

Highly insulated module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode**Features**

- Electrical features
 - $V_{CES} = 6500\text{ V}$
 - $I_{C\text{ nom}} = 400\text{ A} / I_{CRM} = 800\text{ A}$
 - Low $V_{CE,sat}$
- Mechanical features
 - Extended storage temperature down to $T_{stg} = -55\text{ °C}$
 - High creepage and clearance distances
 - Package with CTI > 600
 - Package with enhanced insulation of 10.4 kV AC 60 s
 - ALSiC base plate for increased thermal cycling capability

**Potential applications**

- Medium-voltage converters
- Traction drives

Product validation

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

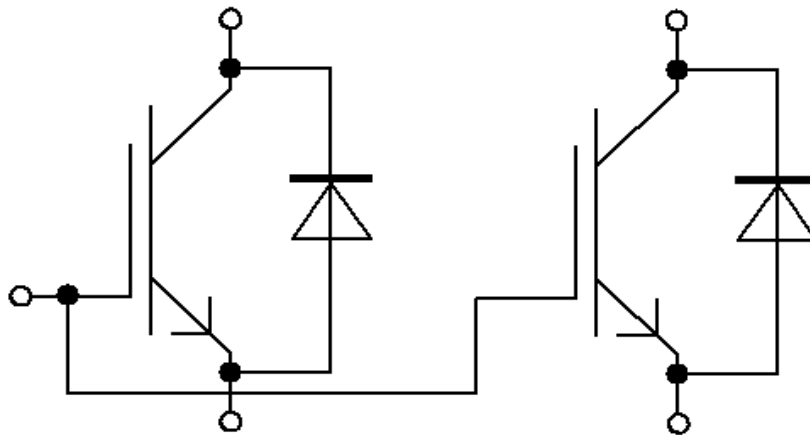
Description

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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50 \text{ Hz}$, $t = 60 \text{ s}$	10.4	kV
Partial discharge extinction voltage	V_{isol}	RMS, $f = 50 \text{ Hz}$, Q_{PD} typ. 10 pC	5.1	kV
DC stability	$V_{CE(D)}$	$T_{vj}=25^{\circ}\text{C}$, 100 Fit	3800	V
Material of module baseplate			AlSiC	
Internal isolation		basic insulation (class 1, IEC 61140)	AlN	
Creepage distance	d_{Creep}	terminal to heatsink	64.0	mm
Creepage distance	d_{Creep}	terminal to terminal	56.0	mm
Clearance	d_{Clear}	terminal to heatsink	40.0	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}			20		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_C=25^{\circ}\text{C}$, per switch		0.18		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C=25^{\circ}\text{C}$, per switch		0.18		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	M4, Screw	1.8	2.1	Nm
			M8, Screw	8	10	
Weight	G			1000		g

2 IGBT, Inverter

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	V_{CES}	$T_{vj} = -50^{\circ}\text{C}$	5900	V
		$T_{vj} = 25^{\circ}\text{C}$	6500	
		$T_{vj} = 125^{\circ}\text{C}$	6500	

(table continues...)

Table 3 (continued) Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Continuous DC collector current	I_{CDC}	$T_{vj\ max} = 150\ ^\circ\text{C}$	$T_C = 80\ ^\circ\text{C}$	400	A
Repetitive peak collector current	I_{CRM}	$t_P = 1\ \text{ms}$		800	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	$V_{CE\ sat}$	$I_C = 400\ \text{A}, V_{GE} = 15\ \text{V}$	$T_{vj} = 25\ ^\circ\text{C}$		3.00	3.40	V
			$T_{vj} = 125\ ^\circ\text{C}$		3.70		
Gate threshold voltage	V_{GEth}	$I_C = 70\ \text{mA}, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ\text{C}$		5.40	6	6.60	V
Gate charge	Q_G	$V_{GE} = \pm 15\ \text{V}, V_{CE} = 3600\ \text{V}$			17		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\ ^\circ\text{C}$			1.1		Ω
Input capacitance	C_{ies}	$f = 1000\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$			110		nF
Reverse transfer capacitance	C_{res}	$f = 1000\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$			1.7		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 6500\ \text{V}, V_{GE} = 0\ \text{V}$	$T_{vj} = 25\ ^\circ\text{C}$			5	mA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\ \text{V}, V_{GE} = 20\ \text{V}, T_{vj} = 25\ ^\circ\text{C}$				400	nA
Turn-on delay time (inductive load)	t_{don}	$I_C = 400\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.9\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		0.640		μs
			$T_{vj} = 125\ ^\circ\text{C}$		0.650		
Rise time (inductive load)	t_r	$I_C = 400\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.9\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		0.180		μs
			$T_{vj} = 125\ ^\circ\text{C}$		0.200		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 400\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 13\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		7.300		μs
			$T_{vj} = 125\ ^\circ\text{C}$		7.600		
Fall time (inductive load)	t_f	$I_C = 400\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 13\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		0.400		μs
			$T_{vj} = 125\ ^\circ\text{C}$		0.500		
Turn-on time (resistive load)	t_{on_R}	$I_C = 500\ \text{A}, V_{CE} = 2000\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.9\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	1.55			μs
Turn-on energy loss per pulse	E_{on}	$I_C = 400\ \text{A}, V_{CE} = 3600\ \text{V}, L_\sigma = 280\ \text{nH}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.9\ \Omega, di/dt = 1600\ \text{A}/\mu\text{s} (T_{vj} = 125\ ^\circ\text{C})$	$T_{vj} = 25\ ^\circ\text{C}$		2250		mJ
			$T_{vj} = 125\ ^\circ\text{C}$		3450		
Turn-off energy loss per pulse	E_{off}	$I_C = 400\ \text{A}, V_{CE} = 3600\ \text{V}, L_\sigma = 280\ \text{nH}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 13\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		2000		mJ
			$T_{vj} = 125\ ^\circ\text{C}$		2250		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
SC data	I_{SC}	$V_{GE} \leq 15 \text{ V}$, $V_{CC} = 4500 \text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq 10 \mu\text{s}$, $T_{vj} \leq 125 \text{ }^\circ\text{C}$	2400		A
Thermal resistance, junction to case	R_{thJC}	per IGBT			15.0	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, $\lambda_{grease} = 1 \text{ W}/(\text{m}^2\text{K})$		13.8		K/kW
Temperature under switching conditions	$T_{vj op}$		-50		125	$^\circ\text{C}$

3 Diode, Inverter

Table 5 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}		$T_{vj} = -50\text{ }^{\circ}\text{C}$	5900	V
			$T_{vj} = 25\text{ }^{\circ}\text{C}$	6500	
			$T_{vj} = 125\text{ }^{\circ}\text{C}$	6500	
Continuous DC forward current	I_F			400	A
Repetitive peak forward current	I_{FRM}	$t_p = 1\text{ ms}$		800	A
I^2t - value	I^2t	$t_p = 10\text{ ms}$, $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^{\circ}\text{C}$	130	kA^2s
Maximum power dissipation	P_{RQM}	$T_{vj} = 125\text{ }^{\circ}\text{C}$		1600	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	$I_F = 400 \text{ A}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		3.00	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$		2.95	
Peak reverse recovery current	I_{RM}	$V_R = 3600 \text{ V}$, $I_F = 400 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 1600 \text{ A}/\mu\text{s}$ ($T_{vj} = 125 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$		600	A
			$T_{vj} = 125 \text{ }^\circ\text{C}$		670	
Recovered charge	Q_r	$V_R = 3600 \text{ V}$, $I_F = 400 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 1600 \text{ A}/\mu\text{s}$ ($T_{vj} = 125 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$		470	μC
			$T_{vj} = 125 \text{ }^\circ\text{C}$		870	

(table continues...)

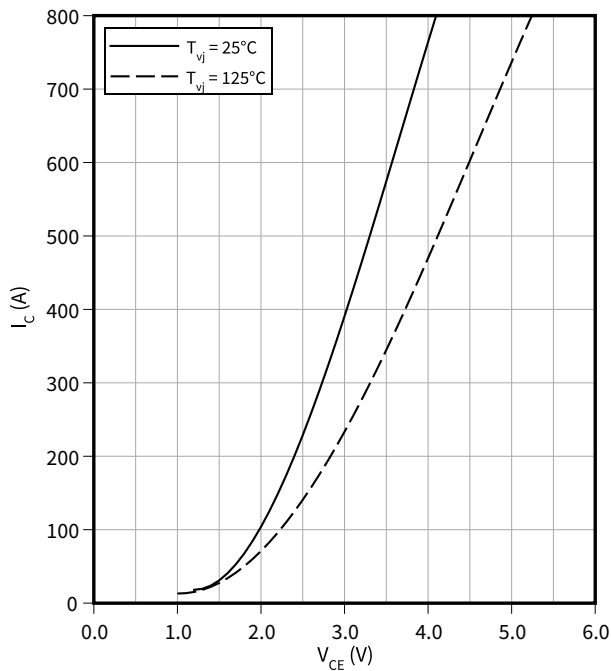
Table 6 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Reverse recovery energy	E_{rec}	$V_R = 3600\text{ V}$, $I_F = 400\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 1600\text{ A}/\mu\text{s}$ ($T_{vj} = 125\text{ }^\circ\text{C}$)				mJ
				740		
				1600		
Thermal resistance, junction to case	R_{thJC}	per diode			33.0	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$		21.6		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$		-50		125	$^\circ\text{C}$

4 Characteristics diagrams

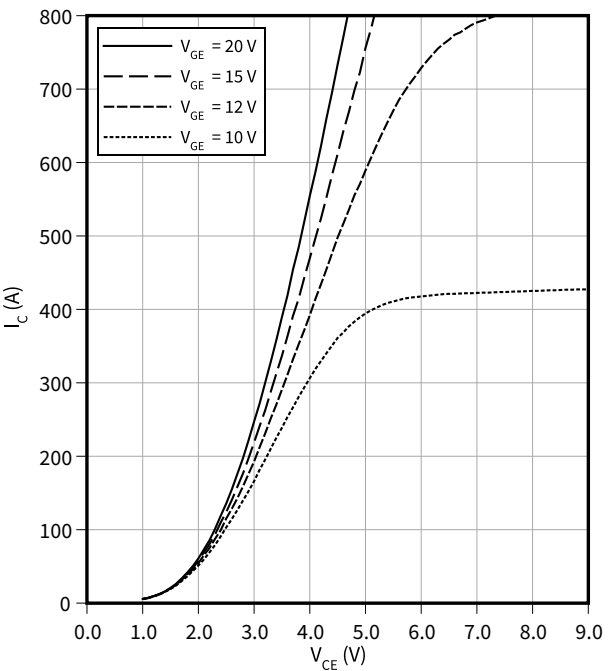
output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$
 $V_{GE} = 15\text{ V}$



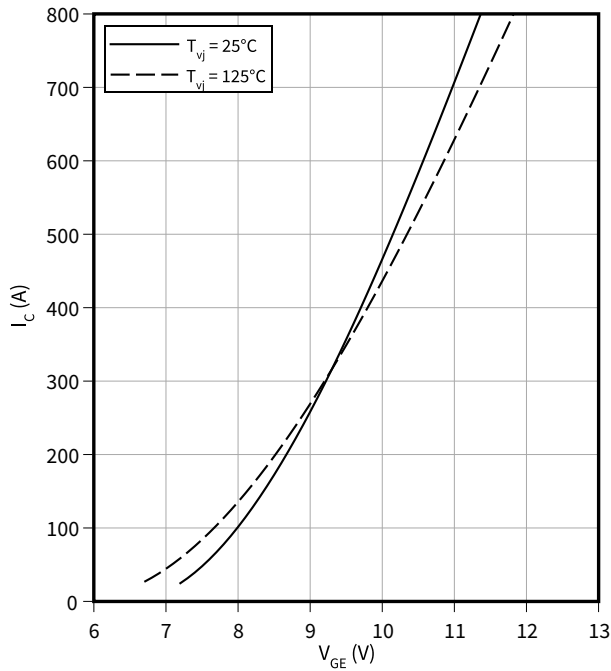
output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$
 $T_{vj} = 125\text{ °C}$



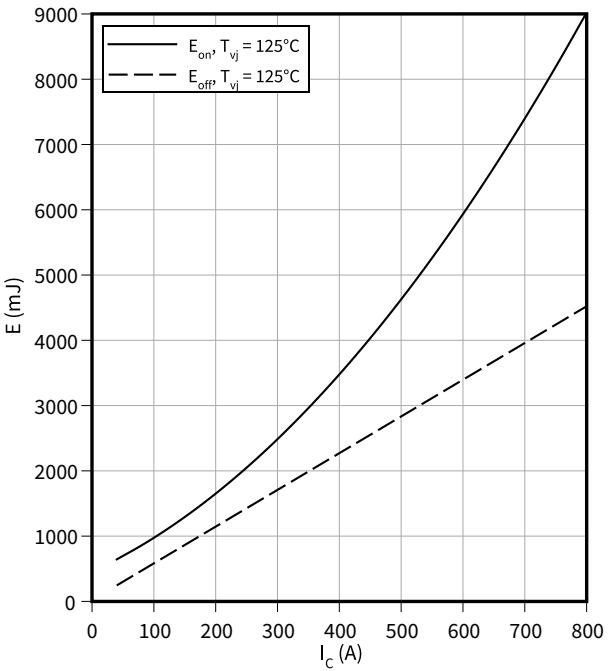
transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$
 $V_{CE} = 20\text{ V}$



switching losses (typical), IGBT, Inverter

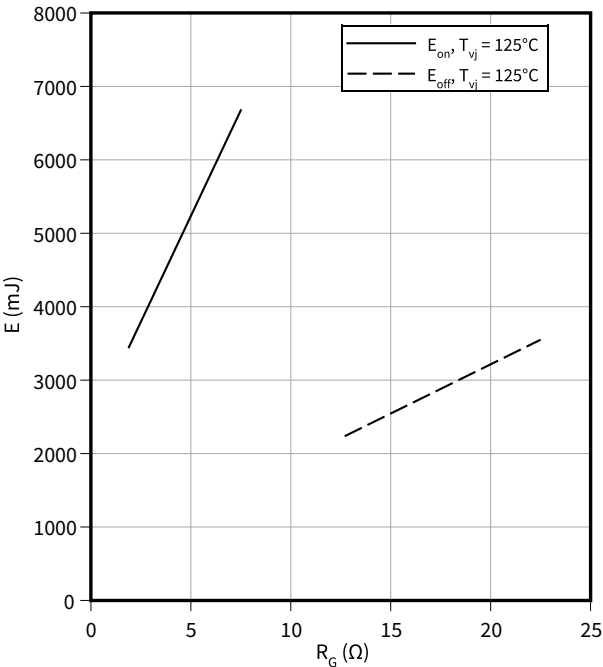
$E = f(I_C)$
 $R_{Goff} = 13\text{ }\Omega$, $R_{Gon} = 1.9\text{ }\Omega$, $V_{CE} = 3600\text{ V}$, $V_{GE} = \pm 15\text{ V}$



4 Characteristics diagrams

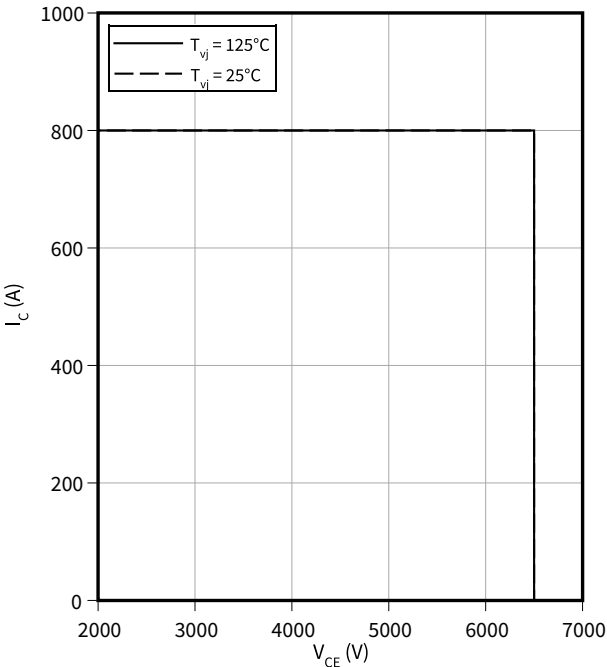
switching losses (typical), IGBT, Inverter

$E = f(R_G)$
 $I_C = 400\text{ A}, V_{CE} = 3600\text{ V}, V_{GE} = \pm 15\text{ V}$



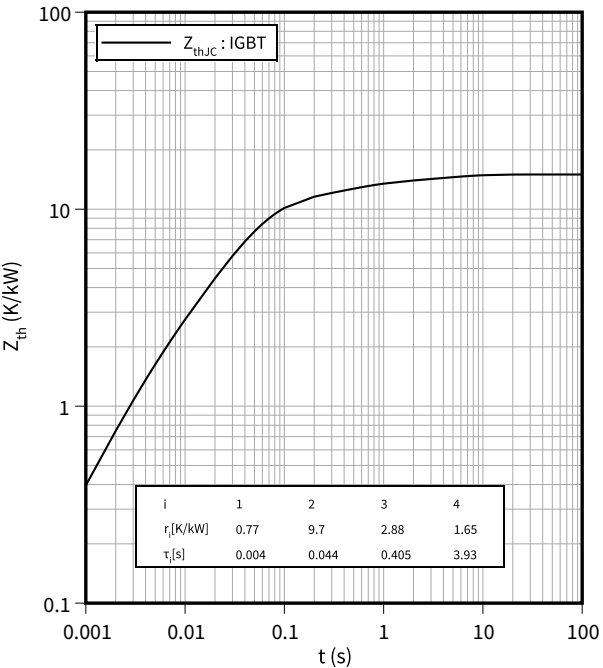
reverse bias safe operating area (RBSOA), IGBT, Inverter

$I_C = f(V_{CE})$
 $R_{Goff} = 13\text{ }\Omega, V_{GE} = \pm 15\text{ V}$



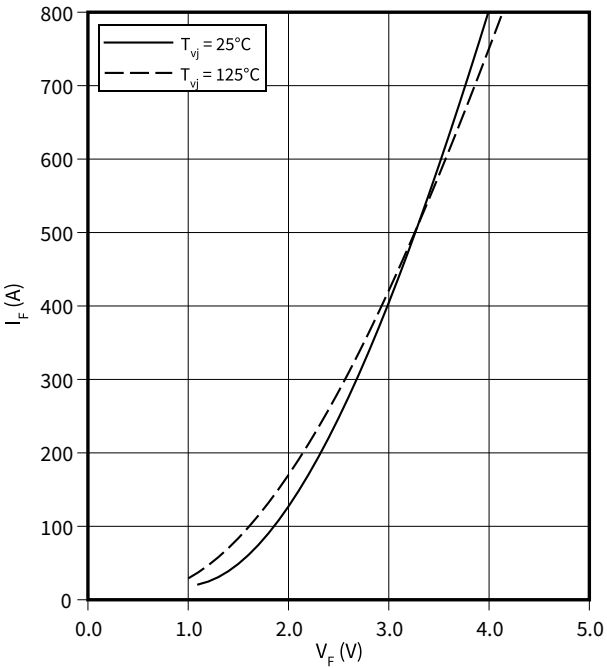
transient thermal impedance , IGBT, Inverter

$Z_{th} = f(t)$



forward characteristic of (typical), Diode, Inverter

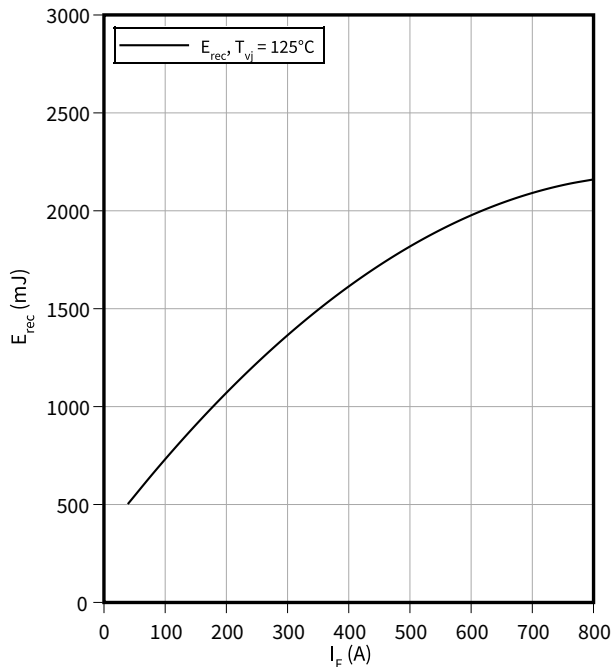
$I_F = f(V_F)$



4 Characteristics diagrams

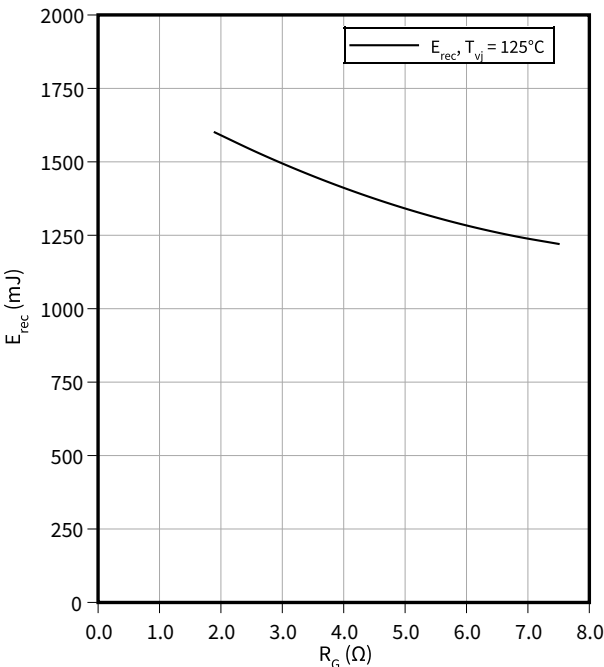
switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$
 $V_{CE} = 3600\text{ V}, R_{Gon} = R_{Gon}(IGBT)$



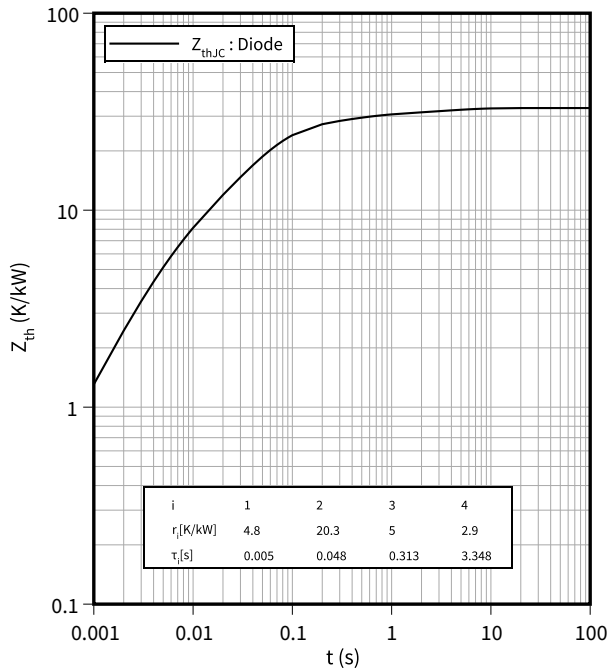
switching losses (typical), Diode, Inverter

$E_{rec} = f(R_G)$
 $V_{CE} = 3600\text{ V}, I_F = 400\text{ A}$



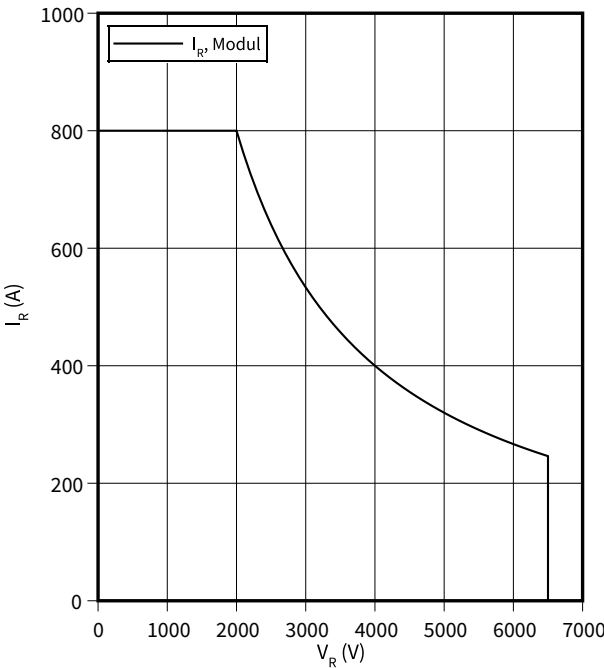
transient thermal impedance , Diode, Inverter

$Z_{th} = f(t)$



safe operation area (SOA), Diode, Inverter

$I_R = f(V_R)$
 $T_{vj} = 125\text{ °C}$



5 Circuit diagram

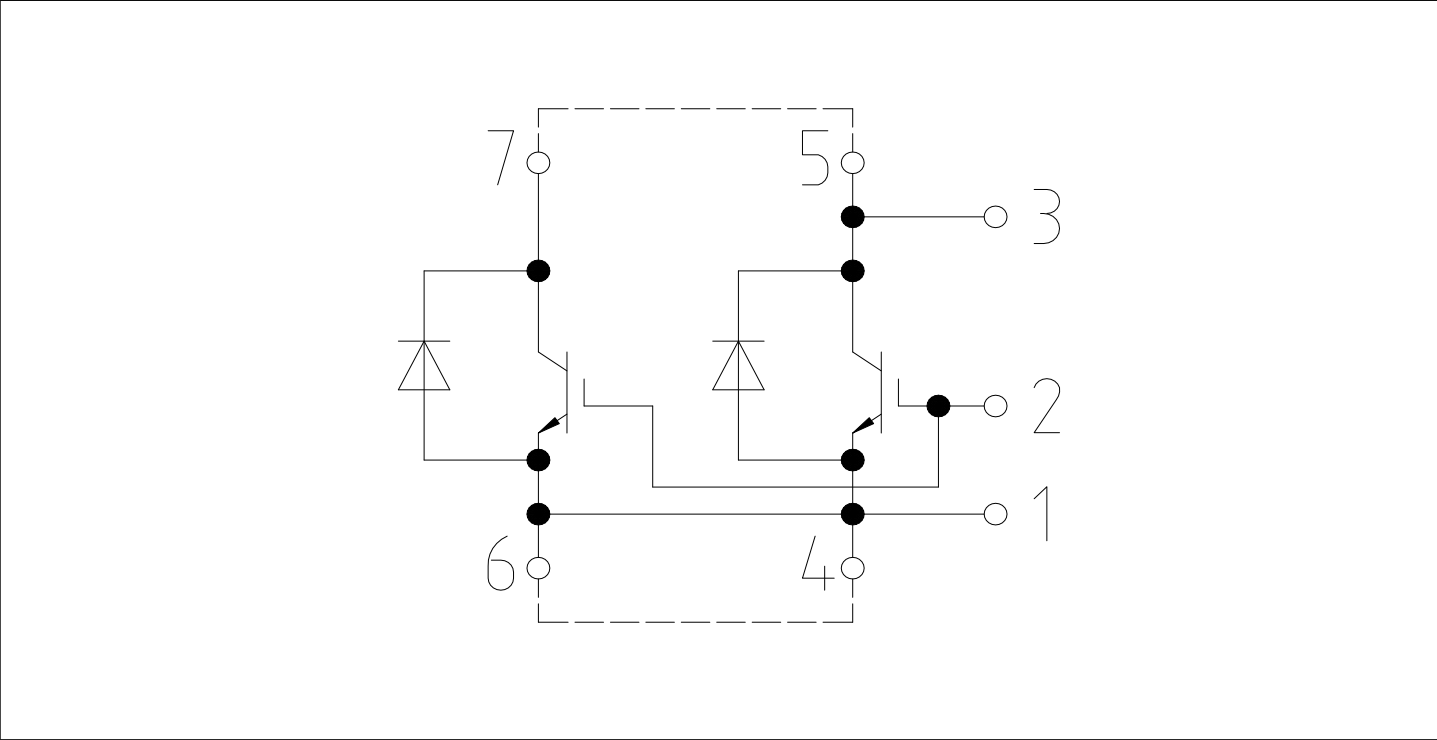


Figure 1

6 Package outlines

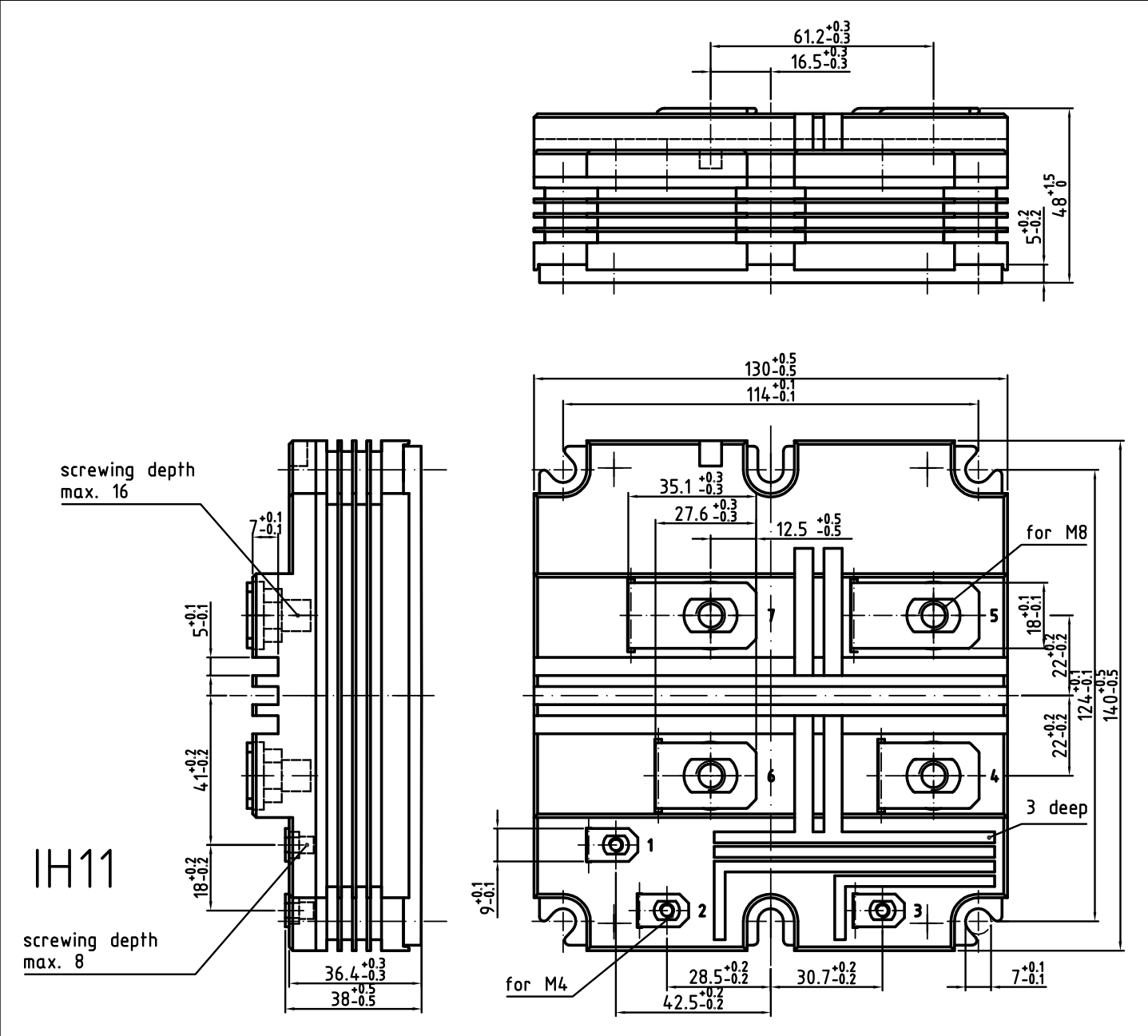


Figure 2

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	<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	2012-02-06	Target datasheet
V1.1	2012-03-06	Target datasheet
V2.0	2012-05-02	Preliminary datasheet
V2.1	2012-06-25	Preliminary datasheet
V3.0	2018-01-15	Final datasheet
V3.1	2019-09-06	Final datasheet
V3.2	2020-05-06	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	2021-10-27	Final datasheet

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