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

Features

- Electrical features
  - V_{CES} = 6500 V
  - $I_{C\ nom}$ = 400 A / I_{CRM} = 800 A
  - Low $V_{CE,sat}$
- Mechanical features
  - Extended storage temperature down to T_{stg} = -55 °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

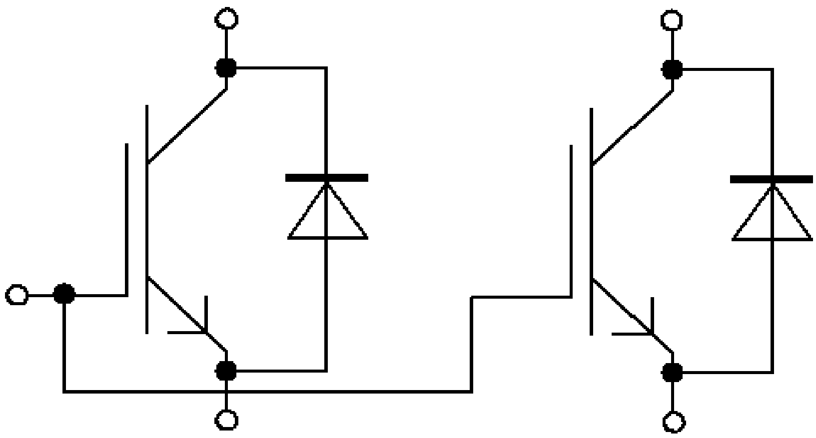
Potential applications

- 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 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	
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°C, per switch			0.18		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_C=25°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 °C	5900	V
			T_{vj} = 25 °C	6500	
			T_{vj} = 125 °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 °C	T_C = 80 °C	400	A
Repetitive peak collector current	I_{CRM}	t_P = 1 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 A, V_{GE} = 15 V	T_{vj} = 25 °C		3.00	3.40	V
			T_{vj} = 125 °C		3.70		
Gate threshold voltage	V_{GEth}	I_C = 70 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			17		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			1.1		Ω
Input capacitance	C_{ies}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			110		nF
Reverse transfer capacitance	C_{res}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			1.7		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 = 400 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 1.9 Ω	T_{vj} = 25 °C		0.640		µs
			T_{vj} = 125 °C		0.650		
Rise time (inductive load)	t_r	I_C = 400 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 1.9 Ω	T_{vj} = 25 °C		0.180		µs
			T_{vj} = 125 °C		0.200		
Turn-off delay time (inductive load)	t_{doff}	I_C = 400 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 13 Ω	T_{vj} = 25 °C		7.300		µs
			T_{vj} = 125 °C		7.600		
Fall time (inductive load)	t_f	I_C = 400 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 13 Ω	T_{vj} = 25 °C		0.400		µs
			T_{vj} = 125 °C		0.500		
Turn-on time (resistive load)	t_{on_R}	I_C = 500 A, V_{CE} = 2000 V, V_{GE} = ±15 V, R_{Gon} = 1.9 Ω	T_{vj} = 25 °C	1.55			µs
Turn-on energy loss per pulse	E_{on}	I_C = 400 A, V_{CE} = 3600 V, L_σ = 280 nH, V_{GE} = ±15 V, R_{Gon} = 1.9 Ω, di/dt = 1600 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		2250		mJ
			T_{vj} = 125 °C		3450		
Turn-off energy loss per pulse	E_{off}	I_C = 400 A, V_{CE} = 3600 V, L_σ = 280 nH, V_{GE} = ±15 V, R_{Goff} = 13 Ω	T_{vj} = 25 °C		2000		mJ
			T_{vj} = 125 °C		2250		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
SC data	I_{SC}	$V_{GE} \leq 15$ V, $V_{CC} = 4500$ V, $V_{CEmax}=V_{CES}-L_{sCE}*di/dt$	$t_P \leq 10$ µs, $T_{vj} \leq$ 125 °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, λ_{grease}= 1 W/(m*K)			13.8		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} = 25 °C	6500	
			T_{vj} = 125 °C	6500	
Continuous DC forward current	I_F			400	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		800	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	130	kA^2s
Maximum power dissipation	P_{RQM}	T_{vj} = 125 °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 A, V_{GE} = 0 V	T_{vj} = 25 °C		3.00	3.50	V
			T_{vj} = 125 °C		2.95		
Peak reverse recovery current	I_{RM}	V_R = 3600 V, I_F = 400 A, V_{GE} = -15 V, -di_F/dt = 1600 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		600		A
			T_{vj} = 125 °C		670		
Recovered charge	Q_r	V_R = 3600 V, I_F = 400 A, V_{GE} = -15 V, -di_F/dt = 1600 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		470		µC
			T_{vj} = 125 °C		870		

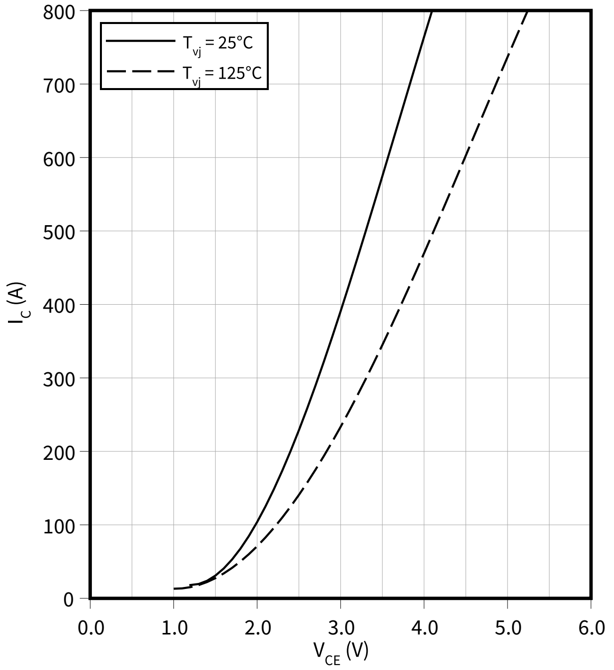
(table continues...)

Table 6 (continued) Characteristic values

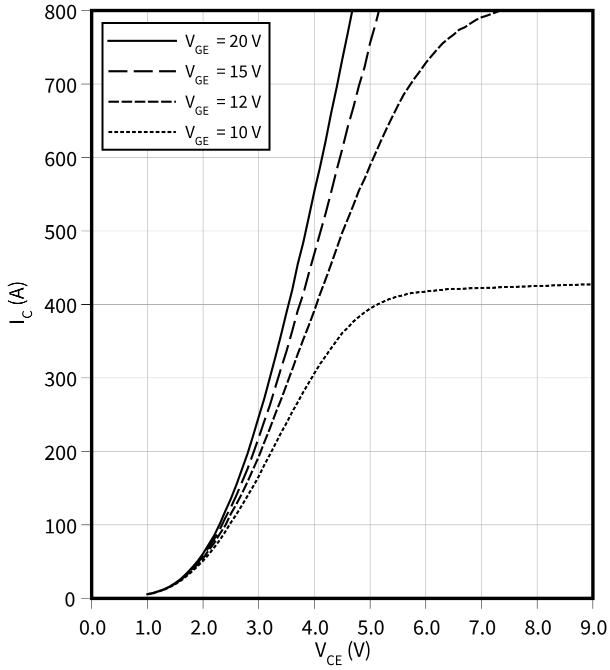
Parameter	Symbol	Note or test condition		Values Min.	Typ.	Max.	Unit
Reverse recovery energy	E_{rec}	V_R = 3600 V, I_F = 400 A, V_{GE} = -15 V, -di_F/dt = 1600 A/µs (T_{vj} = 125 °C)					mJ
			T_{vj} = 25 °C		740		
			T_{vj} = 125 °C		1600		
Thermal resistance, junction to case	R_{thJC}	per diode				33.0	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, λ_{grease}= 1 W/(m*K)			21.6		K/kW
Temperature under switching conditions	$T_{vj\ op}$			-50		125	°C

4 Characteristics diagrams

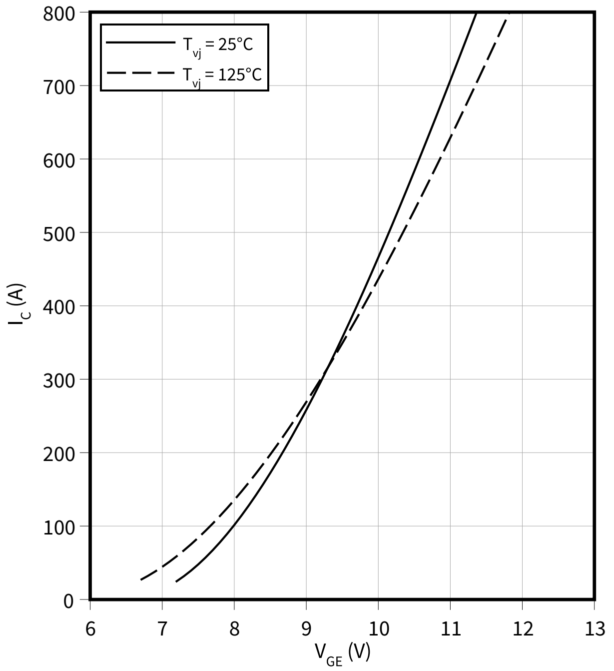
output characteristic (typical), IGBT, Inverter
$I_C = f(V_{CE})$
$V_{GE} = 15\ V$



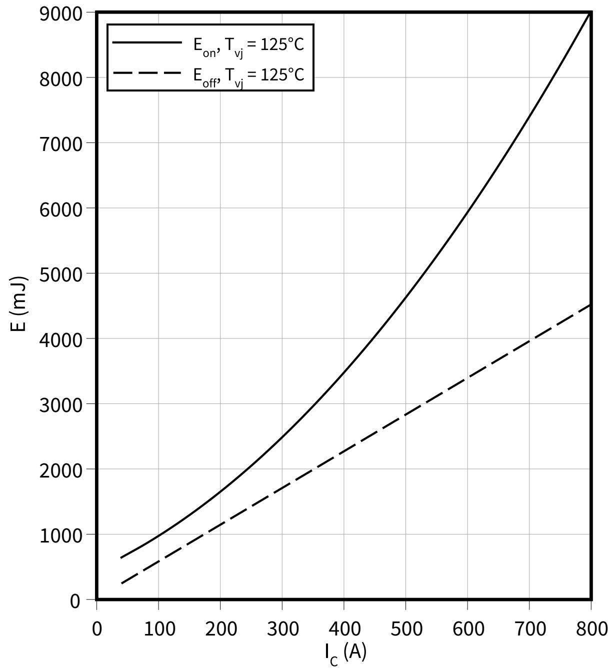
output characteristic (typical), IGBT, Inverter
$I_C = f(V_{CE})$
$T_{vj} = 125\ °C$



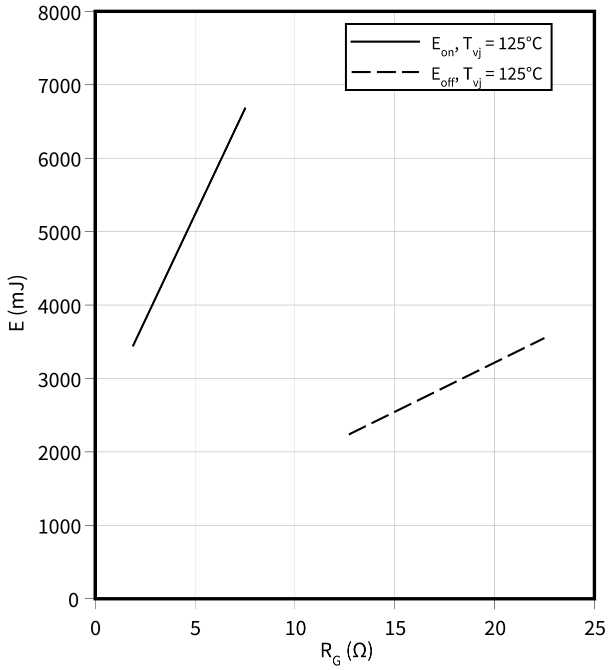
transfer characteristic (typical), IGBT, Inverter
$I_C = f(V_{GE})$
$V_{CE} = 20\ V$



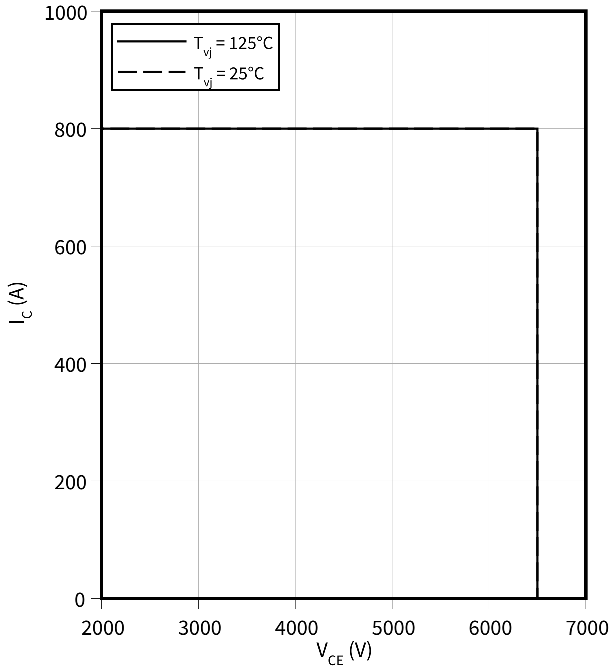
switching losses (typical), IGBT, Inverter
$E = f(I_C)$
$R_{Goff} = 13\ \Omega$, $R_{Gon} = 1.9\ \Omega$, $V_{CE} = 3600\ V$, $V_{GE} = \pm\ 15\ V$



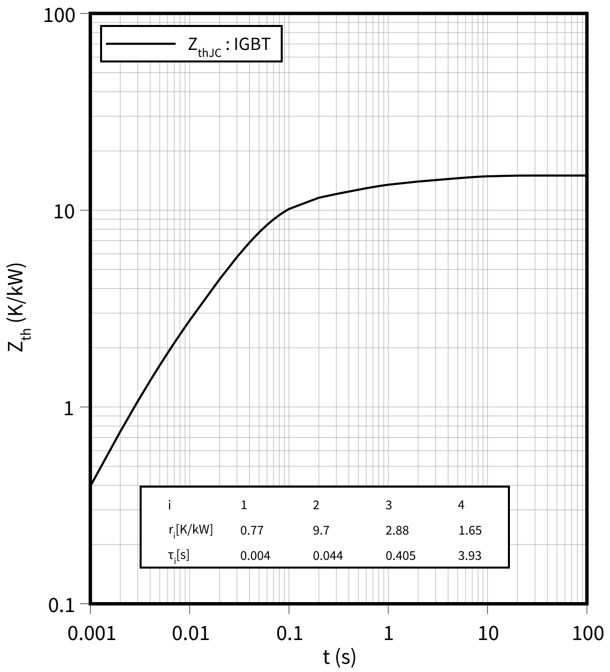
switching losses (typical), IGBT, Inverter
$E = f(R_G)$
$I_C = 400$ A, $V_{CE} = 3600$ V, $V_{GE} = \pm 15$ V



reverse bias safe operating area (RBSOA), IGBT, Inverter
$I_C = f(V_{CE})$
$R_{Goff} = 13\ \Omega$, $V_{GE} = \pm 15$ V

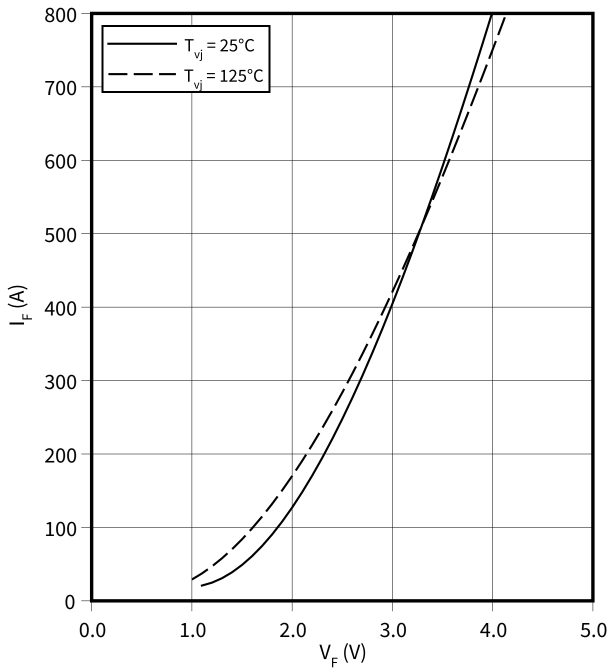


transient thermal impedance , IGBT, Inverter
$Z_{th} = f(t)$

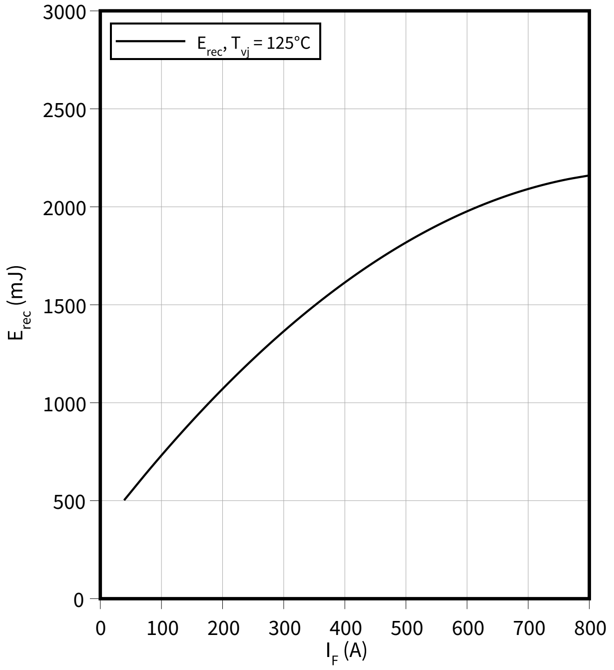


i	1	2	3	4
r_i[K/kW]	0.77	9.7	2.88	1.65
τ_i[s]	0.004	0.044	0.405	3.93

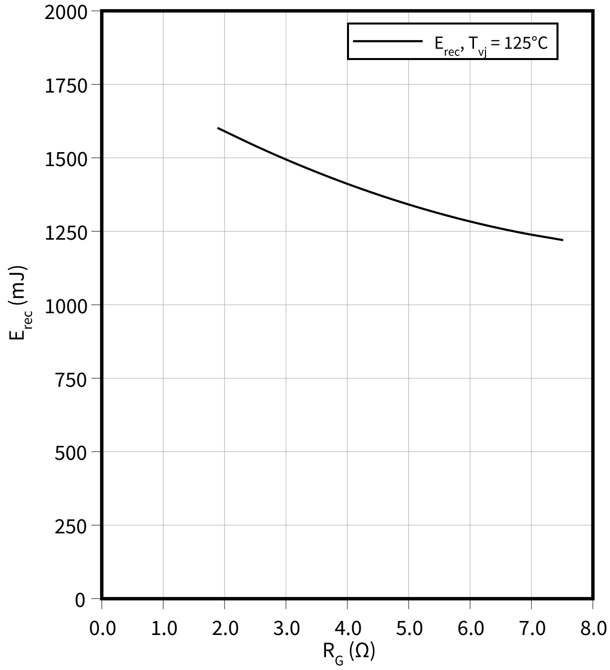
forward characteristic of (typical), Diode, Inverter
$I_F = f(V_F)$



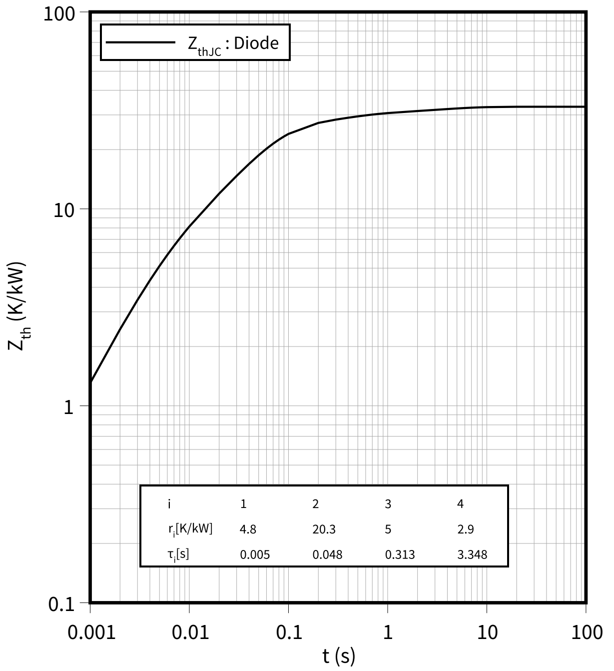
switching losses (typical), Diode, Inverter
$E_{rec} = f(I_F)$
$V_{CE} = 3600$ V, $R_{Gon} = R_{Gon}$(IGBT)



switching losses (typical), Diode, Inverter
$E_{rec} = f(R_G)$
$V_{CE} = 3600$ V, $I_F = 400$ A

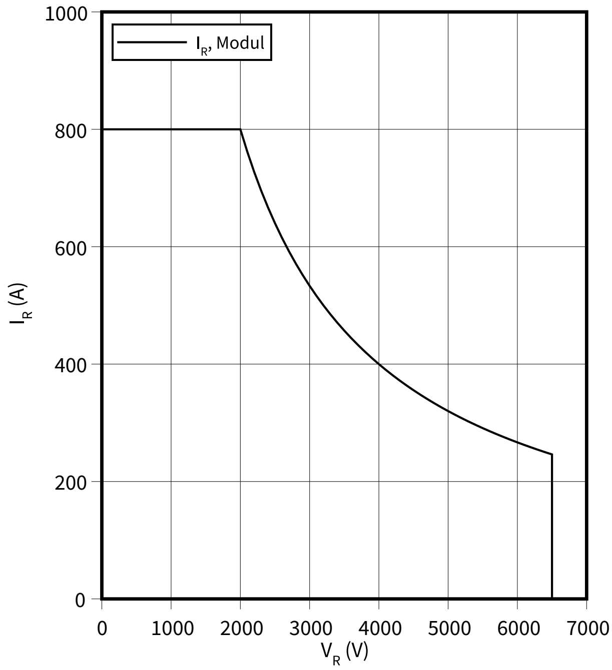


transient thermal impedance , Diode, Inverter
$Z_{th} = f(t)$



i	1	2	3	4
r_i[K/kW]	4.8	20.3	5	2.9
τ_i[s]	0.005	0.048	0.313	3.348

safe operation area (SOA), Diode, Inverter
$I_R = f(V_R)$
$T_{vj} = 125$ °C



5 Circuit diagram

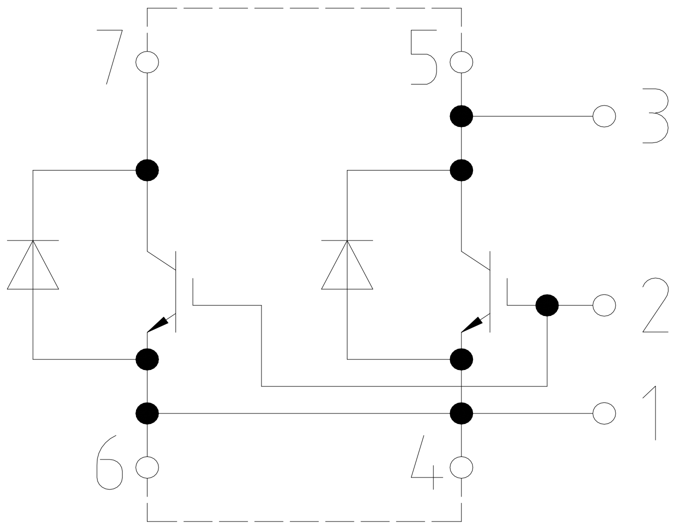


Figure 1

6 Package outlines

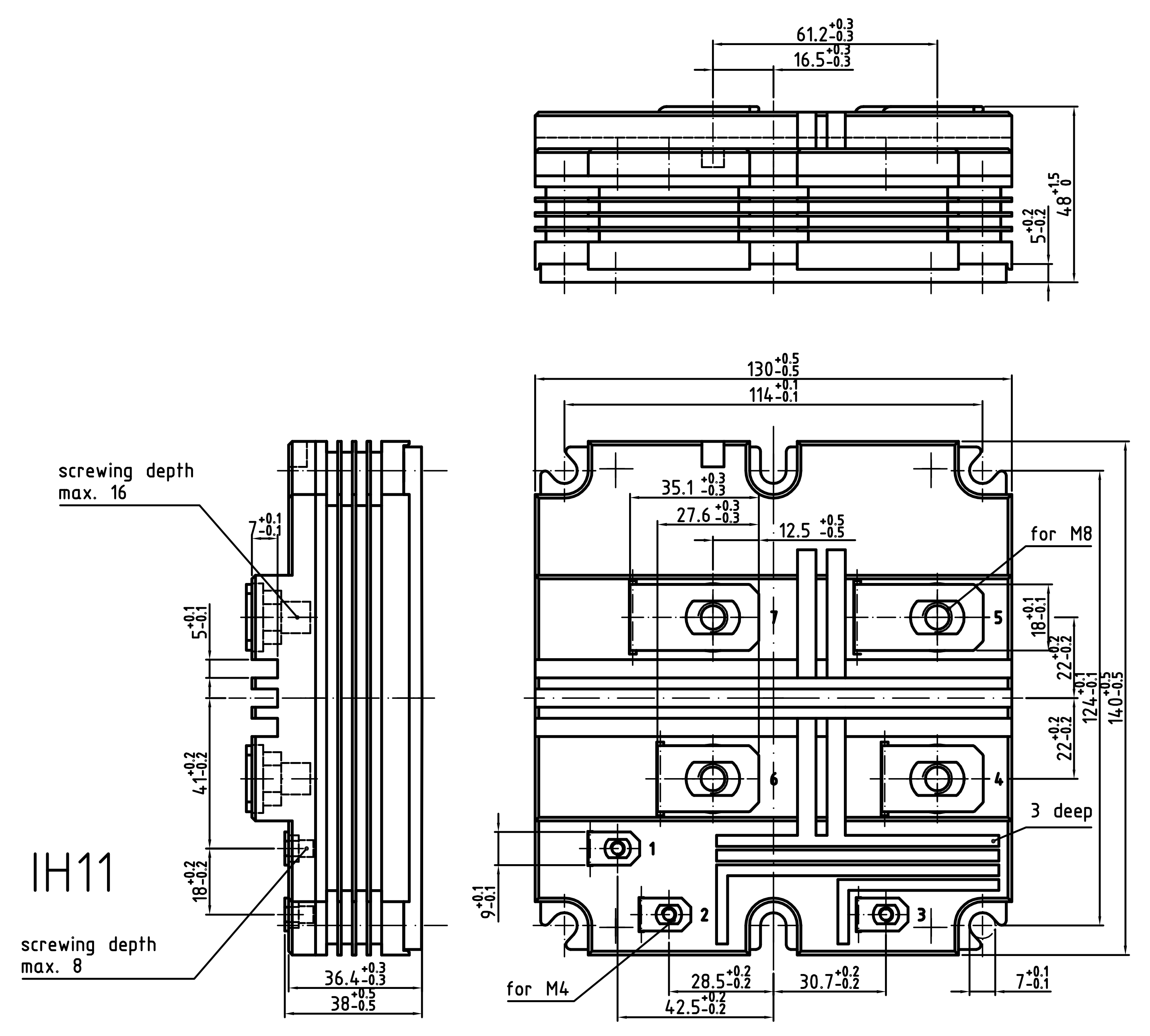


Figure 2

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* 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	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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