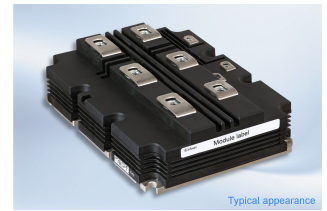


Highly insulated module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode

Features

- Electrical features
 - $V_{CES} = 6500\text{ V}$
 - $I_{C\text{ nom}} = 500\text{ A} / I_{CRM} = 1000\text{ A}$
 - Low $V_{CE,sat}$
- Mechanical features
 - ALSiC base plate for increased thermal cycling capability
 - 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



Potential applications

- Chopper applications
- Medium-voltage converters
- Traction drives

Product validation

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

Description

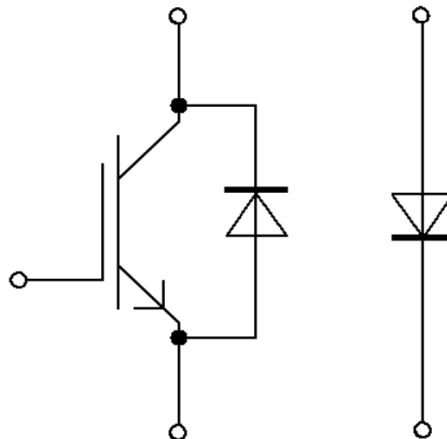


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1 Package

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			1400		g

2 IGBT, Brake-Chopper

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}	$T_{vj\ max} = 150\ ^\circ\text{C}$	$T_C = 80\ ^\circ\text{C}$	500	A
Repetitive peak collector current	I_{CRM}	$t_P = 1\ \text{ms}$		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	$V_{CE\ sat}$	$I_C = 500\ \text{A}, V_{GE} = 15\ \text{V}$	$T_{vj} = 25\ ^\circ\text{C}$		3.00	3.40	V
			$T_{vj} = 125\ ^\circ\text{C}$		3.70	4.20	
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	$V_{GE} = \pm 15\ \text{V}, V_{CE} = 3600\ \text{V}$			20		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\ ^\circ\text{C}$			1.1		Ω
Input capacitance	C_{ies}	$f = 1000\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$			135		nF
Reverse transfer capacitance	C_{res}	$f = 1000\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$			2.1		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}	$I_C = 500\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.5\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		0.640		μs
			$T_{vj} = 125\ ^\circ\text{C}$		0.650		
Rise time (inductive load)	t_r	$I_C = 500\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.5\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		0.180		μs
			$T_{vj} = 125\ ^\circ\text{C}$		0.200		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 500\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 10\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		7.300		μs
			$T_{vj} = 125\ ^\circ\text{C}$		7.600		
Fall time (inductive load)	t_f	$I_C = 500\ \text{A}, V_{CE} = 3600\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 10\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		0.400		μs
			$T_{vj} = 125\ ^\circ\text{C}$		0.500		
Turn-on time (resistive load)	t_{on_R}	$I_C = 500\ \text{A}, V_{CE} = 2000\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.5\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	1.62			μs
Turn-on energy loss per pulse	E_{on}	$I_C = 500\ \text{A}, V_{CE} = 3600\ \text{V}, L_\sigma = 280\ \text{nH}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1.5\ \Omega, di/dt = 2000\ \text{A}/\mu\text{s} (T_{vj} = 125\ ^\circ\text{C})$	$T_{vj} = 25\ ^\circ\text{C}$		2800		mJ
			$T_{vj} = 125\ ^\circ\text{C}$		4300		
Turn-off energy loss per pulse	E_{off}	$I_C = 500\ \text{A}, V_{CE} = 3600\ \text{V}, L_\sigma = 280\ \text{nH}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 10\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$		2400		mJ
			$T_{vj} = 125\ ^\circ\text{C}$		2800		

(table continues...)

Table 4 (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
SC data	I_{SC}	$V_{GE} \leq 15 \text{ V}$, $V_{CC} = 4500 \text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq 10 \mu\text{s}$, $T_{vj} \leq 125 \text{ }^\circ\text{C}$	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, $\lambda_{grease} = 1 \text{ W}/(\text{m}^2\text{K})$		13.0		K/kW
Temperature under switching conditions	$T_{vj op}$		-50		125	$^\circ\text{C}$

3 Diode, Brake-Chopper

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			500	A
Repetitive peak forward current	I_{FRM}	$t_p = 1\text{ ms}$		1000	A
I^2t - value	I^2t	$t_p = 10\text{ ms}$, $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^{\circ}\text{C}$	210	kA^2s
Maximum power dissipation	P_{RQM}	$T_{vj} = 125\text{ }^{\circ}\text{C}$		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	$I_F = 500 \text{ A}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		3.00	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$		2.95	
Peak reverse recovery current	I_{RM}	$V_R = 3600 \text{ V}$, $I_F = 500 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 2000 \text{ A}/\mu\text{s}$ ($T_{vj} = 125 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$		730	A
			$T_{vj} = 125 \text{ }^\circ\text{C}$		800	
Recovered charge	Q_r	$V_R = 3600 \text{ V}$, $I_F = 500 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 2000 \text{ A}/\mu\text{s}$ ($T_{vj} = 125 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$		570	μC
			$T_{vj} = 125 \text{ }^\circ\text{C}$		1050	

(table continues...)

Table 6 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Reverse recovery energy	E_{rec}	$V_R = 3600\text{ V}$, $I_F = 500\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 2000\text{ A}/\mu\text{s}$ ($T_{vj} = 125\text{ °C}$)	$T_{vj} = 25\text{ °C}$	930		mJ
			$T_{vj} = 125\text{ °C}$	2000		
Thermal resistance, junction to case	R_{thJC}	per diode			28.0	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}^2\text{K})$		21.0		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$		-50		125	°C

4 Diode, Reverse

Table 7 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} = -50\text{ °C}$	5900	V
		$T_{vj} = 25\text{ °C}$	6500	
		$T_{vj} = 125\text{ °C}$	6500	
Continuous DC forward current	I_F		500	A
Repetitive peak forward current	I_{FRM}	$t_P = 1\text{ ms}$	1000	A
I^2t - value	I^2t	$t_P = 10\text{ ms}$, $V_R = 0\text{ V}$, $T_{vj} = 125\text{ °C}$	210	kA ² s
Maximum power dissipation	P_{RQM}	$T_{vj} = 125\text{ °C}$	2000	kW
Minimum turn-on time	t_{onmin}		10	μs

Table 8 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 500\text{ A}$, $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	3.00	3.50	V
			$T_{vj} = 125\text{ °C}$	2.95	3.50	
Peak reverse recovery current	I_{RM}	$V_R = 3600\text{ V}$, $I_F = 500\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 2000\text{ A}/\mu\text{s}$ ($T_{vj} = 125\text{ °C}$)	$T_{vj} = 25\text{ °C}$	730		A
			$T_{vj} = 125\text{ °C}$	800		
Recovered charge	Q_r	$V_R = 3600\text{ V}$, $I_F = 500\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 2000\text{ A}/\mu\text{s}$ ($T_{vj} = 125\text{ °C}$)	$T_{vj} = 25\text{ °C}$	570		μC
			$T_{vj} = 125\text{ °C}$	1050		

(table continues...)

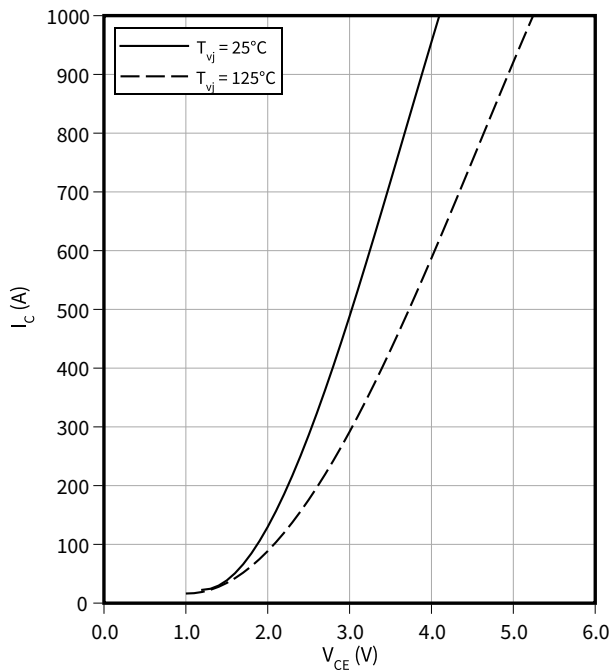
Table 8 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Reverse recovery energy	E_{rec}	$V_R = 3600\text{ V}$, $I_F = 500\text{ A}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 2000\text{ A}/\mu\text{s}$ ($T_{vj} = 125\text{ °C}$)	$T_{vj} = 25\text{ °C}$		930		mJ
			$T_{vj} = 125\text{ °C}$		2000		
Thermal resistance, junction to case	R_{thJC}	per diode				28.0	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}^*\text{K})$			16.0		K/kW
Temperature under switching conditions	$T_{vj\text{ op}}$			-50		125	°C

5 Characteristics diagrams

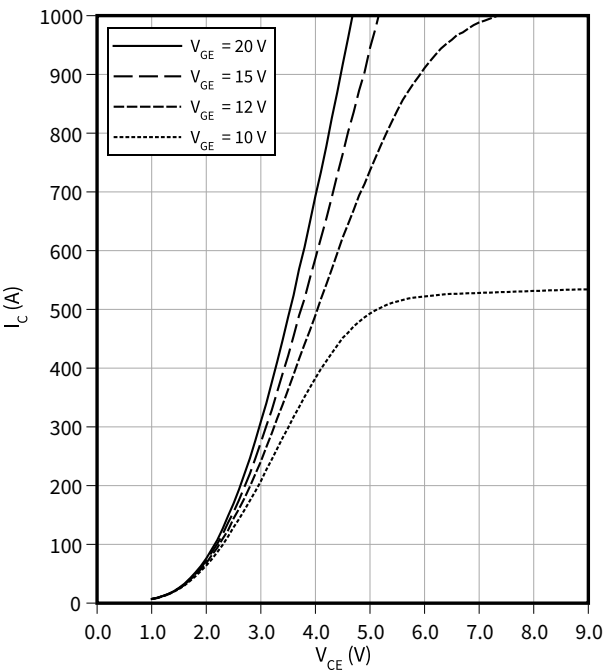
output characteristic (typical), IGBT, Brake-Chopper

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



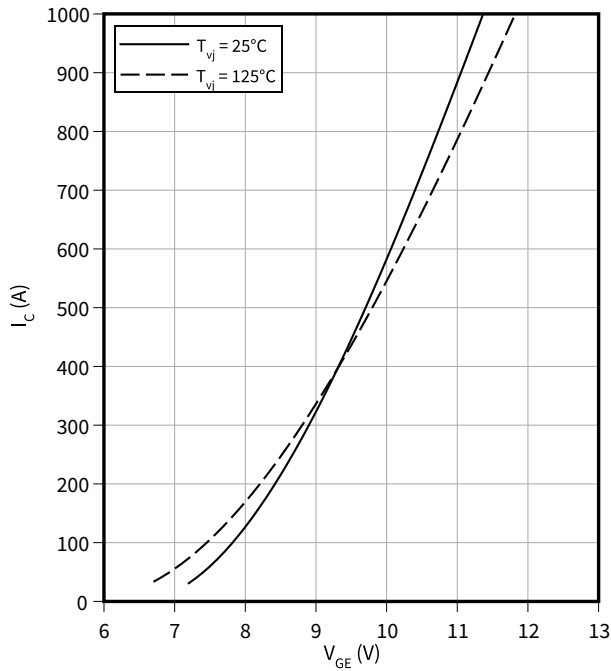
output characteristic (typical), IGBT, Brake-Chopper

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



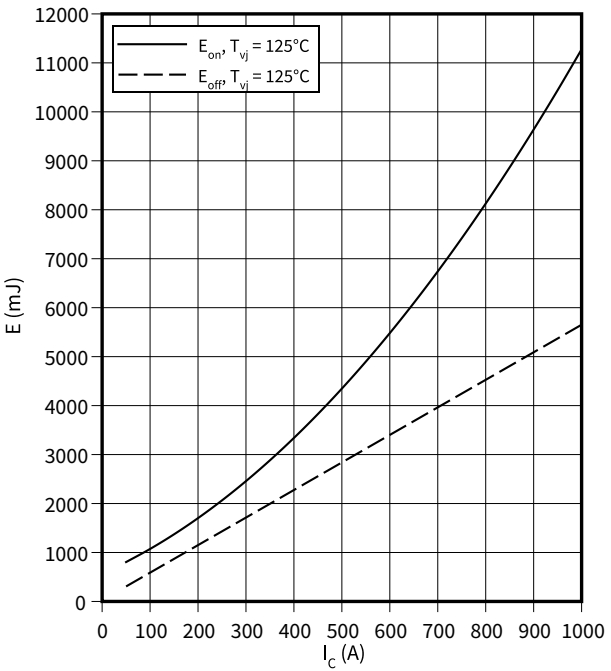
transfer characteristic (typical), IGBT, Brake-Chopper

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



switching losses (typical), IGBT, Brake-Chopper

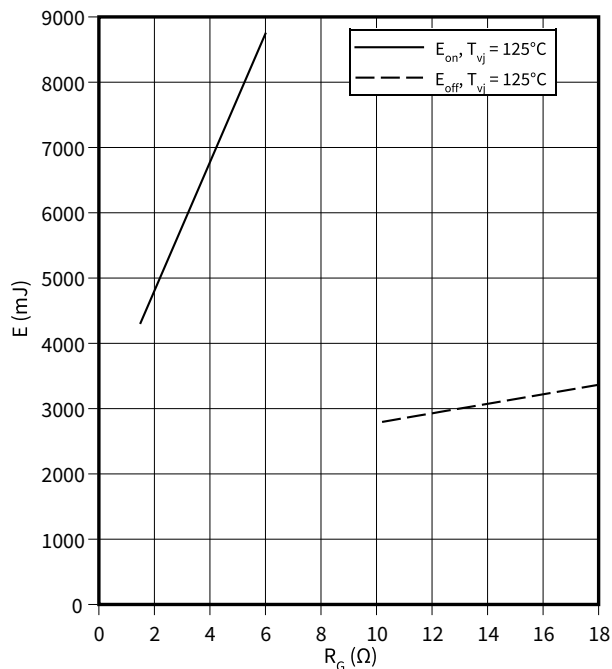
$E = f(I_C)$
 $R_{Goff} = 10\text{ }\Omega$, $R_{Gon} = 1.5\text{ }\Omega$, $V_{CE} = 3600\text{ V}$, $V_{GE} = \pm 15\text{ V}$



5 Characteristics diagrams

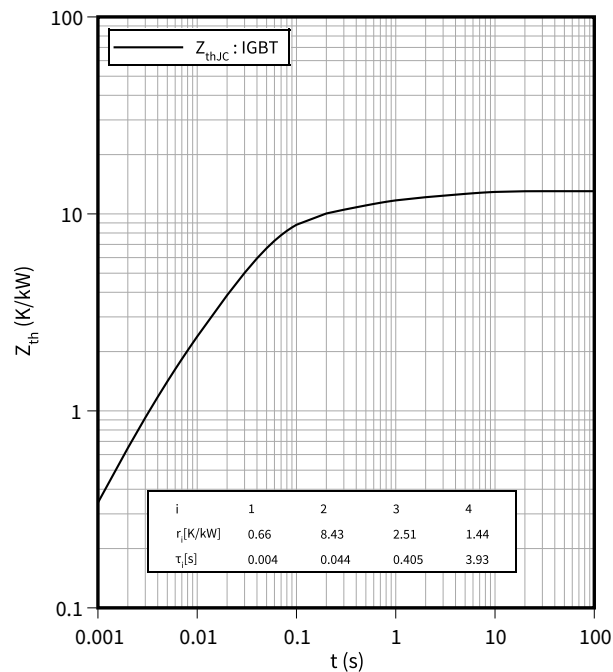
switching losses (typical), IGBT, Brake-Chopper

$E = f(R_G)$
 $I_C = 500\text{ A}$, $V_{CE} = 3600\text{ V}$, $V_{GE} = \pm 15\text{ V}$



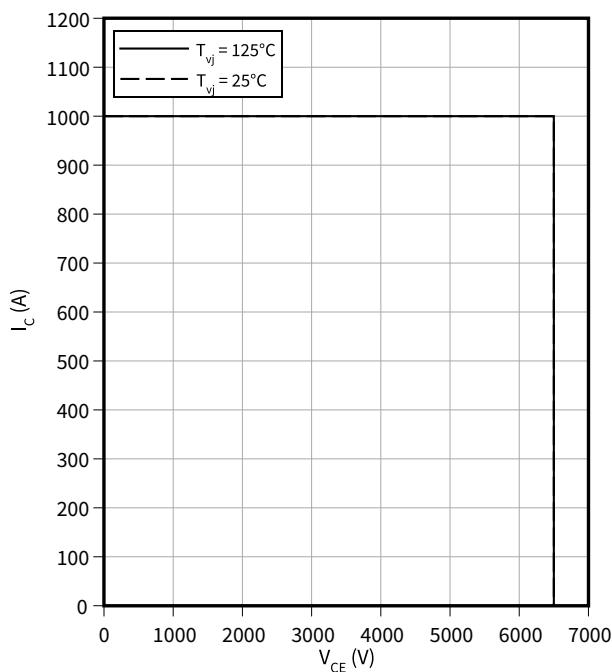
transient thermal impedance , IGBT, Brake-Chopper

$Z_{th} = f(t)$



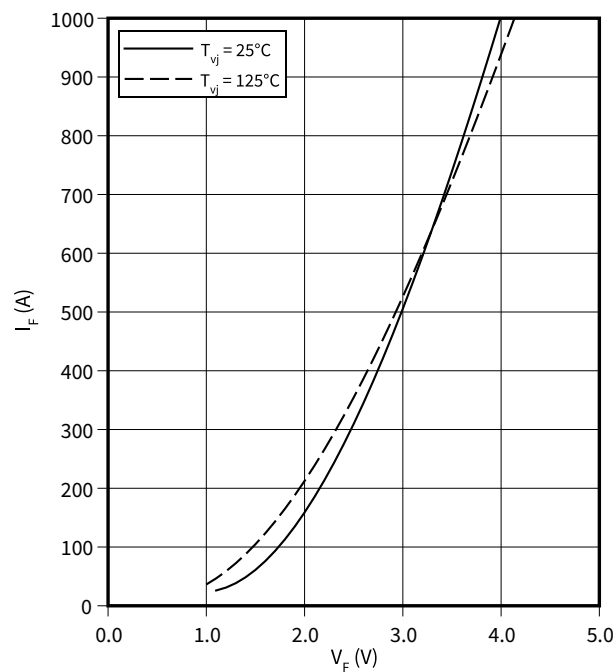
reverse bias safe operating area (RBSOA), IGBT, Brake-Chopper

$I_C = f(V_{CE})$
 $R_{Goff} = 10\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 125\ ^\circ C$



forward characteristic of (typical), Diode, Brake-Chopper

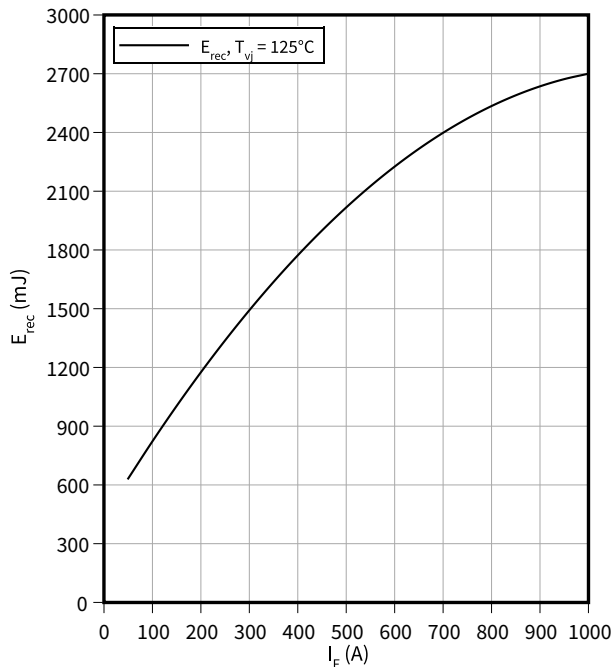
$I_F = f(V_F)$



5 Characteristics diagrams

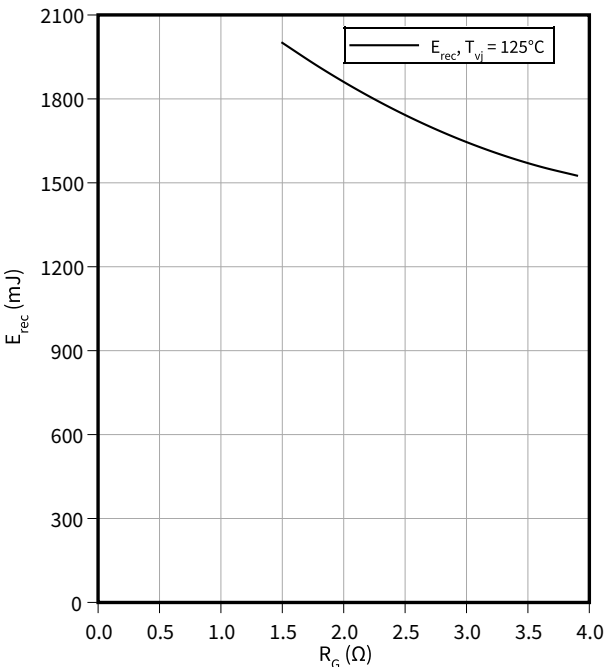
switching losses (typical), Diode, Brake-Chopper

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



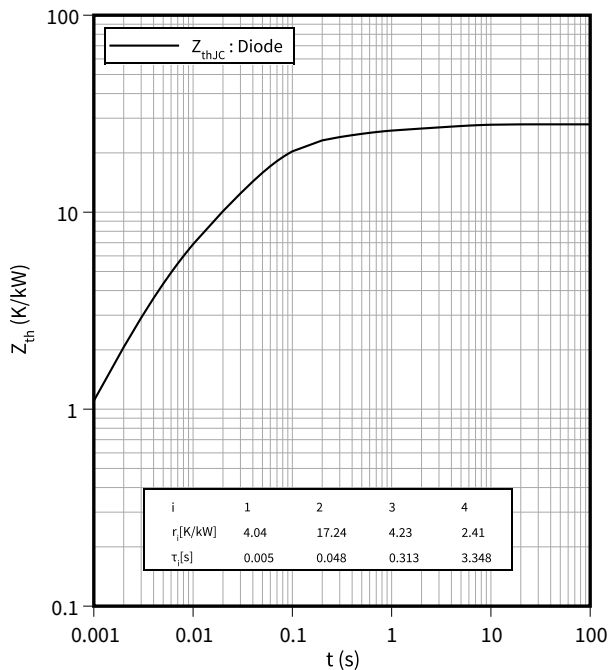
switching losses (typical), Diode, Brake-Chopper

$E_{rec} = f(R_G)$
 $V_{CE} = 3600\text{ V}, I_F = 500\text{ A}$



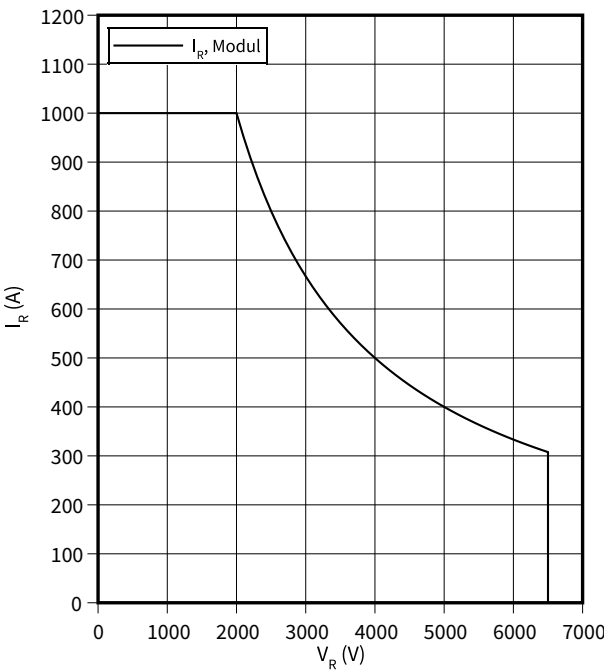
transient thermal impedance , Diode, Brake-Chopper

$Z_{th} = f(t)$



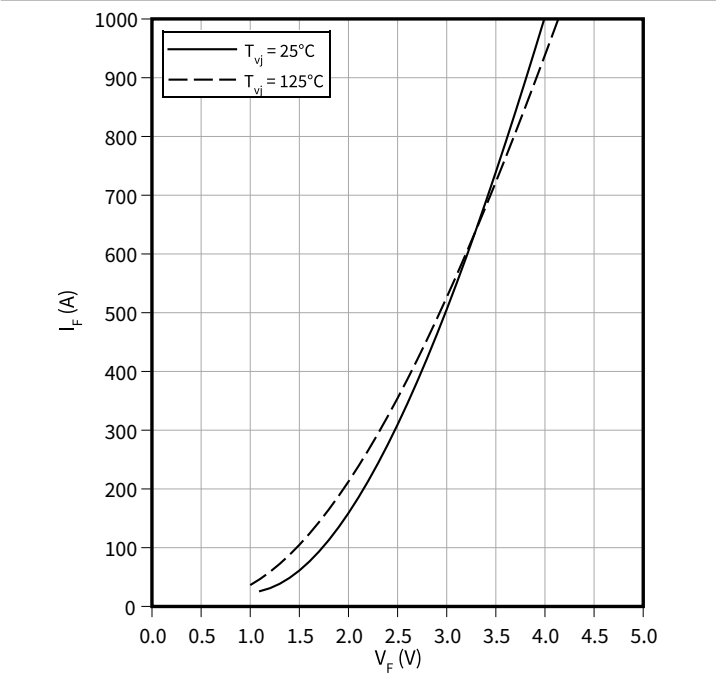
safe operation area (SOA), Diode, Brake-Chopper

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

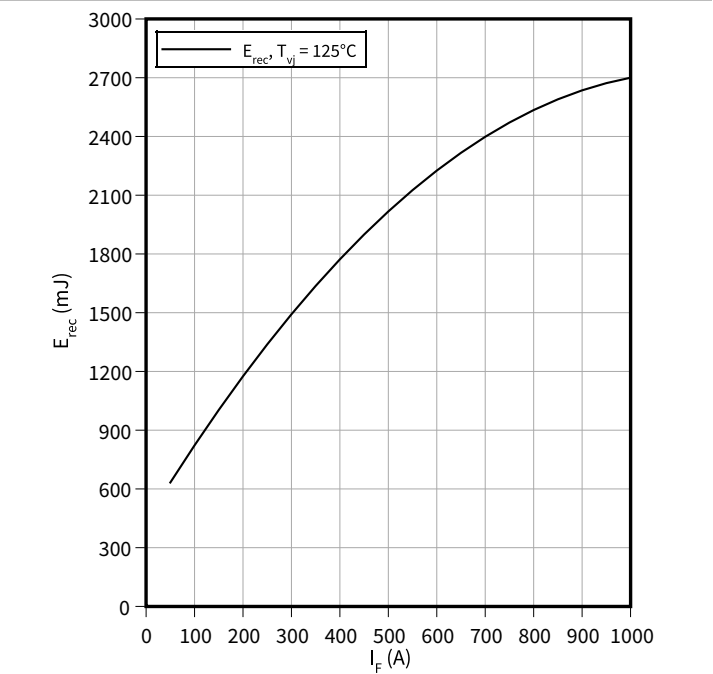


5 Characteristics diagrams

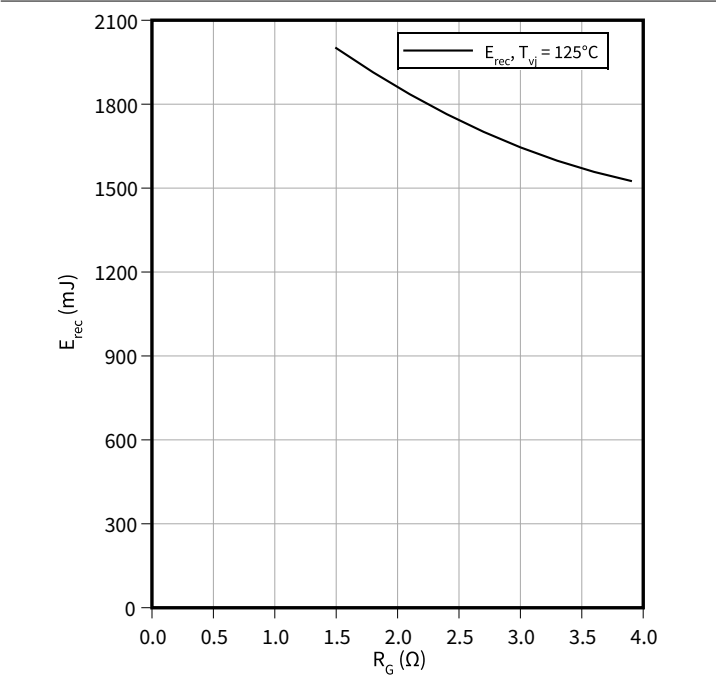
forward characteristic of (typical), Diode, Reverse
 $I_F = f(V_F)$



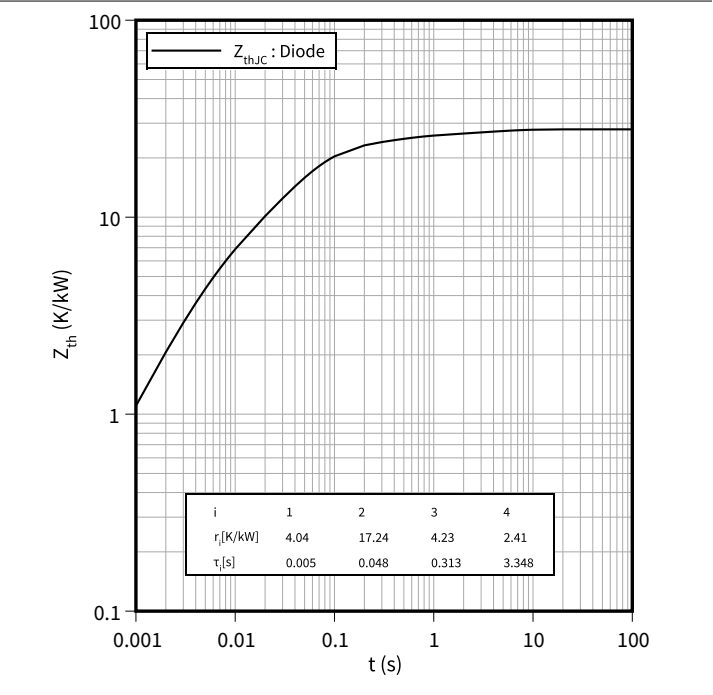
switching losses (typical), Diode, Reverse
 $E_{rec} = f(I_F)$
 $V_{CE} = 3600\text{ V}$, $R_{Gon} = R_{Gon}(IGBT)$



switching losses (typical), Diode, Reverse
 $E_{rec} = f(R_G)$
 $V_{CE} = 3600\text{ V}$, $I_F = 500\text{ A}$



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

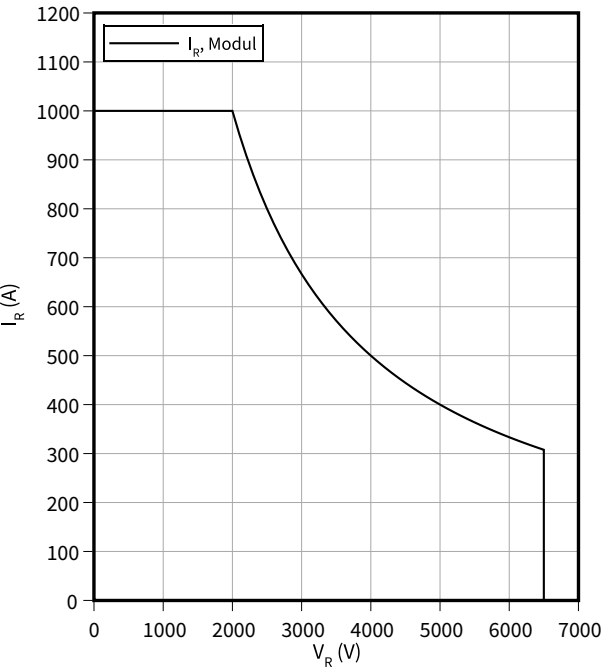


5 Characteristics diagrams

safe operation area (SOA), Diode, Reverse

$I_R = f(V_R)$

$T_{vj} = 125\text{ °C}$



6 Circuit diagram

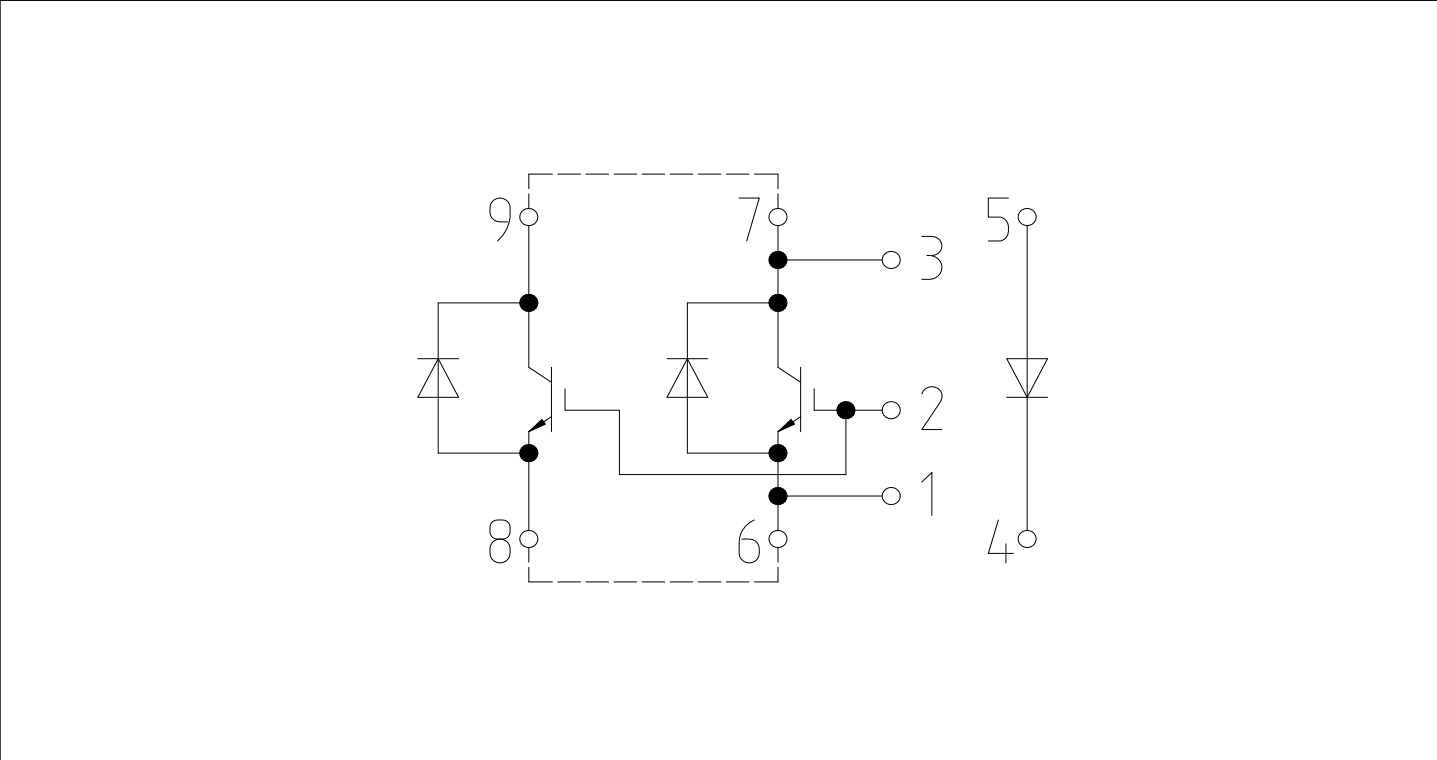


Figure 1

7 Package outlines

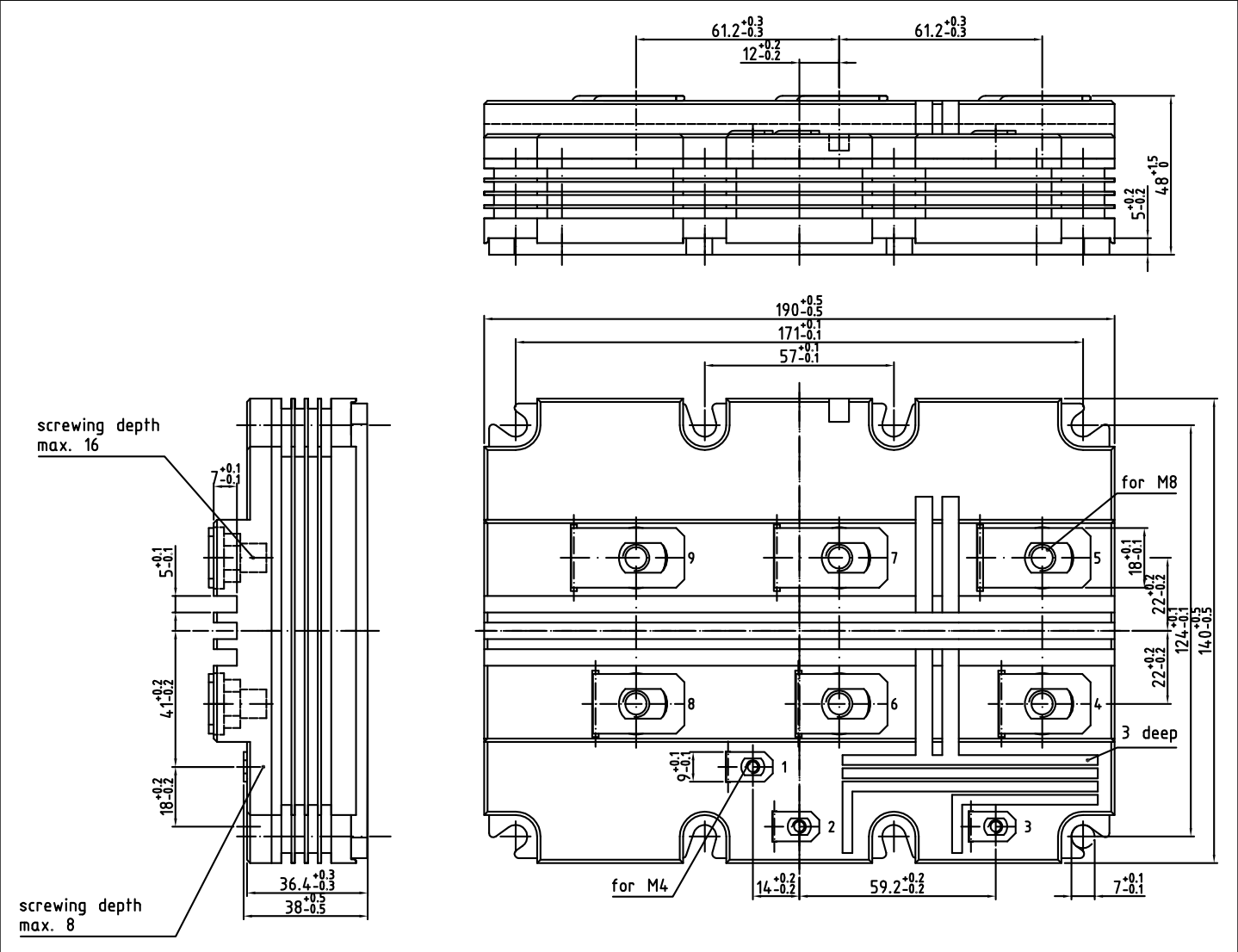


Figure 2

8 Module label code

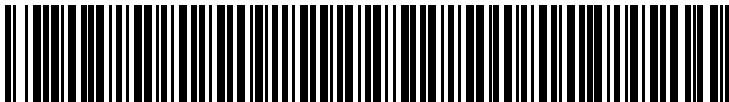
Module label code			
Code format	Data Matrix		Barcode Code128
Encoding	ASCII text		Code Set A
Symbol size	16x16		23 digits
Standard	IEC24720 and IEC16022		IEC8859-1
Code content	<i>Content</i> Module serial number Module material number Production order number Date code (production year) Date code (production week)	<i>Digit</i> 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	<i>Example</i> 71549 142846 55054991 15 30
Example	  71549142846550549911530 71549142846550549911530		

Figure 3

Revision history

Document revision	Date of release	Description of changes
V2.0	2012-08-07	Preliminary datasheet
V2.1	2013-05-07	Preliminary datasheet
V3.0	2014-06-16	Final datasheet
V3.1	2016-08-30	Final datasheet
V3.2	2018-01-15	Final datasheet
V3.3	2019-09-06	Final datasheet
V3.4	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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**Document reference
IFX-AAX227-008**

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