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

Features

- Electrical features
  - V_{CES} = 3300 V
  - $I_{C\ nom}$ = 450 A / I_{CRM} = 900 A
  - Low switching losses
  - High DC stability
  - High short-circuit capability
  - Low $V_{CE,sat}$
  - $T_{vj,op}$ = 150°C
  - Unbeatable robustness
  - $V_{CE,sat}$ with positive temperature coefficient
- Mechanical features
  - AlSiC base plate for increased thermal cycling capability
  - Isolated base plate
  - Package with CTI > 600

Potential applications

- Medium-voltage converters
- Motor drives
- Traction drives
- UPS systems
- Wind turbines

Product validation

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

Description

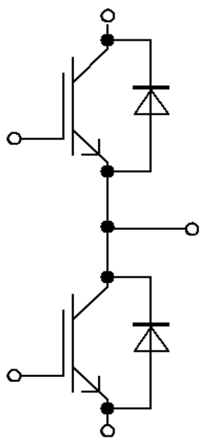


Table of contents

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	6.0	kV
Partial discharge extinction voltage	V_{isol}	RMS, f = 50 Hz, $Q_{PD} \leq 10$ pC	2.6	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°C, per switch			0.31		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_C=25°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 °C	3300	V
			T_{vj} = 150 °C	3300	
Continuous DC collector current	I_{CDC}	$T_{vj\ max}$ = 150 °C	T_C = 100 °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}		±20	V

Table 4 **Characteristic values**

Parameter	Symbol	Note or test condition		Min.	Typ.	Max.	Unit
Collector-emitter saturation voltage	$V_{CE\ sat}$	I_C = 450 A, V_{GE} = 15 V	T_{vj} = 25 °C		2.50	2.75	V
			T_{vj} = 125 °C		2.90		
			T_{vj} = 150 °C		3.00	3.30	
Gate threshold voltage	V_{GEth}	I_C = 12 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.20	5.80	6.40	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 1800 V			12.5		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			1.3		Ω
Input capacitance	C_{ies}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			84		nF
Reverse transfer capacitance	C_{res}	f = 1000 kHz, T_{vj} = 25 °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	T_{vj} = 25 °C			5	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 = 450 A, V_{CE} = 1800 V, V_{GE} = ±15 V, R_{Gon} = 0.7 Ω	T_{vj} = 25 °C		0.530		µs
			T_{vj} = 125 °C		0.570		
			T_{vj} = 150 °C		0.580		
Rise time (inductive load)	t_r	I_C = 450 A, V_{CE} = 1800 V, V_{GE} = ±15 V, R_{Gon} = 0.7 Ω	T_{vj} = 25 °C		0.100		µs
			T_{vj} = 125 °C		0.130		
			T_{vj} = 150 °C		0.130		
Turn-off delay time (inductive load)	t_{doff}	I_C = 450 A, V_{CE} = 1800 V, V_{GE} = ±15 V, R_{Goff} = 3.3 Ω	T_{vj} = 25 °C		1.710		µs
			T_{vj} = 125 °C		1.860		
			T_{vj} = 150 °C		1.920		
Fall time (inductive load)	t_f	I_C = 450 A, V_{CE} = 1800 V, V_{GE} = ±15 V, R_{Goff} = 3.3 Ω	T_{vj} = 25 °C		0.130		µs
			T_{vj} = 125 °C		0.240		
			T_{vj} = 150 °C		0.270		
Turn-on time (resistive load)	t_{on_R}	I_C = 500 A, V_{CE} = 2000 V, V_{GE} = ±15 V, R_{Gon} = 0.7 Ω	T_{vj} = 25 °C	1.15			µs

(table continues...)

Table 4 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values Min.	Values Typ.	Values Max.	Unit
Turn-on energy loss per pulse	E_{on}	I_C = 450 A, V_{CE} = 1800 V, L_σ = 85 nH, V_{GE} = ±15 V, R_{Gon} = 0.7 Ω, di/dt = 3650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		500		mJ
			T_{vj} = 125 °C		765		
			T_{vj} = 150 °C		845		
Turn-off energy loss per pulse	E_{off}	I_C = 450 A, V_{CE} = 1800 V, L_σ = 85 nH, V_{GE} = ±15 V, R_{Goff} = 3.3 Ω, dv/dt = 2850 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		415		mJ
			T_{vj} = 125 °C		610		
			T_{vj} = 150 °C		670		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 2500 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 10 µs, T_{vj} ≤ 150 °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, λ_{grease}= 1 W/(m*K)			17.4		K/kW
Temperature under switching conditions	$T_{vj\ op}$			-40		150	°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 °C	3300	V
			T_{vj} = 150 °C	3300	
Continuous DC forward current	I_F			450	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		900	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	82.9	kA^2s
			T_{vj} = 150 °C	68	
Maximum power dissipation	P_{RQM}		T_{vj} = 150 °C	1000	kW
Minimum turn-on time	t_{onmin}			10	µs

Table 6 **Characteristic values**

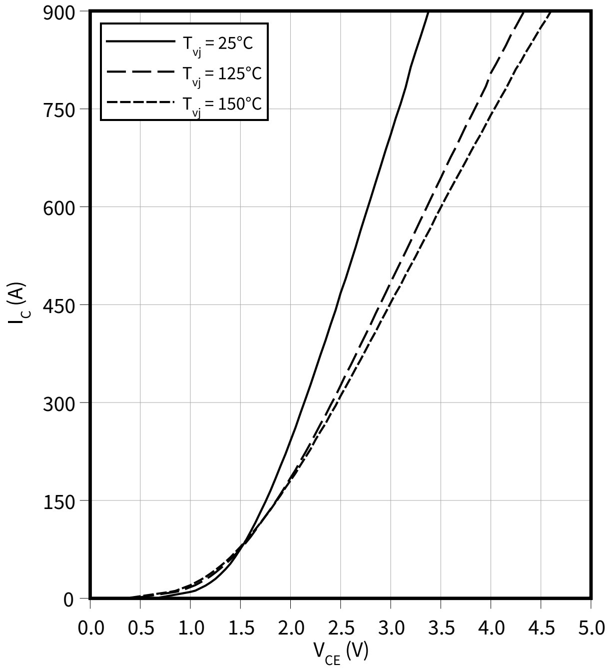
Parameter	Symbol	Note or test condition		Values Min.	Typ.	Max.	Unit
Forward voltage	V_F	I_F = 450 A, V_{GE} = 0 V	T_{vj} = 25 °C		3.10	3.50	V
			T_{vj} = 125 °C		2.75		
			T_{vj} = 150 °C		2.65	2.95	
Peak reverse recovery current	I_{RM}	V_R = 1800 V, I_F = 450 A, V_{GE} = -15 V, -di$_F$/dt = 3650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		680		A
			T_{vj} = 125 °C		680		
			T_{vj} = 150 °C		680		
Recovered charge	Q_r	V_R = 1800 V, I_F = 450 A, V_{GE} = -15 V, -di$_F$/dt = 3650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		230		µC
			T_{vj} = 125 °C		445		
			T_{vj} = 150 °C		525		
Reverse recovery energy	E_{rec}	V_R = 1800 V, I_F = 450 A, V_{GE} = -15 V, -di$_F$/dt = 3650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		220		mJ
			T_{vj} = 125 °C		490		
			T_{vj} = 150 °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, λ_{grease}= 1 W/(m*K)			19.3		K/kW
Temperature under switching conditions	$T_{vj\ op}$			-40		150	°C

4 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

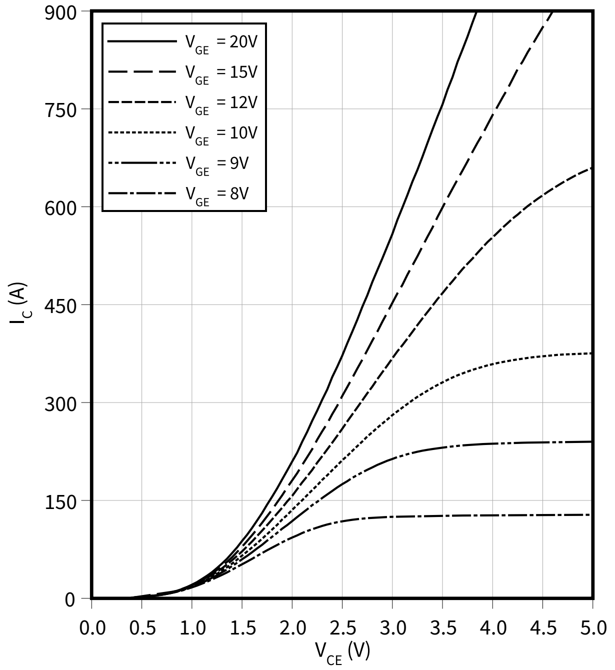
$V_{GE} = 15$ V



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

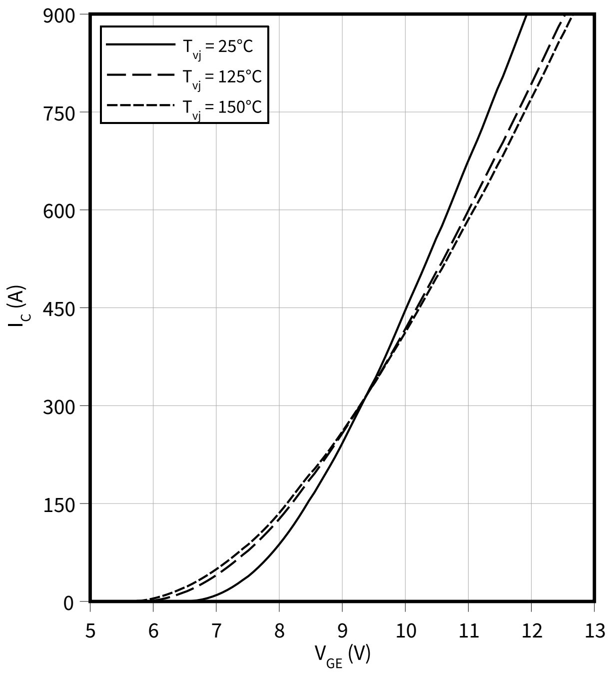
$T_{vj} = 150$ °C



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

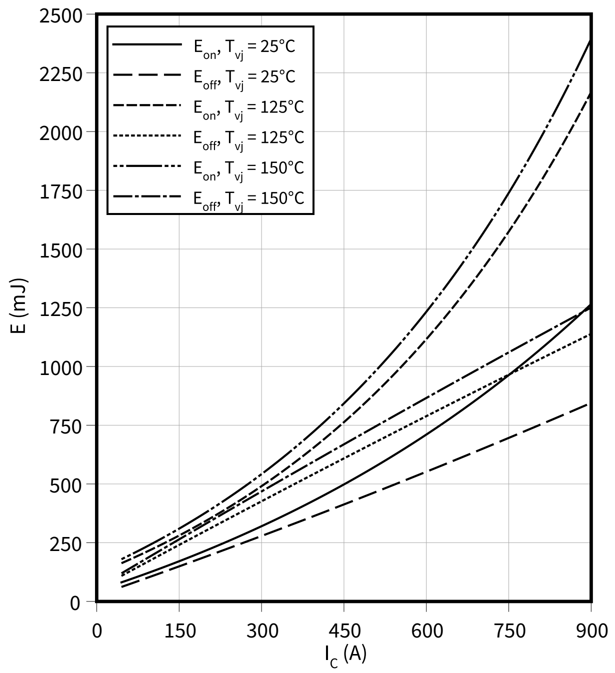
$V_{CE} = 20$ V



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

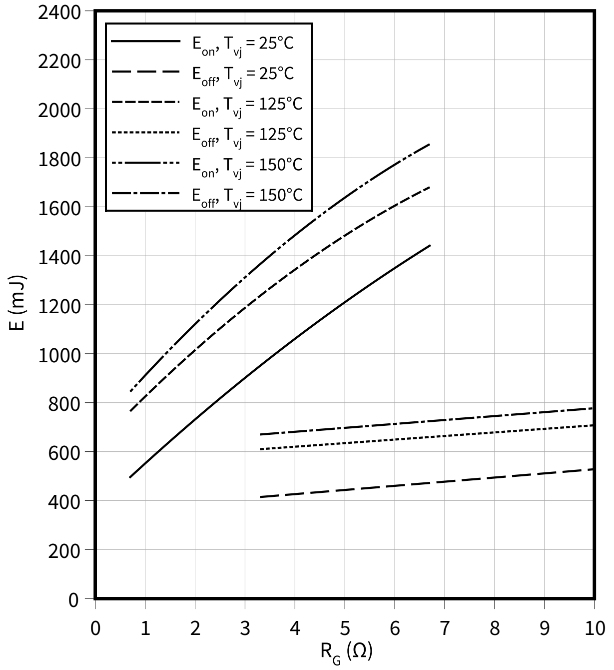
$R_{Goff} = 3.3\ \Omega$, $R_{Gon} = 0.7\ \Omega$, $V_{CE} = 1800$ V, $V_{GE} = \pm 15$ V



Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

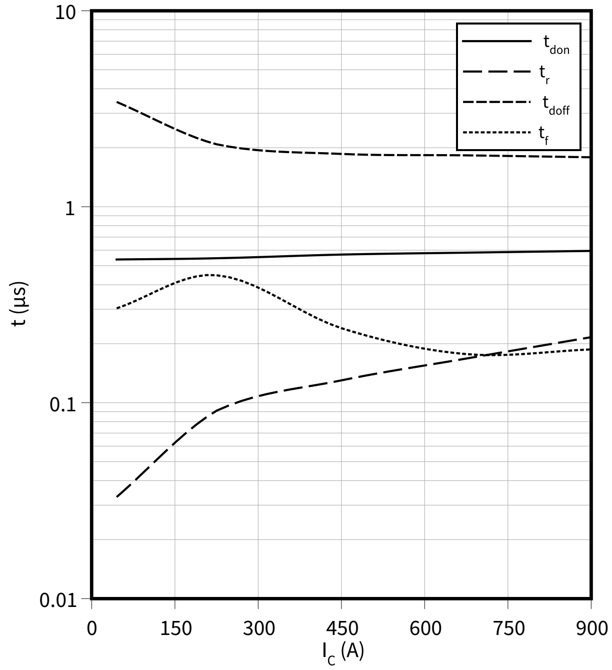
I_C = 450 A, V_{CE} = 1800 V, V_{GE} = ± 15 V



Switching times (typical), IGBT, Inverter

$t = f(I_C)$

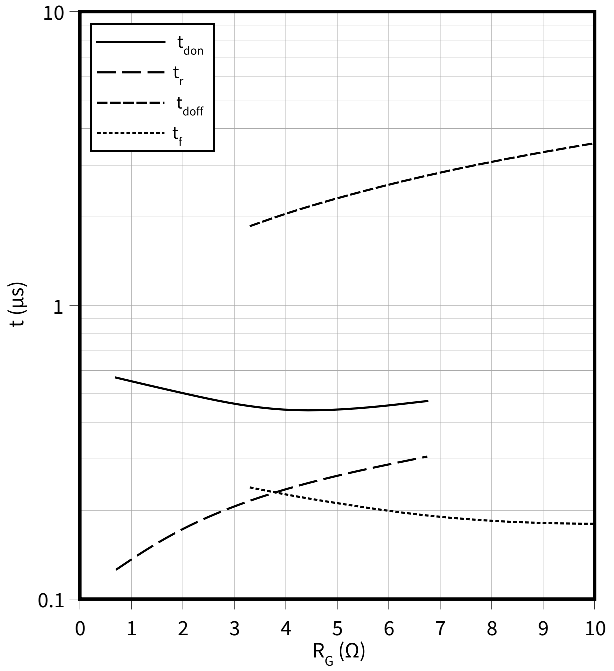
R_{Goff} = 3.3 Ω, R_{Gon} = 0.7 Ω, V_{CE} = 1800 V, V_{GE} = ± 15 V, T_{vj} = 150 °C



Switching times (typical), IGBT, Inverter

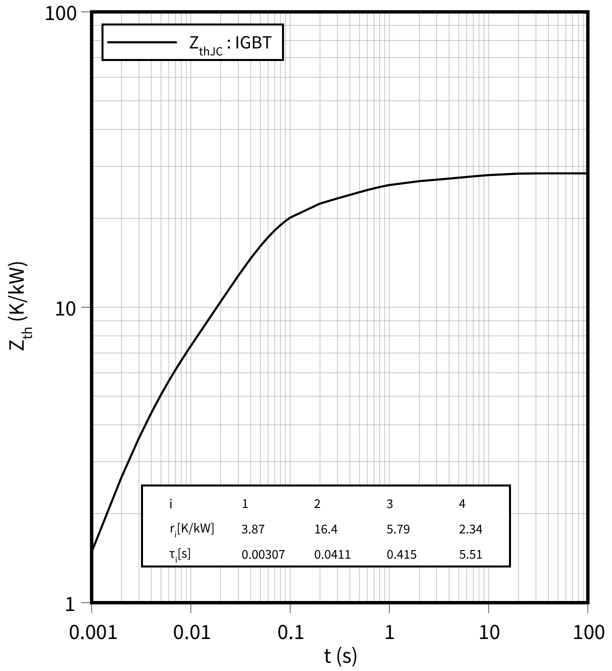
$t = f(R_G)$

I_C = 450 A, V_{CE} = 1800 V, V_{GE} = ± 15 V, T_{vj} = 150 °C



Transient thermal impedance , IGBT, Inverter

$Z_{th} = f(t)$

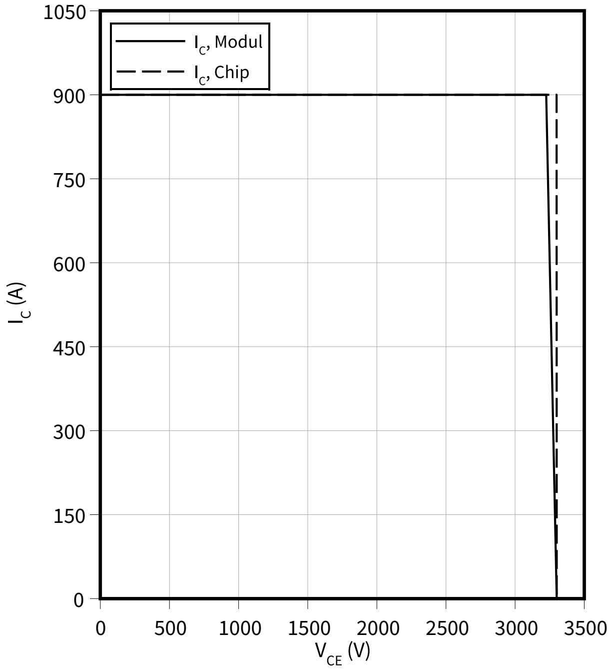


i	1	2	3	4
r_i[K/kW]	3.87	16.4	5.79	2.34
τ_i[s]	0.00307	0.0411	0.415	5.51

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

$I_C = f(V_{CE})$

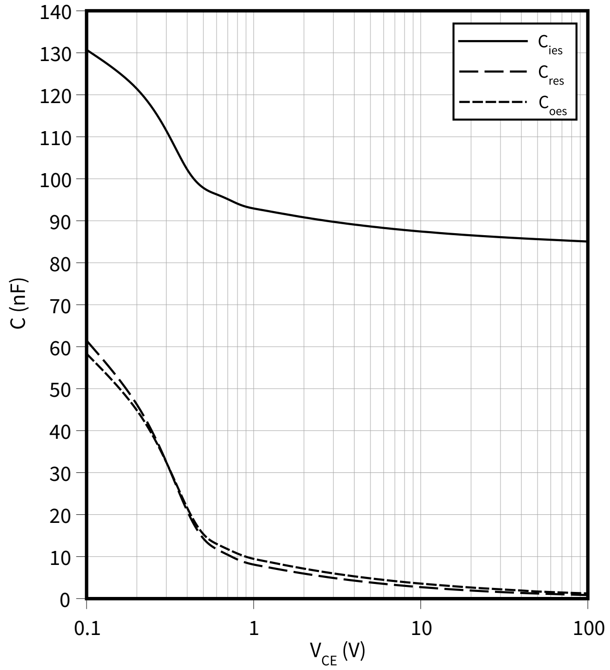
$R_{Goff} = 3.3\ \Omega$, $V_{GE} = \pm 15\ V$, $T_{vj} = 150\ °C$



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

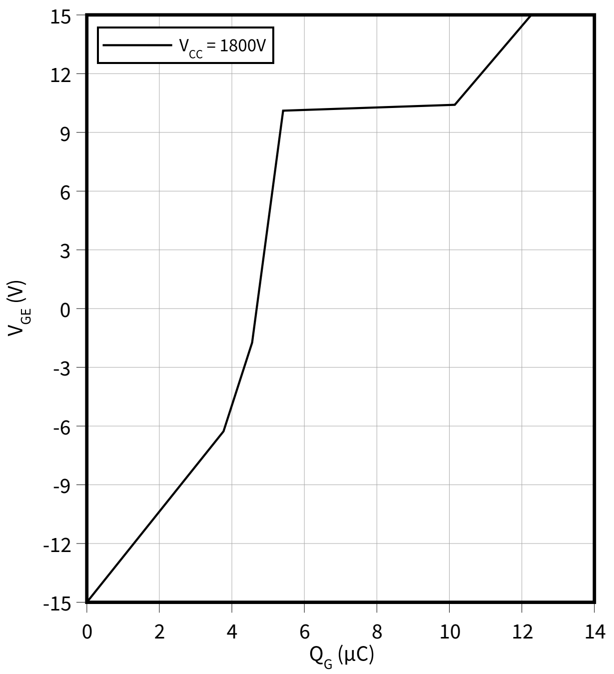
$f = 1000\ kHz$, $V_{GE} = 0\ V$, $T_{vj} = 25\ °C$



Gate charge characteristic (typical), IGBT, Inverter

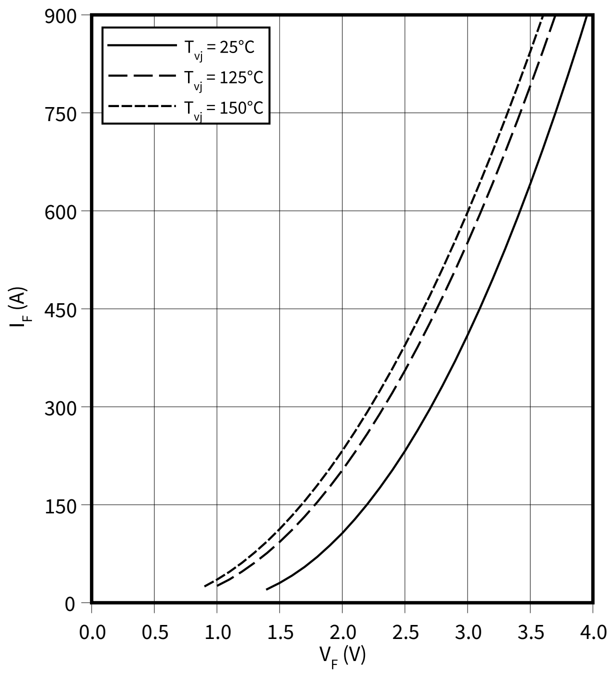
$V_{GE} = f(Q_G)$

$I_C = 450\ A$, $T_{vj} = 25\ °C$



Forward characteristic (typical), Diode, Inverter

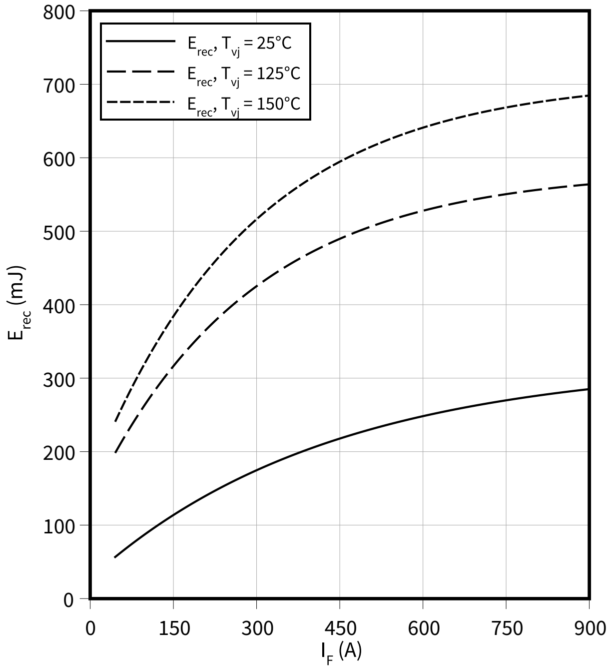
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

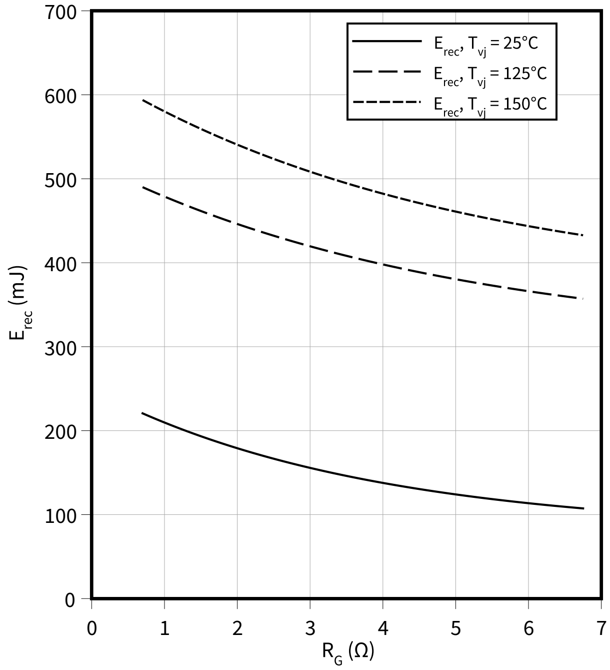
$V_{CE} = 1800$ V, $R_{Gon} = R_{Gon}$(IGBT)



Switching losses (typical), Diode, Inverter

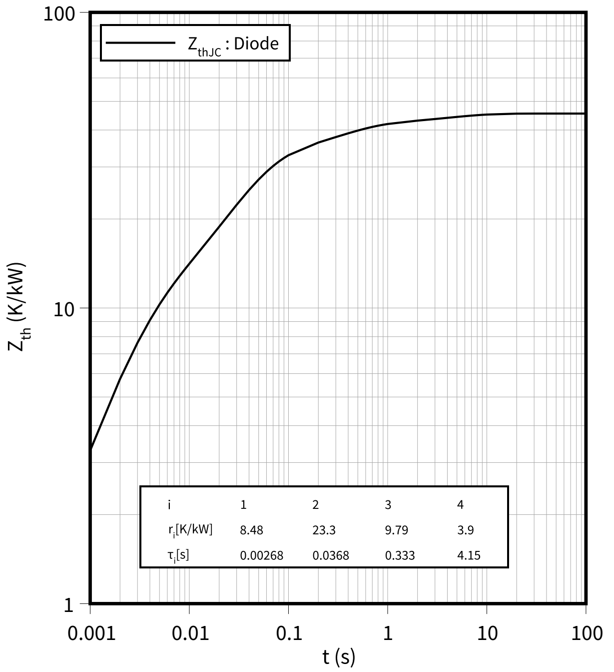
$E_{rec} = f(R_G)$

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



Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$

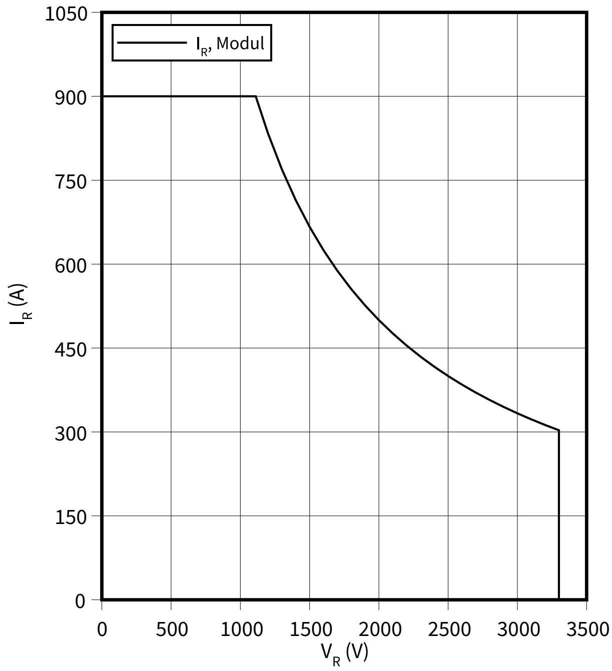


i	1	2	3	4
r_i[K/kW]	8.48	23.3	9.79	3.9
τ_i[s]	0.00268	0.0368	0.333	4.15

Safe operating area (SOA), Diode, Inverter

$I_R = f(V_R)$

$T_{vj} = 150$ °C



5 Circuit diagram

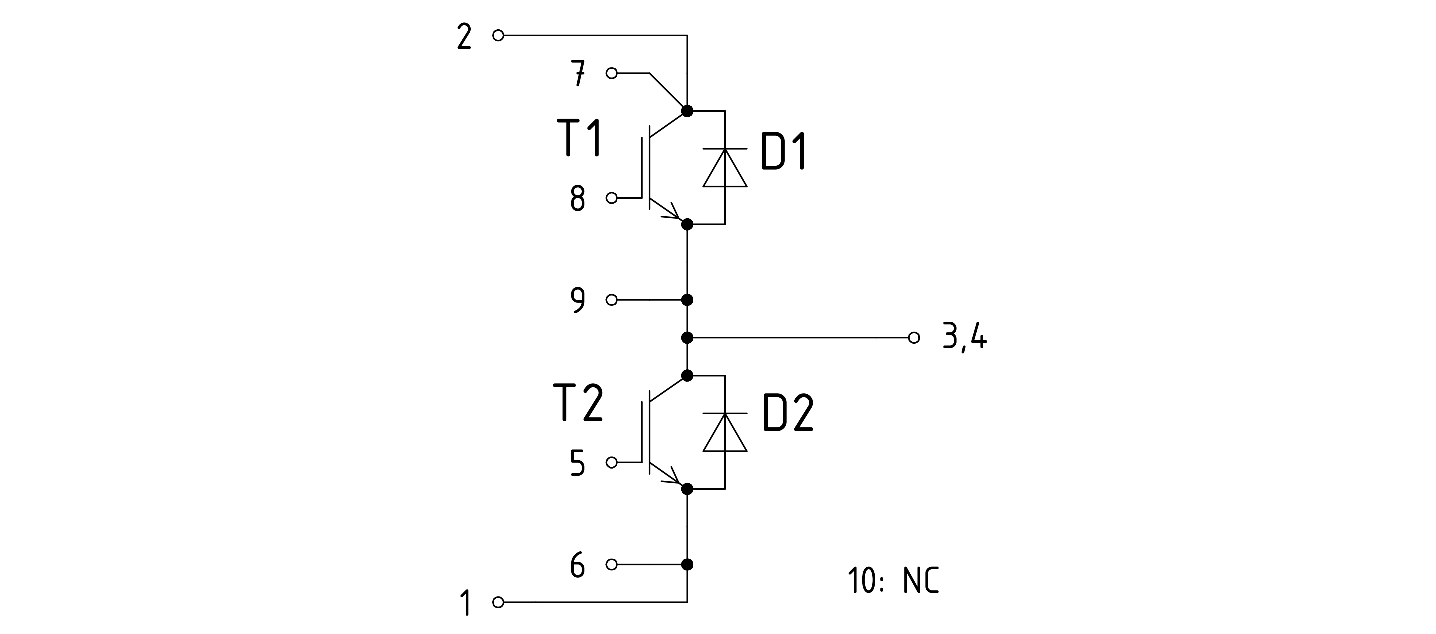


Figure 1

6 Package outlines

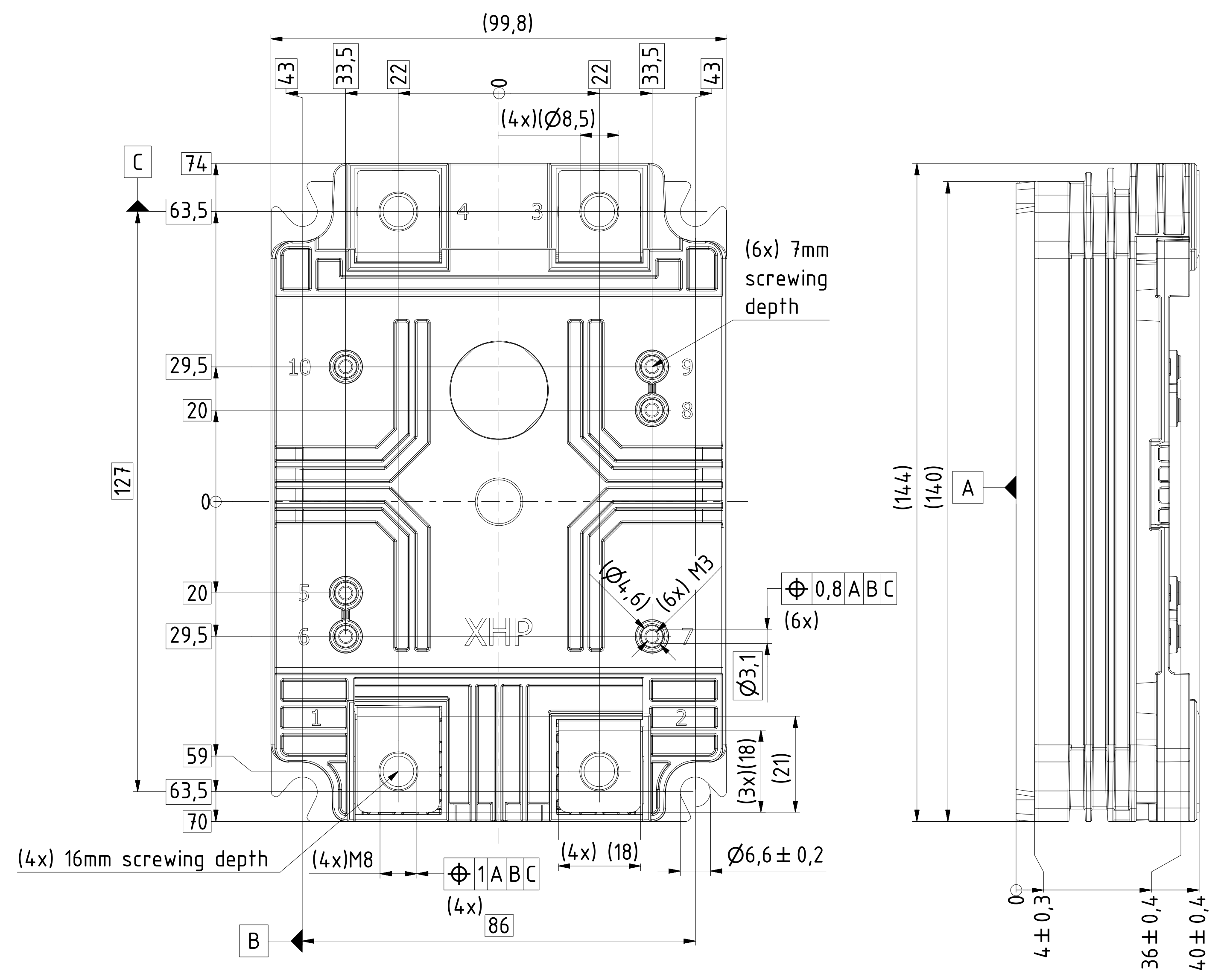


Figure 2

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	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production week)	*Digit* 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	*Example* 71549 142846 55054991 15 30
Example	71549142846550549911530		71549142846550549911530

Figure 3

Revision history

Document revision	Date of release	Description of changes
V1.0	2013-12-05	Target datasheet
V1.1	2014-08-25	Target datasheet
V1.2	2015-01-22	Target datasheet
V1.3	2015-10-16	Target datasheet
V1.4	2015-10-16	Target datasheet
V2.0	2016-05-18	Preliminary datasheet
V2.1	2016-09-02	Preliminary datasheet
V2.2	2016-12-23	Preliminary datasheet
V2.3	2018-02-14	Preliminary datasheet
V3.0	2018-12-12	Final datasheet
V3.1	2018-12-13	Final datasheet
V3.2	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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