

## Final datasheet

### EconoDUAL™3 module with Trench/Fieldstop IGBT4 and emitter controlled diode and PressFIT / NTC

#### Features

- Electrical features
  - $V_{CES} = 1200\text{ V}$
  - $I_{C\text{ nom}} = 600\text{ A} / I_{CRM} = 1200\text{ A}$
  - Low  $V_{CE,sat}$
  - $T_{vj,op} = 150^\circ\text{C}$
  - $V_{CE,sat}$  with positive temperature coefficient
- Mechanical features
  - High power density
  - Isolated base plate
  - Standard housing



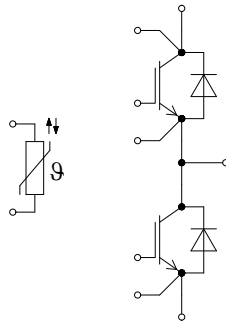
#### Potential applications

- High-power converters
- Motor drives
- Servo drives
- UPS systems
- Wind turbines

#### 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, $t = 1$ min	3.4	kV
Isolation test voltage NTC	$V_{ISOL(NTC)}$	RMS, $f = 50$ Hz, $t = 1$ min	3.4	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	$Al_2O_3$	
Creepage distance	$d_{Creep\ nom}$	terminal to baseplate, nom., (PD2, IEC 60664-1, Ed. 3.0)	> 15	mm
Creepage distance	$d_{Creep\ min}$	terminal to baseplate, min., (PD2, IEC 60664-1, Ed. 3.0)	14.7	mm
Creepage distance	$d_{Creep\ nom}$	terminal to terminal, nom., (PD2, IEC 60664-1, Ed. 3.0)	12.1	mm
Creepage distance	$d_{Creep\ min}$	terminal to terminal, min., (PD2, IEC 60664-1, Ed. 3.0)	11.5	mm
Clearance	$d_{Clear\ nom}$	terminal to baseplate, nom.	> 12.5	mm
Clearance	$d_{Clear\ min}$	terminal to baseplate, min.	12.5	mm
Clearance	$d_{Clear\ nom}$	terminal to terminal, nom.	10.0	mm
Clearance	$d_{Clear\ min}$	terminal to terminal, min.	9.6	mm
Comparative tracking index	$CTI$		> 200	
Relative thermal index (electrical)	$RTI$	housing	140	°C

**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	$R_{CC'+EE'}$	$T_C = 25$ °C, per switch		1		mΩ
Storage temperature	$T_{stg}$		-40		125	°C
Mounting torque for module mounting	$M$	- Mounting according to valid application note	M5, Screw	3	6	Nm
Terminal connection torque	$M$	- Mounting according to valid application note	M6, Screw	3	6	Nm
Weight	$G$			345		g

## 2 IGBT, Inverter

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	$V_{CES}$		$T_{vj} = 25\text{ °C}$	1200 V
Continuous DC collector current	$I_{CDC}$	$T_{vj\text{ max}} = 175\text{ °C}$	$T_C = 100\text{ °C}$	600 A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{vj\text{ op}}$		1200 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	$V_{CE\text{ sat}}$	$I_C = 600\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.75	2.10	V
			$T_{vj} = 125\text{ °C}$	2.00		
			$T_{vj} = 150\text{ °C}$	2.05		
Gate threshold voltage	$V_{GETh}$	$I_C = 23\text{ mA}, V_{CE} = V_{GE}, T_{vj} = 25\text{ °C}$	5.20	5.80	6.40	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\text{ V}$		4.4		$\mu\text{C}$
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\text{ °C}$		1.2		$\Omega$
Input capacitance	$C_{ies}$	$f = 1000\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$		37		nF
Reverse transfer capacitance	$C_{res}$	$f = 1000\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$		2.05		nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		3	mA
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}, T_{vj} = 25\text{ °C}$			400	nA
Turn-on delay time (inductive load)	$t_{don}$	$I_C = 600\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 1.5\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.160		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	0.210		
			$T_{vj} = 150\text{ °C}$	0.210		
Rise time (inductive load)	$t_r$	$I_C = 600\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 1.5\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.090		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	0.090		
			$T_{vj} = 150\text{ °C}$	0.100		
Turn-off delay time (inductive load)	$t_{doff}$	$I_C = 600\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 1.5\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.480		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	0.610		
			$T_{vj} = 150\text{ °C}$	0.650		

(table continues...)

**Table 4** (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Fall time (inductive load)	$t_f$	$I_C = 600 \text{ A}, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, R_{Goff} = 1.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$	0.070		$\mu\text{s}$
			$T_{vj} = 125 \text{ }^\circ\text{C}$	0.110		
			$T_{vj} = 150 \text{ }^\circ\text{C}$	0.120		
Turn-on energy loss per pulse	$E_{on}$	$I_C = 600 \text{ A}, V_{CC} = 600 \text{ V}, L_\sigma = 35 \text{ nH}, V_{GE} = \pm 15 \text{ V}, R_{Gon} = 1.5 \Omega, di/dt = 5100 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ }^\circ\text{C})$	$T_{vj} = 25 \text{ }^\circ\text{C}$	62.5		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	83		
			$T_{vj} = 150 \text{ }^\circ\text{C}$	90		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 600 \text{ A}, V_{CC} = 600 \text{ V}, L_\sigma = 35 \text{ nH}, V_{GE} = \pm 15 \text{ V}, R_{Goff} = 1.5 \Omega, dv/dt = 3700 \text{ V}/\mu\text{s} (T_{vj} = 150 \text{ }^\circ\text{C})$	$T_{vj} = 25 \text{ }^\circ\text{C}$	47		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	72		
			$T_{vj} = 150 \text{ }^\circ\text{C}$	79.5		
SC data	$I_{SC}$	$V_{GE} \leq 15 \text{ V}, V_{CC} = 800 \text{ V}, V_{CEmax} = V_{CES} - L_{SCE} \cdot di/dt$	$t_p \leq 10 \mu\text{s}, T_{vj} = 150 \text{ }^\circ\text{C}$	2400		A
Thermal resistance, junction to case	$R_{thJC}$	per IGBT			0.0473	K/W
Thermal resistance, case to heat sink	$R_{thCH}$	per IGBT, $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot\text{K})$		0.0304		K/W
Temperature under switching conditions	$T_{vj op}$		-40		150	$^\circ\text{C}$

### 3 Diode, Inverter

**Table 5** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	1200	V	
Continuous DC forward current	$I_F$		600	A	
Repetitive peak forward current	$I_{FRM}$	$t_p = 1 \text{ ms}$	1200	A	
$I^2t$ - value	$I^2t$	$t_p = 10 \text{ ms}, V_R = 0 \text{ V}$	$T_{vj} = 125 \text{ }^\circ\text{C}$	40000	$\text{A}^2\text{s}$
			$T_{vj} = 150 \text{ }^\circ\text{C}$	37500	

**Table 6** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	$V_F$	$I_F = 600 \text{ A}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		1.65	2.10	V
			$T_{vj} = 125 \text{ °C}$		1.65		
			$T_{vj} = 150 \text{ °C}$		1.65		
Peak reverse recovery current	$I_{RM}$	$V_{CC} = 600 \text{ V}, I_F = 600 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 5100 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		290		A
			$T_{vj} = 125 \text{ °C}$		420		
			$T_{vj} = 150 \text{ °C}$		450		
Recovered charge	$Q_r$	$V_{CC} = 600 \text{ V}, I_F = 600 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 5100 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		62		$\mu\text{C}$
			$T_{vj} = 125 \text{ °C}$		115		
			$T_{vj} = 150 \text{ °C}$		130		
Reverse recovery energy	$E_{rec}$	$V_{CC} = 600 \text{ V}, I_F = 600 \text{ A}, V_{GE} = -15 \text{ V}, -di_F/dt = 5100 \text{ A}/\mu\text{s} (T_{vj} = 150 \text{ °C})$	$T_{vj} = 25 \text{ °C}$		22		mJ
			$T_{vj} = 125 \text{ °C}$		44		
			$T_{vj} = 150 \text{ °C}$		51		
Thermal resistance, junction to case	$R_{thJC}$	per diode			0.0767	K/W	
Thermal resistance, case to heat sink	$R_{thCH}$	per diode, $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot\text{K})$		0.0474		K/W	
Temperature under switching conditions	$T_{vj\text{op}}$		-40		150	$^{\circ}\text{C}$	

## 4 NTC-Thermistor

**Table 7** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	$R_{25}$	$T_{NTC} = 25 \text{ °C}$		5		k $\Omega$
Deviation of $R_{100}$	$\Delta R/R$	$T_{NTC} = 100 \text{ °C}, R_{100} = 493 \text{ }\Omega$	-5		5	%
Power dissipation	$P_{25}$	$T_{NTC} = 25 \text{ °C}$			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15 \text{ K}))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15 \text{ K}))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15 \text{ K}))]$		3433		K

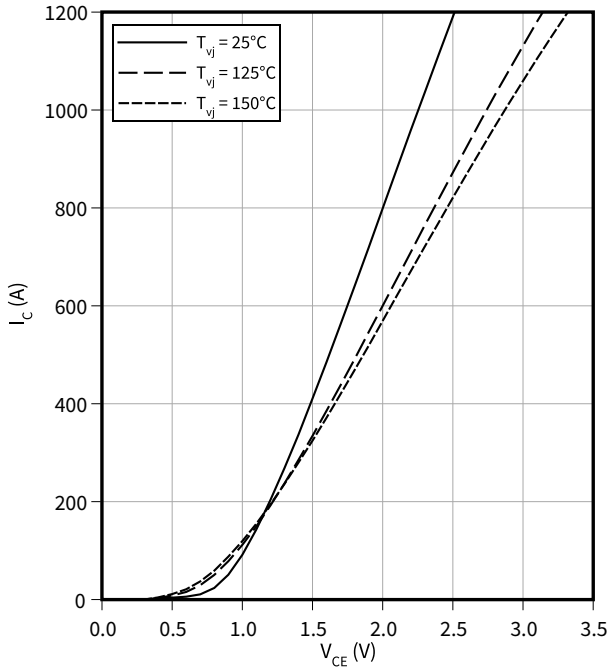
**Note:** For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4.

## 5 Characteristics diagrams

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

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

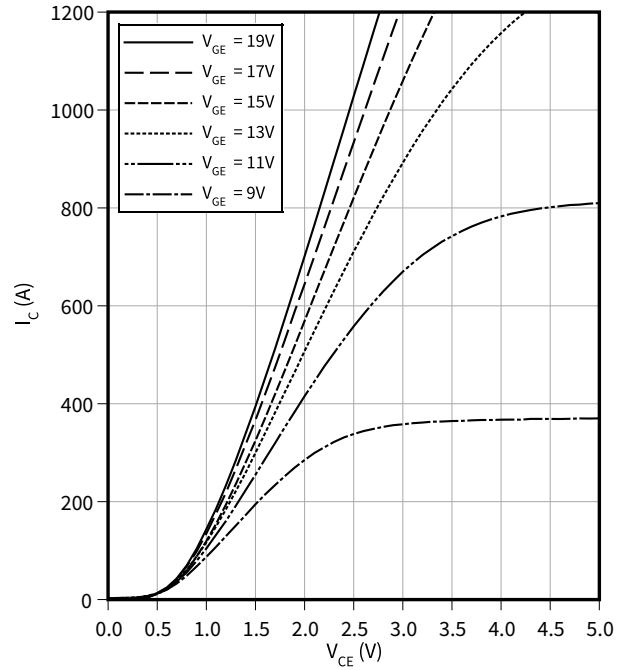
$$V_{GE} = 15 \text{ V}$$



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

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

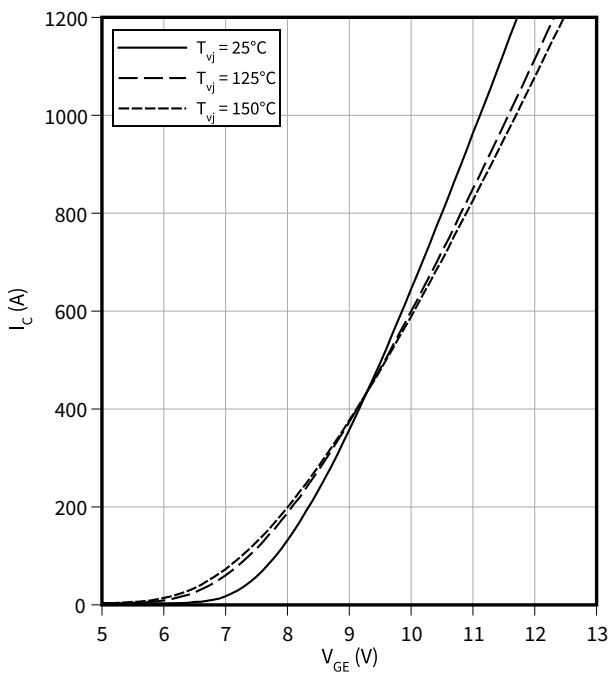
$$T_{vj} = 150 \text{ °C}$$



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

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

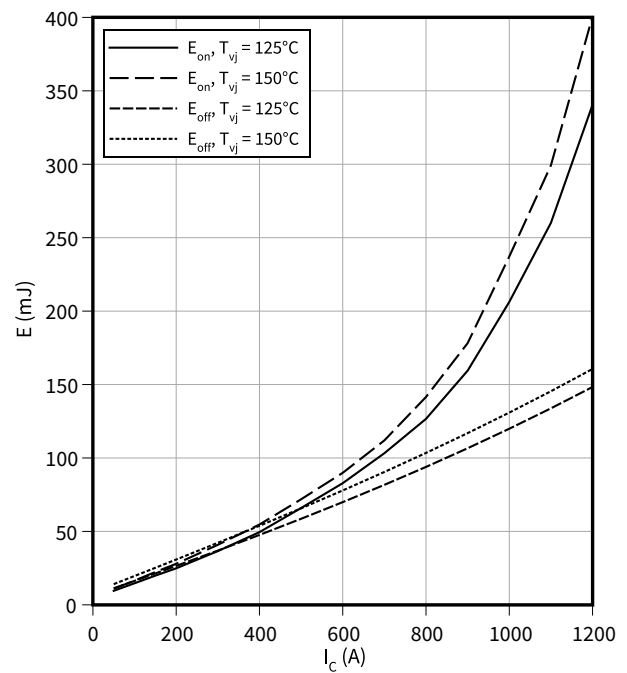
$$V_{CE} = 20 \text{ V}$$



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

$$E = f(I_C)$$

$$R_{Goff} = 1.5 \text{ } \Omega, R_{Gon} = 1.5 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, V_{CC} = 600 \text{ V}$$

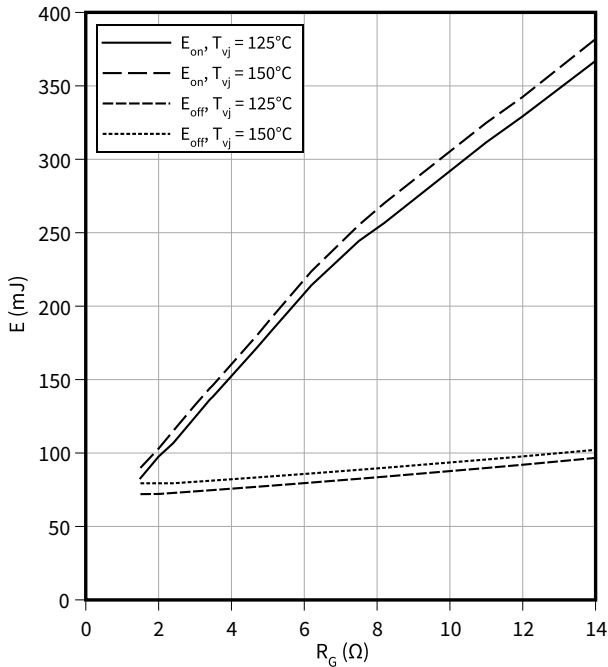


**5 Characteristics diagrams**

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

$E = f(R_G)$

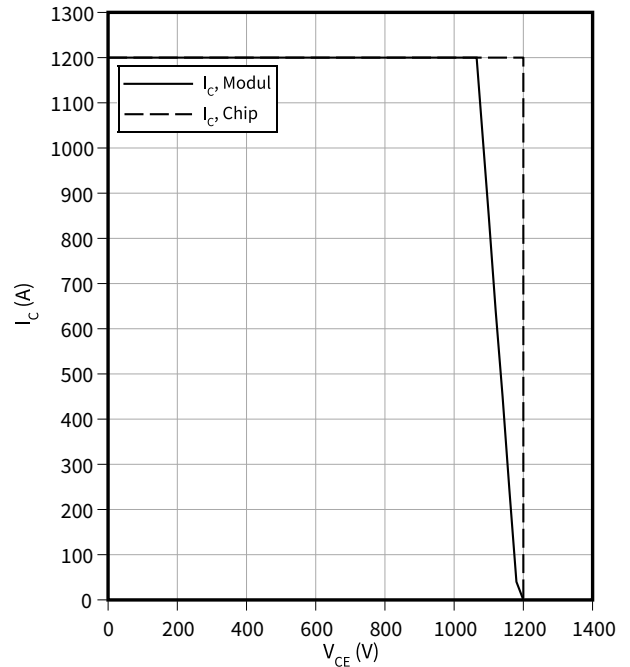
$V_{GE} = \pm 15 \text{ V}, I_C = 600 \text{ A}, V_{CC} = 600 \text{ V}$



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

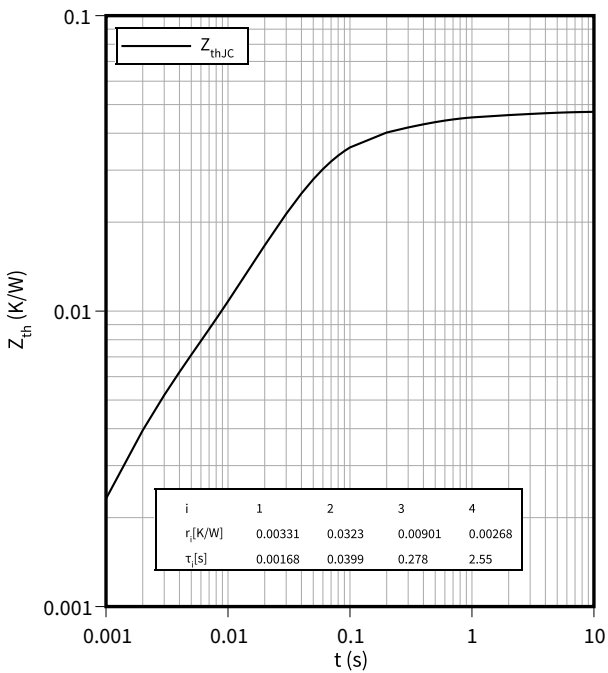
$I_C = f(V_{CE})$

$R_{Goff} = 1.5 \Omega, V_{GE} = \pm 15 \text{ V}, T_{vj} = 150 \text{ °C}$



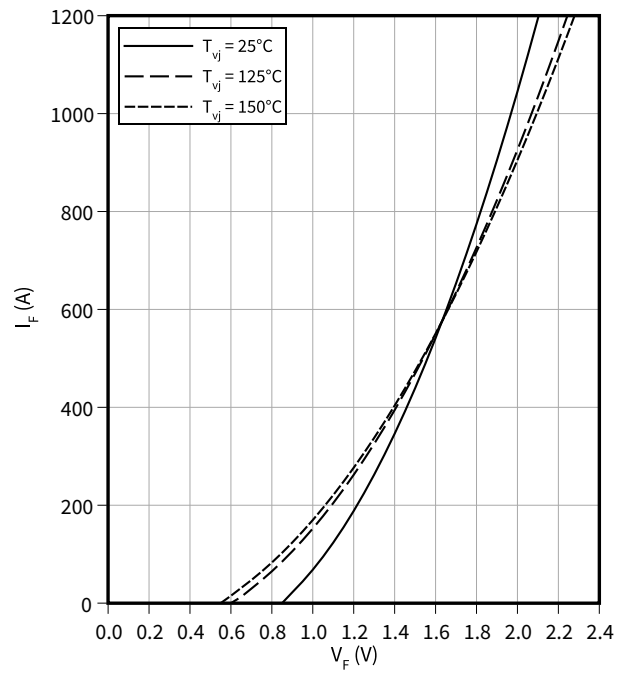
**Transient thermal impedance, IGBT, Inverter**

$Z_{th} = f(t)$



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

$I_F = f(V_F)$

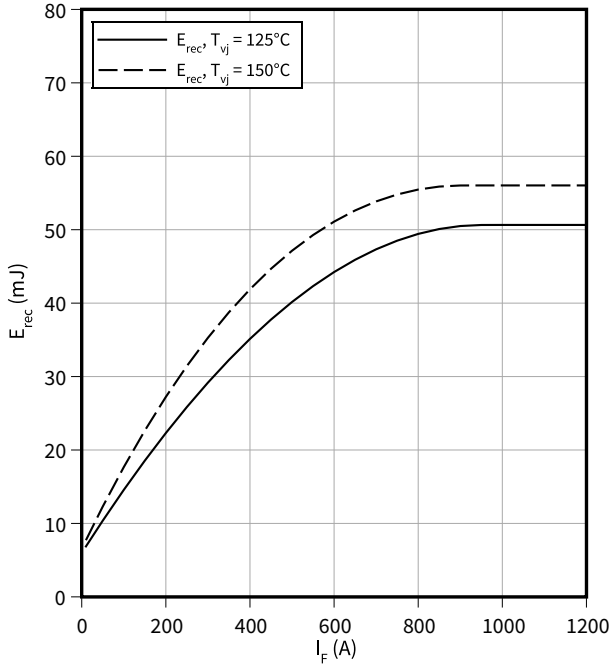




**5 Characteristics diagrams**

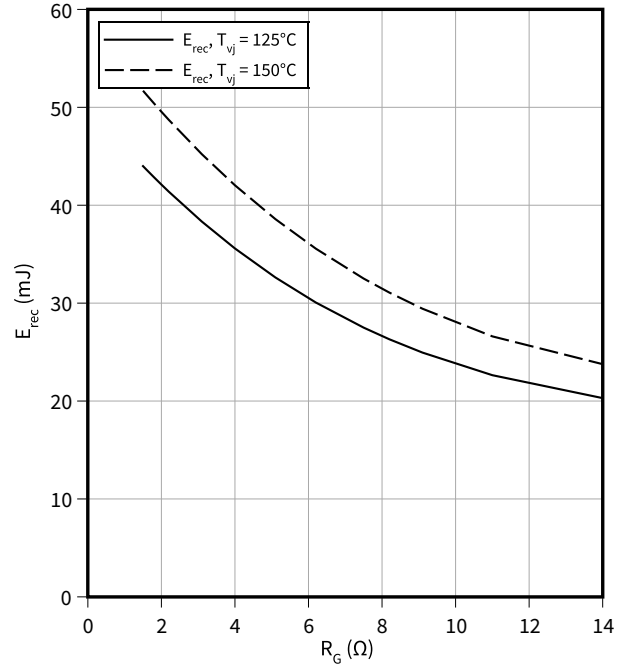
**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(I_F)$   
 $R_{Gon} = 1.5 \Omega, V_{CC} = 600 V$



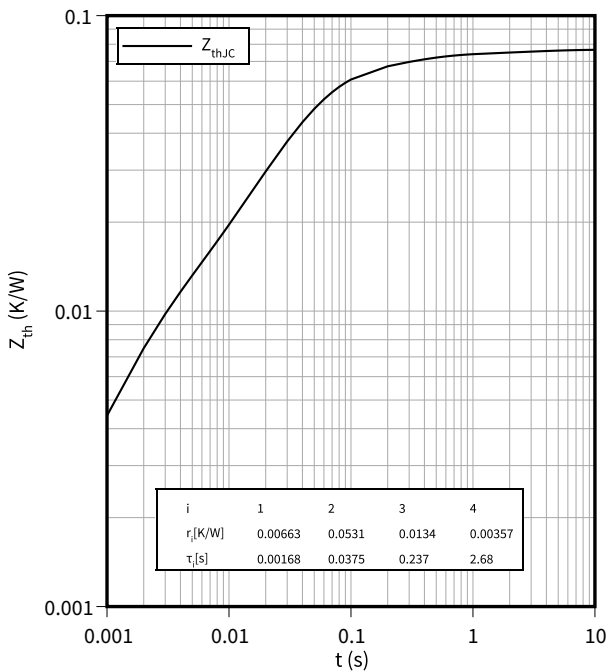
**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(R_G)$   
 $I_F = 600 A, V_{CC} = 600 V$



**Transient thermal impedance, Diode, Inverter**

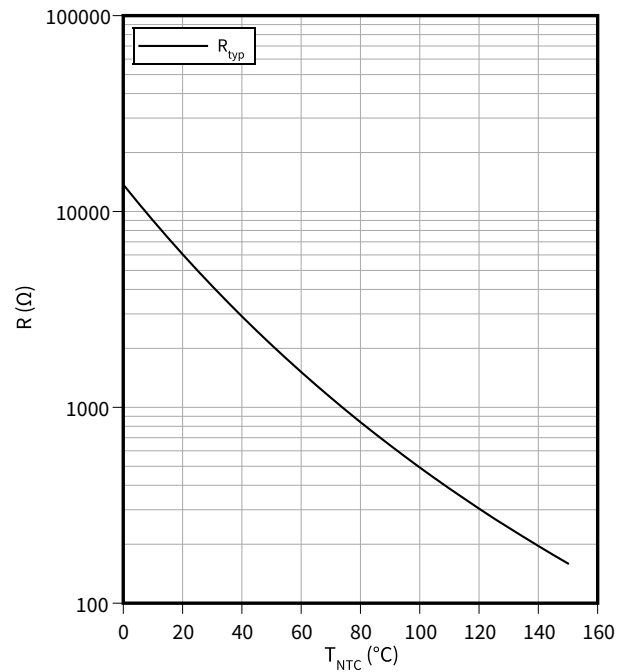
$Z_{th} = f(t)$



i	1	2	3	4
$r_i$ [K/W]	0.00663	0.0531	0.0134	0.00357
$\tau_i$ [s]	0.00168	0.0375	0.237	2.68

**Temperature characteristic (typical), NTC-Thermistor**

$R = f(T_{NTC})$



## 6 Circuit diagram

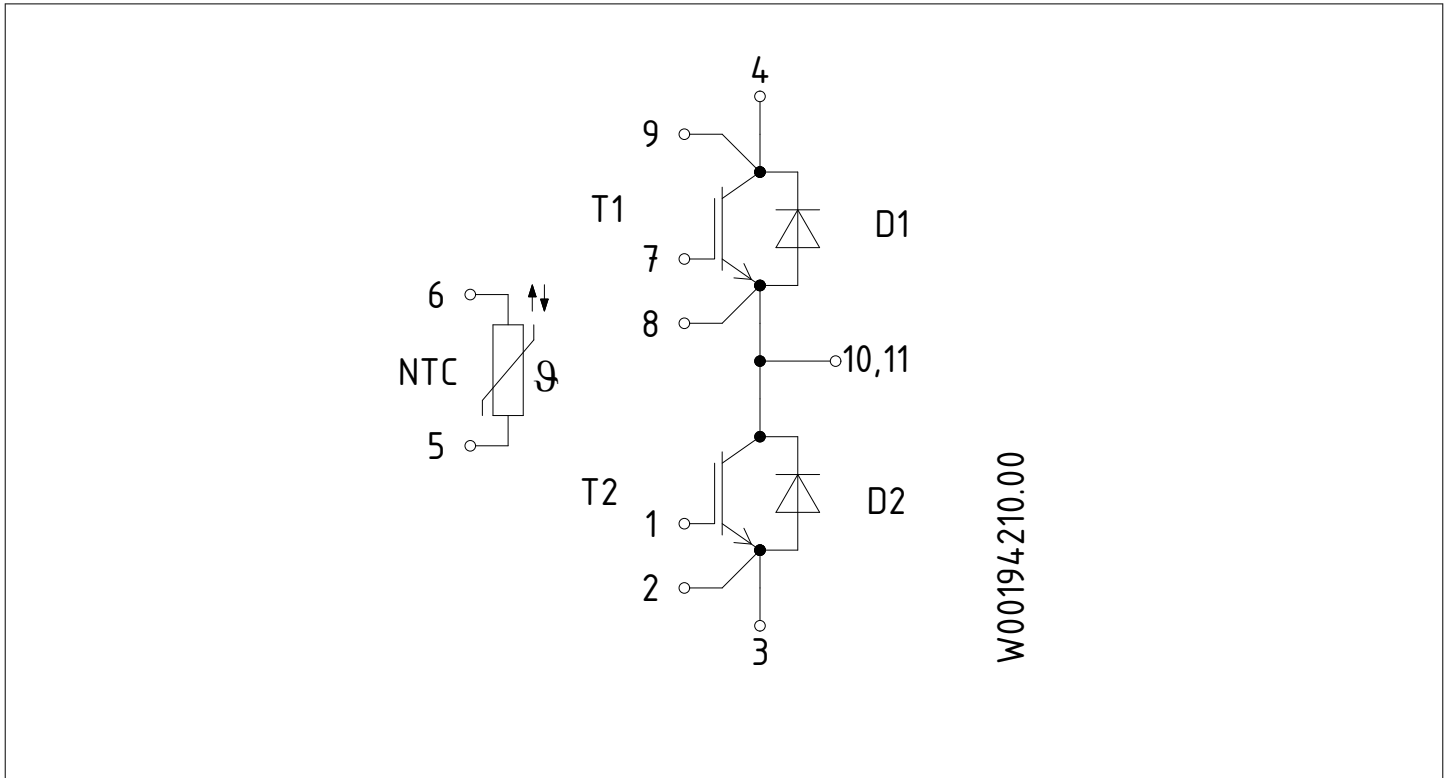


Figure 1

## 7 Package outlines

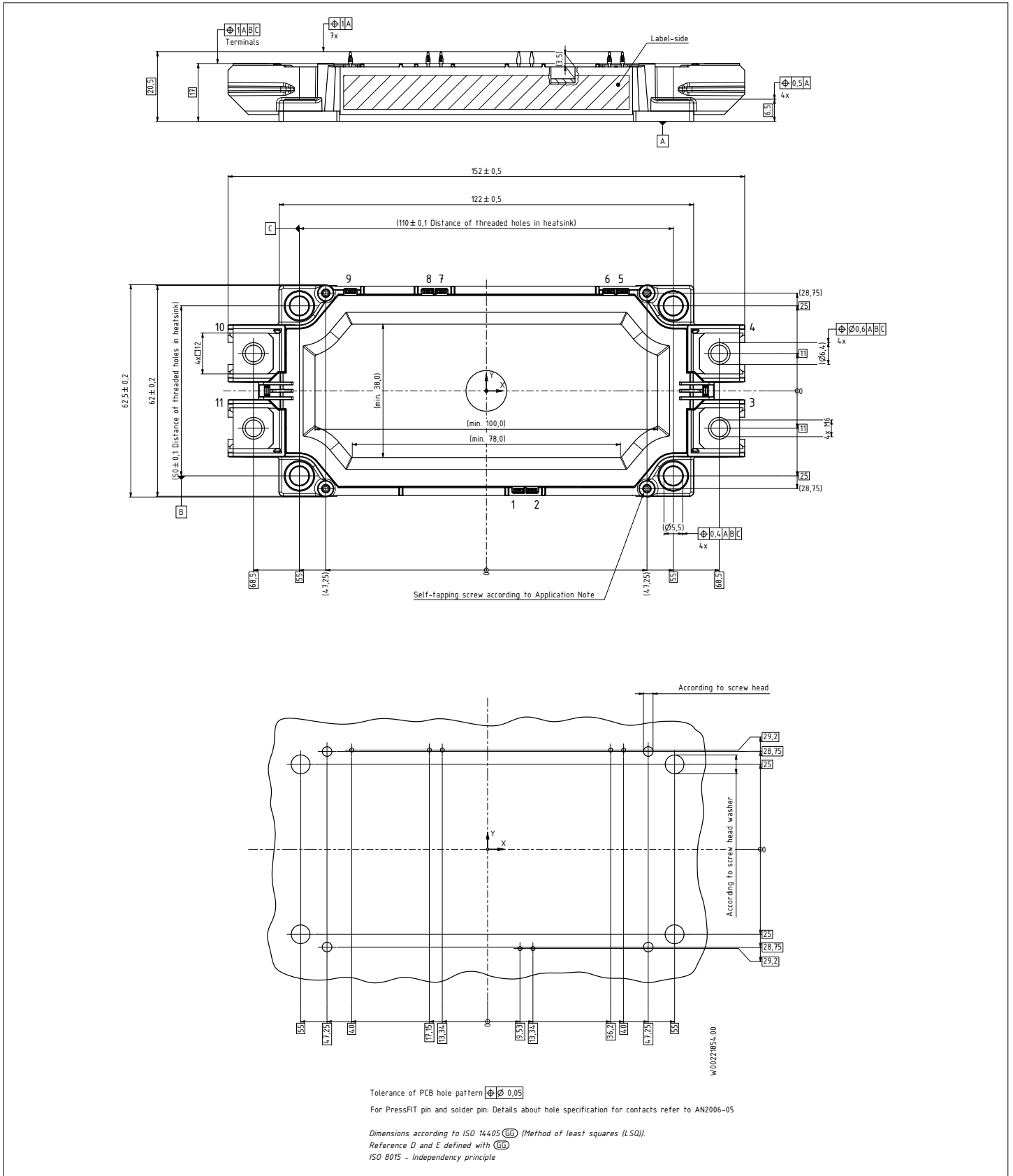

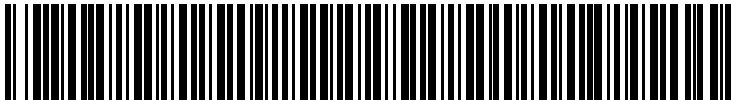


Figure 2

## 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	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	2017-06-23	Target datasheet
V3.0	2017-09-05	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	2024-03-15	Final datasheet

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