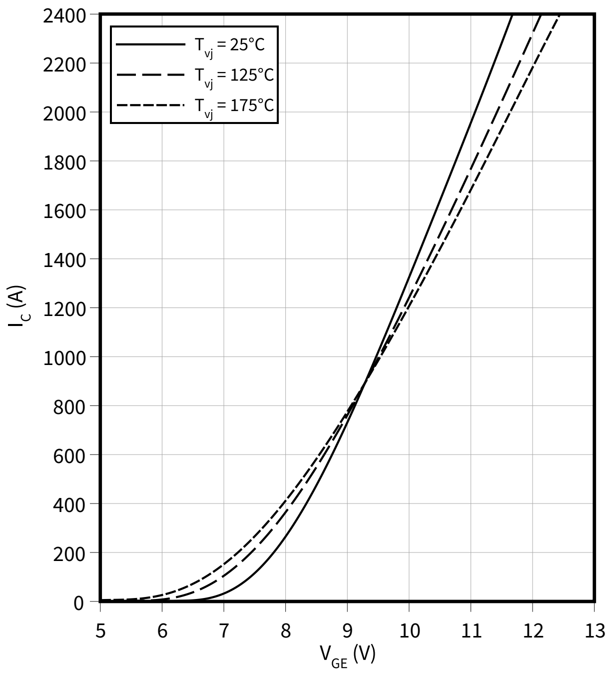
$T_{vj} = 175\ °C$



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

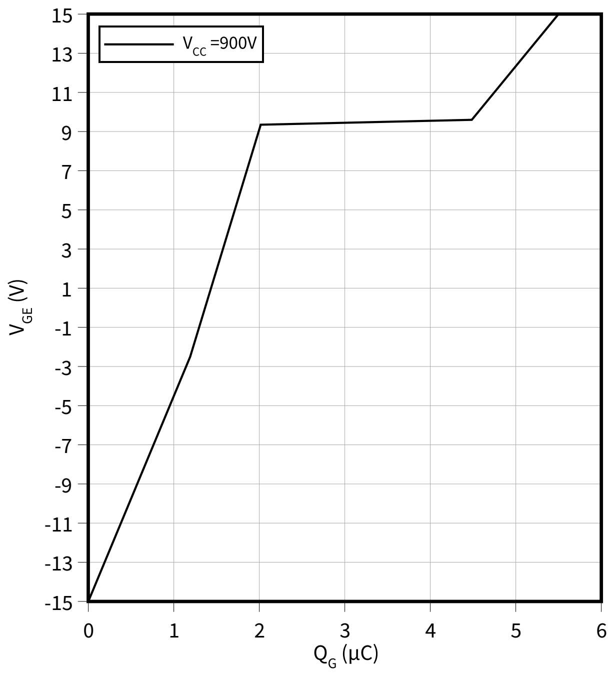
$V_{CE} = 20\ V$



Gate charge characteristic (typical), IGBT, Inverter

$V_{GE} = f(Q_G)$

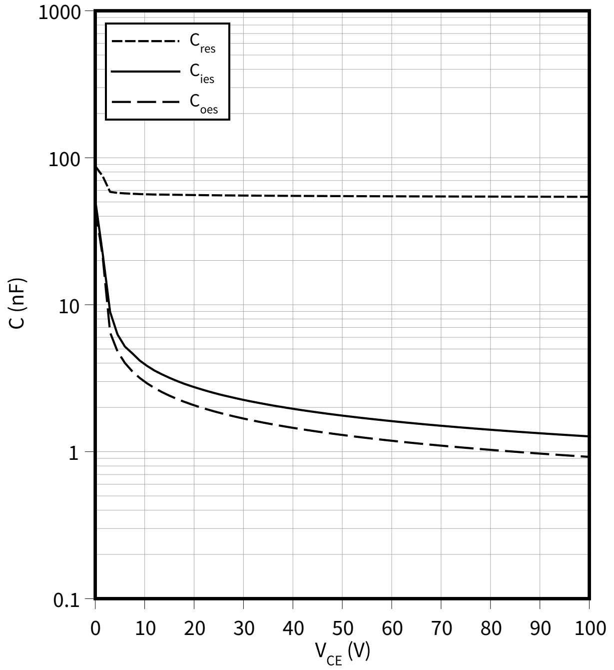
$I_C = 1200\ A$, $T_{vj} = 25\ °C$



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

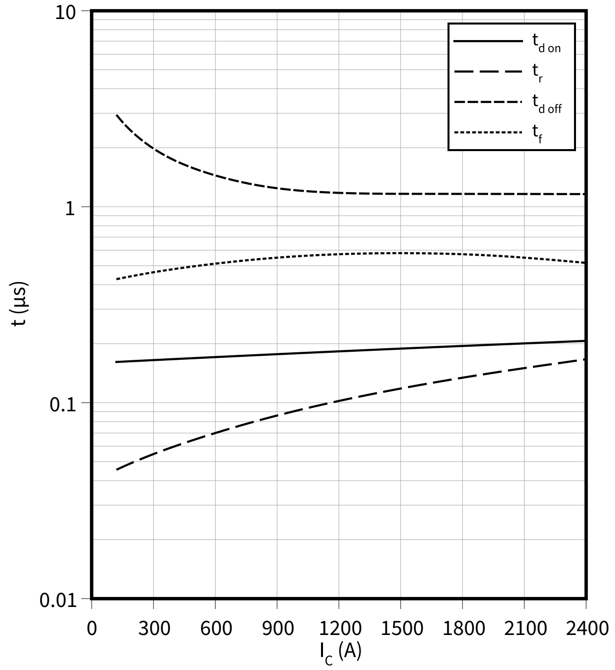
$f = 100$ kHz, $V_{GE} = 0$ V, $T_{vj} = 25$ °C



Switching times (typical), IGBT, Inverter

$t = f(I_C)$

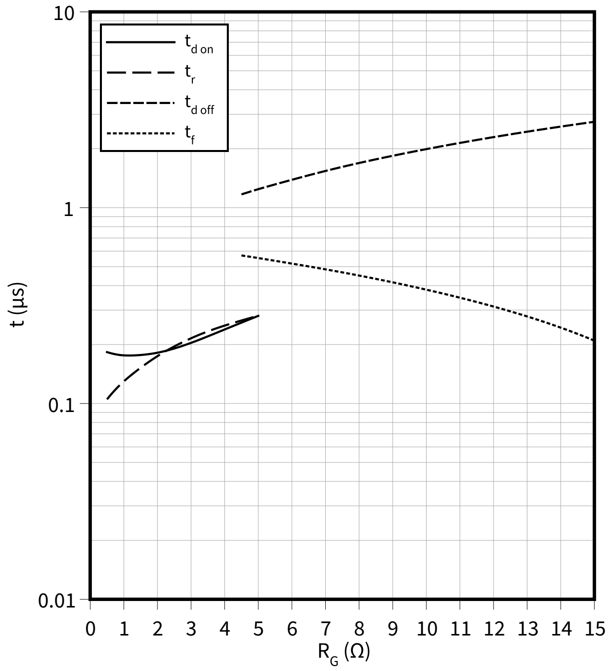
$R_{Goff} = 4.5\ \Omega$, $R_{Gon} = 0.5\ \Omega$, $V_{GE} = \pm15$ V, $V_{CC} = 900$ V, $T_{vj} = 175$ °C



Switching times (typical), IGBT, Inverter

$t = f(R_G)$

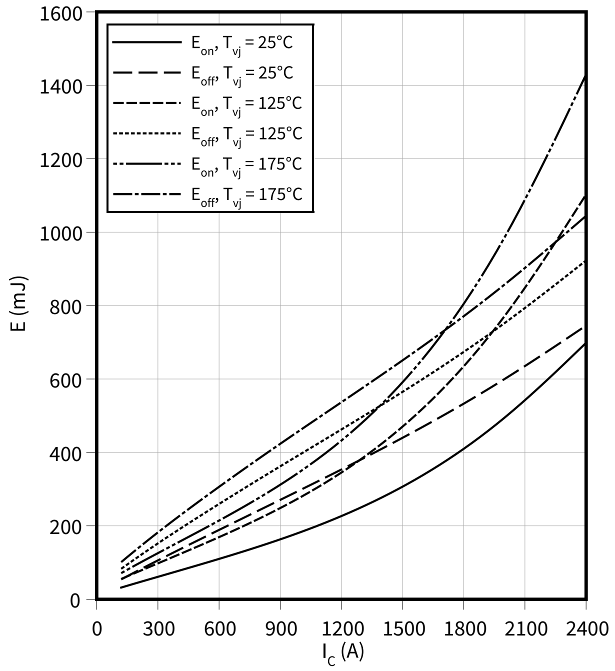
$V_{GE} = \pm15$ V, $I_C = 1200$ A, $V_{CC} = 900$ V, $T_{vj} = 175$ °C



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

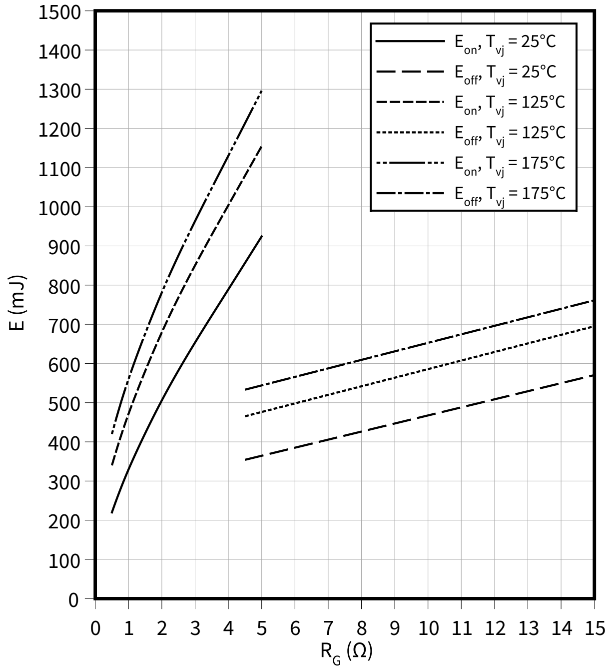
$R_{Goff} = 4.5\ \Omega$, $R_{Gon} = 0.5\ \Omega$, $V_{CC} = 900$ V, $V_{GE} = \pm 15$ V



Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

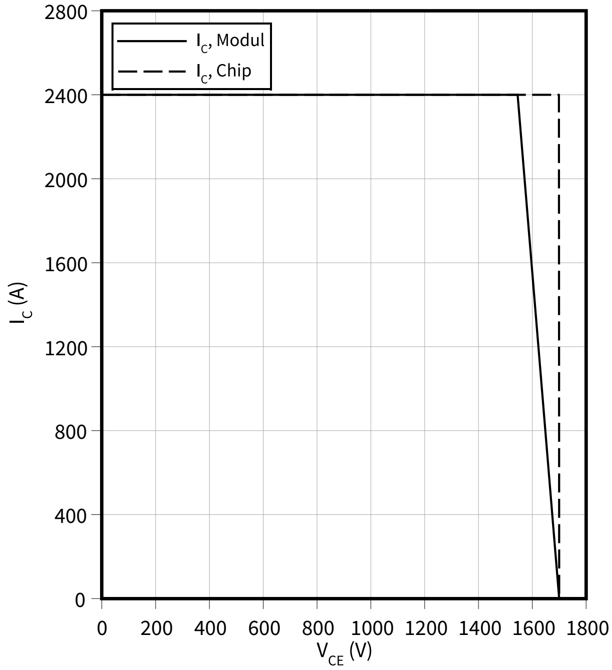
I_C = 1200 A, V_{CC} = 900 V, V_{GE} = ± 15 V



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

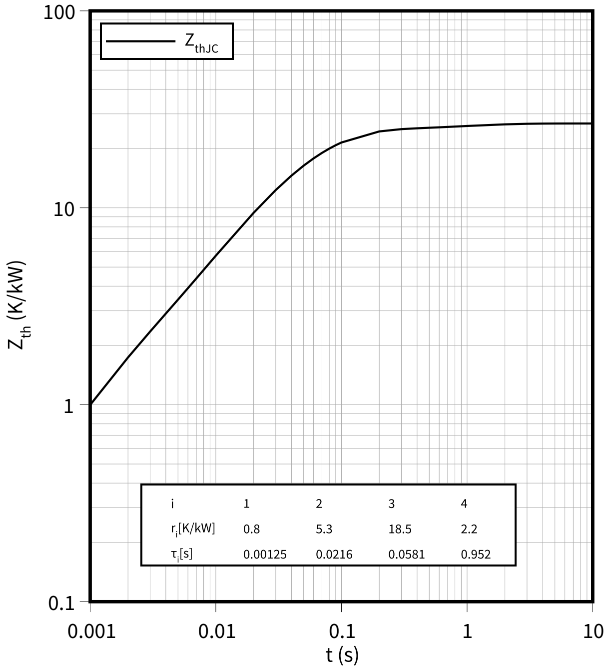
$I_C = f(V_{CE})$

R_{Goff} ≥ 4.5 Ω, V_{GE} = ±15 V, T_{vj} = 175 °C



Transient thermal impedance, IGBT, Inverter

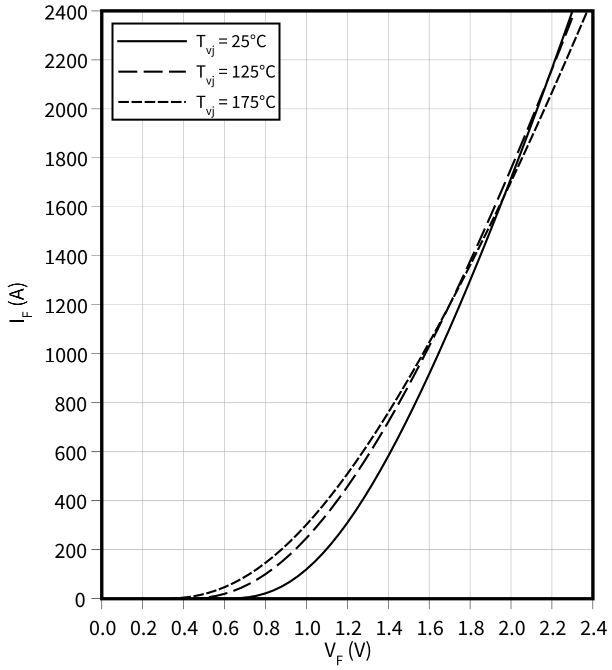
$Z_{th} = f(t)$



i	1	2	3	4
r_i[K/kW]	0.8	5.3	18.5	2.2
τ_i[s]	0.00125	0.0216	0.0581	0.952

Forward characteristic (typical), Diode, Inverter

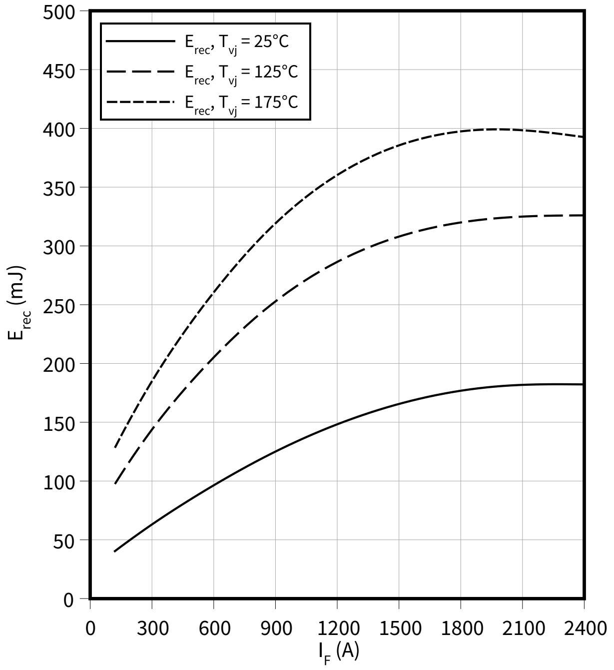
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

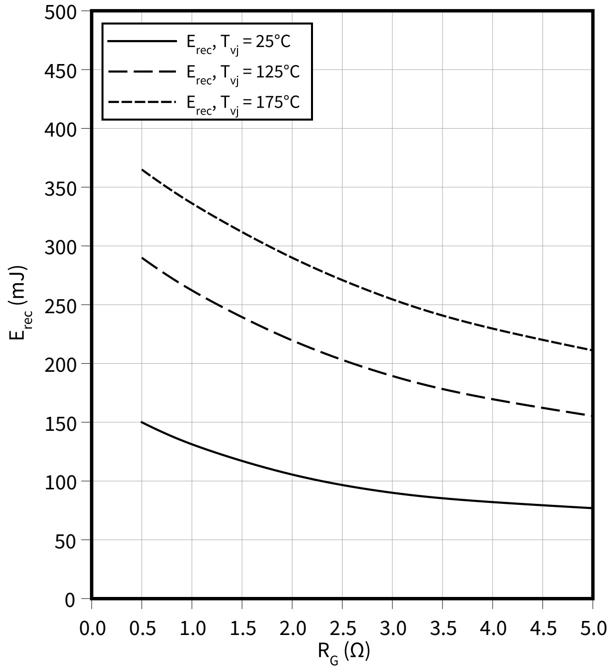
$V_{CE} = 900\ V$, $R_{Gon} = R_{Gon}(IGBT)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(R_G)$

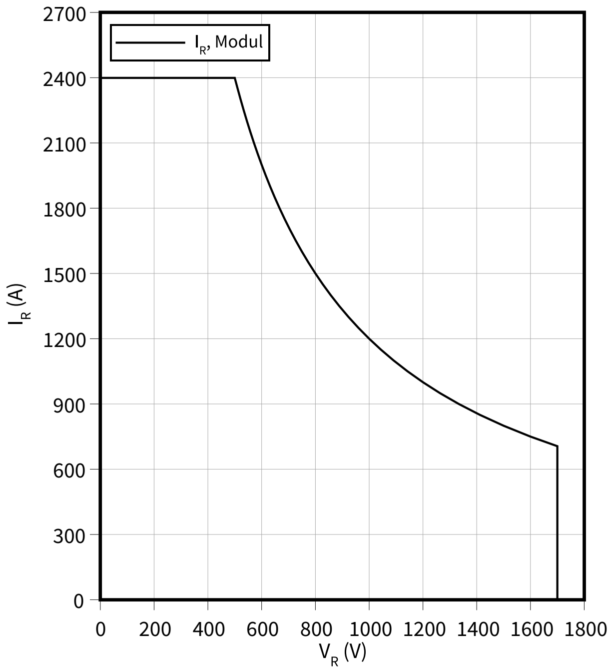
$V_{CE} = 900\ V$, $I_F = 1200\ A$



Safe operating area (SOA), Diode, Inverter

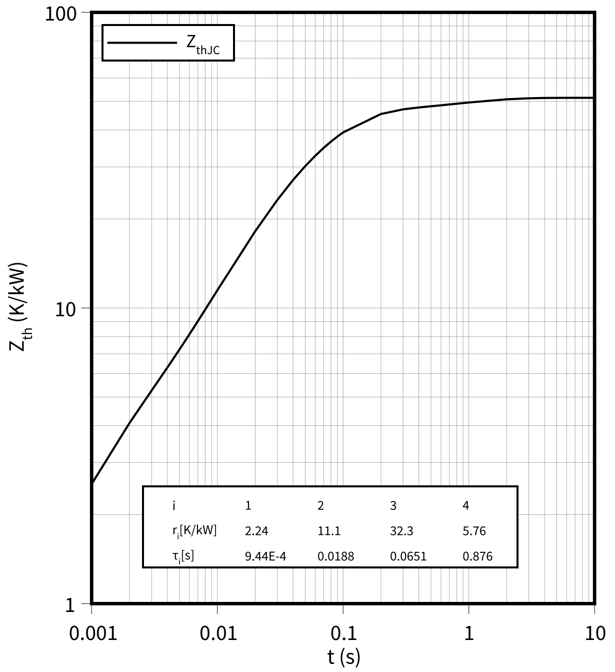
$I_R = f(V_R)$

$T_{vj} = 175\ °C$

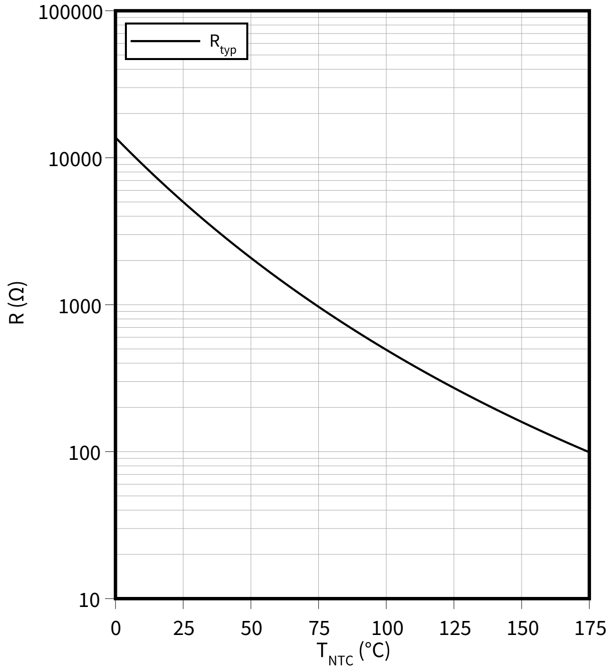


Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor
$R = f(T_{NTC})$



6 Circuit diagram

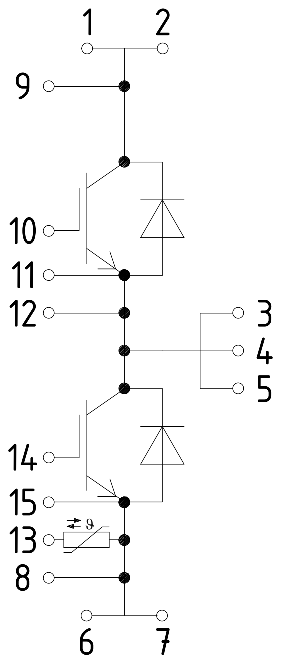


Figure 1

7 Package outlines

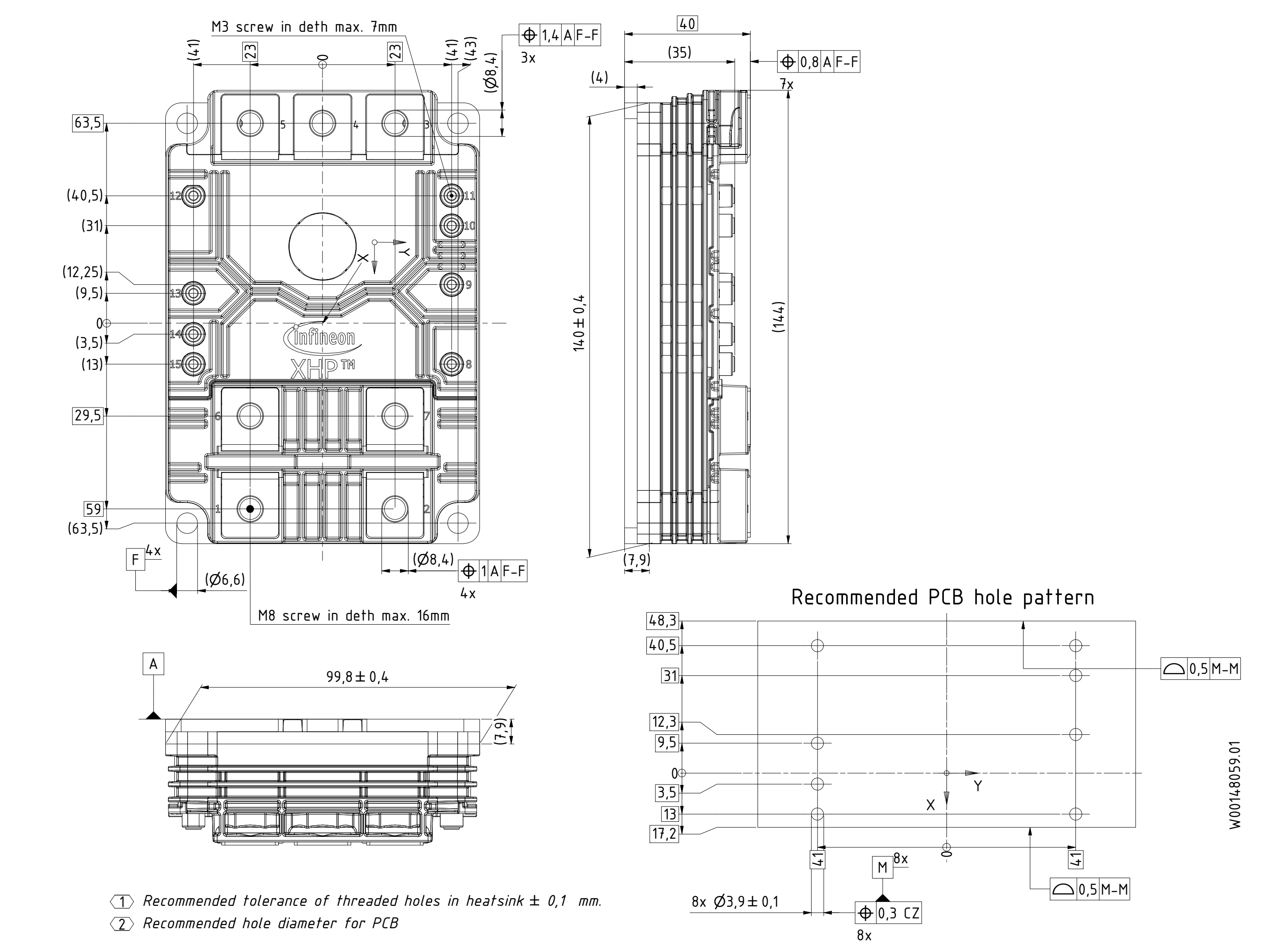


Figure 2

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	*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
V1.0	2019-02-06	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	2021-05-04	Target datasheet
0.20	2022-11-03	Preliminary datasheet
1.00	2023-10-30	Final datasheet

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