

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

### Features

- Electrical features
  - $V_{CES} = 4500\text{ V}$
  - $I_{C\text{nom}} = 1000\text{ A} / I_{CRM} = 2000\text{ A}$
  - High DC stability
  - High dynamic robustness
  - High short-circuit capability
  - Low  $V_{CE,sat}$
  - Trench IGBT 3
  - $V_{CE,sat}$  with positive temperature coefficient
- Mechanical features
  - ALSiC base plate for increased thermal cycling capability
  - High creepage and clearance distances
  - Isolated base plate
  - Package with CTI > 600
  - Package with enhanced insulation of 10.4 kV AC 60 s



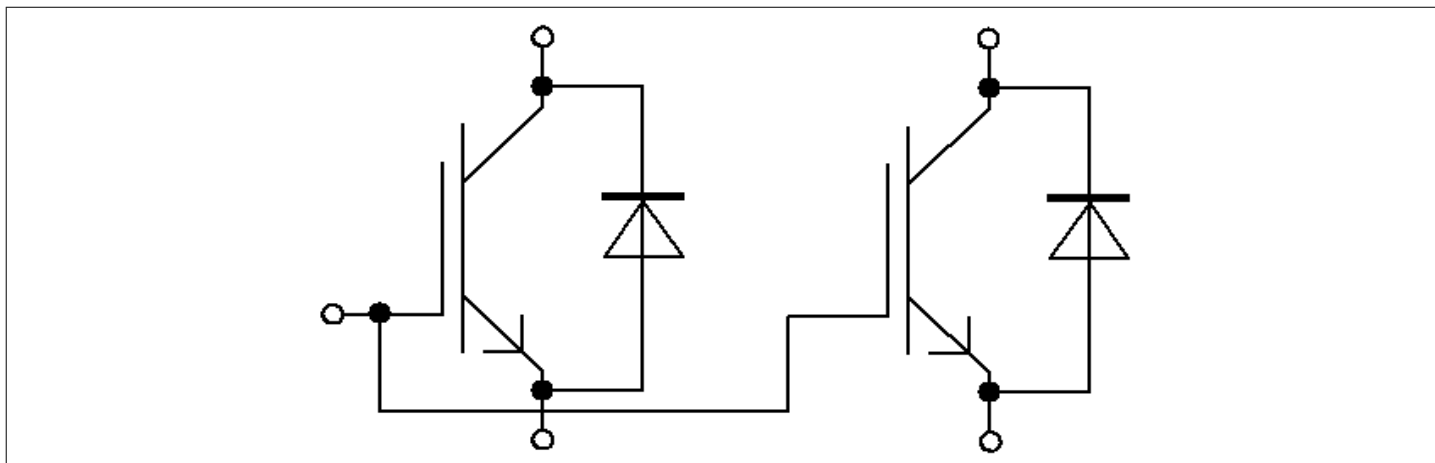
### Potential applications

- Motor drives
- Traction drives
- Multi-level inverter
- High-power converters
- 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, $f = 50 \text{ Hz}$ , $t = 60 \text{ s}$	10.4	kV
Partial discharge extinction voltage	$V_{isol}$	RMS, $f = 50 \text{ Hz}$ , $Q_{PD} \leq 10 \text{ pC}$	3.5	kV
DC stability	$V_{CE(D)}$	$T_{vj}=25^{\circ}\text{C}$ , 100 Fit	3000	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	$R_{CC'+EE'}$	$T_C=25^{\circ}\text{C}$ , 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	

Note: The maximum allowed  $dv/dt$  measured between 0,6 and  $1 \times V_{ce}$  is  $1400\text{V}/\mu\text{s}$ .

## 2 IGBT, Inverter

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	$V_{CES}$	$T_{vj} = -40^{\circ}\text{C}$	4500	V
		$T_{vj} = 25^{\circ}\text{C}$	4500	
		$T_{vj} = 125^{\circ}\text{C}$	4500	

(table continues...)  
 Datasheet

**Table 3 (continued) Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Continuous DC collector current	$I_{CDC}$	$T_{vj\ max} = 150\ ^\circ\text{C}$ $T_C = 80\ ^\circ\text{C}$	1000	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{vj\ op}$	2000	A
Gate-emitter peak voltage	$V_{GES}$		$\pm 20$	V

**Table 4 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\ sat}$	$I_C = 1000\ \text{A}, V_{GE} = 15\ \text{V}$	$T_{vj} = 25\ ^\circ\text{C}$	2.70	3.05	V
			$T_{vj} = 125\ ^\circ\text{C}$	3.25	3.85	
Gate threshold voltage	$V_{GETh}$	$I_C = 70.5\ \text{mA}, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ\text{C}$	5.40	6	6.60	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\ \text{V}, V_{CC} = 2800\ \text{V}$		26.5		$\mu\text{C}$
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\ ^\circ\text{C}$		1.1		$\Omega$
Input capacitance	$C_{ies}$	$f = 1000\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$		185		nF
Reverse transfer capacitance	$C_{res}$	$f = 1000\ \text{kHz}, T_{vj} = 25\ ^\circ\text{C}, V_{CE} = 25\ \text{V}, V_{GE} = 0\ \text{V}$		3.1		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 4500\ \text{V}, V_{GE} = 0\ \text{V}$ $T_{vj} = 25\ ^\circ\text{C}$			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)	$t_{don}$	$I_C = 1000\ \text{A}, V_{CC} = 2800\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	0.910		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	0.960		
Rise time (inductive load)	$t_r$	$I_C = 1000\ \text{A}, V_{CC} = 2800\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	0.210		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	0.230		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 1000\ \text{A}, V_{CC} = 2800\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 9.1\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	7.150		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	7.530		
Fall time (inductive load)	$t_f$	$I_C = 1000\ \text{A}, V_{CC} = 2800\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Goff} = 9.1\ \Omega$	$T_{vj} = 25\ ^\circ\text{C}$	1.100		$\mu\text{s}$
			$T_{vj} = 125\ ^\circ\text{C}$	2.120		
Turn-on time (resistive load)	$t_{on\_R}$	$I_C = 500\ \text{A}, V_{CC} = 2000\ \text{V}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1\ \Omega$	1.80			$\mu\text{s}$
Turn-on energy loss per pulse	$E_{on}$	$I_C = 1000\ \text{A}, V_{CC} = 2800\ \text{V}, L_\sigma = 95\ \text{nH}, V_{GE} = \pm 15\ \text{V}, R_{Gon} = 1\ \Omega, di/dt = 3500\ \text{A}/\mu\text{s} (T_{vj} = 125\ ^\circ\text{C})$	$T_{vj} = 25\ ^\circ\text{C}$	3700		mJ
			$T_{vj} = 125\ ^\circ\text{C}$	5400		

(table continues...)

**Table 4** (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off energy loss per pulse	$E_{off}$	$I_C = 1000\text{ A}$ , $V_{CC} = 2800\text{ V}$ , $L_\sigma = 95\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{Goff} = 9.1\ \Omega$ , $dv/dt = 1300\text{ V}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	3800		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	5000		
SC data	$I_{SC}$	$V_{GE} \leq 15\text{ V}$ , $V_{CC} = 2800\text{ V}$ , $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_p \leq 10\ \mu\text{s}$ , $T_{vj} \leq 125\text{ }^\circ\text{C}$	4600		A
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			11.1	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{K})$		13.5		K/kW
Temperature under switching conditions	$T_{vjop}$		-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	$V_{RRM}$		$T_{vj} = -40\text{ }^\circ\text{C}$	4500	V
			$T_{vj} = 25\text{ }^\circ\text{C}$	4500	
			$T_{vj} = 125\text{ }^\circ\text{C}$	4500	
Continuous DC forward current	$I_F$		1000	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	2000	A	
$I^2t$ - value	$I^2t$	$t_p = 10\text{ ms}$ , $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^\circ\text{C}$	255	$\text{kA}^2\text{s}$
Maximum power dissipation	$P_{RQM}$		$T_{vj} = 125\text{ }^\circ\text{C}$	1600	kW
Minimum turn-on time	$t_{onmin}$		10	$\mu\text{s}$	

**Table 6** **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$I_F = 1000\text{ A}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	2.80	3.40	V
			$T_{vj} = 125\text{ }^\circ\text{C}$	2.70	3.20	
Peak reverse recovery current	$I_{RM}$	$V_{CC} = 2800\text{ V}$ , $I_F = 1000\text{ A}$ , $V_{GE} = -15\text{ V}$ , $-di_F/dt = 3500\text{ A}/\mu\text{s}$ ( $T_{vj} = 125\text{ }^\circ\text{C}$ )	$T_{vj} = 25\text{ }^\circ\text{C}$	1030		A
			$T_{vj} = 125\text{ }^\circ\text{C}$	1100		

(table continues...)

**Table 6 (continued) Characteristic values**

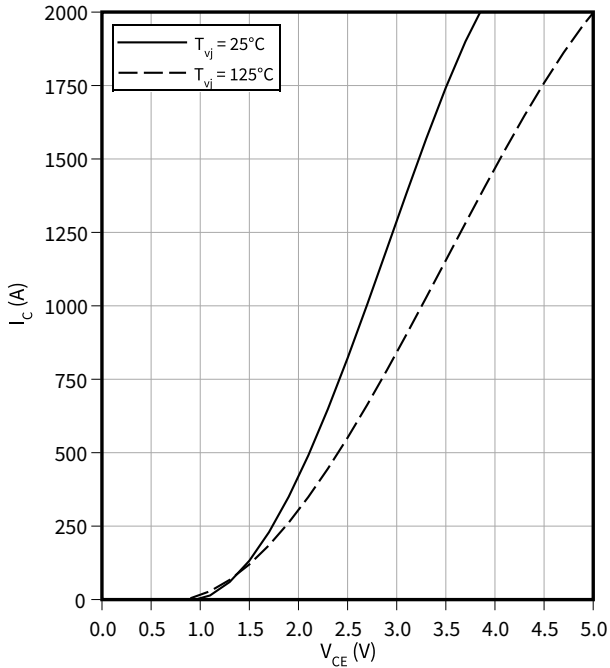
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Recovered charge	$Q_r$	$V_{CC} = 2800 \text{ V}$ , $I_F = 1000 \text{ A}$ , $V_{GE} = -15 \text{ V}$ , $-di_F/dt =$ $3500 \text{ A}/\mu\text{s}$ ( $T_{vj} = 125 \text{ }^\circ\text{C}$ )	$T_{vj} = 25 \text{ }^\circ\text{C}$		860	$\mu\text{C}$
			$T_{vj} = 125 \text{ }^\circ\text{C}$		1700	
Reverse recovery energy	$E_{rec}$	$V_{CC} = 2800 \text{ V}$ , $I_F = 1000 \text{ A}$ , $V_{GE} = -15 \text{ V}$ , $-di_F/dt =$ $3500 \text{ A}/\mu\text{s}$ ( $T_{vj} = 125 \text{ }^\circ\text{C}$ )	$T_{vj} = 25 \text{ }^\circ\text{C}$		1300	mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$		2800	
Thermal resistance, junction to case	$R_{thJC}$	per diode			25.5	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot\text{K})$		21.0		K/kW
Temperature under switching conditions	$T_{vjop}$		-50		125	$^\circ\text{C}$

## 4 Characteristics diagrams

**Output characteristic (typical), IGBT, Inverter**

$$I_C = f(V_{CE})$$

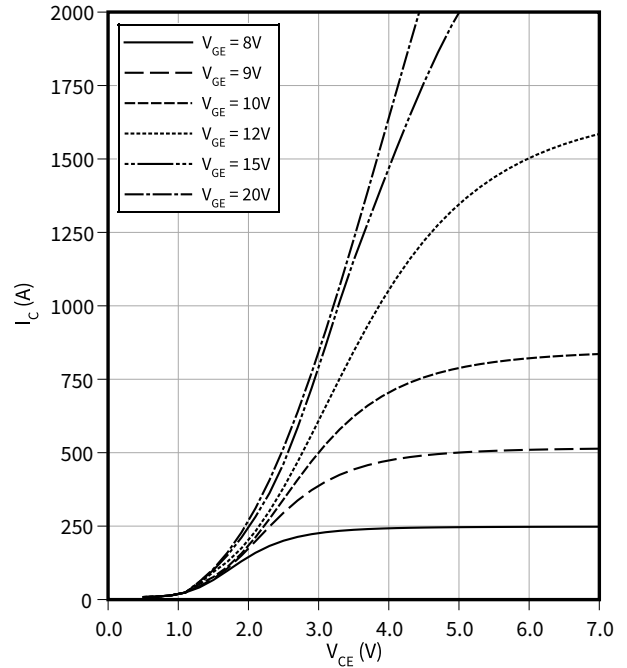
$$V_{GE} = 15 \text{ V}$$



**Output characteristic field (typical), IGBT, Inverter**

$$I_C = f(V_{CE})$$

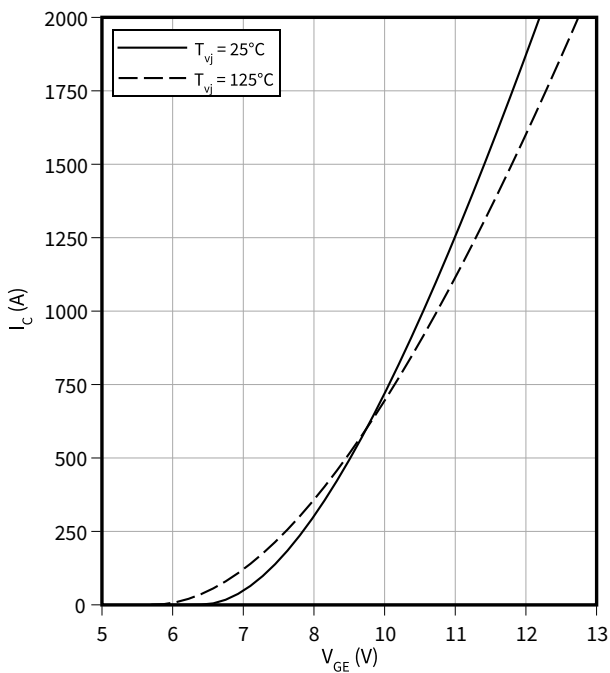
$$T_{vj} = 125 \text{ °C}$$



**Transfer characteristic (typical), IGBT, Inverter**

$$I_C = f(V_{GE})$$

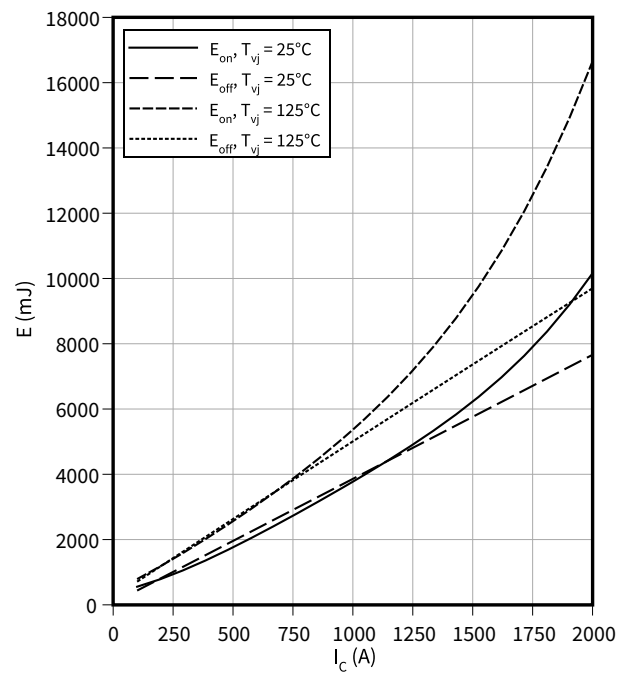
$$V_{CE} = 20 \text{ V}$$



**Switching losses (typical), IGBT, Inverter**

$$E = f(I_C)$$

$$R_{Goff} = 9,1 \text{ } \Omega, R_{Gon} = 1 \text{ } \Omega, V_{CC} = 2800 \text{ V}, V_{GE} = \pm 15 \text{ V}$$

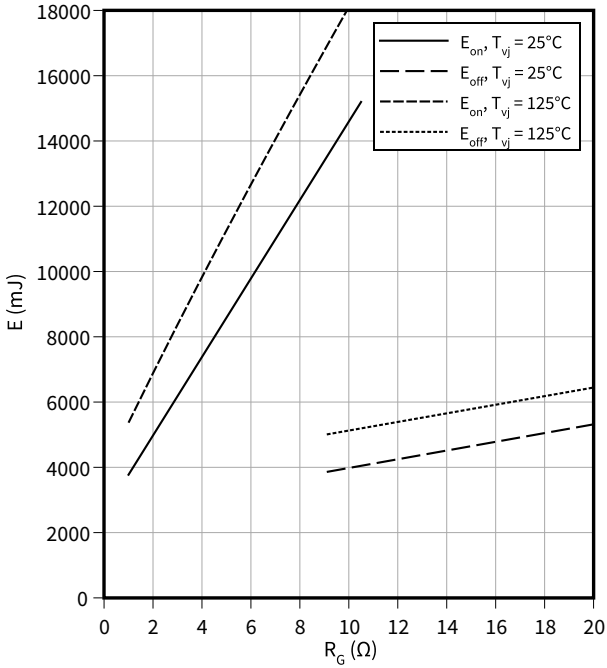


4 Characteristics diagrams

**Switching losses (typical), IGBT, Inverter**

$E = f(R_G)$

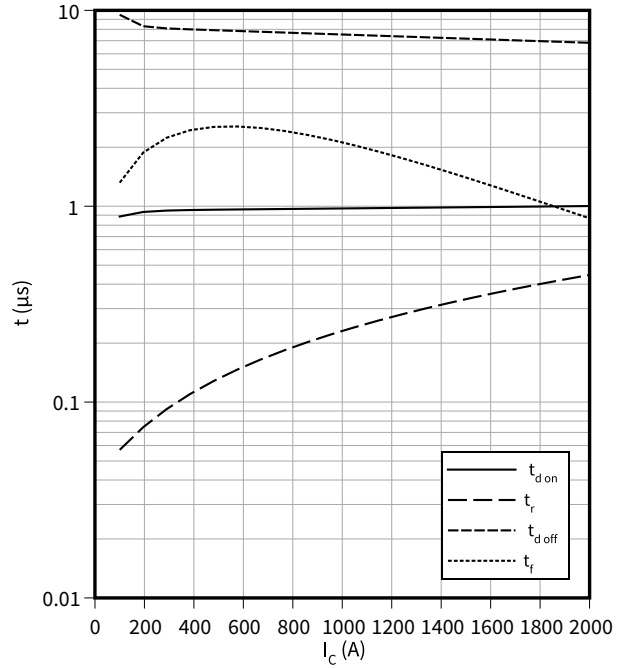
$I_C = 1000 \text{ A}$ ,  $V_{CC} = 2800 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$



**Switching times (typical), IGBT, Inverter**

$t = f(I_C)$

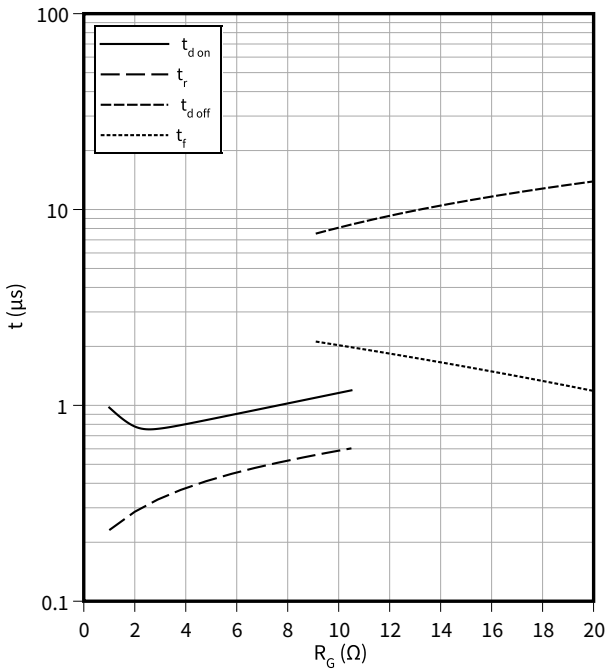
$R_{Goff} = 9.1 \Omega$ ,  $R_{Gon} = 1 \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $V_{CC} = 2800 \text{ V}$ ,  $T_{vj} = 125 \text{ °C}$



**Switching times (typical), IGBT, Inverter**

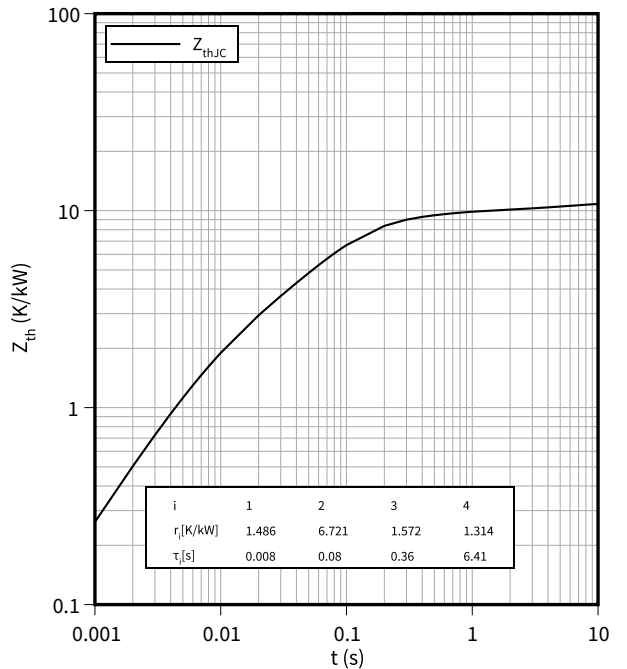
$t = f(R_G)$

$V_{GE} = \pm 15 \text{ V}$ ,  $I_C = 1000 \text{ A}$ ,  $V_{CC} = 2800 \text{ V}$ ,  $T_{vj} = 125 \text{ °C}$



**Transient thermal impedance , IGBT, Inverter**

$Z_{th} = f(t)$



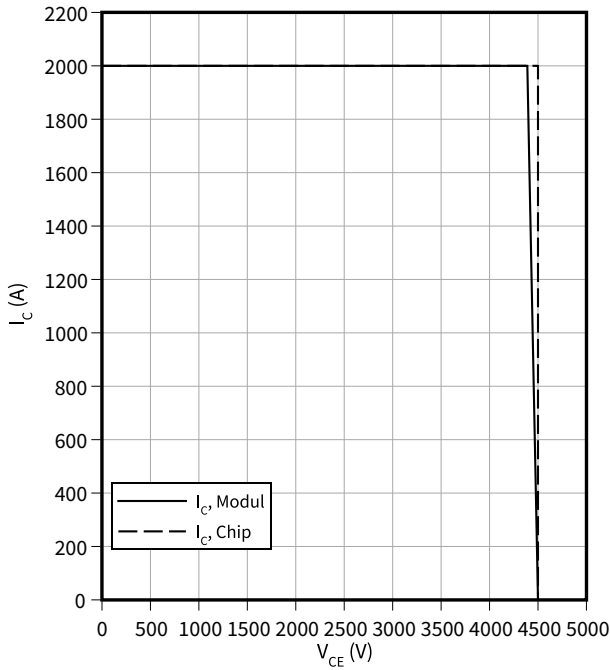


4 Characteristics diagrams

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

$I_C = f(V_{CE})$

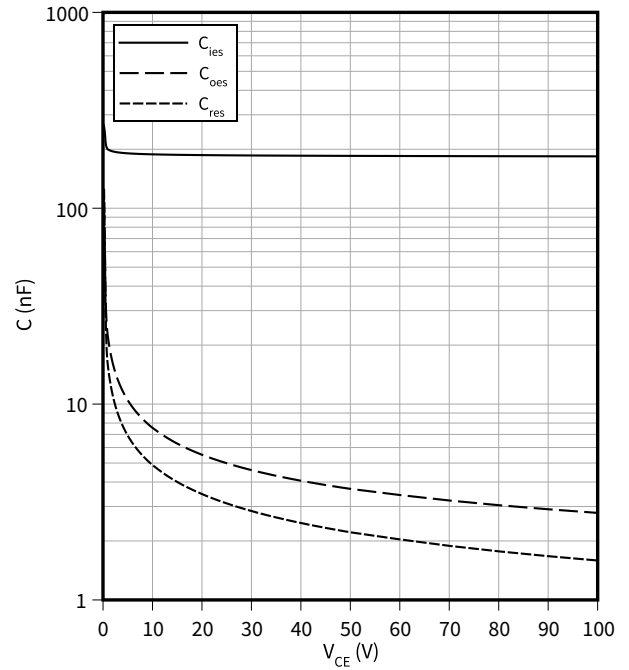
$R_{Goff} = 9.1 \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $T_{vj} = 125 \text{ }^\circ\text{C}$



**Capacity characteristic (typical), IGBT, Inverter**

$C = f(V_{CE})$

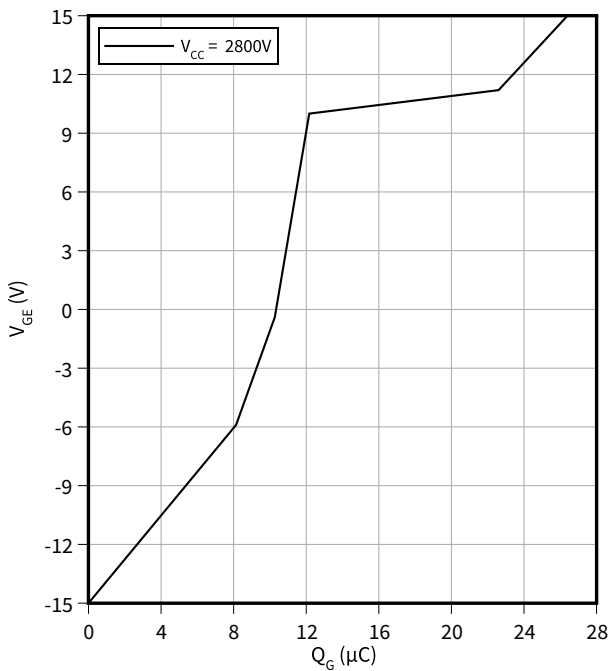
$f = 1000 \text{ kHz}$ ,  $V_{GE} = 0 \text{ V}$ ,  $T_{vj} = 25 \text{ }^\circ\text{C}$



**Gate charge characteristic (typical), IGBT, Inverter**

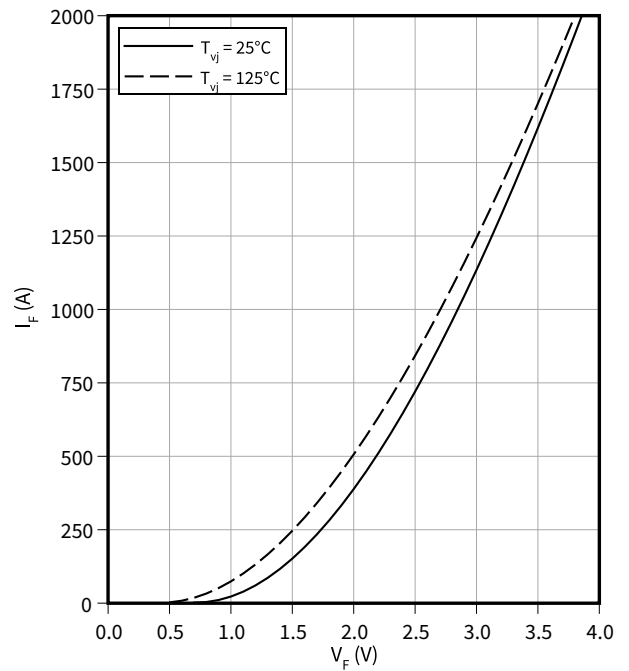
$V_{GE} = f(Q_G)$

$I_C = 1000 \text{ A}$ ,  $T_{vj} = 25 \text{ }^\circ\text{C}$



**Forward characteristic (typical), Diode, Inverter**

$I_F = f(V_F)$

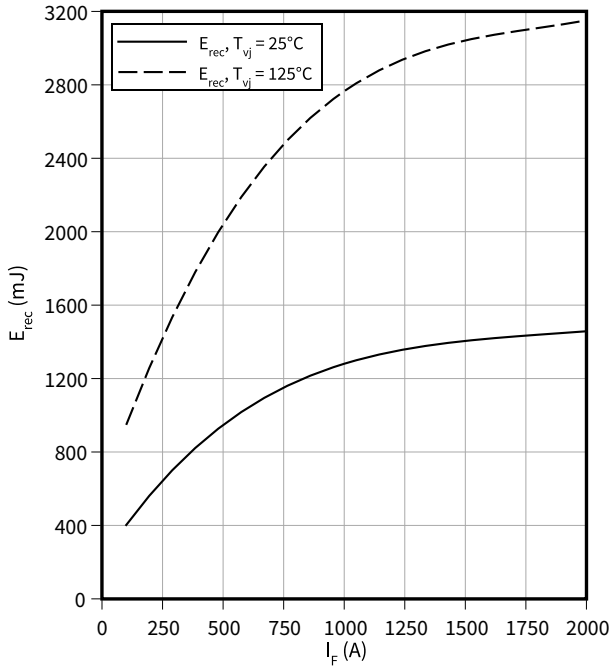


4 Characteristics diagrams

**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(I_F)$

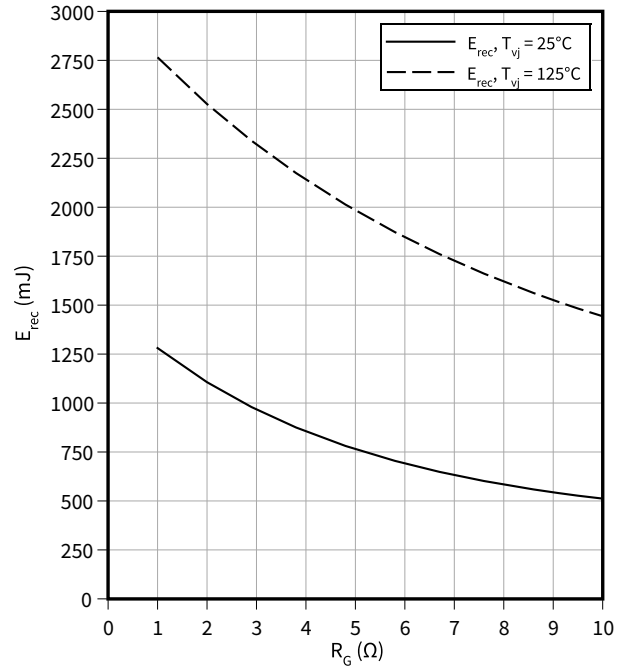
$R_{Gon} = R_{Gon}(IGBT), V_{CC} = 2800 V$



**Switching losses (typical), Diode, Inverter**

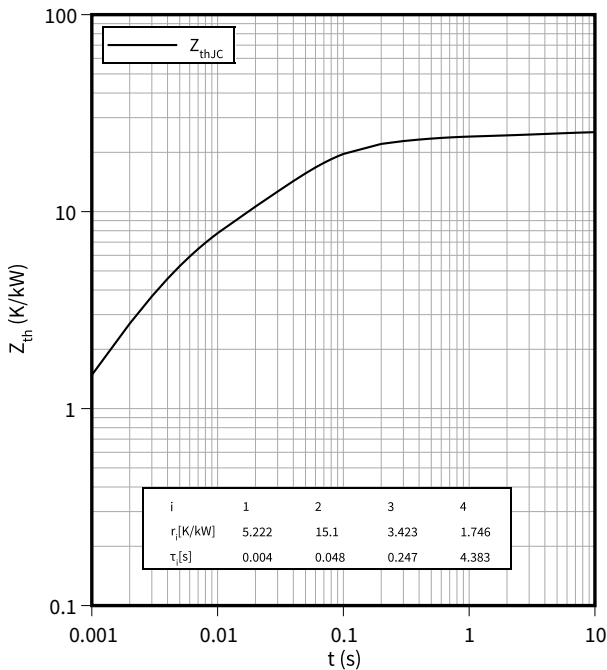
$E_{rec} = f(R_G)$

$I_F = 1000 A, V_{CC} = 2800 V$



**Transient thermal impedance, Diode, Inverter**

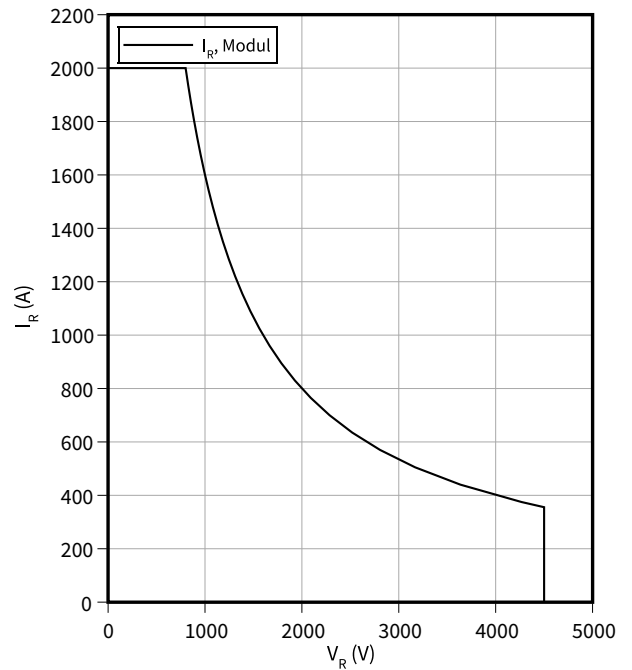
$Z_{th} = f(t)$



**Safe operating area (SOA), Diode, Inverter**

$I_R = f(V_R)$

$T_{vj} = 125 \text{ }^\circ\text{C}$



## 5 Circuit diagram

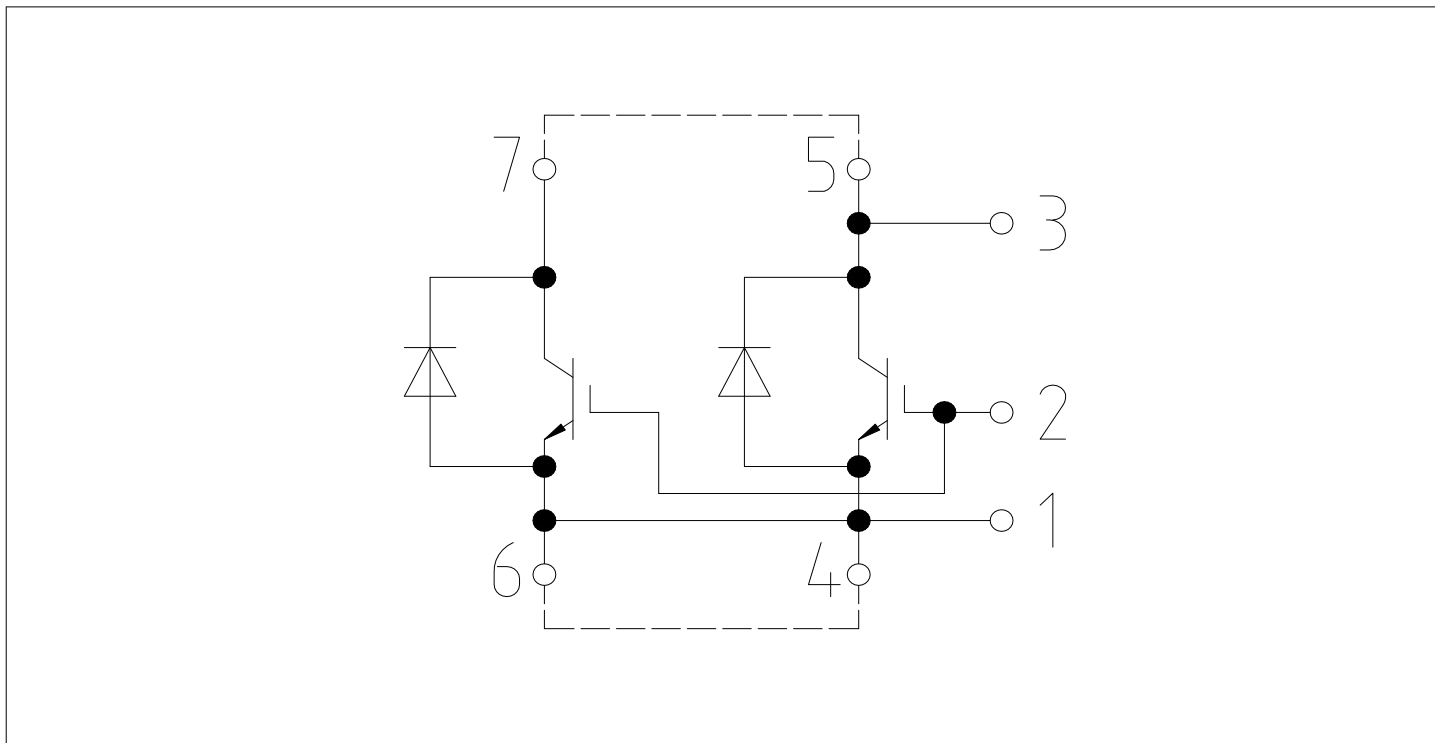


Figure 1

6 Package outlines

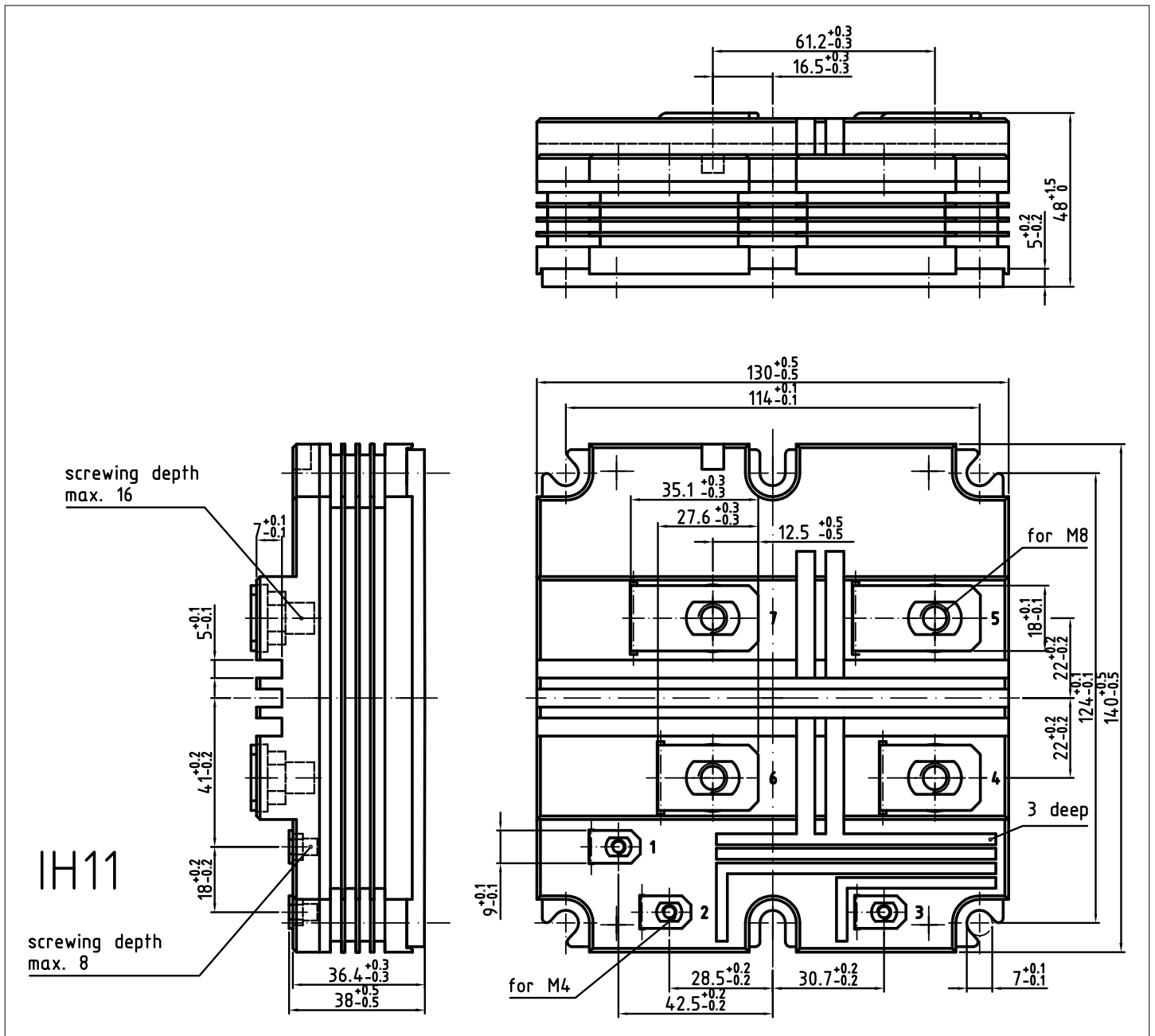


Figure 2

## 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> 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	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">   71549142846550549911530 </div> <div style="text-align: center;">   71549142846550549911530 </div> </div>		

**Figure 3**

## Revision history

Document revision	Date of release	Description of changes
0.10	2021-09-15	Initial version
0.20	2022-02-24	Target datasheet
0.30	2022-05-16	Preliminary datasheet
1.00	2022-08-15	Final datasheet

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**Document reference**

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