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

Features

- Electrical features
  - V_{CES} = 6500 V
  - $I_{C\ nom}$ = 225 A / I_{CRM} = 450 A
  - High dynamic robustness
  - Low $V_{CE,sat}$
  - Trench IGBT 3
- Mechanical features
  - Package with CTI > 600
  - Package with enhanced insulation of 10.4 kV AC 60 s
  - AlSiC base plate for increased thermal cycling capability
  - Extended storage temperature down to T_{stg} = -55 °C
  - High creepage and clearance distances
  - Housing material compliant with the classification R23 (HL3) of the EN45545-2 “Fire protection of railway vehicles”

Potential applications

- Traction drives
- Medium-voltage converters

Product validation

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

Description

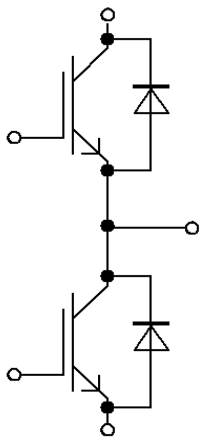


Table of contents

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	10.4	kV
Partial discharge extinction voltage	V_{isol}	RMS, f = 50 Hz, Q_{PD} typ. 10 pC	5.1	kV
DC stability	$V_{CE(D)}$	T_{vj}=25°C, 100 Fit	3800	V
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			0.33		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_C=25°C, per switch			0.42		mΩ
Storage temperature	T_{stg}			-55		125	°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} = -50 °C	5900	V
			T_{vj} = 125 °C	6500	
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 125 °C	T_C = 80 °C	225	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 $T_{vj\ op}$	450	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 = 225 A, V_{GE} = 15 V	T_{vj} = 25 °C		3.00	3.40	V
			T_{vj} = 125 °C		3.70	4.20	
Gate threshold voltage	V_{GEth}	I_C = 33 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.40	6	6.60	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 3600 V			10.5		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0.67		Ω
Input capacitance	C_{ies}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			65.6		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			1		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 6500 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 = 225 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 4.7 Ω	T_{vj} = 25 °C		0.240		µs
			T_{vj} = 125 °C		0.240		
Rise time (inductive load)	t_r	I_C = 225 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 4.7 Ω	T_{vj} = 25 °C		0.070		µs
			T_{vj} = 125 °C		0.080		
Turn-off delay time (inductive load)	t_{doff}	I_C = 225 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 22 Ω	T_{vj} = 25 °C		6.000		µs
			T_{vj} = 125 °C		6.400		
Fall time (inductive load)	t_f	I_C = 225 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 22 Ω	T_{vj} = 25 °C		0.950		µs
			T_{vj} = 125 °C		2.000		
Turn-on energy loss per pulse	E_{on}	I_C = 225 A, V_{CE} = 3600 V, $L_σ$ = 85 nH, V_{GE} = ±15 V, R_{Gon} = 4.7 Ω, di/dt = 2200 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		1230		mJ
			T_{vj} = 125 °C		1710		
Turn-off energy loss per pulse	E_{off}	I_C = 225 A, V_{CE} = 3600 V, $L_σ$ = 85 nH, V_{GE} = ±15 V, R_{Goff} = 22 Ω, dv/dt = 2100 V/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		875		mJ
			T_{vj} = 125 °C		1170		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 4500 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 10 µs, T_{vj}=125 °C		1300		A

(table continues...)

Table 4 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, junction to case	R_{thJC}	per IGBT			29.1	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per IGBT		21.3		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-50		125	°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} = -50 °C	5900	V
			T_{vj} = 125 °C	6500	
Continuous DC forward current	I_F			225	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		450	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	45.2	kA^2s
Maximum power dissipation	P_{RQM}		T_{vj} = 125 °C	1000	kW
Minimum turn-on time	t_{onmin}			10	µs

Table 6 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 225 A, V_{GE} = 0 V	T_{vj} = 25 °C		3.10	3.55	V
			T_{vj} = 125 °C		2.85	3.25	
Peak reverse recovery current	I_{RM}	V_R = 3600 V, I_F = 225 A, V_{GE} = -15 V, -di_F/dt = 2200 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		405		A
			T_{vj} = 125 °C		365		
Recovered charge	Q_r	V_R = 3600 V, I_F = 225 A, V_{GE} = -15 V, -di_F/dt = 2200 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		255		µC
			T_{vj} = 125 °C		505		
Reverse recovery energy	E_{rec}	V_R = 3600 V, I_F = 225 A, V_{GE} = -15 V, -di_F/dt = 2200 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		450		mJ
			T_{vj} = 125 °C		1070		
Thermal resistance, junction to case	R_{thJC}	per diode				51.3	K/kW

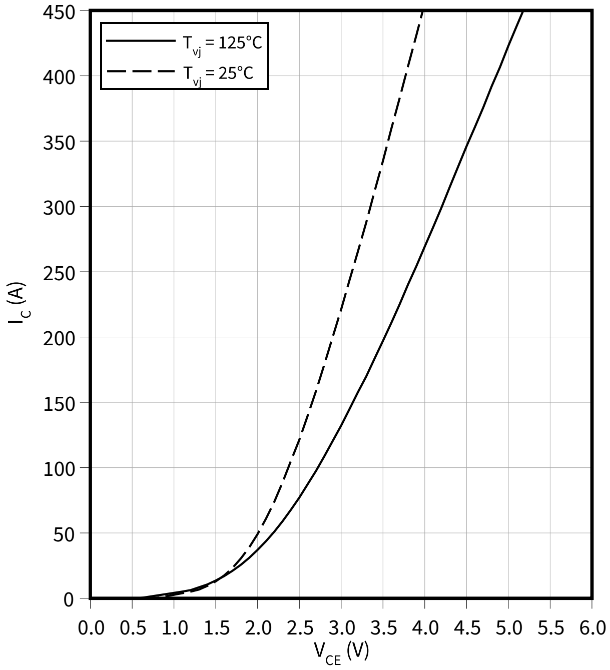
(table continues...)

Table 6 (continued) Characteristic values

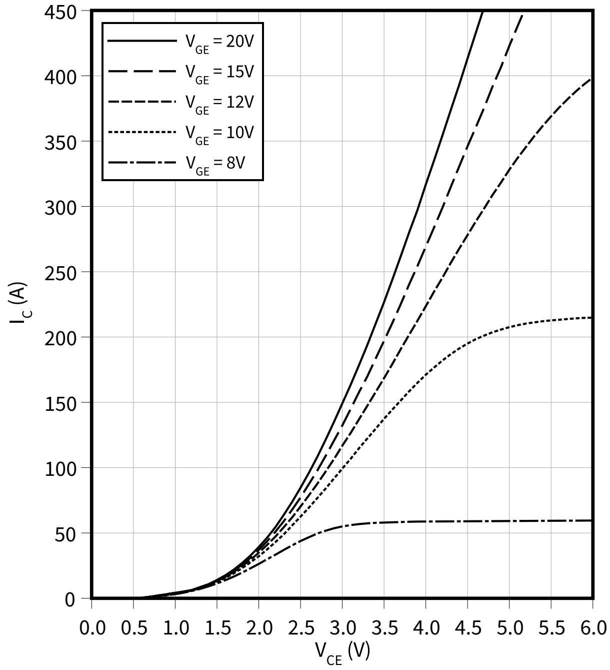
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, case to heat sink	R_{thCH}	per diode		24.2		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-50		125	°C

4 Characteristics diagrams

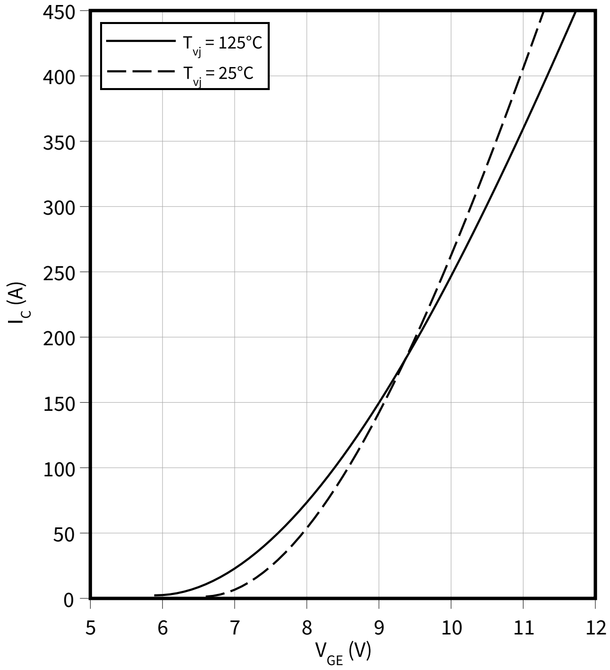
Output characteristic (typical), IGBT, Inverter
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



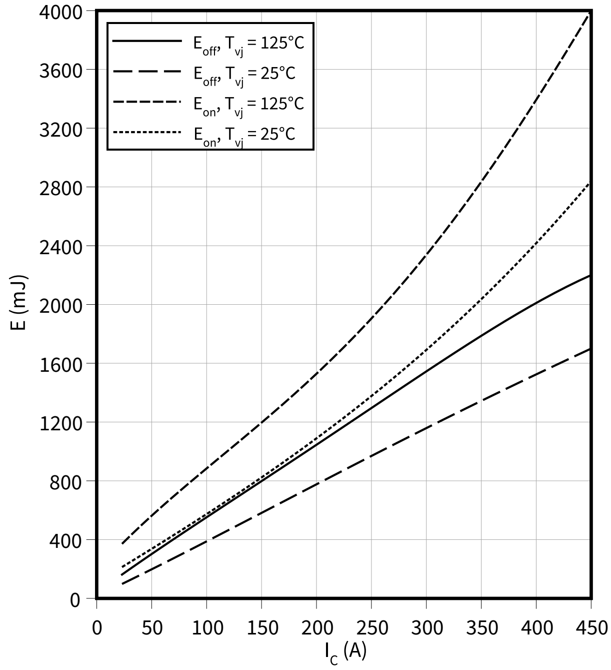
Output characteristic field (typical), IGBT, Inverter
$I_C = f(V_{CE})$
$T_{vj} = 125$ °C



Transfer characteristic (typical), IGBT, Inverter
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



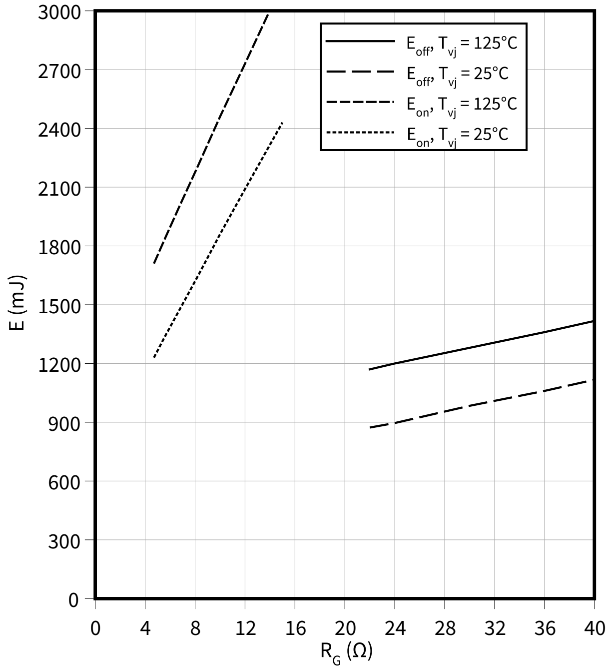
Switching losses (typical), IGBT, Inverter
$E = f(I_C)$
$R_{Goff} = 22\ \Omega$, $R_{Gon} = 4.7\ \Omega$, $V_{CE} = 3600$ V, $V_{GE} = \pm 15$ V



Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

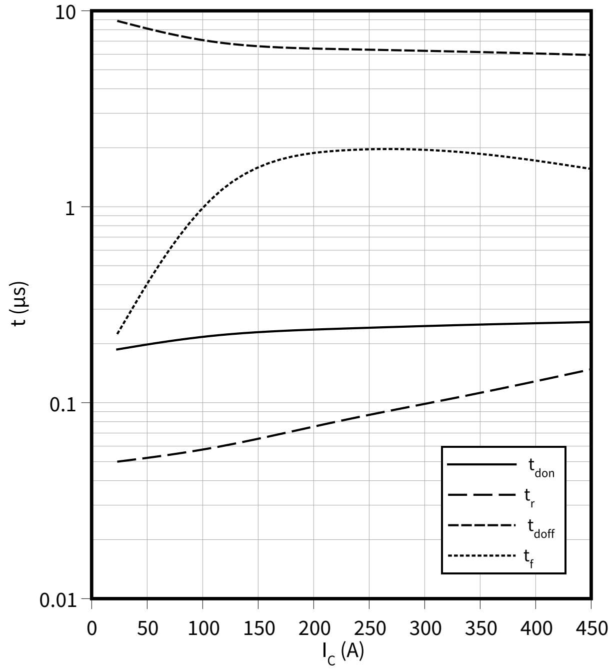
$I_C = 225$ A, $V_{CE} = 3600$ V, $V_{GE} = \pm 15$ V



Switching times (typical), IGBT, Inverter

$t = f(I_C)$

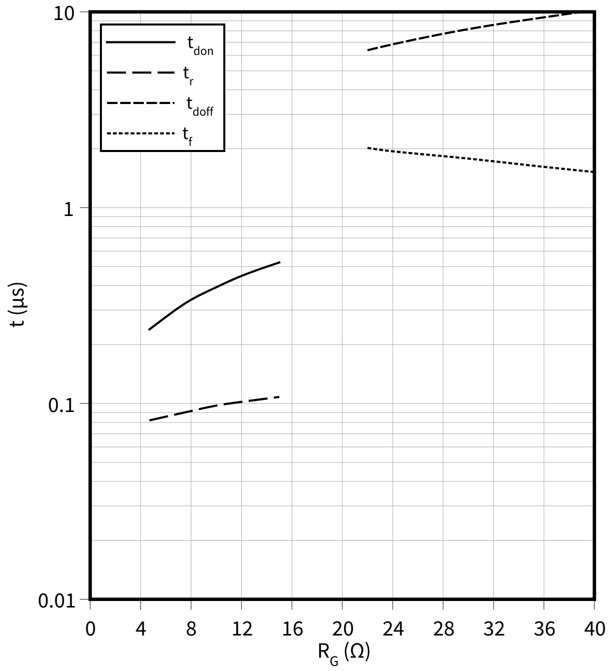
$R_{Goff} = 22\ \Omega$, $R_{Gon} = 4.7\ \Omega$, $V_{CE} = 3600$ V, $V_{GE} = \pm 15$ V, $T_{vj} = 125$ °C



Switching times (typical), IGBT, Inverter

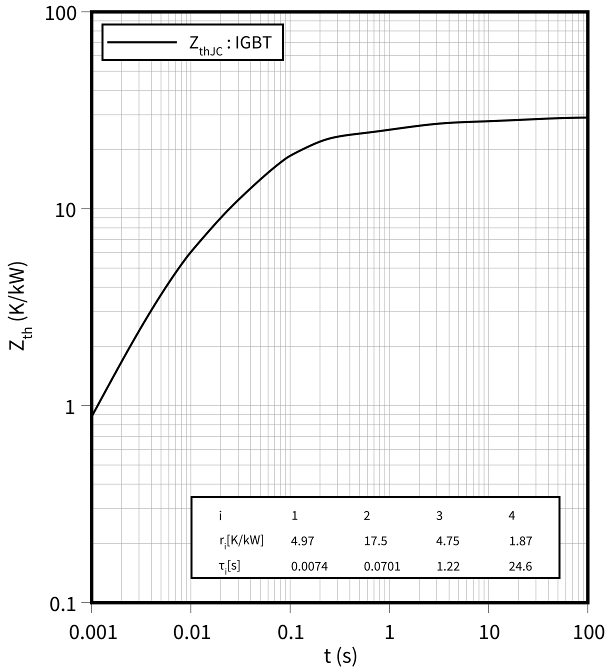
$t = f(R_G)$

$I_C = 225$ A, $V_{CE} = 3600$ V, $V_{GE} = \pm 15$ V, $T_{vj} = 125$ °C



Transient thermal impedance , IGBT, Inverter

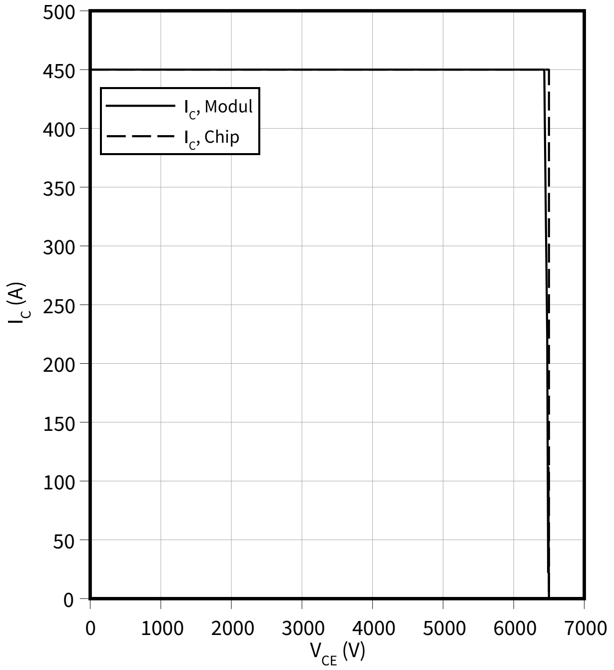
$Z_{th} = f(t)$



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

$I_C = f(V_{CE})$

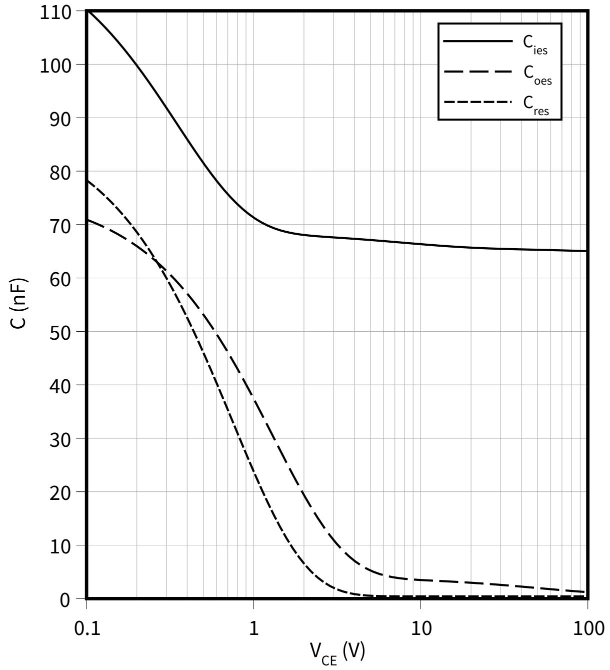
$R_{Goff} = 22\ \Omega$, $V_{GE} = \pm15$ V, $T_{vj} = 125$ °C



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

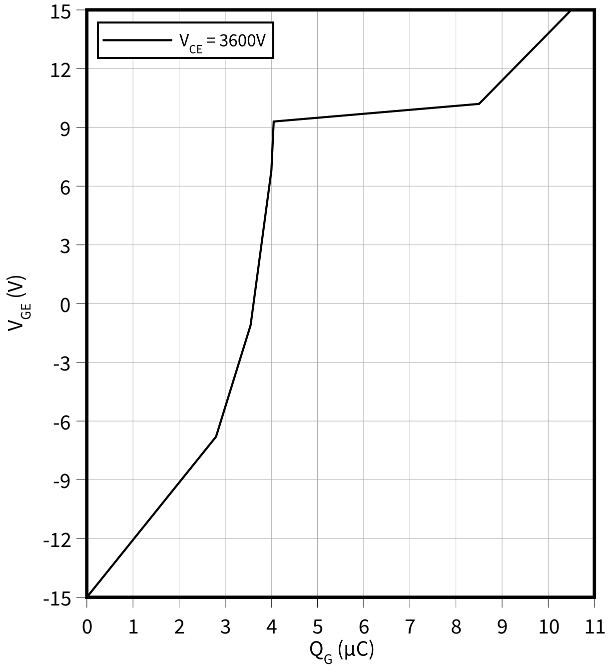
$f = 100$ kHz, $V_{GE} = 0$ V, $T_{vj} = 25$ °C



Gate charge characteristic (typical), IGBT, Inverter

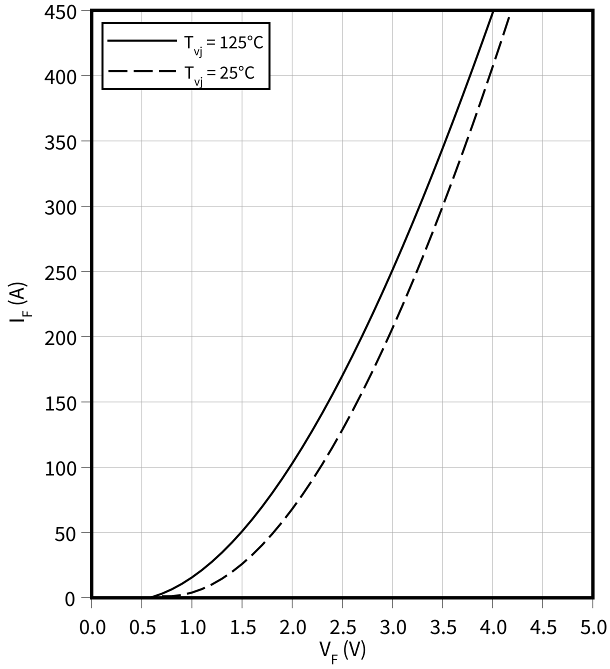
$V_{GE} = f(Q_G)$

$I_C = 225$ A, $T_{vj} = 25$ °C



Forward characteristic (typical), Diode, Inverter

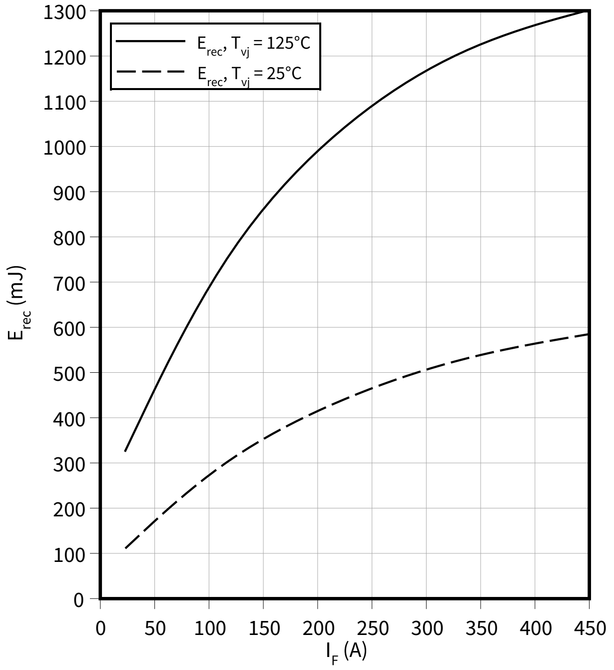
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

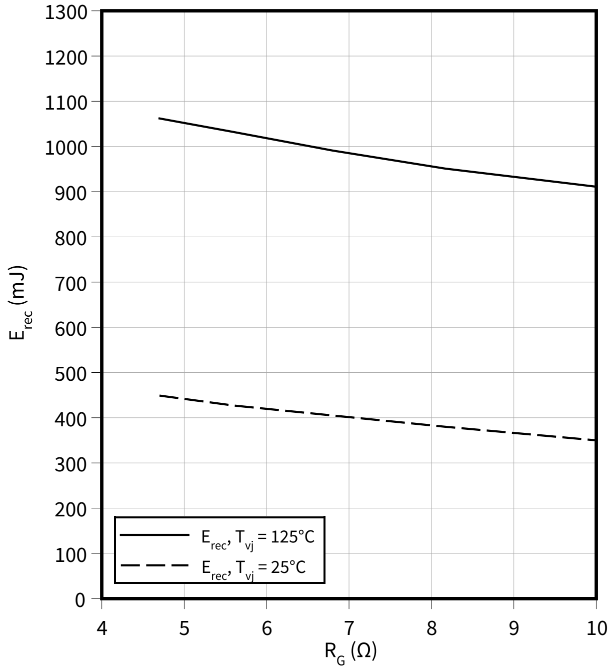
$V_{CE} = 3600$ V, $R_{Gon} = R_{Gon}$(IGBT)



Switching losses (typical), Diode, Inverter

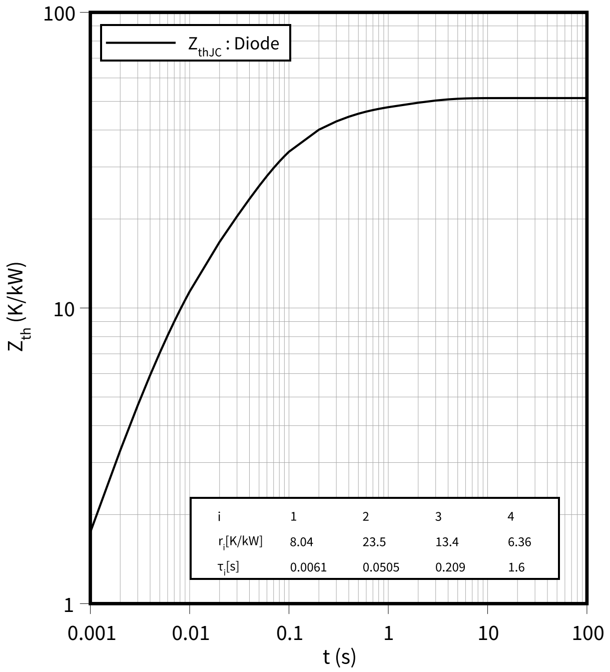
$E_{rec} = f(R_G)$

$V_{CE} = 3600$ V, $I_F = 225$ A



Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$

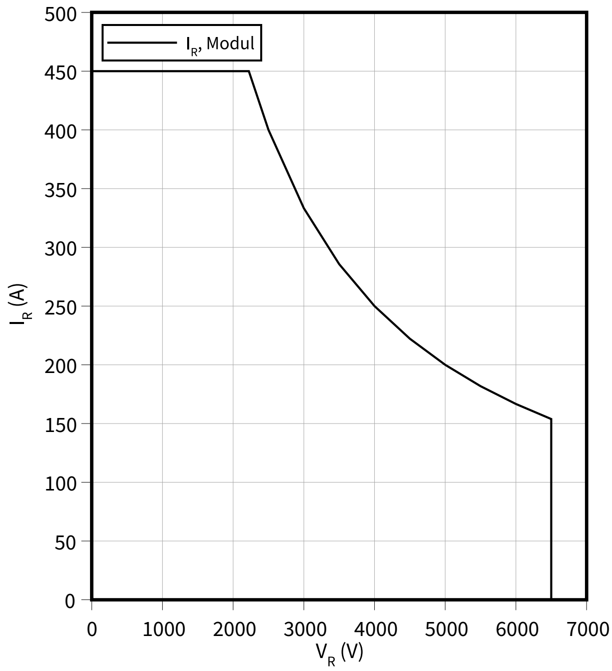


i	1	2	3	4
r_i[K/kW]	8.04	23.5	13.4	6.36
τ_i[s]	0.0061	0.0505	0.209	1.6

Safe operating area (SOA), Diode, Inverter

$I_R = f(V_R)$

$T_{vj} = 125$ °C



5 Circuit diagram

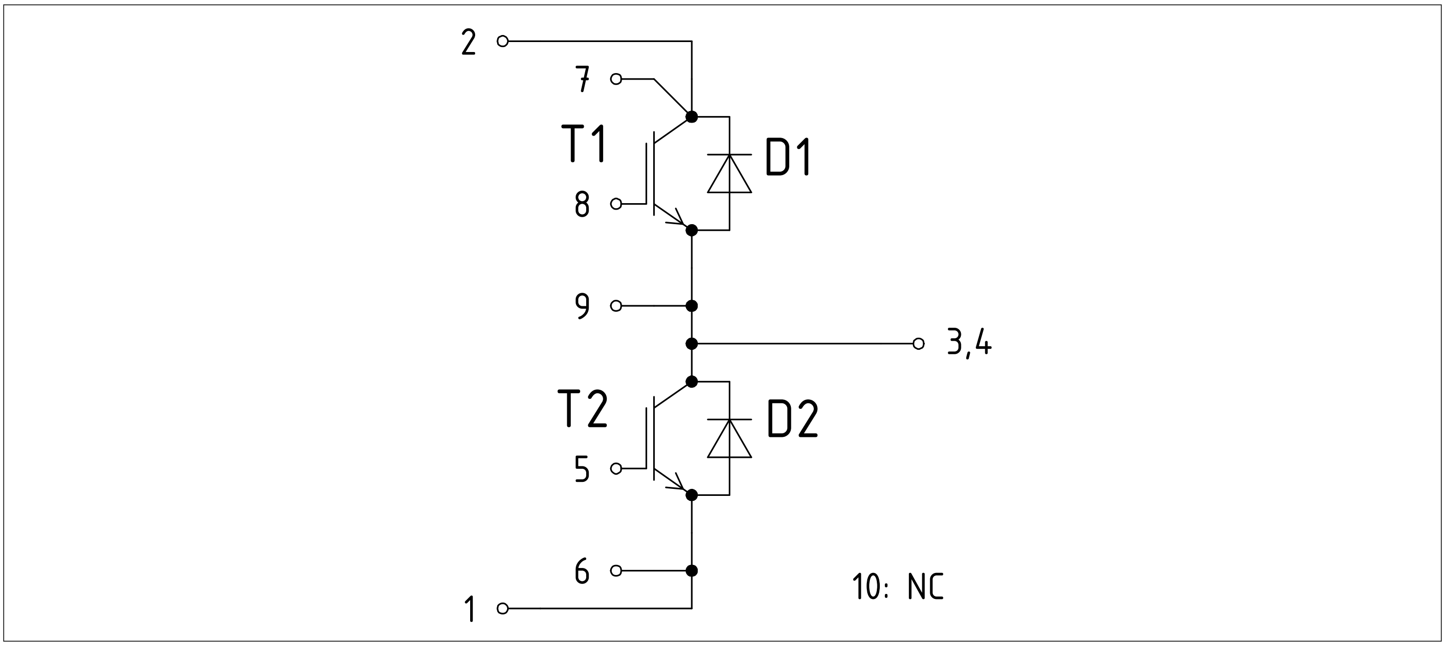


Figure 1

6 Package outlines

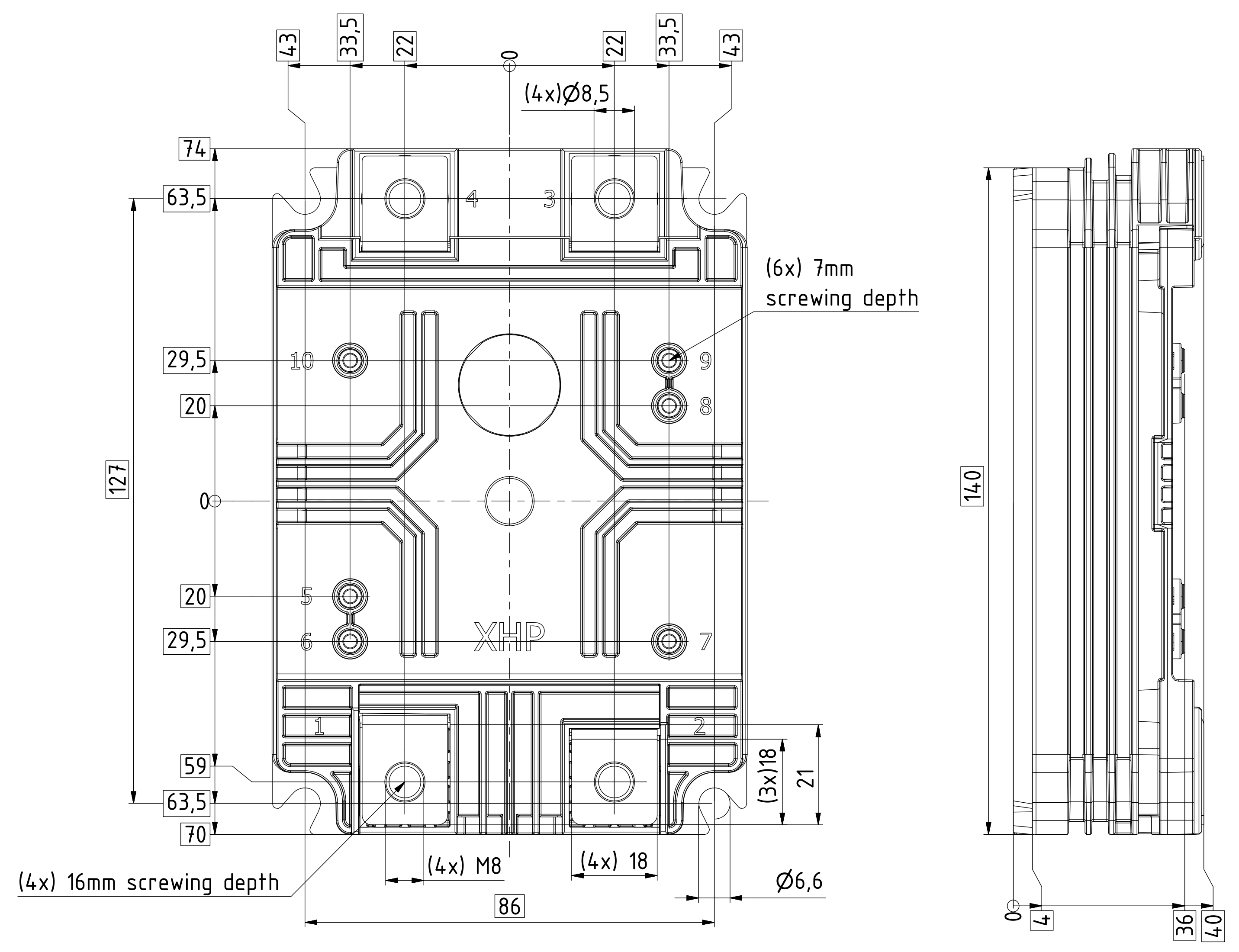


Figure 2

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*	*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	2017-12-19	Target datasheet
V1.1	2018-04-17	Target datasheet
V2.0	2018-04-23	Preliminary 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	2020-12-11	
1.11	2022-04-12	Final datasheet

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