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

Features



- Electrical features
  - V_{CES} = 6500 V
  - $I_{C\ nom}$ = 500 A / I_{CRM} = 1000 A
  - Low $V_{CE,sat}$
- Mechanical features
  - AlSiC base plate for increased thermal cycling capability
  - Extended storage temperature down to T_{stg} = -55 °C
  - High creepage and clearance distances
  - Package with enhanced insulation of 10.4 kV AC 60 s
  - Package with CTI > 600

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

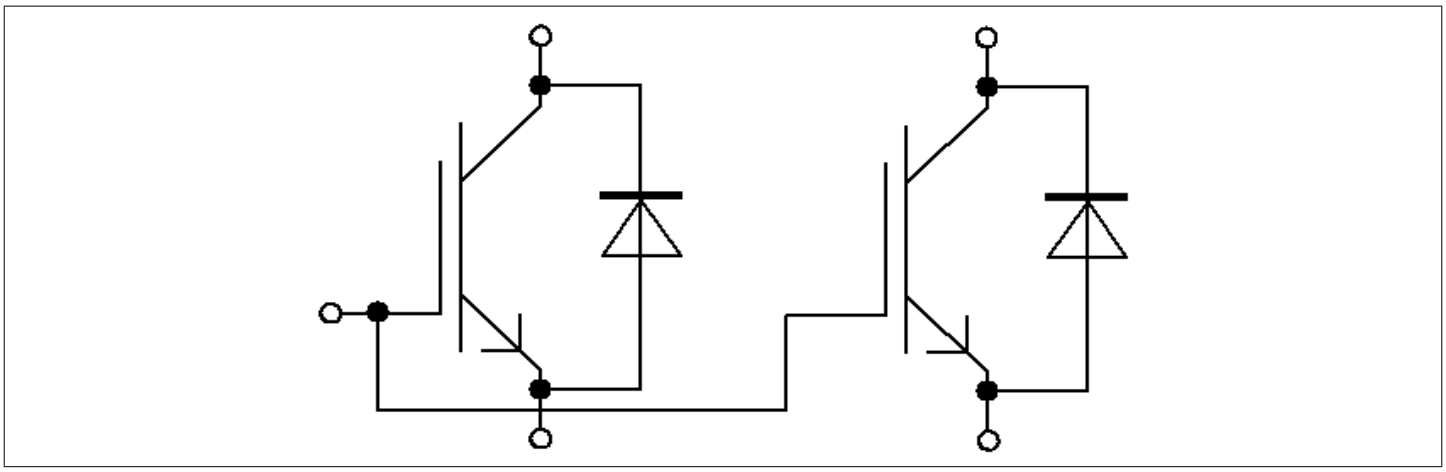


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1 Package

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	500	A
Repetitive peak collector current	I_{CRM}	t_P = 1 ms		1000	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 = 500 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 = 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			20		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			135		nF
Reverse transfer capacitance	C_{res}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			2.1		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 = 500 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 1.5 Ω	T_{vj} = 25 °C		0.640		µs
			T_{vj} = 125 °C		0.650		
Rise time (inductive load)	t_r	I_C = 500 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 1.5 Ω	T_{vj} = 25 °C		0.180		µs
			T_{vj} = 125 °C		0.200		
Turn-off delay time (inductive load)	t_{doff}	I_C = 500 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 10 Ω	T_{vj} = 25 °C		7.300		µs
			T_{vj} = 125 °C		7.600		
Fall time (inductive load)	t_f	I_C = 500 A, V_{CE} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 10 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} = 1.5 Ω	T_{vj} = 25 °C	1.62			µs
Turn-on energy loss per pulse	E_{on}	I_C = 500 A, V_{CE} = 3600 V, L_σ = 280 nH, V_{GE} = ±15 V, R_{Gon} = 1.5 Ω, di/dt = 2000 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		2800		mJ
			T_{vj} = 125 °C		4300		
Turn-off energy loss per pulse	E_{off}	I_C = 500 A, V_{CE} = 3600 V, L_σ = 280 nH, V_{GE} = ±15 V, R_{Goff} = 10 Ω, dv/dt = V/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		2400		mJ
			T_{vj} = 125 °C		2800		

(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		3000		A
Thermal resistance, junction to case	R_{thJC}	per IGBT				13.1	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, $\lambda_{grease}= 1$ W/(m*K)			13.2		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			500	A
Repetitive peak forward current	I_{FRM}	$t_P = 1$ ms		1000	A
I^2t - value	I^2t	$t_P = 10$ ms, $V_R = 0$ V	T_{vj} = 125 °C	210	kA^2s
Maximum power dissipation	P_{RQM}	T_{vj} = 125 °C		2000	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	$I_F = 500$ A, $V_{GE} = 6500$ V	T_{vj} = 25 °C		3.00	3.50	V
			T_{vj} = 125 °C		2.95	3.50	
Peak reverse recovery current	I_{RM}	$V_R = 3600$ V, $I_F = 500$ A, $V_{GE} = -15$ V, $-di_F/dt =$ 2000 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		730		A
			T_{vj} = 125 °C		800		
Recovered charge	Q_r	$V_R = 3600$ V, $I_F = 500$ A, $V_{GE} = -15$ V, $-di_F/dt =$ 2000 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		570		µC
			T_{vj} = 125 °C		1050		

(table continues...)

Table 6 (continued) Characteristic values

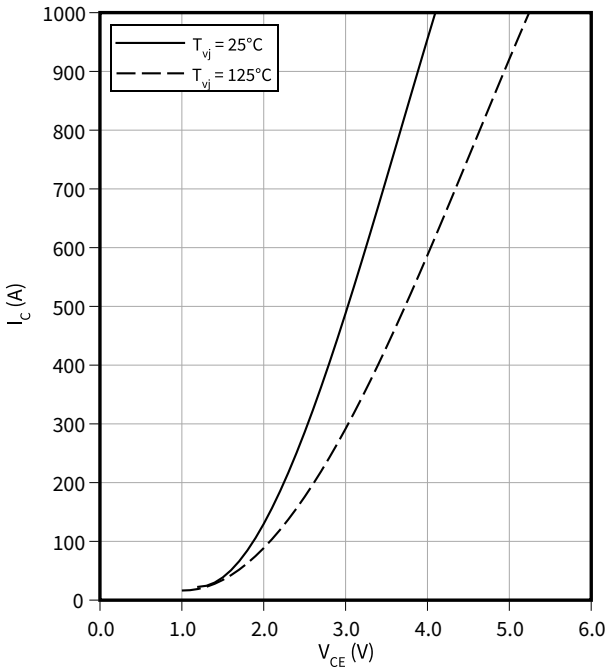
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Reverse recovery energy	E_{rec}	V_R = 3600 V, I_F = 500 A, V_{GE} = -15 V, -di$_F$/dt = 2000 A/µs (T_{vj} = 125 °C)	T_{vj} = 25 °C		930		mJ
			T_{vj} = 125 °C		2000		
Thermal resistance, junction to case	R_{thJC}	per diode				27.9	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, λ_{grease}= 1 W/(m*K)			21.0		K/kW
Temperature under switching conditions	$T_{vj\,op}$			-50		125	°C

4 Characteristics diagrams

output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

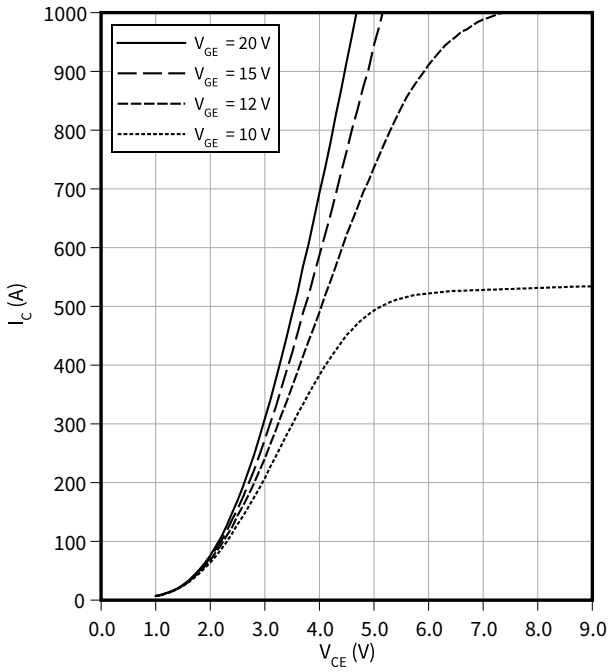
V_{GE} = 15 V



output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

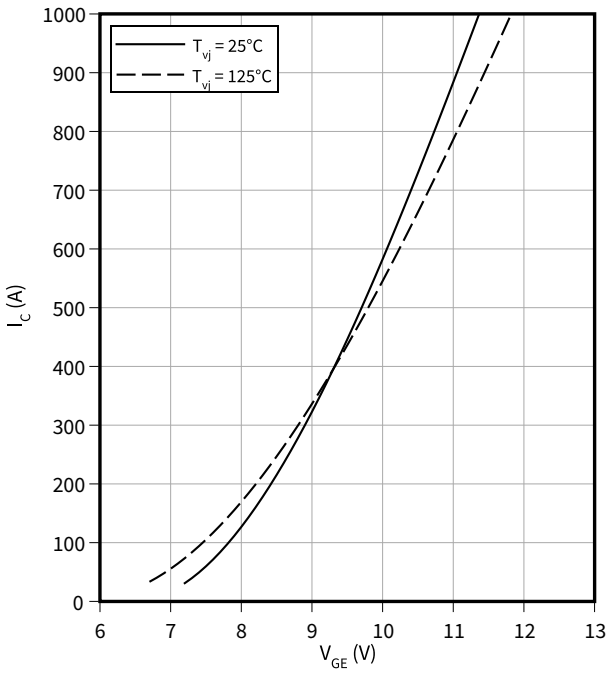
T_{vj} = 125 °C



transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

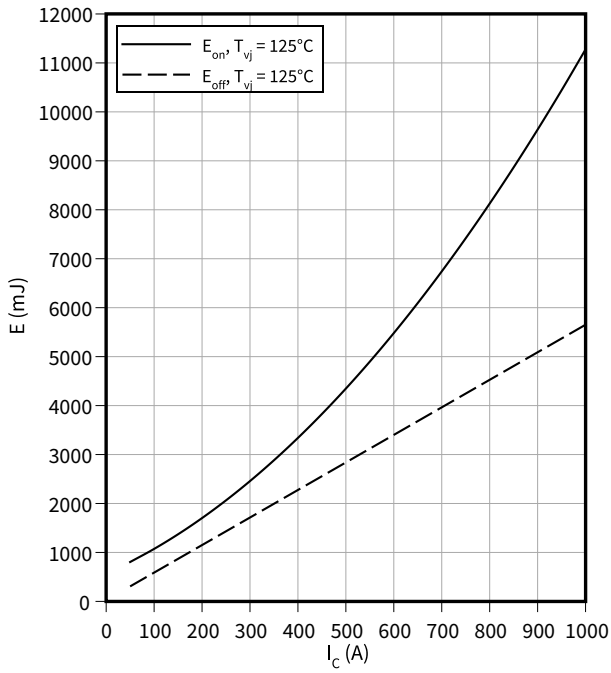
V_{CE} = 20 V



switching losses (typical), IGBT, Inverter

$E = f(I_C)$

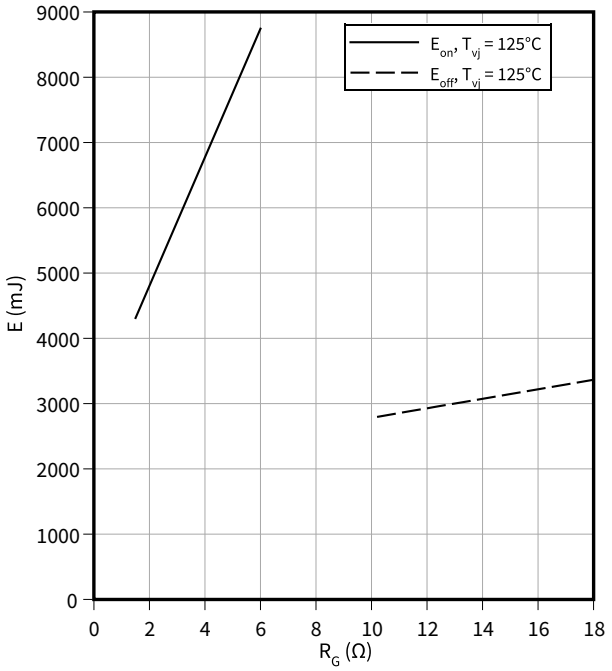
R_{Goff} = 10 Ω, R_{Gon} = 1.5 Ω, V_{CE} = 3600 V, V_{GE} = ± 15 V



switching losses (typical), IGBT, Inverter

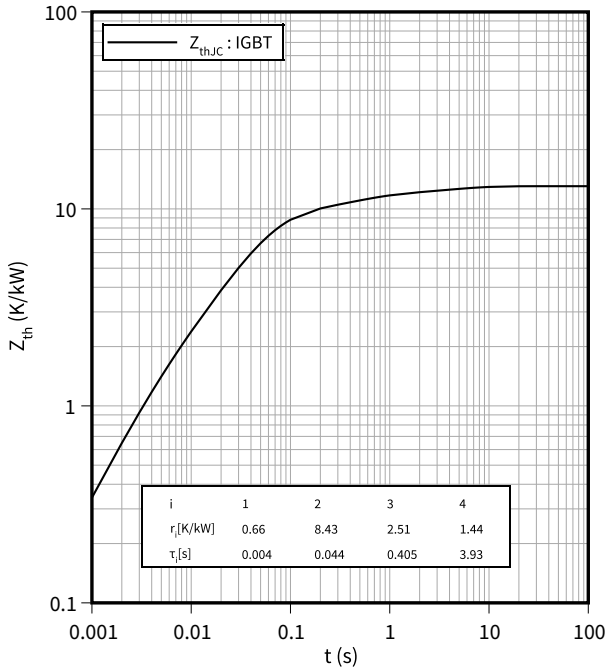
$E = f(R_G)$

$I_C = 500$ A, $V_{CE} = 3600$ V, $V_{GE} = \pm 15$ V



transient thermal impedance , IGBT, Inverter

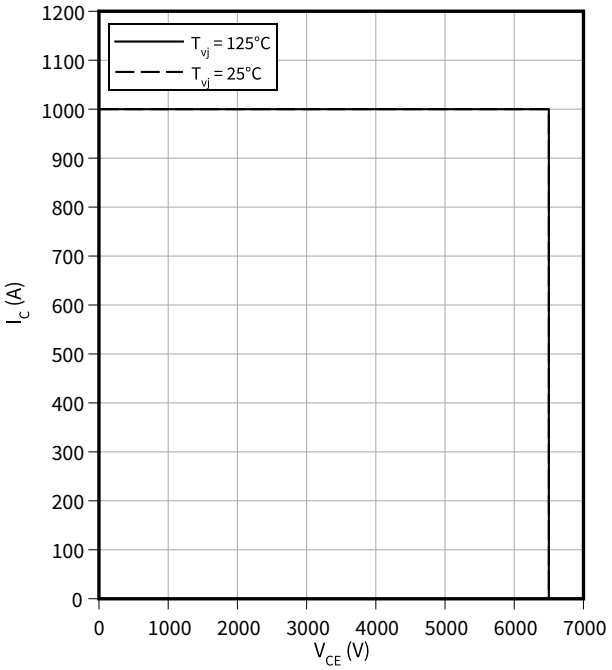
$Z_{th} = f(t)$



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

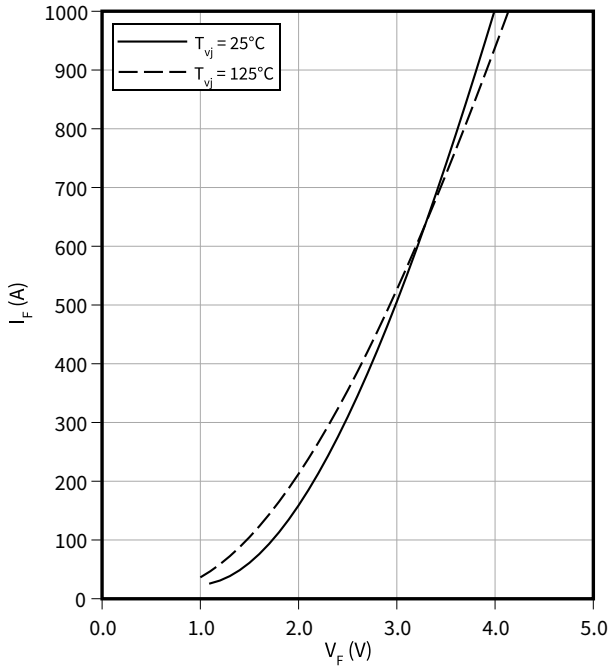
$I_C = f(V_{CE})$

$R_{Goff} = 10\ \Omega$, $V_{GE} = \pm 15$ V, $T_{vj} = 125$ °C



forward characteristic of (typical), Diode, Inverter

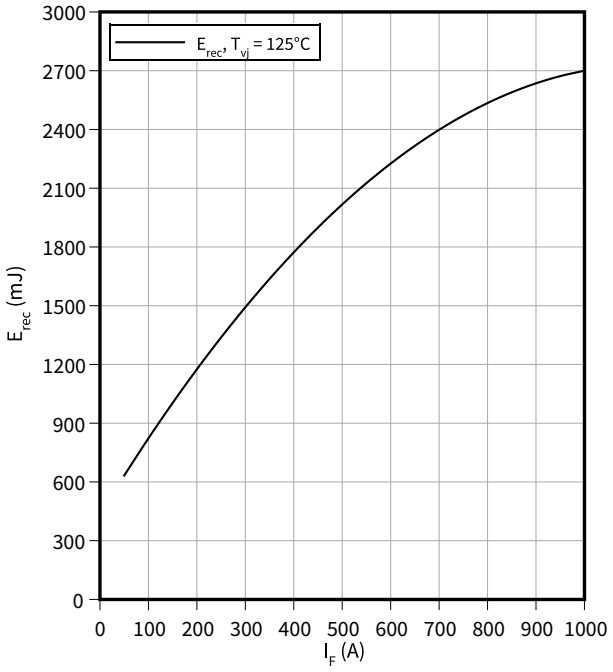
$I_F = f(V_F)$



switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

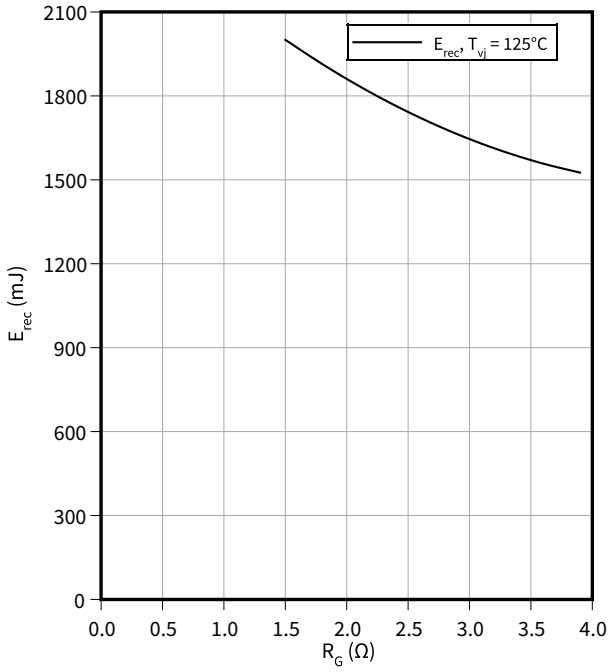
V_{CE} = 3600 V, $R_{Gon} = R_{Gon}$(IGBT)



switching losses (typical), Diode, Inverter

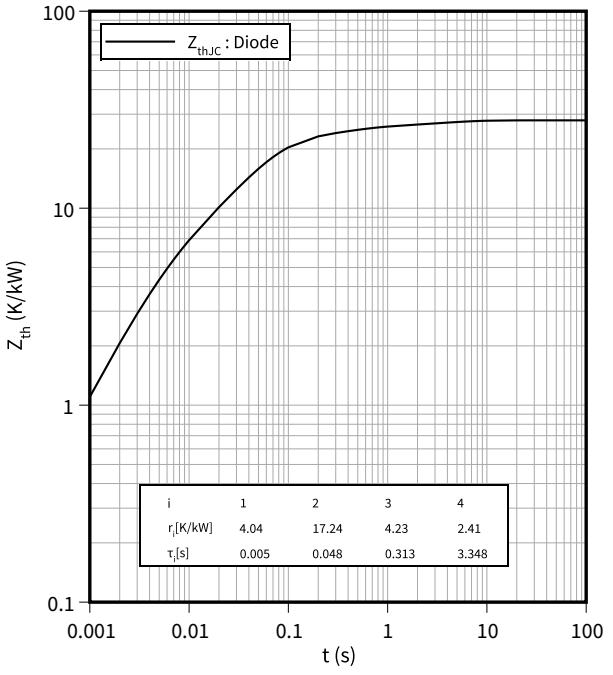
$E_{rec} = f(R_G)$

V_{CE} = 3600 V, I_F = 500 A



transient thermal impedance , Diode, Inverter

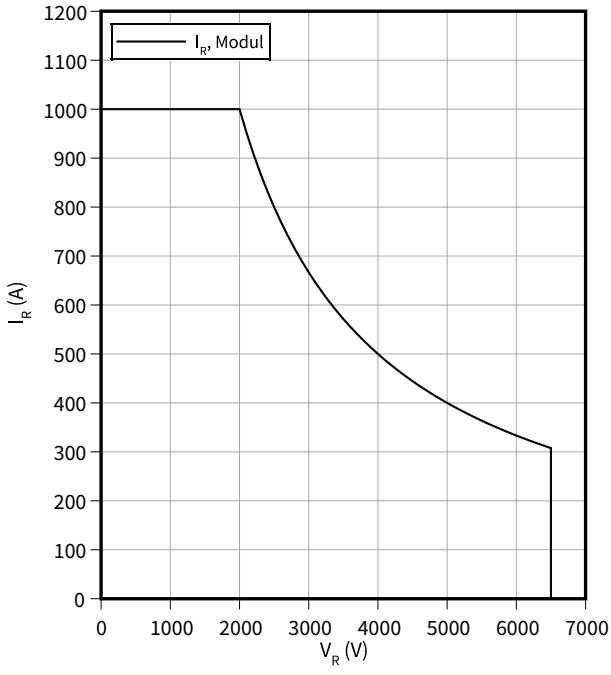
$Z_{th} = f(t)$



safe operation area (SOA), Diode, Inverter

$I_R = f(V_R)$

T_{vj} = 125 °C



5 Circuit diagram

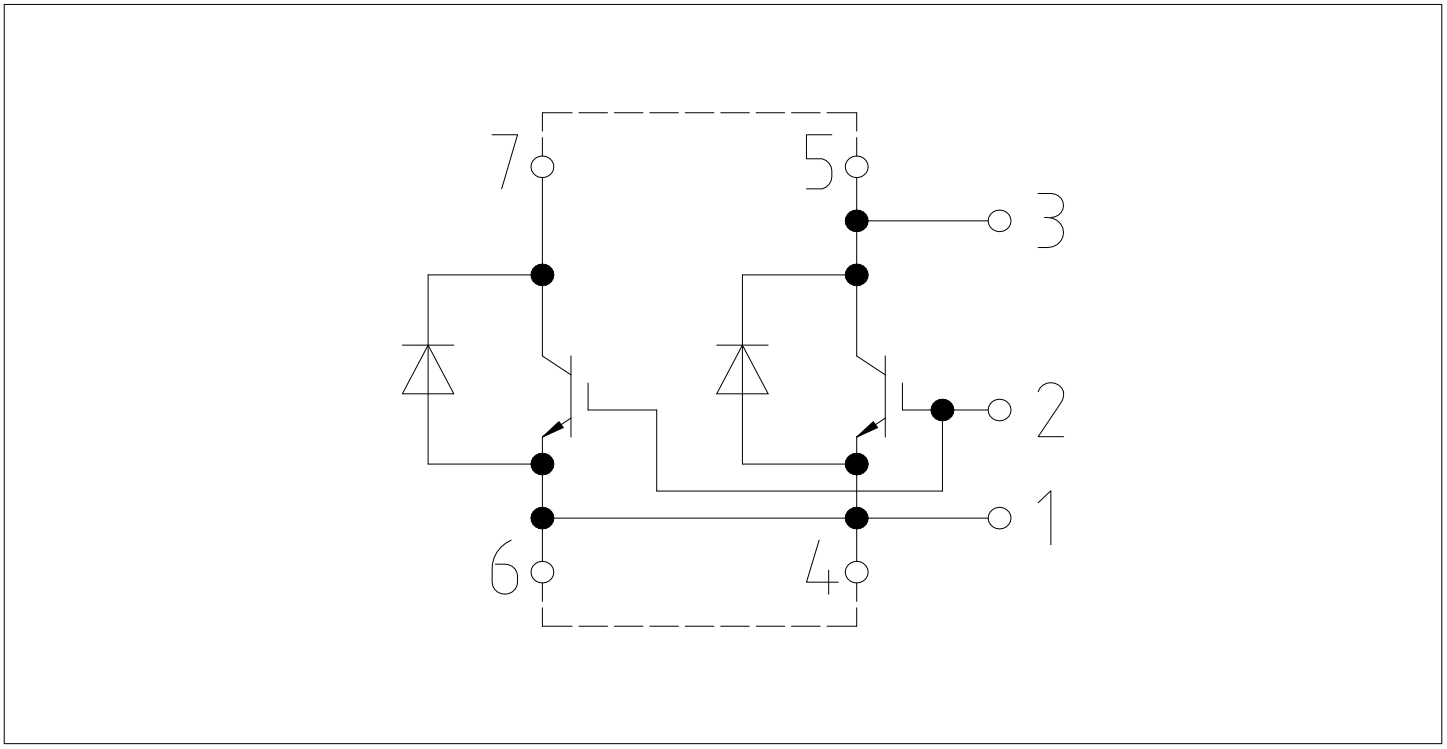


Figure 1

6 Package outlines

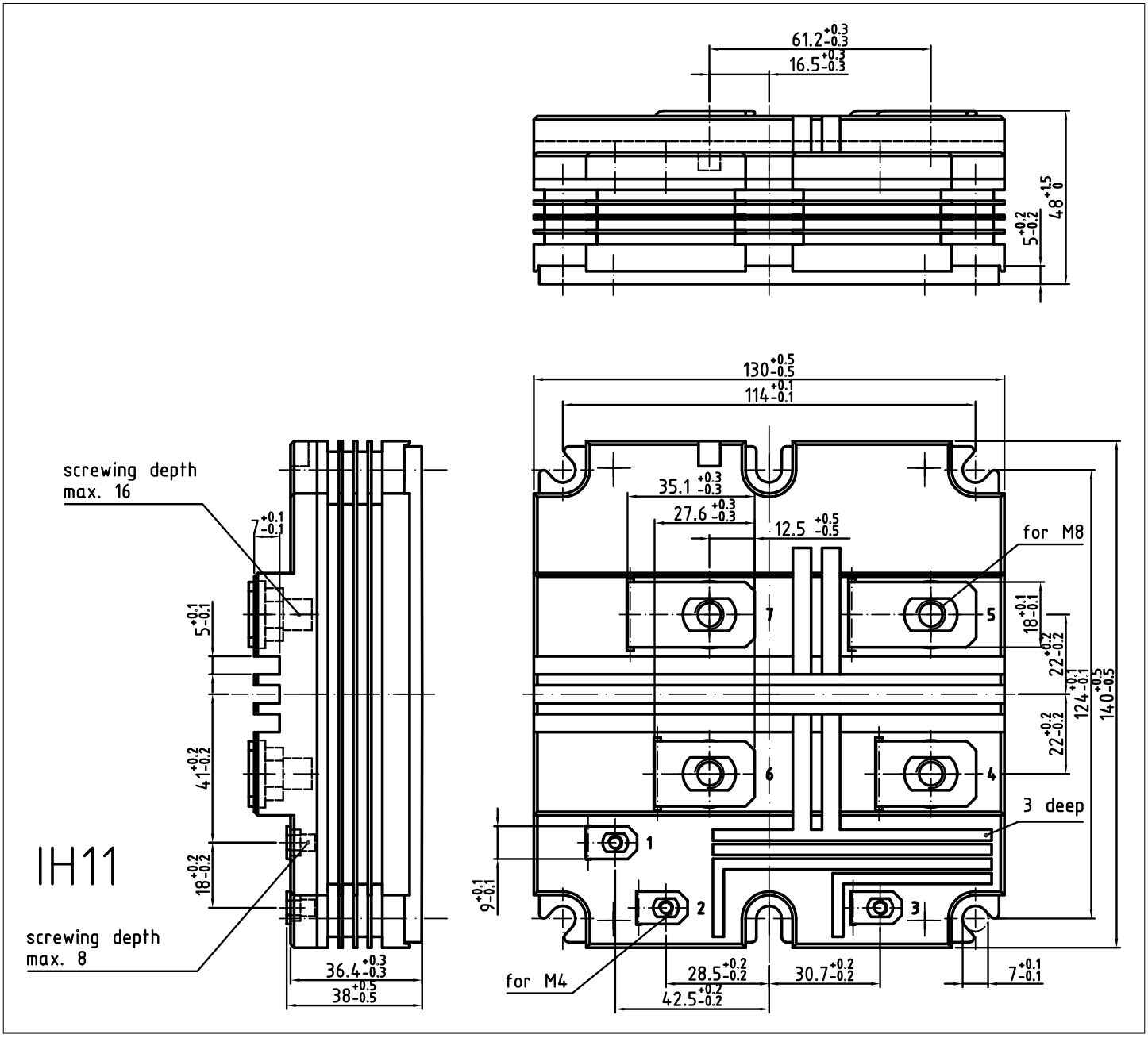


Figure 2

7 Module label code

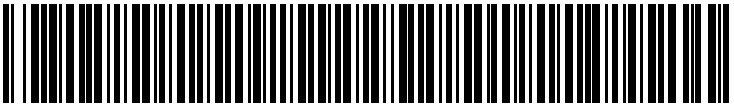
Module label code			
Code format	Data Matrix		Barcode Code128
Encoding	ASCII text		Code Set A
Symbol size	16x16		23 digits
Standard	IEC24720 and IEC16022		IEC8859-1
Code content	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production week)	*Digit* 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	*Example* 71549 142846 55054991 15 30
Example	 7154914284655054991530	 7154914284655054991530	

Figure 3

Revision history

Document revision	Date of release	Description of changes
V1.0	2009-04-06	Target datasheet
V2.0	2010-12-13	Preliminary datasheet
V2.1	2012-06-25	Preliminary datasheet
V2.2	2012-08-22	Preliminary datasheet
V3.0	2014-06-16	Final datasheet
V3.1	2018-01-15	Final datasheet
V3.2	2019-09-06	Final datasheet
V3.3	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	2021-10-25	Final datasheet

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