Final datasheet

Highly insulated module with Trench/Fieldstop IGBT4 and emitter controlled 4 diode

Features

- Electrical features
  - V_{CES} = 6500 V
  - $I_{C\,nom}$ = 1000 A / I_{CRM} = 2000 A
  - Low $V_{CE,sat}$
- Mechanical features
  - Extended storage temperature down to T_{stg} = -55 °C
  - Package with enhanced insulation of 10.4 kV AC 60 s
  - High creepage and clearance distances
  - Package with CTI > 600
  - AlSiC base plate for increased thermal cycling capability

Typical appearance

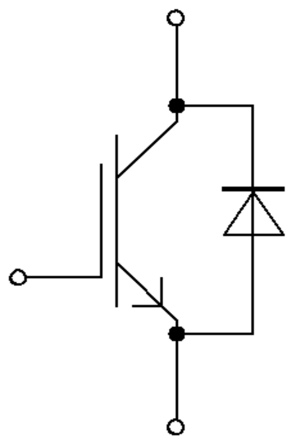
Potential applications

- Medium-voltage converters
- Traction
- Power transmission and distribution

Product validation

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

Description



Please read the sections "Important notice" and "Warnings" at the end of this document

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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	$d_{Creep\ nom}$	terminal to baseplate, nom.	64.0	mm
Creepage distance	$d_{Creep\ nom}$	terminal to terminal, nom.	56.0	mm
Clearance	$d_{Clear\ nom}$	terminal to baseplate, nom.	40.0	mm
Clearance	$d_{Clear\ nom}$	terminal to terminal, nom.	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}				18		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	T_C = 25 °C, per switch			0.12		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_C = 25 °C, per switch			0.12		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, 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} = 135 °C	6500	
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 135 °C	T_C = 100 °C	1000	A
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\,op}$		2000	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 = 1000 A, V_{GE} = 15 V	T_{vj} = 25 °C		2.85	3.25	V
			T_{vj} = 125 °C		3.55		
			T_{vj} = 135 °C		3.60	4.10	
Gate threshold voltage	V_{GEth}	I_C = 130 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.45	6.10	6.55	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CC} = 3600 V			42		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0.84		Ω
Input capacitance	C_{ies}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			245		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			4.2		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 = 1000 A, V_{CC} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 0.68 Ω	T_{vj} = 25 °C		1.110		µs
			T_{vj} = 125 °C		1.200		
			T_{vj} = 135 °C		1.220		
Rise time (inductive load)	t_r	I_C = 1000 A, V_{CC} = 3600 V, V_{GE} = ±15 V, R_{Gon} = 0.68 Ω	T_{vj} = 25 °C		0.150		µs
			T_{vj} = 125 °C		0.170		
			T_{vj} = 135 °C		0.170		
Turn-off delay time (inductive load)	t_{doff}	I_C = 1000 A, V_{CC} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 9.1 Ω	T_{vj} = 25 °C		10.200		µs
			T_{vj} = 125 °C		10.630		
			T_{vj} = 135 °C		10.690		

(table continues...)

Table 4 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Fall time (inductive load)	t_f	I_C = 1000 A, V_{CC} = 3600 V, V_{GE} = ±15 V, R_{Goff} = 9.1 Ω	T_{vj} = 25 °C		0.680		µs
			T_{vj} = 125 °C		1.680		
			T_{vj} = 135 °C		1.820		
Turn-on time (resistive load)	t_{on_R}	I_C = 500 A, V_{CC} = 2000 V, V_{GE} = ±15 V, R_{Gon} = 0.68 Ω	T_{vj} = 25 °C	2.10			µs
Turn-on energy loss per pulse	E_{on}	I_C = 1000 A, V_{CC} = 3600 V, L_σ = 150 nH, V_{GE} = ±15 V, R_{Gon} = 0.68 Ω	T_{vj} = 25 °C		5400		mJ
			T_{vj} = 125 °C		7950		
			T_{vj} = 135 °C		8350		
Turn-off energy loss per pulse	E_{off}	I_C = 1000 A, V_{CC} = 3600 V, L_σ = 150 nH, V_{GE} = ±15 V, R_{Goff} = 9.1 Ω	T_{vj} = 25 °C		5550		mJ
			T_{vj} = 125 °C		6750		
			T_{vj} = 135 °C		6900		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 4500 V, $V_{CEmax}=V_{CES}-L_{sCE}*di/dt$	t_P ≤ 10 µs, T_{vj}=135 °C		4900		A
Thermal resistance, junction to case	R_{thJC}	per IGBT				7.70	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, λ_{grease} = 1 W/(m·K)			3.60		K/kW
Temperature under switching conditions	$T_{vj\,op}$			-50		135	°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} = 135 °C	6500	
Continuous DC forward current	I_F			1000	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		2000	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	760	kA^2s
			T_{vj} = 135 °C	720	
Maximum power dissipation	P_{RQM}		T_{vj} = 135 °C	3600	kW
Minimum turn-on time	t_{onmin}			10	µs

Table 6 Characteristic values

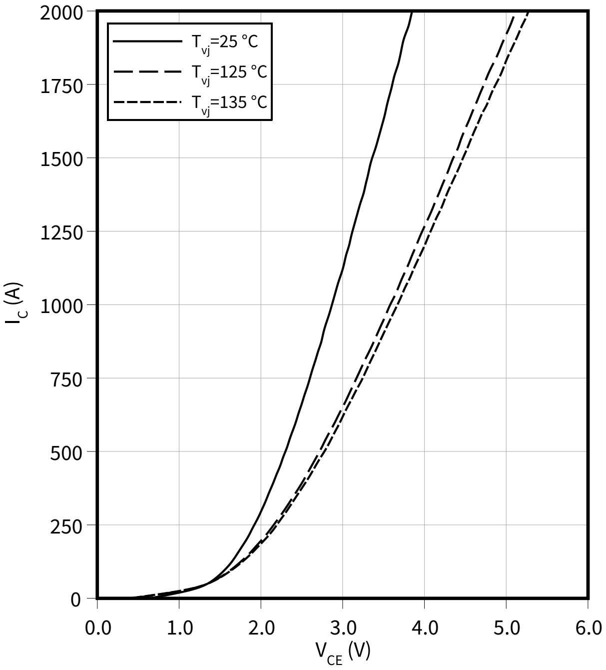
Parameter	Symbol	Note or test condition		Values Min.	Typ.	Max.	Unit
Forward voltage	V_F	I_F = 1000 A, V_{GE} = 0 V	T_{vj} = 25 °C		2.65	3.20	V
			T_{vj} = 125 °C		2.45		
			T_{vj} = 135 °C		2.40	2.95	
Peak reverse recovery current	I_{RM}	V_{CC} = 3600 V, I_F = 1000 A, V_{GE} = -15 V, -di_F/dt = 1000 A/µs (T_{vj} = 135 °C)	T_{vj} = 25 °C		1800		A
			T_{vj} = 125 °C		1850		
			T_{vj} = 135 °C		1850		
Recovered charge	Q_r	V_{CC} = 3600 V, I_F = 1000 A, V_{GE} = -15 V, -di_F/dt = 1000 A/µs (T_{vj} = 135 °C)	T_{vj} = 25 °C		1300		µC
			T_{vj} = 125 °C		2550		
			T_{vj} = 135 °C		2700		
Reverse recovery energy	E_{rec}	V_{CC} = 3600 V, I_F = 1000 A, V_{GE} = -15 V, -di_F/dt = 1000 A/µs (T_{vj} = 135 °C)	T_{vj} = 25 °C		2600		mJ
			T_{vj} = 125 °C		5600		
			T_{vj} = 135 °C		5950		
Thermal resistance, junction to case	R_{thJC}	per diode				12.8	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode, λ_{grease} = 1 W/(m·K)			6.80		K/kW
Temperature under switching conditions	$T_{vj\,op}$			-50		135	°C

4 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

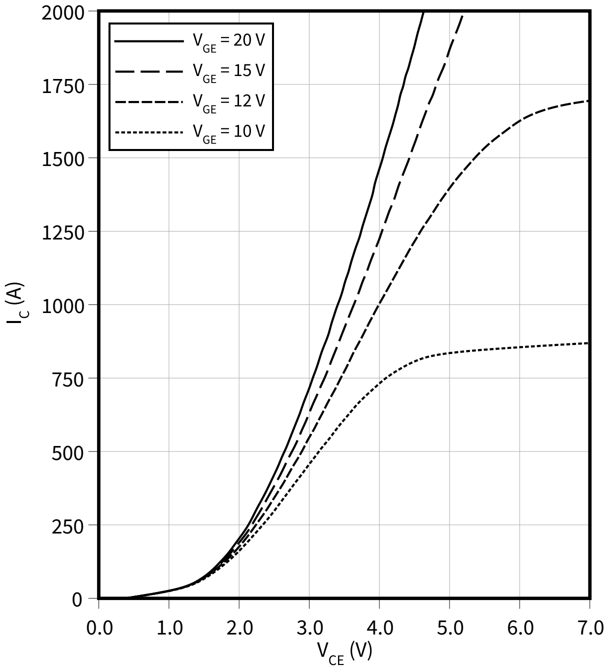
$V_{GE} = 15$ V



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

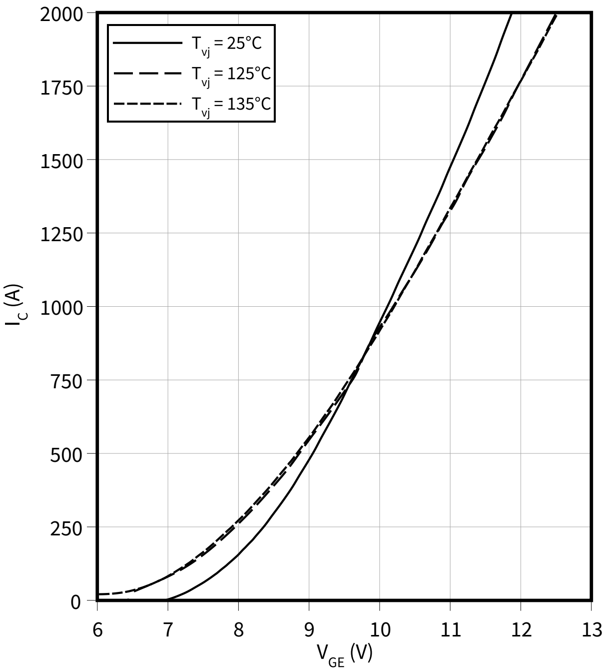
$T_{vj} = 135$ °C



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

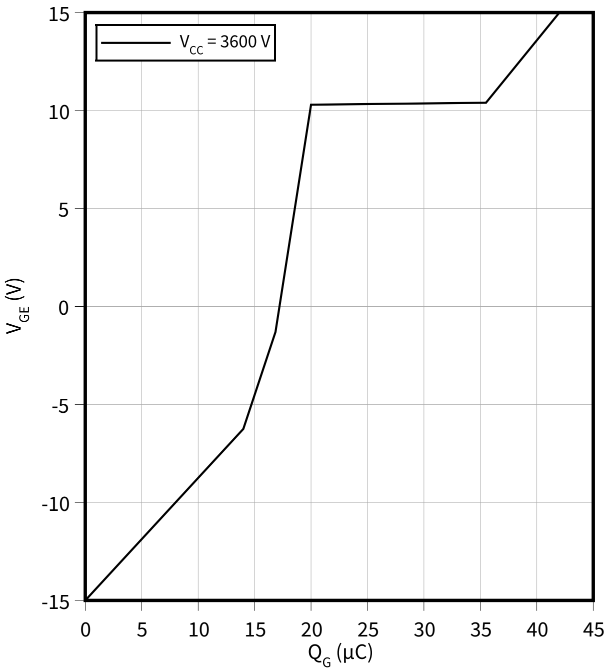
$V_{CE} = 20$ V



Gate charge characteristic (typical), IGBT, Inverter

$V_{GE} = f(Q_G)$

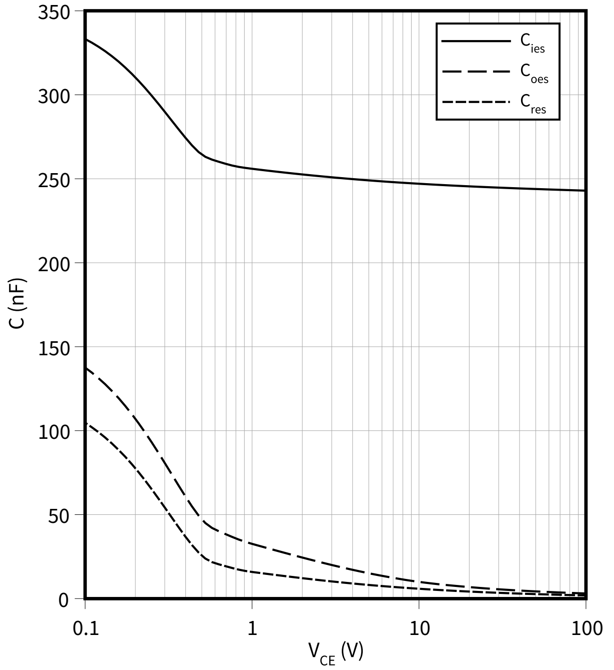
$I_C = 1000$ A, $T_{vj} = 25$ °C



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

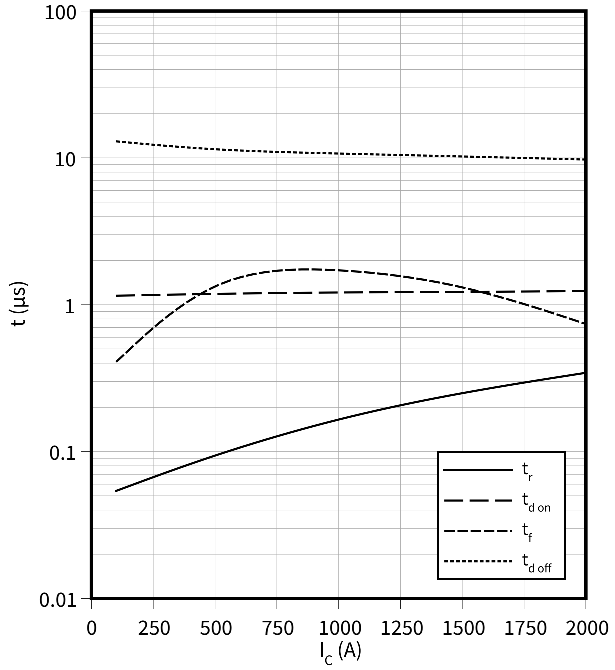
$f = 100$ kHz, $V_{GE} = 0$ V, $T_{vj} = 25$ °C



Switching times (typical), IGBT, Inverter

$t = f(I_C)$

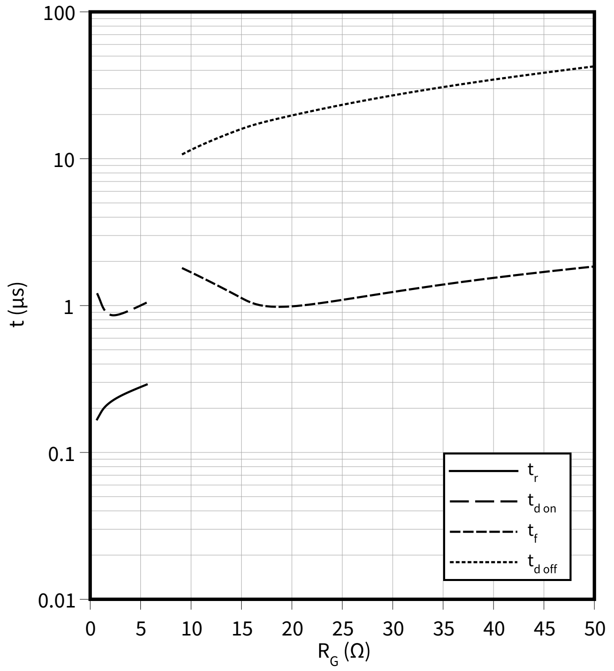
$R_{Goff} = 9.1\ \Omega$, $R_{Gon} = 0.68\ \Omega$, $V_{GE} = \pm15$ V, $V_{CC} = 3600$ V, $T_{vj} =$ 135 °C



Switching times (typical), IGBT, Inverter

$t = f(R_G)$

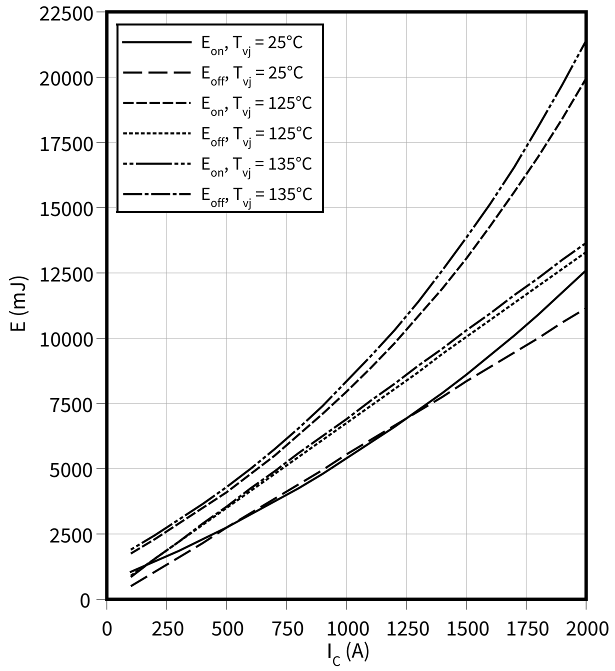
$V_{GE} = \pm15$ V, $I_C = 1000$ A, $V_{CC} = 3600$ V, $T_{vj} = 135$ °C



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

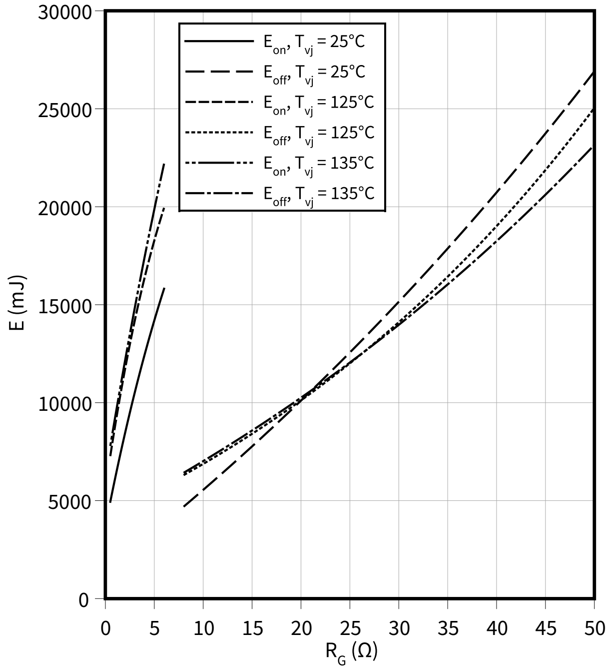
$R_{Goff} = 9.1\ \Omega$, $R_{Gon} = 0.68\ \Omega$, $V_{CC} = 3600$ V, $V_{GE} = \pm 15$ V



Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

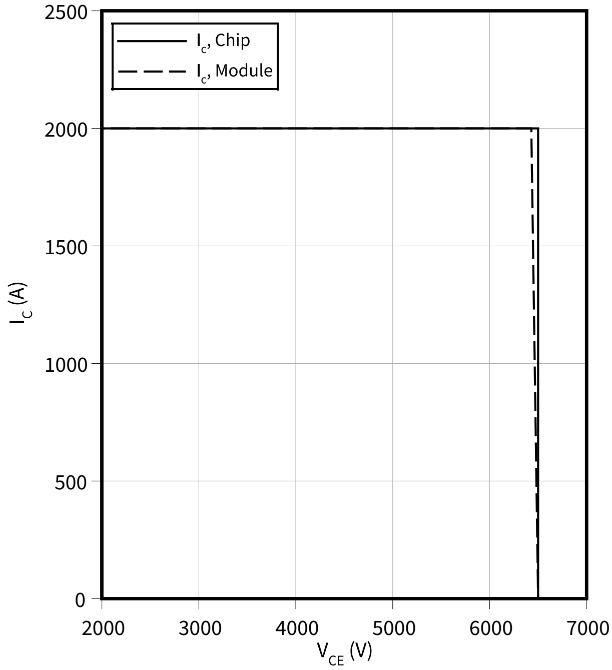
I_C = 1000 A, V_{CC} = 3600 V, V_{GE} = ± 15 V



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

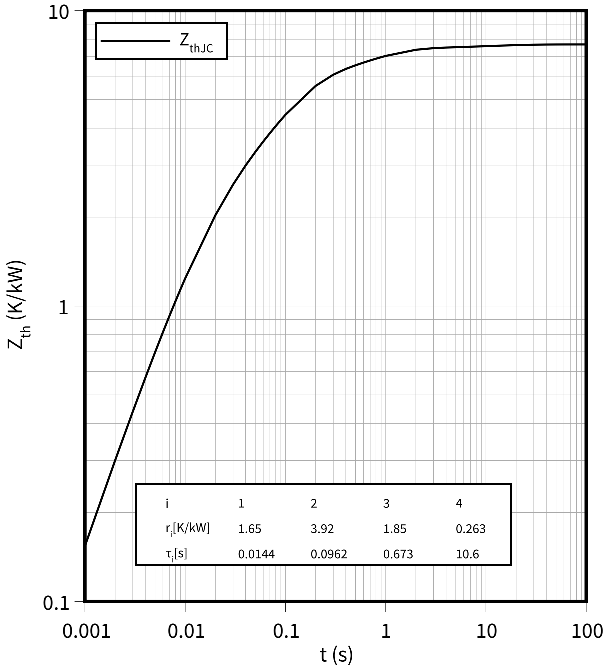
$I_C = f(V_{CE})$

R_{Goff} ≥ 9.1 Ω, V_{GE} = ±15 V, T_{vj} = 135 °C



Transient thermal impedance, IGBT, Inverter

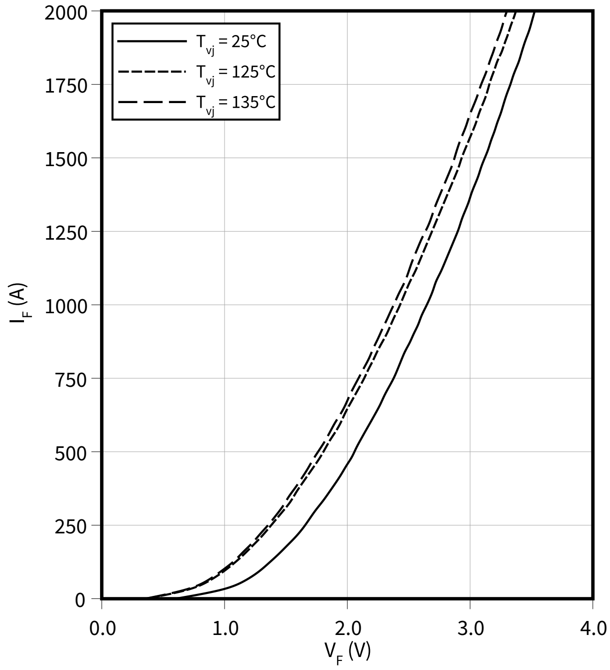
$Z_{th} = f(t)$



i	1	2	3	4
r_i[K/kW]	1.65	3.92	1.85	0.263
τ_i[s]	0.0144	0.0962	0.673	10.6

Forward characteristic (typical), Diode, Inverter

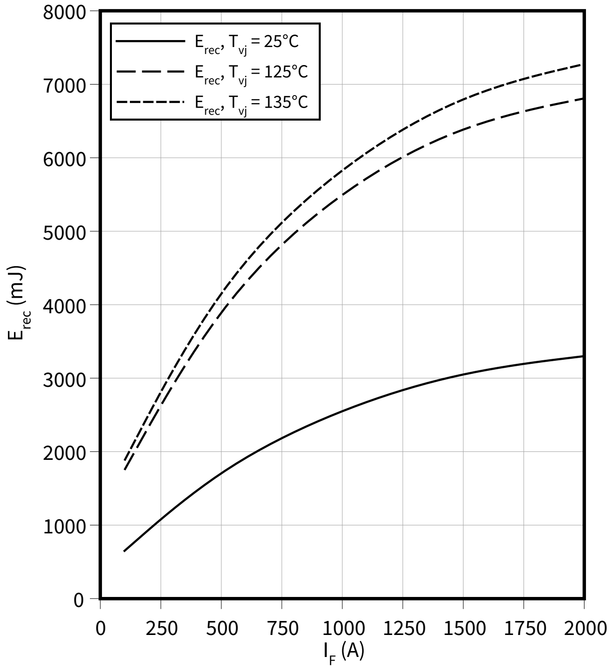
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

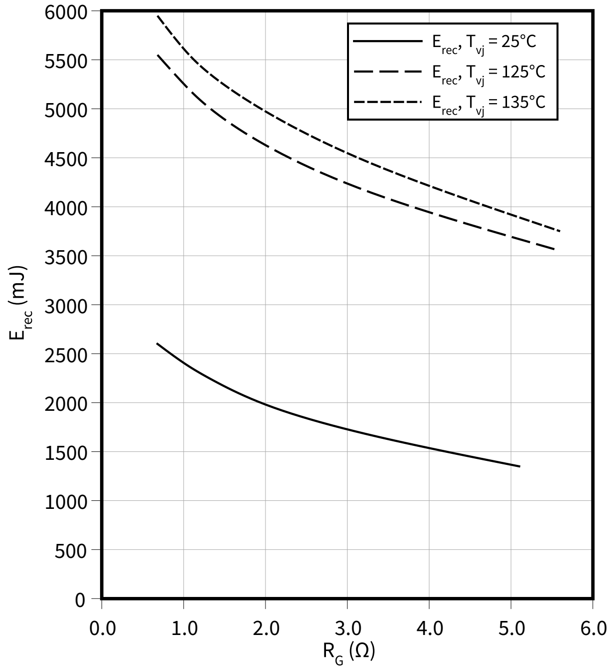
$R_{Gon} = R_{Gon}(IGBT)$, $V_{CC} = 3600$ V



Switching losses (typical), Diode, Inverter

$E_{rec} = f(R_G)$

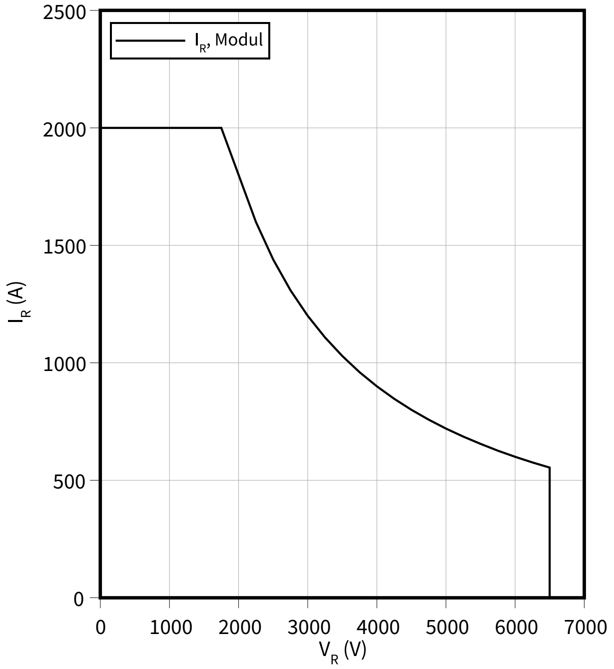
$I_F = 1000$ A, $V_{CC} = 3600$ V



Safe operating area (SOA), Diode, Inverter

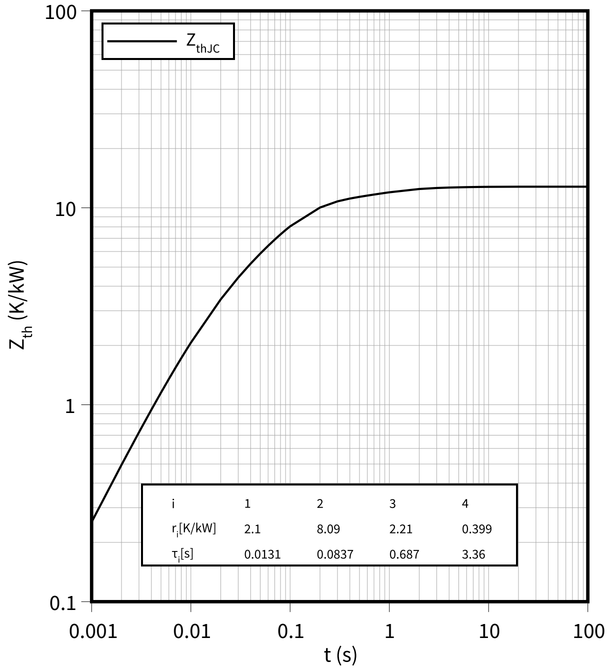
$I_R = f(V_R)$

$T_{vj} = 135$ °C



Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



i	1	2	3	4
r_i[K/kW]	2.1	8.09	2.21	0.399
τ_i[s]	0.0131	0.0837	0.687	3.36

5 Circuit diagram

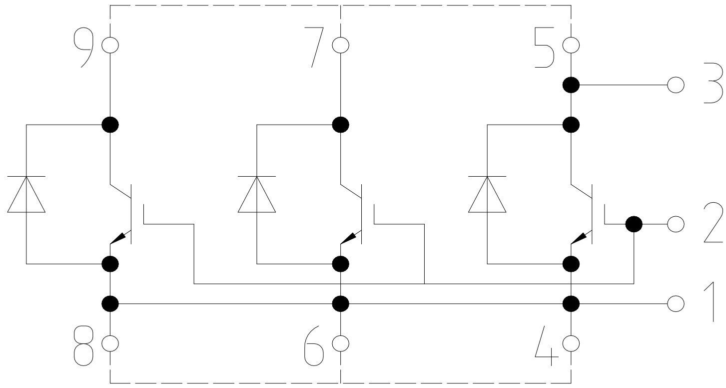


Figure 1

6 Package outlines

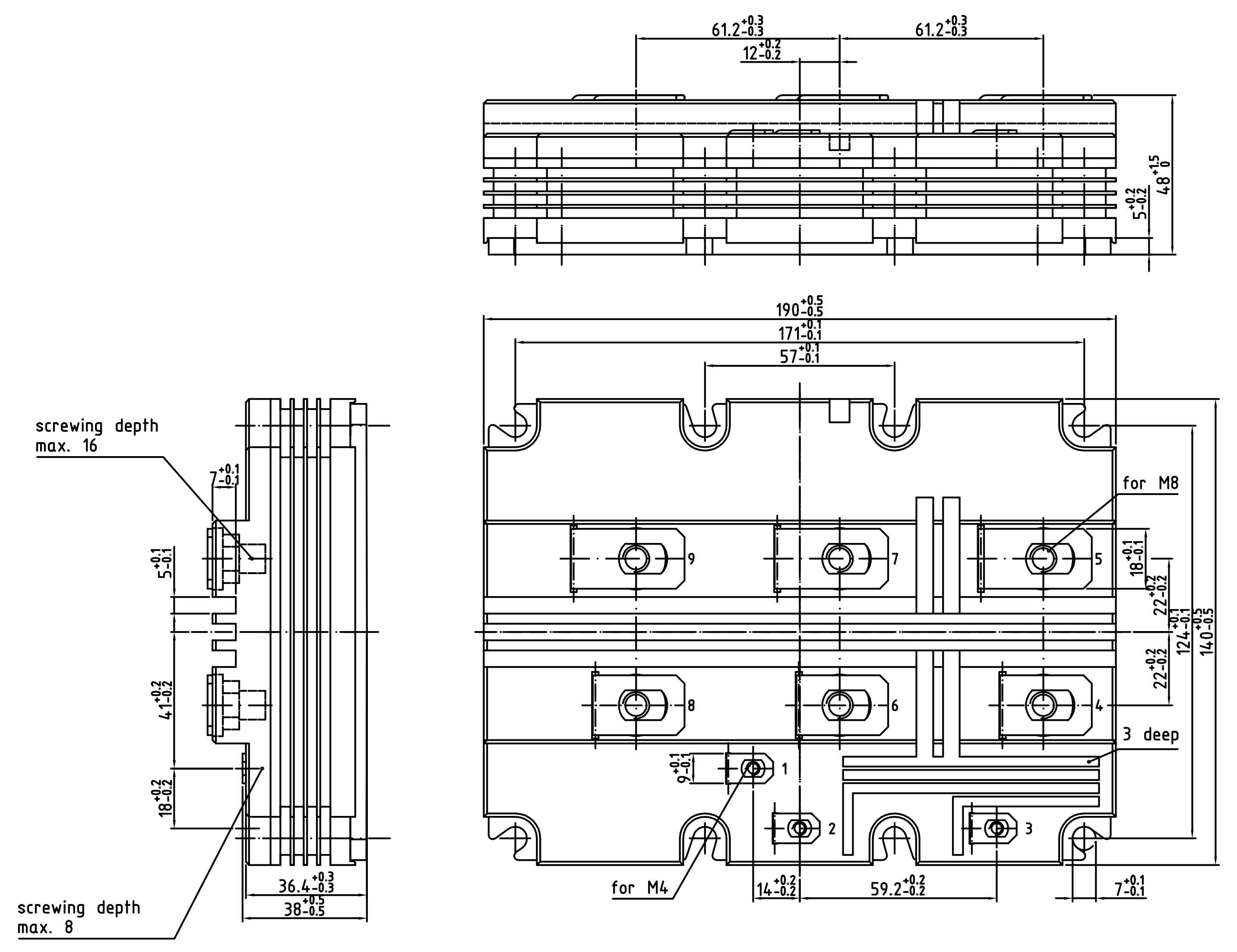


Figure 2

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*	*Digit*	*Example*
	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	2018-11-02	Target datasheet
V1.1	2018-11-07	Target 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
0.20	2022-12-22	Target datasheet
0.30	2023-03-16	Target datasheet
0.40	2023-12-04	Preliminary datasheet
1.00	2024-03-27	Final datasheet

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