

Final datasheet

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

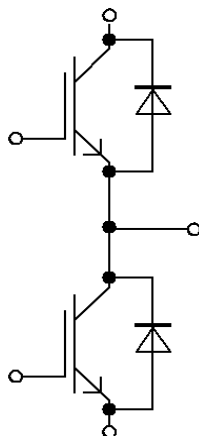


Table of contents

	Description	1
	Features	1
	Potential applications	1
	Product validation	1
	Table of contents	2
1	Package	3
2	IGBT, Inverter	3
3	Diode, Inverter	5
4	Characteristics diagrams	7
5	Circuit diagram	11
6	Package outlines	12
7	Module label code	13
	Revision history	14
	Disclaimer	15

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	
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	$R_{AA'+CC'}$	$T_C = 25\text{ }^{\circ}\text{C}$, per switch			0.31		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25\text{ }^{\circ}\text{C}$, 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}		$T_{vj} = -40 \text{ °C}$	3300	V
			$T_{vj} = 150 \text{ °C}$	3300	
Continuous DC collector current	I_{CDC}	$T_{vj \text{ max}} = 150 \text{ °C}$	$T_C = 100 \text{ °C}$	450	A
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj \text{ op}}$		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}	$I_C = 21\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$		5.20	5.80	6.40	V
Gate charge	Q_G	$V_{GE} = \pm 15\ V, V_{CC} = 1800\ V, T_{vj} = 25\ ^\circ C$			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}	$I_C = 450\ A, V_{CC} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$		0.530		μs
			$T_{vj} = 125\ ^\circ C$		0.570		
			$T_{vj} = 150\ ^\circ C$		0.580		
Rise time (inductive load)	t_r	$I_C = 450\ A, V_{CC} = 1800\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$		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}	$I_C = 450\ A, V_{CC} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$		1.710		μs
			$T_{vj} = 125\ ^\circ C$		1.860		
			$T_{vj} = 150\ ^\circ C$		1.920		
Fall time (inductive load)	t_f	$I_C = 450\ A, V_{CC} = 1800\ V, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega$	$T_{vj} = 25\ ^\circ C$		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}	$I_C = 500\ A, V_{CC} = 2000\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega$	$T_{vj} = 25\ ^\circ C$	1.15			μs
Turn-on energy loss per pulse	E_{on}	$I_C = 450\ A, V_{CC} = 1800\ V, L_\sigma = 85\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 0.7\ \Omega, di/dt = 3650\ A/\mu s (T_{vj} = 150\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$		500		mJ
			$T_{vj} = 125\ ^\circ C$		765		
			$T_{vj} = 150\ ^\circ C$		845		
Turn-off energy loss per pulse	E_{off}	$I_C = 450\ A, V_{CC} = 1800\ V, L_\sigma = 85\ nH, V_{GE} = \pm 15\ V, R_{Goff} = 3.3\ \Omega, dv/dt = 2850\ V/\mu s (T_{vj} = 150\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$		415		mJ
			$T_{vj} = 125\ ^\circ C$		610		
			$T_{vj} = 150\ ^\circ C$		670		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
SC data	I_{SC}	$V_{GE} \leq 15 \text{ V}$, $V_{CC} = 2500 \text{ V}$, $V_{CEmax} = V_{CES} - L_{SCE} \cdot di/dt$ $t_p \leq 10 \mu\text{s}$, $T_{vj} \leq 150 \text{ }^\circ\text{C}$		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, $\lambda_{grease} = 1 \text{ W/(m}\cdot\text{K)}$		17.4		K/kW
Temperature under switching conditions	$T_{vj op}$		-40		150	$^\circ\text{C}$

3 Diode, Inverter

Table 5 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}		$T_{vj} = -40 \text{ }^\circ\text{C}$	3300	V
			$T_{vj} = 150 \text{ }^\circ\text{C}$	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	$t_p = 10 \text{ ms}$, $V_R = 0 \text{ V}$	$T_{vj} = 125 \text{ }^\circ\text{C}$	82.9	kA^2s
			$T_{vj} = 150 \text{ }^\circ\text{C}$	68	
Maximum power dissipation	P_{RQM}		$T_{vj} = 150 \text{ }^\circ\text{C}$	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	$I_F = 450 \text{ A}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	3.10	3.50	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$	2.75		
			$T_{vj} = 150 \text{ }^\circ\text{C}$	2.65	2.95	
Peak reverse recovery current	I_{RM}	$V_{CC} = 1800 \text{ V}$, $I_F = 450 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 3650 \text{ A}/\mu\text{s}$ ($T_{vj} = 150 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$	680		A
			$T_{vj} = 125 \text{ }^\circ\text{C}$	680		
			$T_{vj} = 150 \text{ }^\circ\text{C}$	680		

(table continues...)

Table 6 (continued) Characteristic values

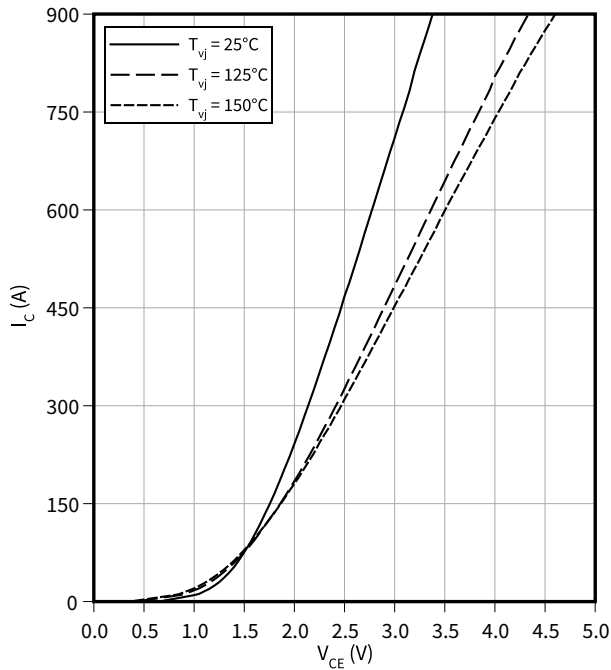
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Recovered charge	Q_r	$V_{CC} = 1800 \text{ V}$, $I_F = 450 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 3650 \text{ A}/\mu\text{s}$ ($T_{vj} = 150 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$		230		μC
		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

4 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

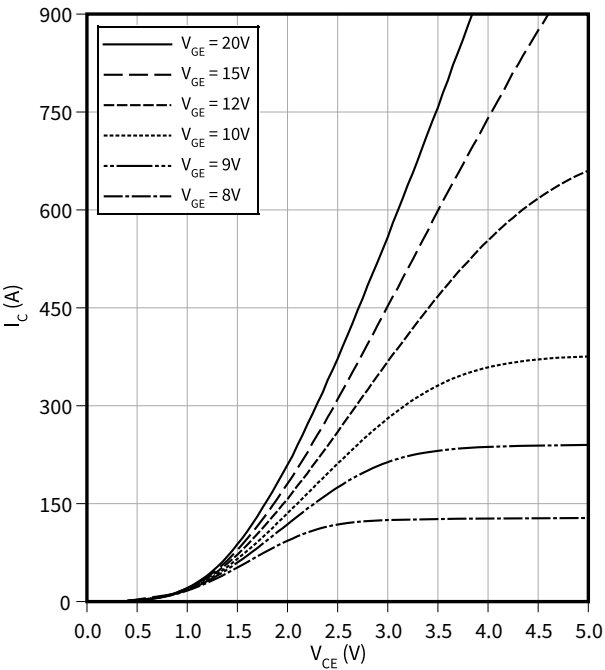
$V_{GE} = 15\text{ V}$



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

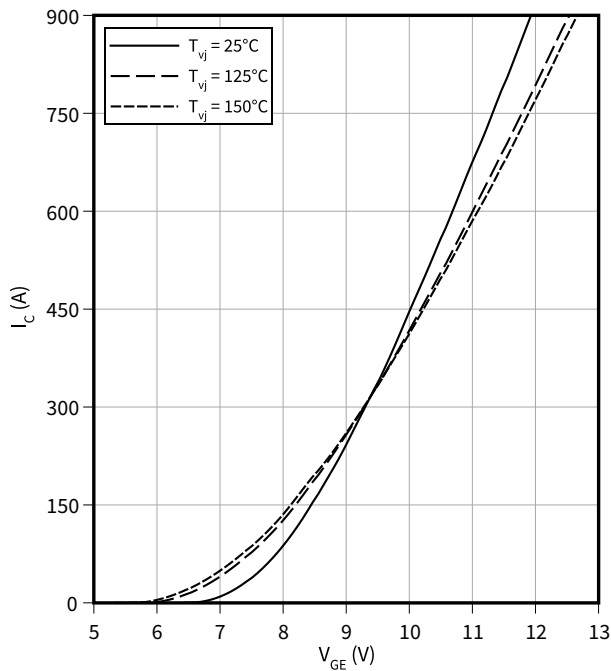
$T_{vj} = 150\text{ °C}$



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

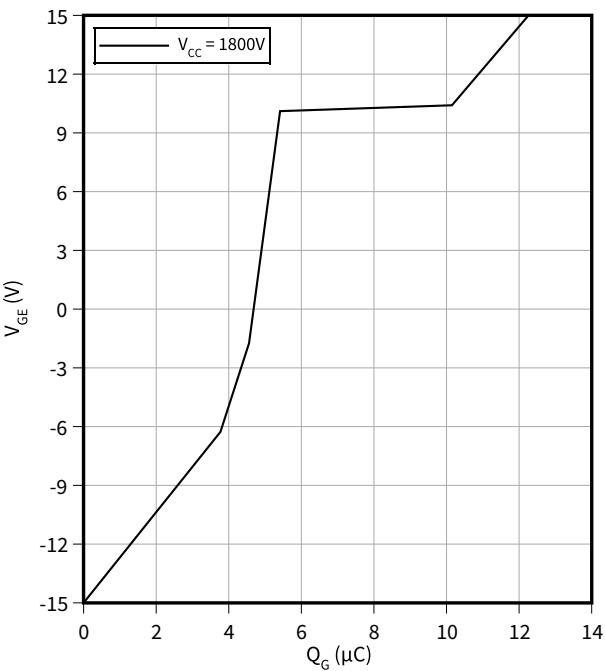
$V_{CE} = 20\text{ V}$



Gate charge characteristic (typical), IGBT, Inverter

$V_{GE} = f(Q_G)$

$I_C = 450\text{ A}, T_{vj} = 25\text{ °C}$

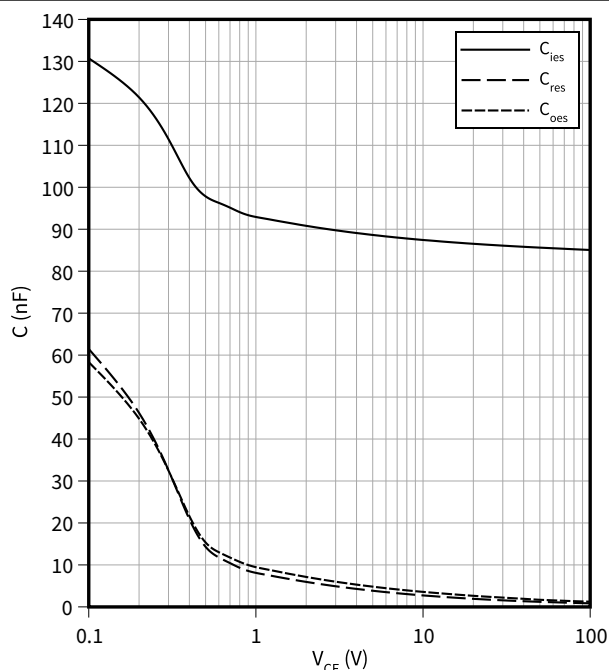


4 Characteristics diagrams

Capacity characteristic (typical), IGBT, Inverter

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

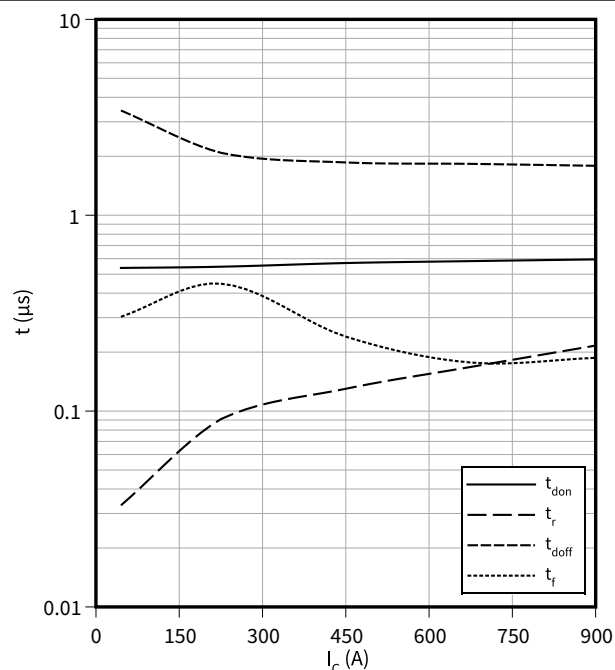
$f = 1000 \text{ kHz}$, $V_{GE} = 0 \text{ V}$, $T_{vj} = 25 \text{ °C}$



Switching times (typical), IGBT, Inverter

$$t = f(I_C)$$

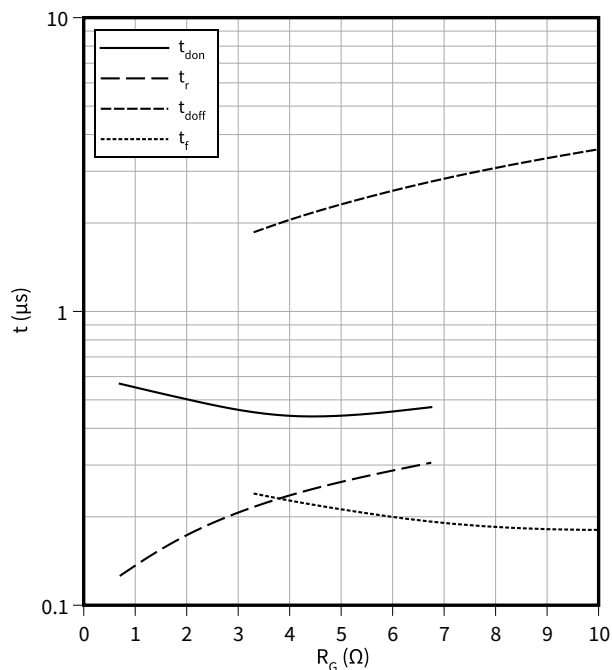
$R_{Goff} = 3.3 \text{ } \Omega$, $R_{Gon} = 0.7 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $V_{CC} = 1800 \text{ V}$, $T_{vj} = 150 \text{ °C}$



Switching times (typical), IGBT, Inverter

$$t = f(R_G)$$

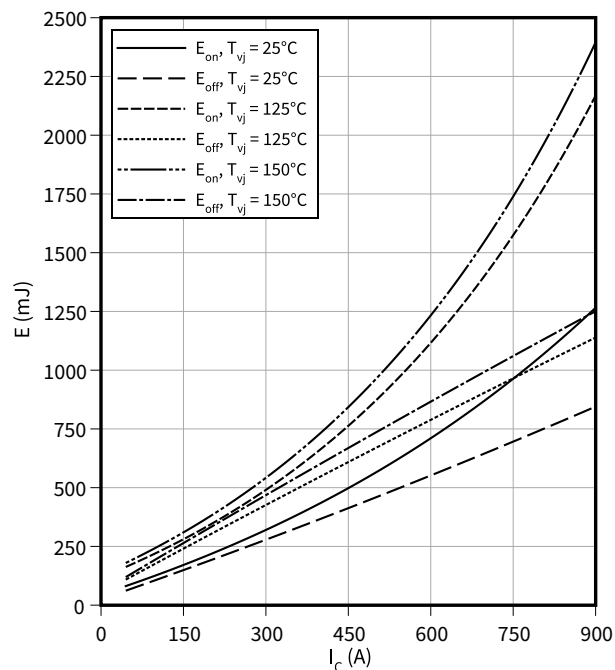
$V_{GE} = \pm 15 \text{ V}$, $I_C = 450 \text{ A}$, $V_{CC} = 1800 \text{ V}$, $T_{vj} = 150 \text{ °C}$



Switching losses (typical), IGBT, Inverter

$$E = f(I_C)$$

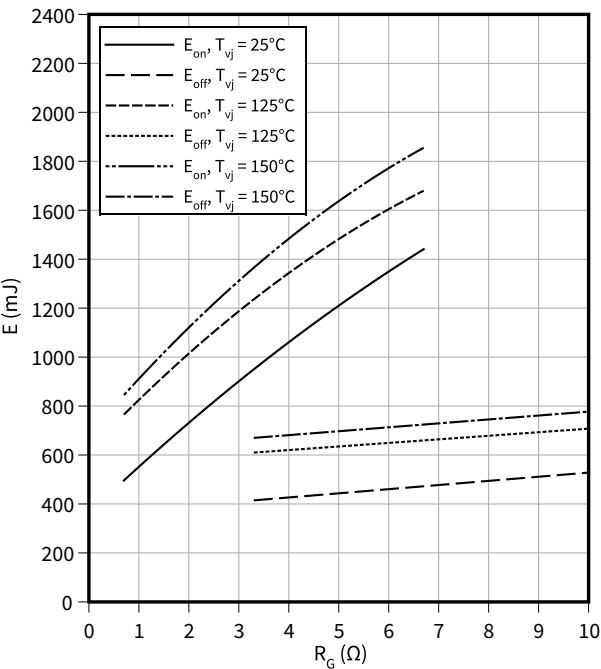
$R_{Goff} = 3.3 \text{ } \Omega$, $R_{Gon} = 0.7 \text{ } \Omega$, $V_{GE} = \pm 15 \text{ V}$, $V_{CC} = 1800 \text{ V}$



4 Characteristics diagrams

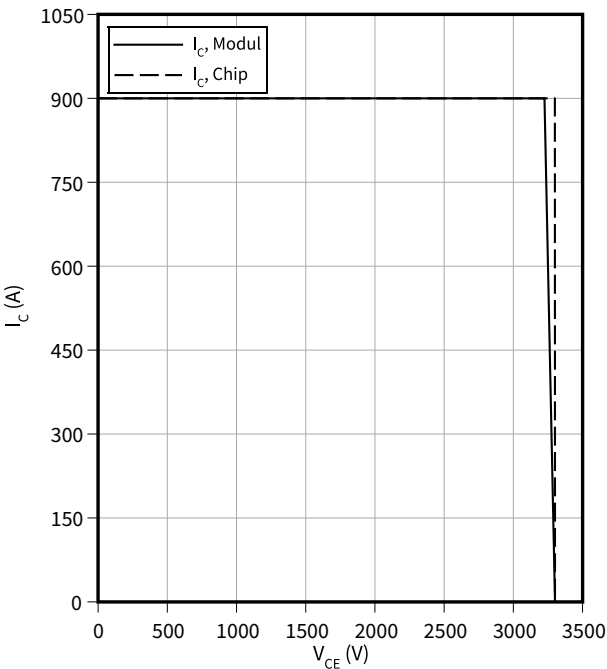
Switching losses (typical), IGBT, Inverter

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



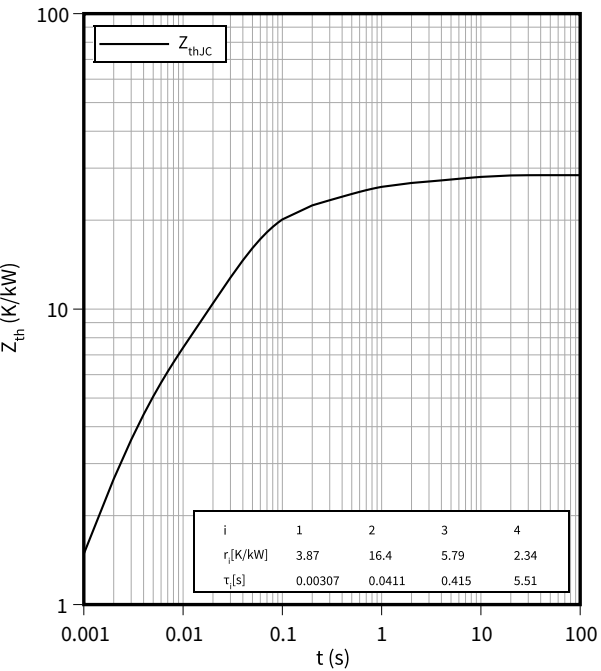
Reverse bias safe operating area (RBSOA), IGBT, Inverter

$I_C = f(V_{CE})$
 $R_{Goff} = 3.3\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 150\text{ °C}$



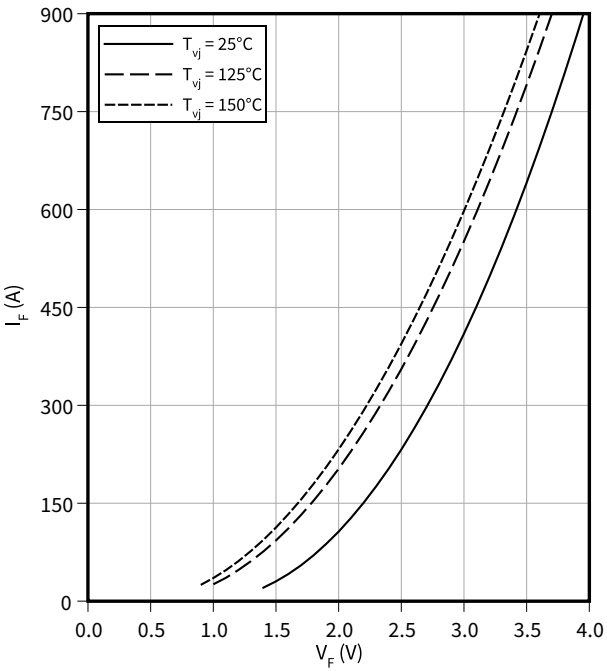
Transient thermal impedance, IGBT, Inverter

$Z_{th} = f(t)$



Forward characteristic (typical), Diode, Inverter

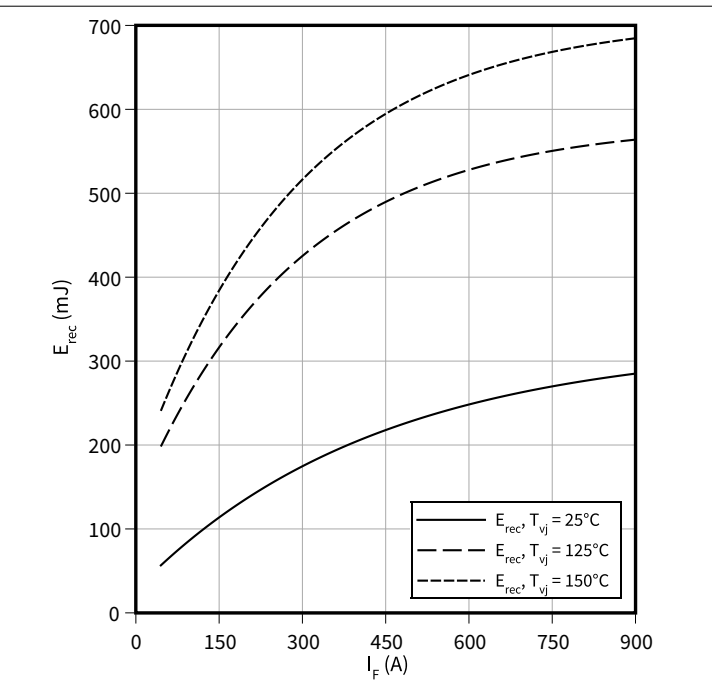
$I_F = f(V_F)$



4 Characteristics diagrams

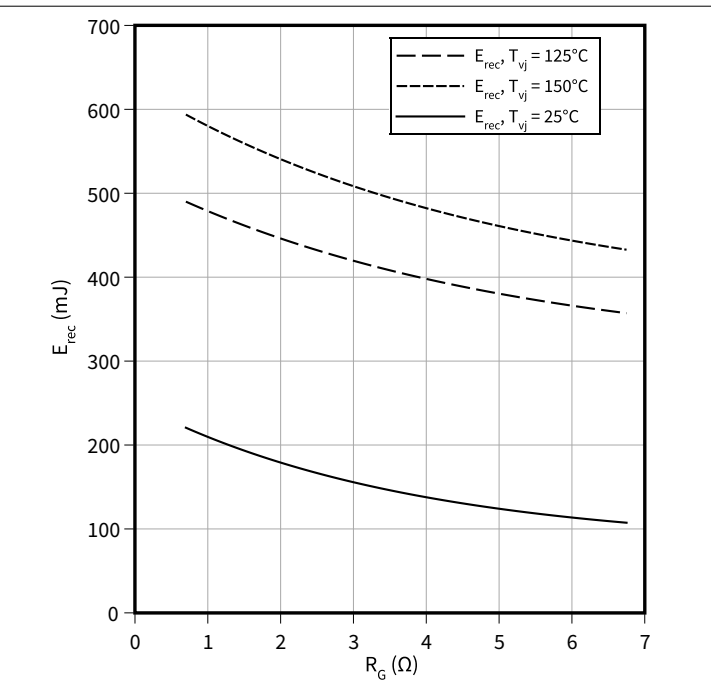
Switching losses (typical), Diode, Inverter

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



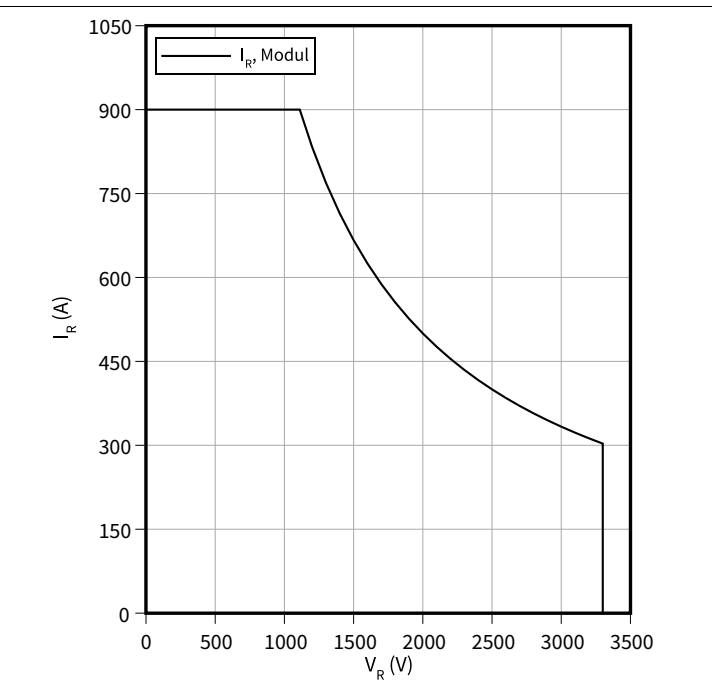
Switching losses (typical), Diode, Inverter

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



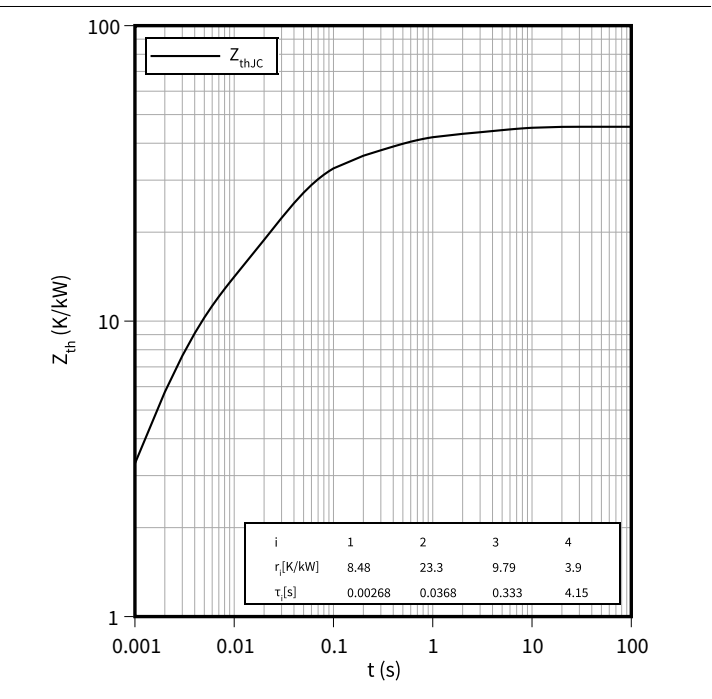
Safe operating area (SOA), Diode, Inverter

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



Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



5 Circuit diagram

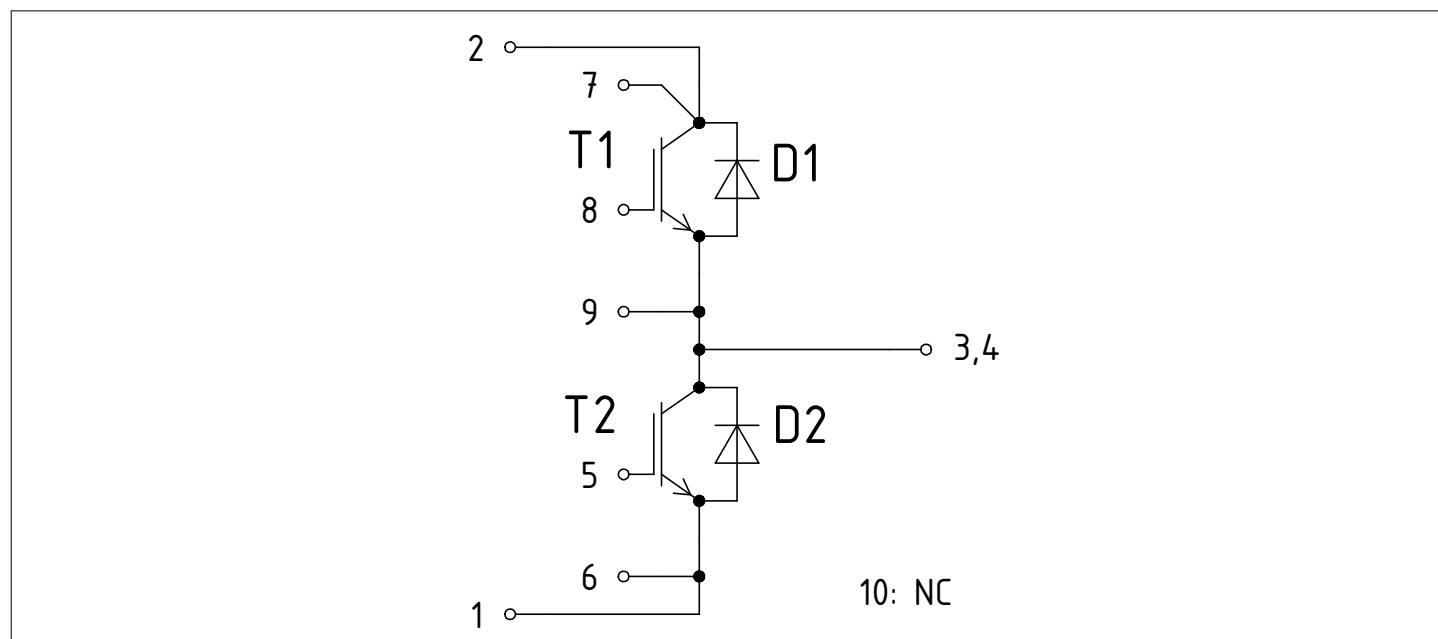


Figure 1

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
1.30	2026-04-01	Typo correction for Ic condition at Vgeth and harmonization of insulation coordination information

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