

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

- Electrical features
 - $V_{CES} = 3300\text{ V}$
 - $I_{C\text{ nom}} = 450\text{ A} / I_{CRM} = 900\text{ A}$
 - Low switching losses
 - High DC stability
 - High short-circuit capability
 - Low $V_{CE,sat}$
 - $T_{vj,op} = 150^{\circ}\text{C}$
 - 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

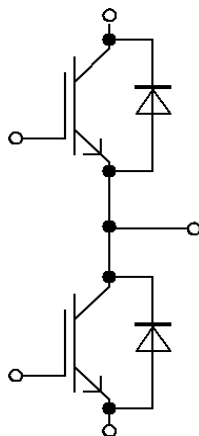
Description

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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50 \text{ Hz}$, $t = 60 \text{ s}$	6.0	kV
Partial discharge extinction voltage	V_{isol}	RMS, $f = 50 \text{ Hz}$, $Q_{PD} \leq 10 \text{ pC}$	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	$R_{AA'+CC'}$	$T_C=25^{\circ}C$, per switch			0.31		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C=25^{\circ}C$, 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}		$T_{vj} = -40^\circ\text{C}$	3300	V
			$T_{vj} = 150^\circ\text{C}$	3300	
Continuous DC collector current	I_{CDC}	$T_{vj \text{ max}} = 150^\circ\text{C}$	$T_C = 100^\circ\text{C}$	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	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\ sat}$	$I_C = 450\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	2.50	2.75	V
			$T_{vj} = 125\ ^\circ C$	2.90		
			$T_{vj} = 150\ ^\circ C$	3.00	3.30	
Gate threshold voltage	V_{GEth}	$I_C = 12\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.20	5.80	6.40	V
Gate charge	Q_G	$V_{GE} = \pm 15\ V, V_{CE} = 1800\ V$		12.5		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\ ^\circ C$		1.3		Ω
Input capacitance	C_{ies}	$f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		84		nF
Reverse transfer capacitance	C_{res}	$f = 1000\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		2		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 3300\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$		5	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}	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.530		μs
			$T_{vj} = 125\ ^\circ C$	0.570		
			$T_{vj} = 150\ ^\circ C$	0.580		
Rise time (inductive load)	t_r	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.100		μs
			$T_{vj} = 125\ ^\circ C$	0.130		
			$T_{vj} = 150\ ^\circ C$	0.130		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$	1.710		μs
			$T_{vj} = 125\ ^\circ C$	1.860		
			$T_{vj} = 150\ ^\circ C$	1.920		
Fall time (inductive load)	t_f	$I_C = 450\ A, V_{CE} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.130		μs
			$T_{vj} = 125\ ^\circ C$	0.240		
			$T_{vj} = 150\ ^\circ C$	0.270		
Turn-on time (resistive load)	t_{on_R}	$I_C = 500\ A, V_{CE} = 2000\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$	1.15		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}	$I_C = 450\text{ A}$, $V_{CE} = 1800\text{ V}$, $L_\sigma = 85\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Gon} = 0.7\ \Omega$, $di/dt = 3650\text{ A}/\mu\text{s}$ ($T_{vj} = 150\text{ °C}$)	$T_{vj} = 25\text{ °C}$	500		mJ
			$T_{vj} = 125\text{ °C}$	765		
			$T_{vj} = 150\text{ °C}$	845		
Turn-off energy loss per pulse	E_{off}	$I_C = 450\text{ A}$, $V_{CE} = 1800\text{ V}$, $L_\sigma = 85\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Goff} = 3.3\ \Omega$, $dv/dt = 2850\text{ V}/\mu\text{s}$ ($T_{vj} = 150\text{ °C}$)	$T_{vj} = 25\text{ °C}$	415		mJ
			$T_{vj} = 125\text{ °C}$	610		
			$T_{vj} = 150\text{ °C}$	670		
SC data	I_{SC}	$V_{GE} \leq 15\text{ V}$, $V_{CC} = 2500\text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_p \leq 10\ \mu\text{s}$, $T_{vj} \leq 150\text{ °C}$	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, $\lambda_{grease} = 1\text{ W}/(\text{m} \cdot \text{K})$		17.4		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$		-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}	$T_{vj} = -40\text{ °C}$	3300	V
		$T_{vj} = 150\text{ °C}$	3300	
Continuous DC forward current	I_F		450	A
Repetitive peak forward current	I_{FRM}	$t_p = 1\text{ ms}$	900	A
I^2t - value	I^2t	$t_p = 10\text{ ms}$, $V_R = 0\text{ V}$	$T_{vj} = 125\text{ °C}$	kA ² s
			$T_{vj} = 150\text{ °C}$	
Maximum power dissipation	P_{RQM}	$T_{vj} = 150\text{ °C}$	1000	kW
Minimum turn-on time	t_{onmin}		10	μs

Table 6 **Characteristic values**

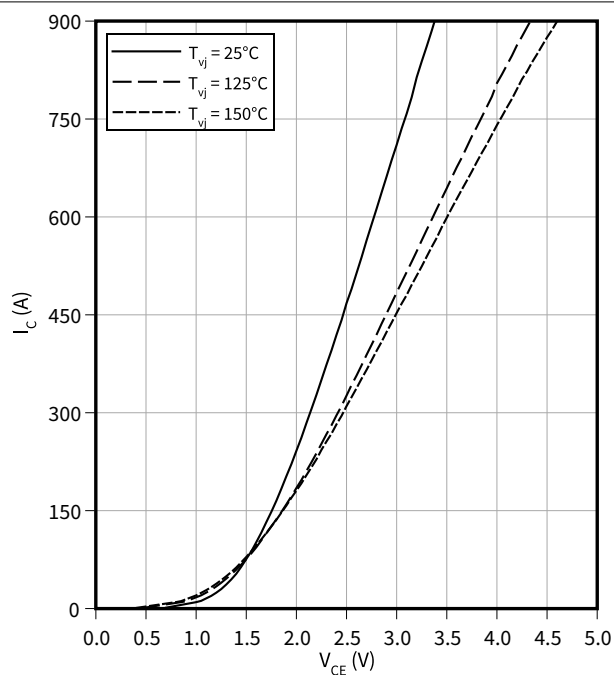
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 450 \text{ A}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	3.10	3.50	V
			$T_{vj} = 125 \text{ °C}$	2.75		
			$T_{vj} = 150 \text{ °C}$	2.65	2.95	
Peak reverse recovery current	I_{RM}	$V_R = 1800 \text{ V}$, $I_F = 450 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 3650 \text{ A}/\mu\text{s}$ ($T_{vj} = 150 \text{ °C}$)	$T_{vj} = 25 \text{ °C}$	680		A
			$T_{vj} = 125 \text{ °C}$	680		
			$T_{vj} = 150 \text{ °C}$	680		
Recovered charge	Q_r	$V_R = 1800 \text{ V}$, $I_F = 450 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 3650 \text{ A}/\mu\text{s}$ ($T_{vj} = 150 \text{ °C}$)	$T_{vj} = 25 \text{ °C}$	230		μC
			$T_{vj} = 125 \text{ °C}$	445		
			$T_{vj} = 150 \text{ °C}$	525		
Reverse recovery energy	E_{rec}	$V_R = 1800 \text{ V}$, $I_F = 450 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 3650 \text{ A}/\mu\text{s}$ ($T_{vj} = 150 \text{ °C}$)	$T_{vj} = 25 \text{ °C}$	220		mJ
			$T_{vj} = 125 \text{ °C}$	490		
			$T_{vj} = 150 \text{ °C}$	595		
Thermal resistance, junction to case	R_{thJC}	per diode			45.5	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, $\lambda_{grease} = 1 \text{ W}/(\text{m}^2\text{K})$		19.3		K/kW
Temperature under switching conditions	$T_{vj op}$		-40		150	°C

4 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

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

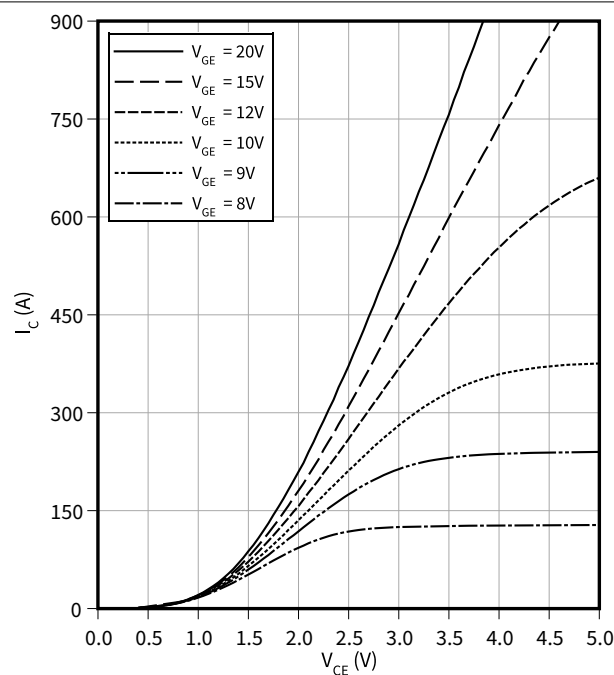
$$V_{GE} = 15 \text{ V}$$



Output characteristic field (typical), IGBT, Inverter

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

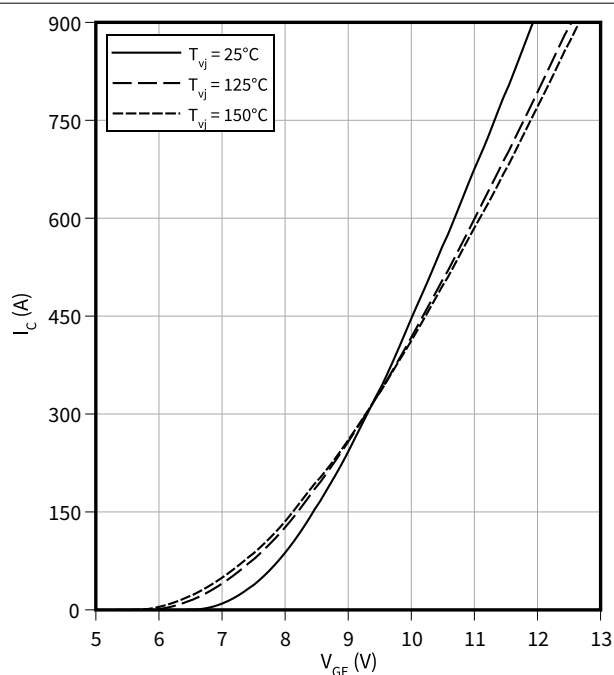
$$T_{vj} = 150 \text{ °C}$$



Transfer characteristic (typical), IGBT, Inverter

$$I_C = f(V_{GE})$$

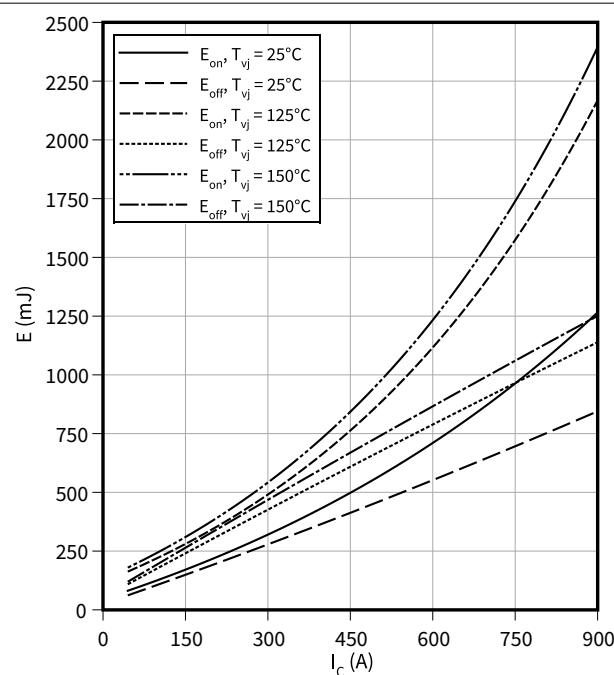
$$V_{CE} = 20 \text{ V}$$



Switching losses (typical), IGBT, Inverter

$$E = f(I_C)$$

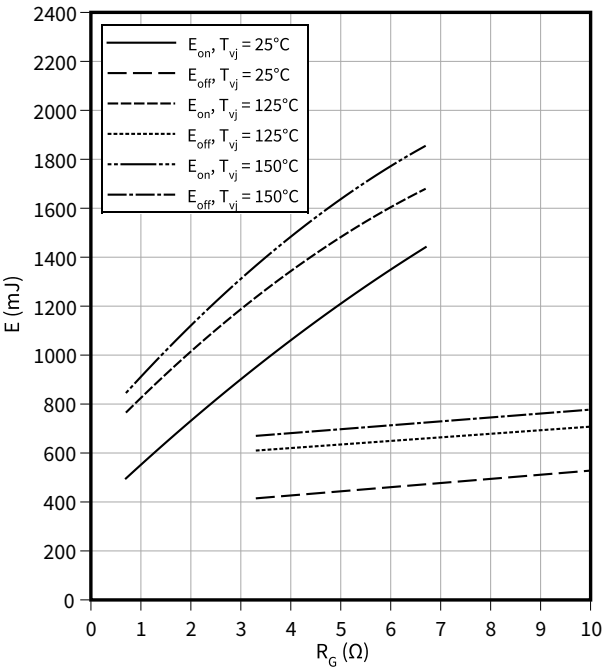
$$R_{Goff} = 3.3 \text{ } \Omega, R_{Gon} = 0.7 \text{ } \Omega, V_{CE} = 1800 \text{ V}, V_{GE} = \pm 15 \text{ V}$$



4 Characteristics diagrams

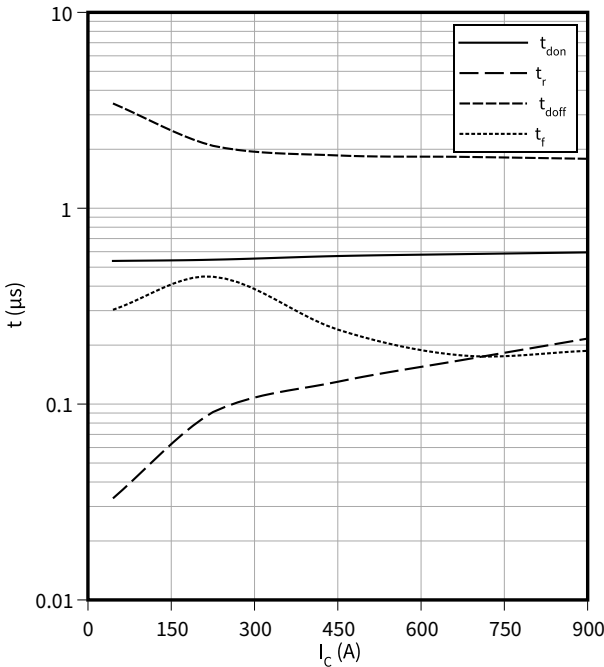
Switching losses (typical), IGBT, Inverter

$E = f(R_G)$
 $I_C = 450\text{ A}$, $V_{CE} = 1800\text{ V}$, $V_{GE} = \pm 15\text{ V}$



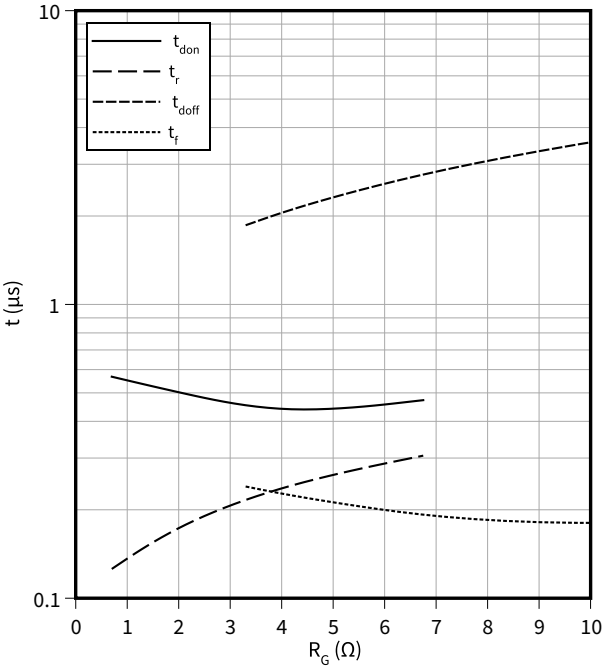
Switching times (typical), IGBT, Inverter

$t = f(I_C)$
 $R_{Goff} = 3.3\text{ }\Omega$, $R_{Gon} = 0.7\text{ }\Omega$, $V_{CE} = 1800\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 150\text{ }^\circ\text{C}$



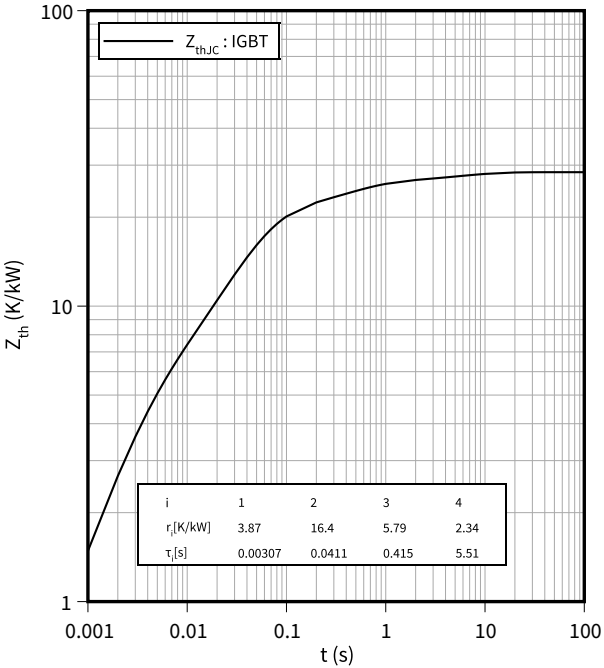
Switching times (typical), IGBT, Inverter

$t = f(R_G)$
 $I_C = 450\text{ A}$, $V_{CE} = 1800\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 150\text{ }^\circ\text{C}$



Transient thermal impedance , IGBT, Inverter

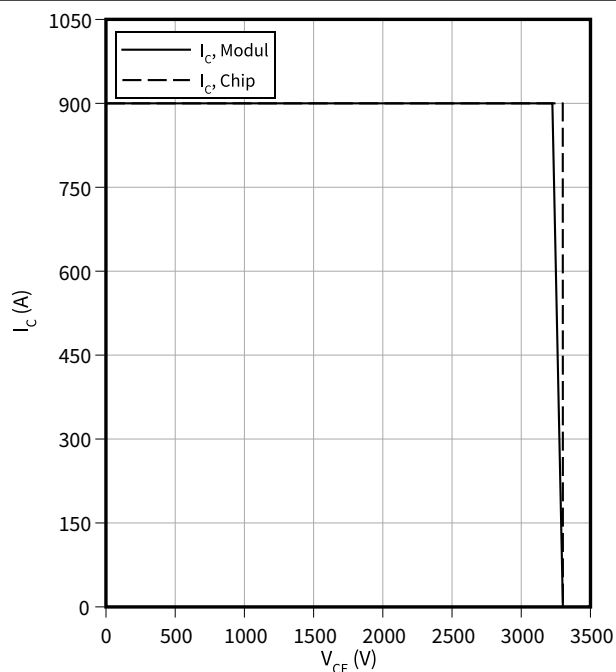
$Z_{th} = f(t)$



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

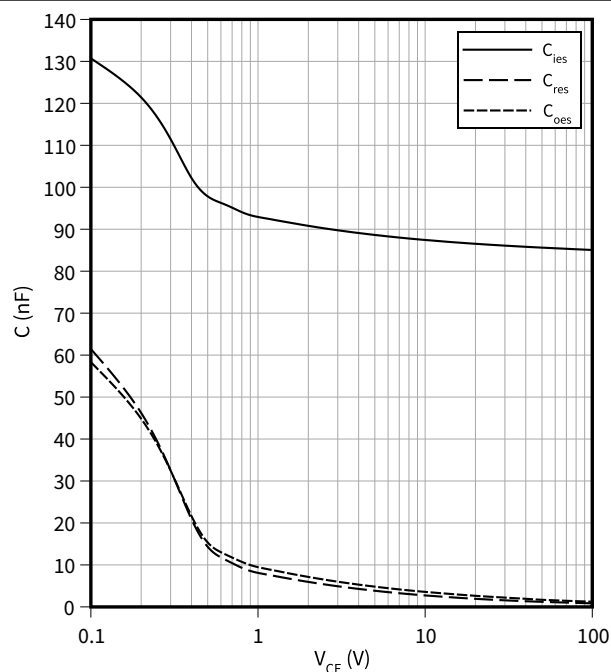
$$I_C = f(V_{CE})$$

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


Capacity characteristic (typical), IGBT, Inverter

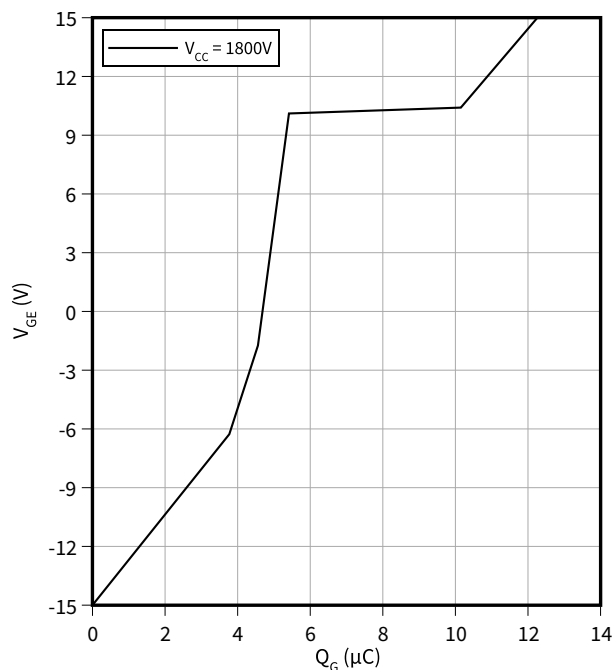
$$C = f(V_{CE})$$

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

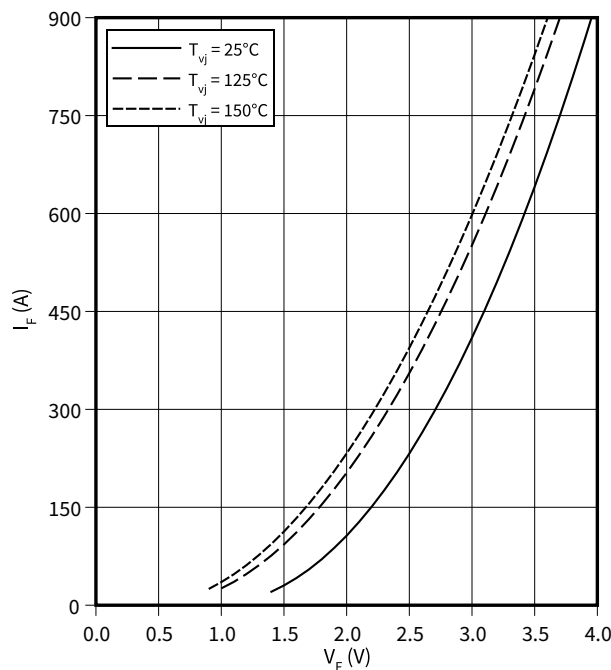

Gate charge characteristic (typical), IGBT, Inverter

$$V_{GE} = f(Q_G)$$

$$I_C = 450 \, A, T_{vj} = 25 \, ^\circ C$$


Forward characteristic (typical), Diode, Inverter

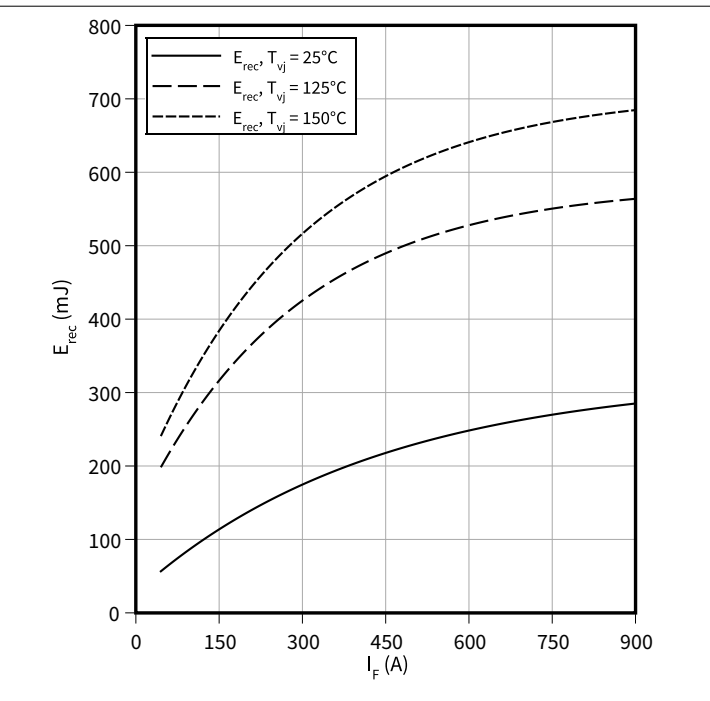
$$I_F = f(V_F)$$



4 Characteristics diagrams

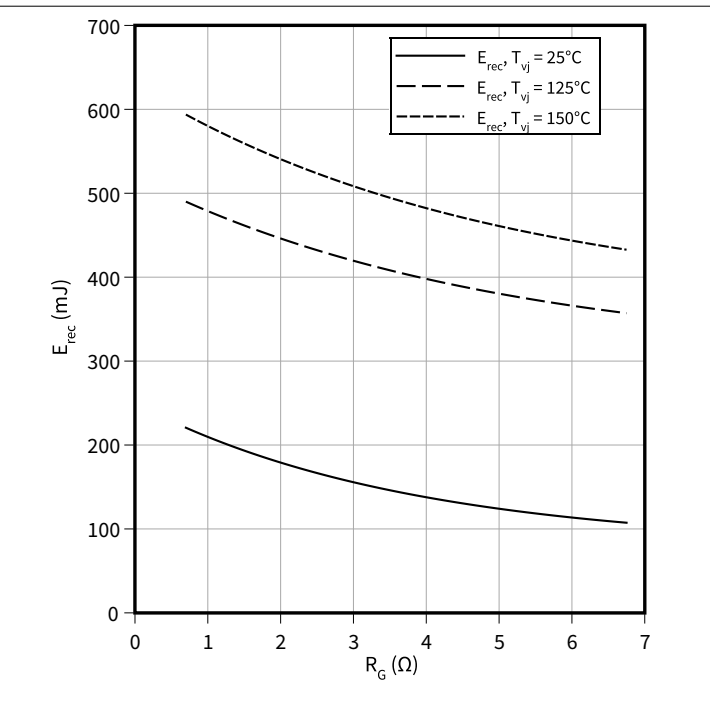
Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$
 $V_{CE} = 1800\text{ V}, R_{Gon} = R_{Gon}(IGBT)$



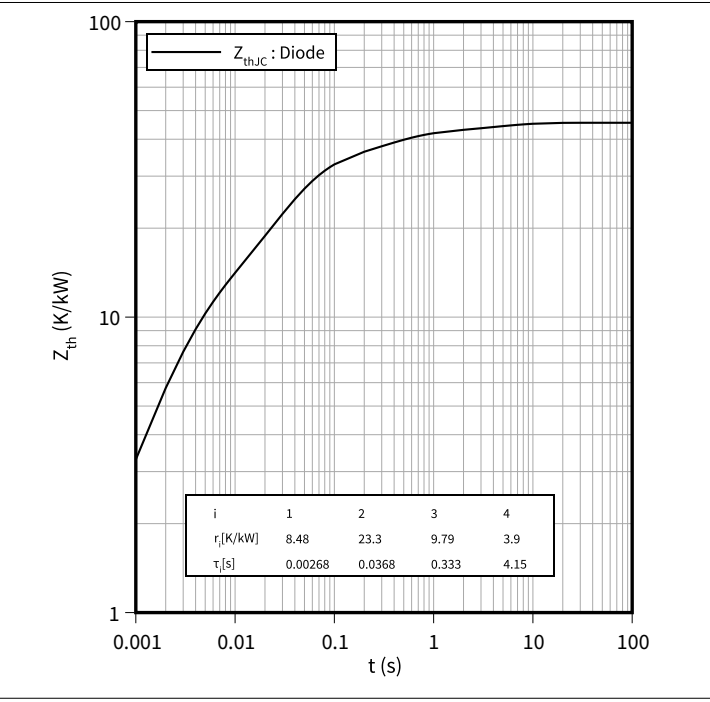
Switching losses (typical), Diode, Inverter

$E_{rec} = f(R_G)$
 $V_{CE} = 1800\text{ V}, I_F = 450\text{ A}$



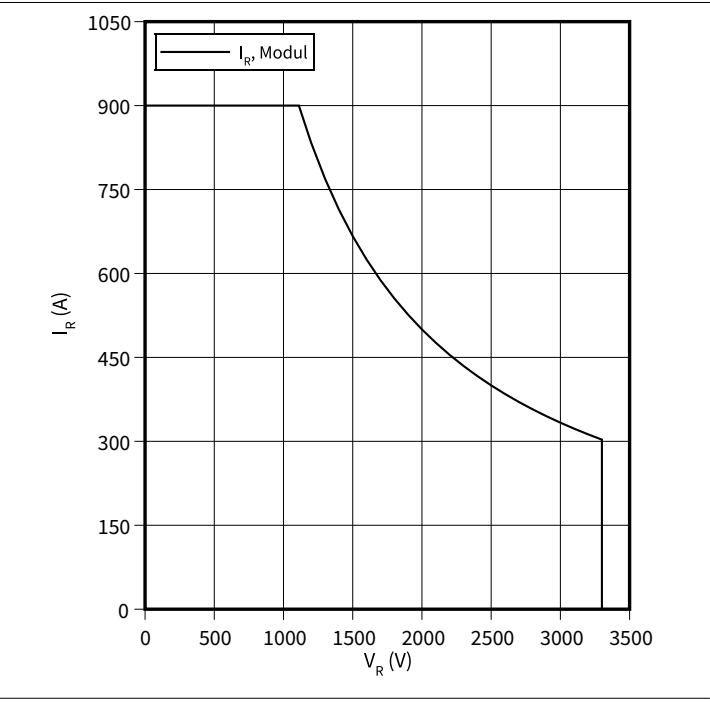
Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



Safe operating area (SOA), Diode, Inverter

$I_R = f(V_R)$
 $T_{vj} = 150\text{ °C}$



5 Circuit diagram

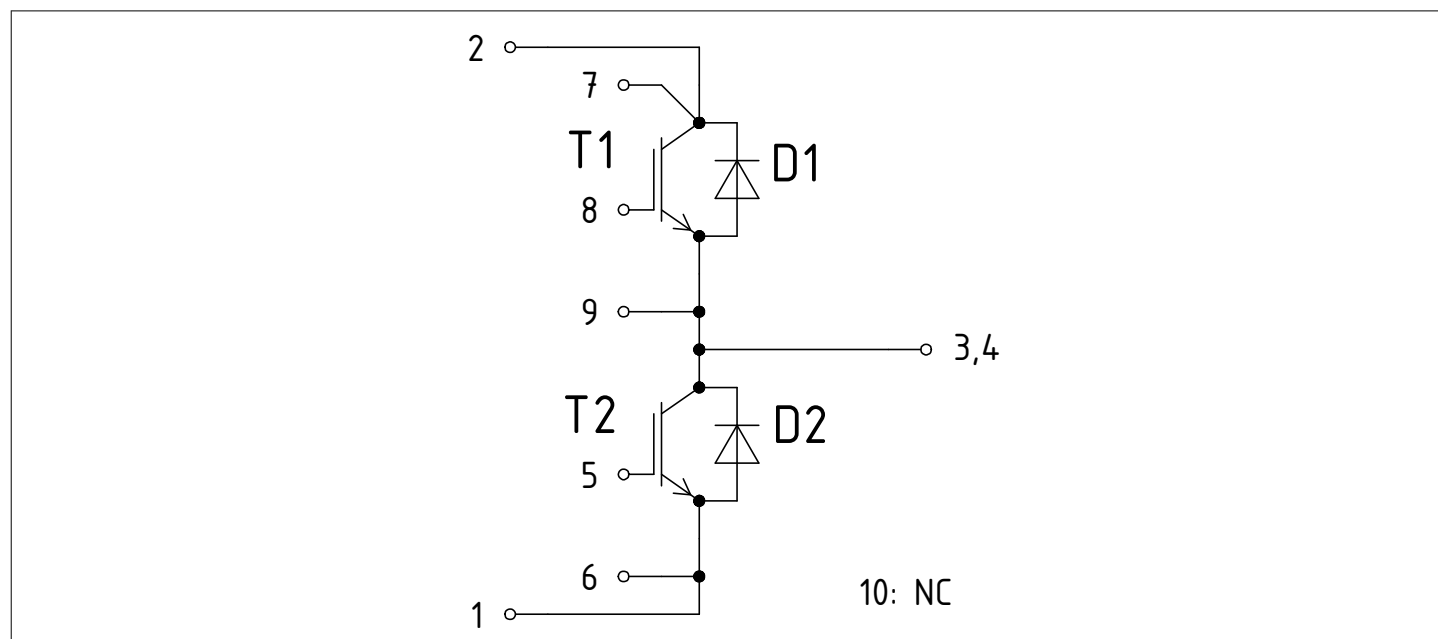


Figure 1

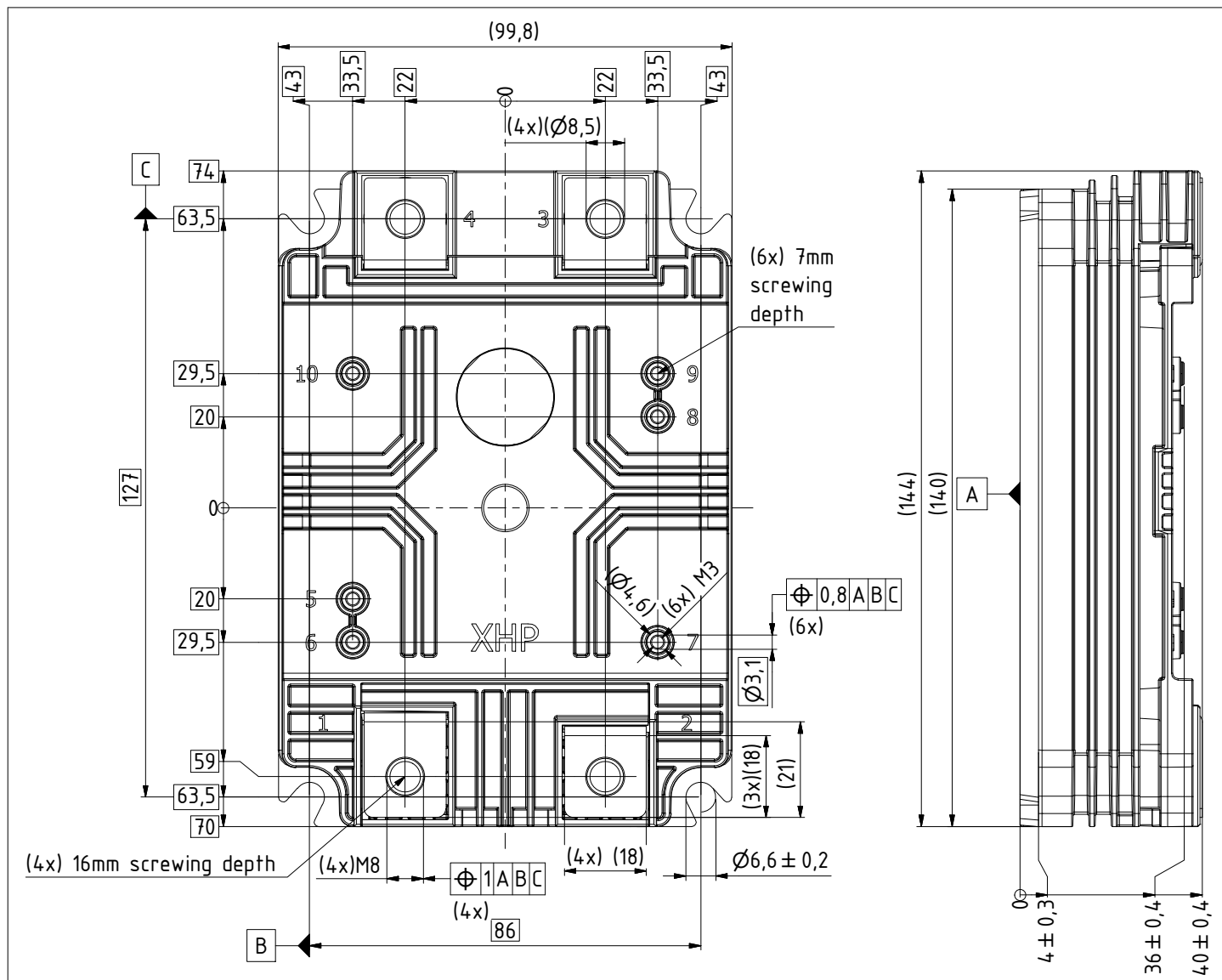


Figure 2

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	<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	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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[FF450R33T3E3P6BPMA1](#) [FF450R33T3E3B5P3BPSA1](#) [FF450R33T3E3B5P4BPMA1](#) [FF450R33T3E3B5P6BPMA1](#)
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