

PrimePACK™2 module with TRENCHSTOP™ IGBT7 and emitter controlled 7 diode and NTC

Features

- Electrical features
 - $V_{CES} = 1200\text{ V}$
 - $I_{C\text{ nom}} = 1600\text{ A} / I_{CRM} = 3200\text{ A}$
 - Extended operating temperature $T_{vj\text{ op}}$
 - Low $V_{CE,sat}$
- Mechanical features
 - 4 kV AC 1 min insulation
 - High creepage and clearance distances
 - High power and thermal cycling capability
 - High power density

Potential applications

- Motor drives
- Construction, commercial, and agriculture vehicles
- UPS systems
- Energy storage systems

Product validation

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

Description

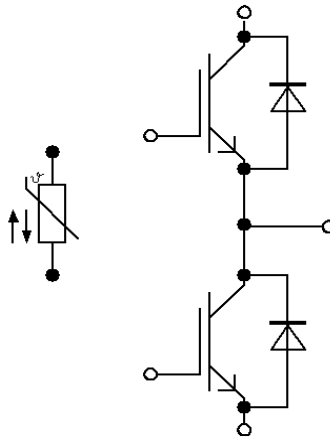


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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50 \text{ Hz}$, $t = 60 \text{ s}$	4.0	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	d_{Creep}	terminal to heatsink	33.0	mm
Creepage distance	d_{Creep}	terminal to terminal	33.0	mm
Clearance	d_{Clear}	terminal to heatsink	19.0	mm
Clearance	d_{Clear}	terminal to terminal	19.0	mm
Comparative tracking index	CTI		> 400	

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	$R_{AA'+CC'}$	$T_C = 25^\circ\text{C}$, per switch		0.22		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25^\circ\text{C}$, per switch		0.3		mΩ
Storage temperature	T_{stg}		-40		150	°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	M4, Screw	1.8	2.1	Nm
			M8, Screw	8	10	
Weight	G			825		g

2 IGBT, Inverter

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CES}		$T_{vj} = 25^\circ\text{C}$	1200	V
Implemented collector current	I_{CN}			1600	A
Continuous DC collector current	I_{CDC}	$T_{vj \text{ max}} = 175^\circ\text{C}$	$T_C = 90^\circ\text{C}$	1600	A

(table continues...)

Table 3 (continued) Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\ op}$	3200	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	$V_{CE\ sat}$	$I_C = 1600\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.27	1.79	V
			$T_{vj} = 125\ ^\circ C$	1.37	1.82	
			$T_{vj} = 175\ ^\circ C$	1.43	1.85	
Gate threshold voltage	V_{GEth}	$I_C = 32\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.15	5.80	6.45	V
Gate charge	Q_G	$V_{GE} = \pm 15\ V, V_{CC} = 600\ V$		25.4		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\ ^\circ C$		0.5		Ω
Input capacitance	C_{ies}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		217		nF
Reverse transfer capacitance	C_{res}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		1.28		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 1200\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$		5	mA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\ V, V_{GE} = 20\ V, T_{vj} = 25\ ^\circ C$			400	nA
Turn-on delay time (inductive load)	t_{don}	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.35\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.700		μs
			$T_{vj} = 125\ ^\circ C$	0.800		
			$T_{vj} = 175\ ^\circ C$	0.870		
Rise time (inductive load)	t_r	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 0.35\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.130		μs
			$T_{vj} = 125\ ^\circ C$	0.150		
			$T_{vj} = 175\ ^\circ C$	0.160		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 1\ \Omega$	$T_{vj} = 25\ ^\circ C$	1.050		μs
			$T_{vj} = 125\ ^\circ C$	1.150		
			$T_{vj} = 175\ ^\circ C$	1.250		
Fall time (inductive load)	t_f	$I_C = 1600\ A, V_{CC} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 1\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.200		μs
			$T_{vj} = 125\ ^\circ C$	0.400		
			$T_{vj} = 175\ ^\circ C$	0.500		
Turn-on energy loss per pulse	E_{on}	$I_C = 1600\ A, V_{CC} = 600\ V, L_\sigma = 30\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 0.35\ \Omega, di/dt = 9350\ A/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	125		mJ
			$T_{vj} = 125\ ^\circ C$	225		
			$T_{vj} = 175\ ^\circ C$	290		

(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}	$I_C = 1600\text{ A}$, $V_{CC} = 600\text{ V}$, $L_\sigma = 30\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Goff} = 1\ \Omega$, $dv/dt = 2100\text{ V}/\mu\text{s}$ ($T_{vj} = 175\text{ }^\circ\text{C}$)	$T_{vj} = 25\text{ }^\circ\text{C}$	260		mJ
			$T_{vj} = 125\text{ }^\circ\text{C}$	360		
			$T_{vj} = 175\text{ }^\circ\text{C}$	410		
SC data	I_{SC}	$V_{GE} \leq 15\text{ V}$, $V_{CC} = 800\text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_p \leq 6\ \mu\text{s}$, $T_{vj} \leq 150\text{ }^\circ\text{C}$	5300		A
			$t_p \leq 6\ \mu\text{s}$, $T_{vj} \leq 175\text{ }^\circ\text{C}$	5100		
Thermal resistance, junction to case	R_{thJC}	per IGBT			27.4	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per IGBT		20.6		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-40		175	$^\circ\text{C}$

Note: Maximum RMS module DC-terminal current according to application note AN2009-08.

$T_{vj\ op} > 150\text{ }^\circ\text{C}$ is only allowed for operation at overload conditions. For detailed specifications please refer to AN2018-14.

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			1600	A
Repetitive peak forward current	I_{FRM}	$t_P = 1\text{ ms}$		3200	A
I^2t - value	I^2t	$t_P = 10\text{ ms}$, $V_R = 0\text{ V}$	$T_{vj} = 125\text{ }^{\circ}\text{C}$	150	kA^2s
			$T_{vj} = 175\text{ }^{\circ}\text{C}$	145	

Table 6 **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 1600\text{ A}$, $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1.70	2.03	V
			$T_{vj} = 125\text{ }^\circ\text{C}$	1.65	1.96	
			$T_{vj} = 175\text{ }^\circ\text{C}$	1.55	1.91	

(table continues...)

Table 6 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Peak reverse recovery current	I_{RM}	$V_{CC} = 600 \text{ V}$, $I_F = 1600 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 9350 \text{ A}/\mu\text{s}$ ($T_{vj} = 175 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$	865		A
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1080		
			$T_{vj} = 175 \text{ }^\circ\text{C}$	1180		
Recovered charge	Q_r	$V_{CC} = 600 \text{ V}$, $I_F = 1600 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 9350 \text{ A}/\mu\text{s}$ ($T_{vj} = 175 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$	160		μC
			$T_{vj} = 125 \text{ }^\circ\text{C}$	305		
			$T_{vj} = 175 \text{ }^\circ\text{C}$	400		
Reverse recovery energy	E_{rec}	$V_{CC} = 600 \text{ V}$, $I_F = 1600 \text{ A}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 9350 \text{ A}/\mu\text{s}$ ($T_{vj} = 175 \text{ }^\circ\text{C}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$	75		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	130		
			$T_{vj} = 175 \text{ }^\circ\text{C}$	170		
Thermal resistance, junction to case	R_{thJC}	per diode			50.7	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per diode		25.2		K/kW
Temperature under switching conditions	$T_{vj \text{ op}}$		-40		175	$^\circ\text{C}$

Note: $T_{vj \text{ op}} > 150 \text{ }^\circ\text{C}$ is only allowed for operation at overload conditions. For detailed specifications please refer to AN2018-14.

4 NTC-Thermistor

Table 7 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	$T_{NTC} = 25 \text{ }^\circ\text{C}$		5		k Ω
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 100 \text{ }^\circ\text{C}$, $R_{100} = 493 \text{ } \Omega$	-5		5	%
Power dissipation	P_{25}	$T_{NTC} = 25 \text{ }^\circ\text{C}$			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

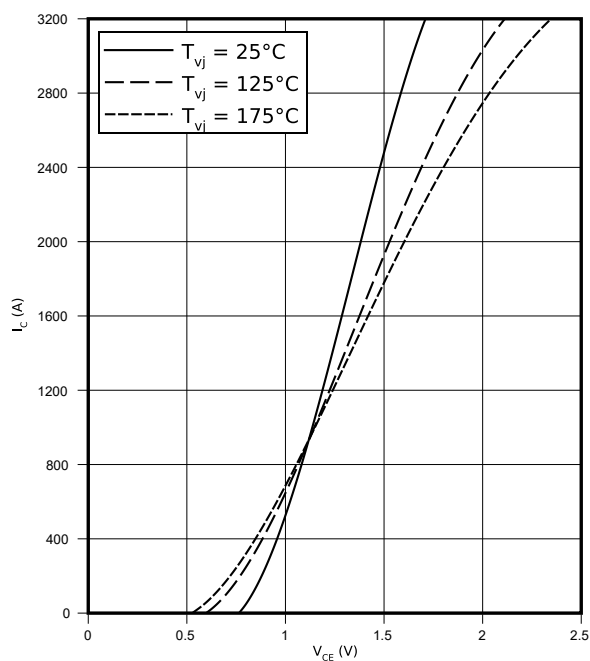
Note: For detailed specifications please refer to AN2009-10.

5 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

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

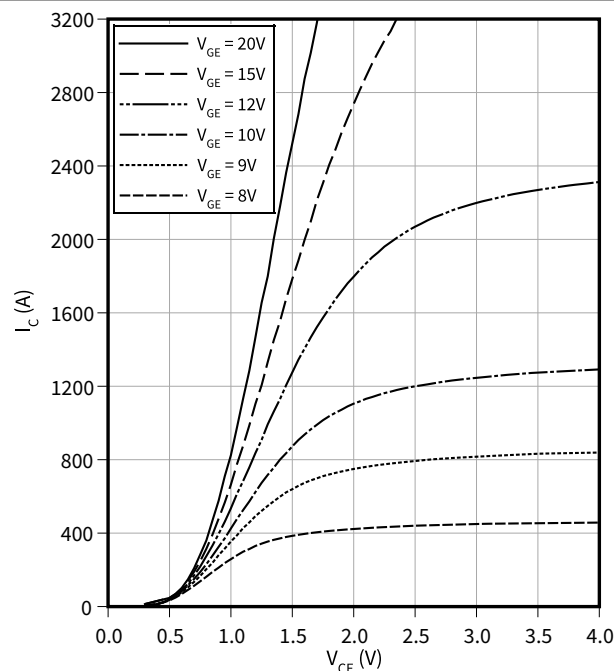
$$V_{GE} = 15 \text{ V}$$



Output characteristic field (typical), IGBT, Inverter

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

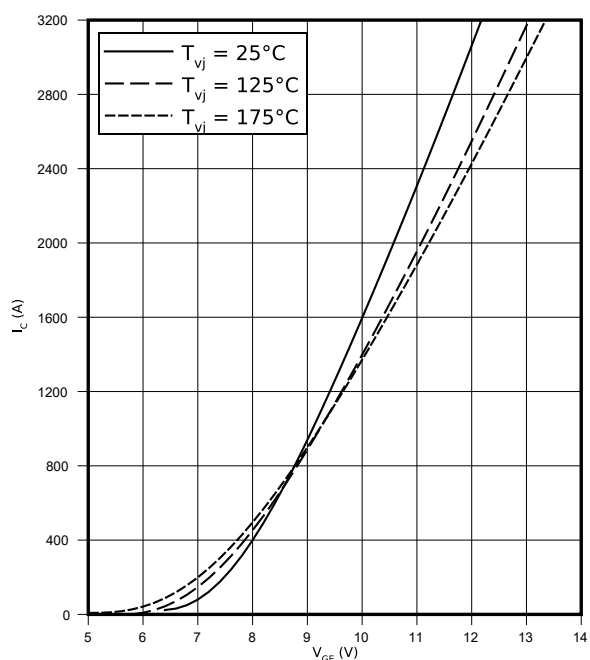
$$T_{vj} = 175 \text{ °C}$$



Transfer characteristic (typical), IGBT, Inverter

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

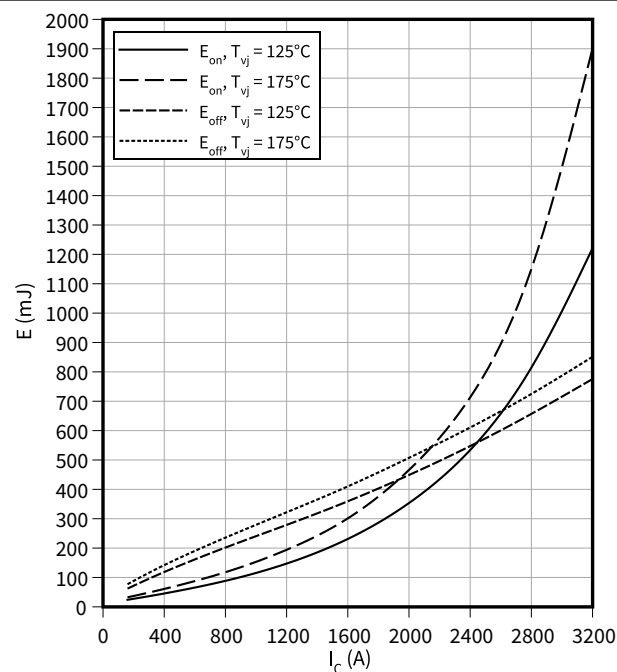
$$V_{CE} = 20 \text{ V}$$



Switching losses (typical), IGBT, Inverter

$$E = f(I_C)$$

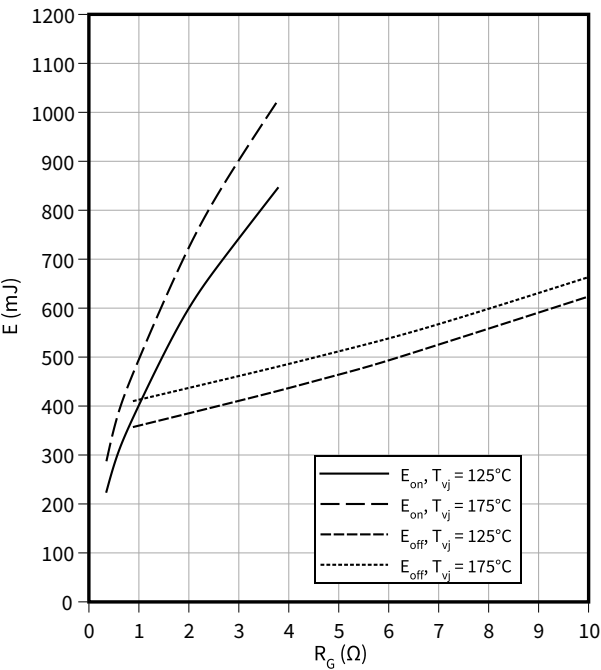
$$R_{Goff} = 1 \text{ } \Omega, R_{Gon} = 0.35 \text{ } \Omega, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}$$



5 Characteristics diagrams

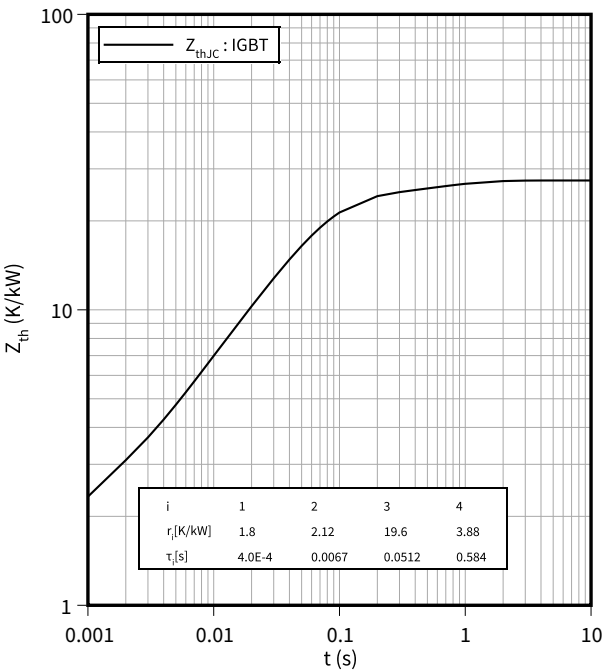
Switching losses (typical), IGBT, Inverter

$E = f(R_G)$
 $I_C = 1600\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$



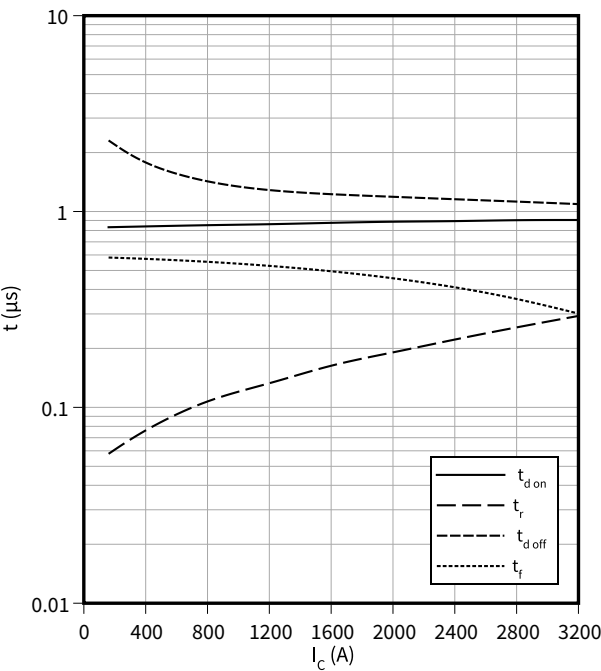
Transient thermal impedance , IGBT, Inverter

$Z_{th} = f(t)$



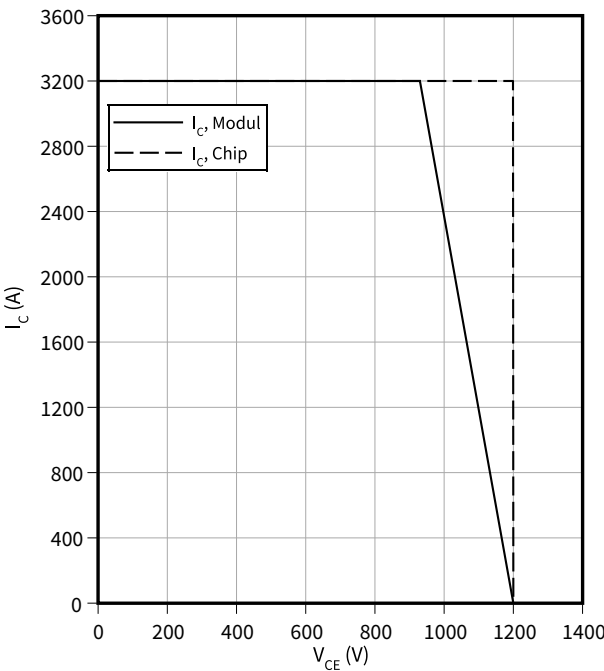
Switching times (typical), IGBT, Inverter

$t = f(I_C)$
 $R_{Goff} = 1\ \Omega$, $R_{Gon} = 0.35\ \Omega$, $V_{CC} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 175\text{ }^\circ\text{C}$



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

$I_C = f(V_{CE})$
 $R_{Goff} = 1\ \Omega$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 175\text{ }^\circ\text{C}$

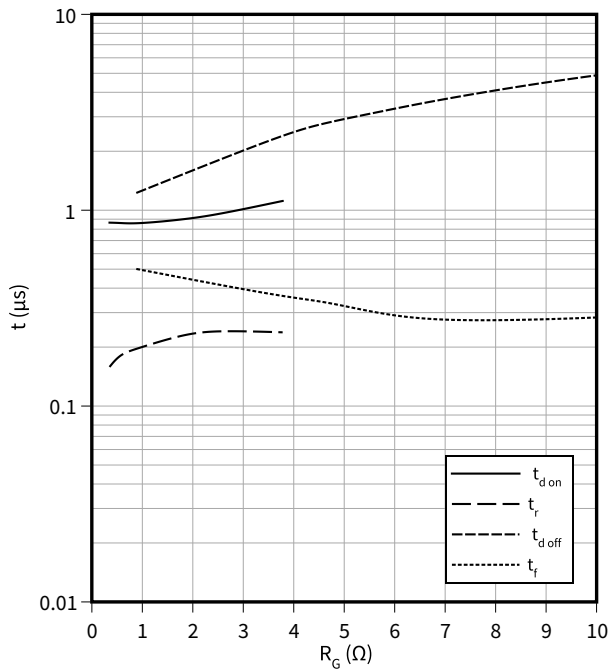


5 Characteristics diagrams

Switching times (typical), IGBT, Inverter

$t = f(R_G)$

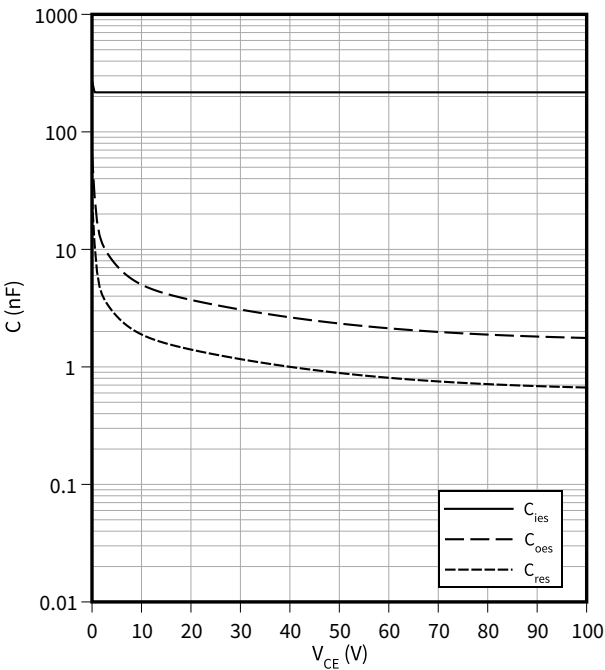
$I_C = 1600\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $T_{vj} = 175\text{ }^\circ\text{C}$



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

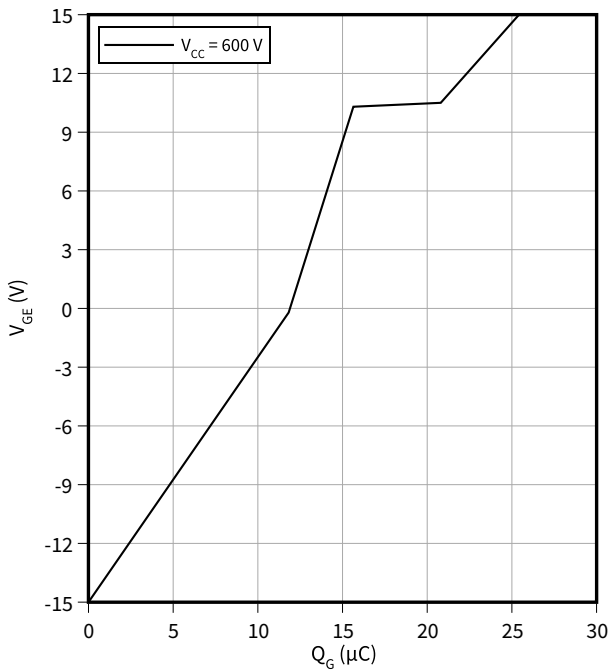
$f = 100\text{ kHz}$, $V_{GE} = 0\text{ V}$, $T_{vj} = 25\text{ }^\circ\text{C}$



Gate charge characteristic (typical), IGBT, Inverter

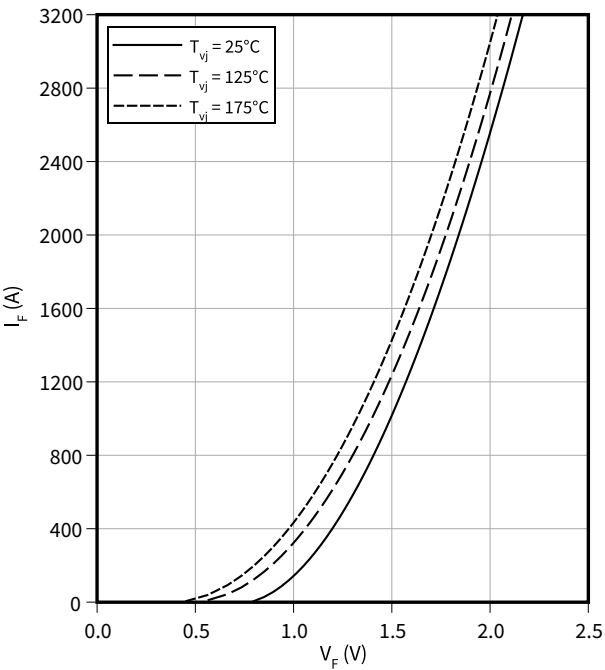
$V_{GE} = f(Q_G)$

$I_C = 1600\text{ A}$, $T_{vj} = 25\text{ }^\circ\text{C}$



Forward characteristic (typical), Diode, Inverter

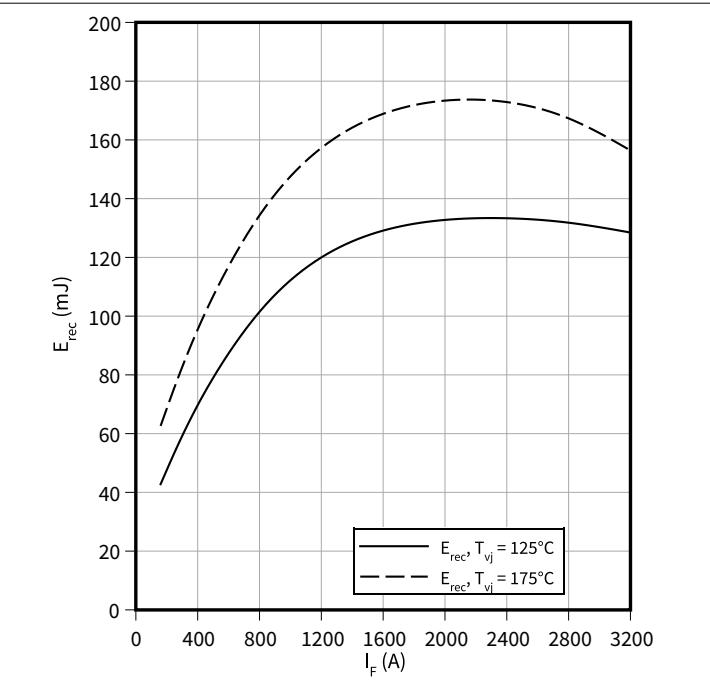
$I_F = f(V_F)$



5 Characteristics diagrams

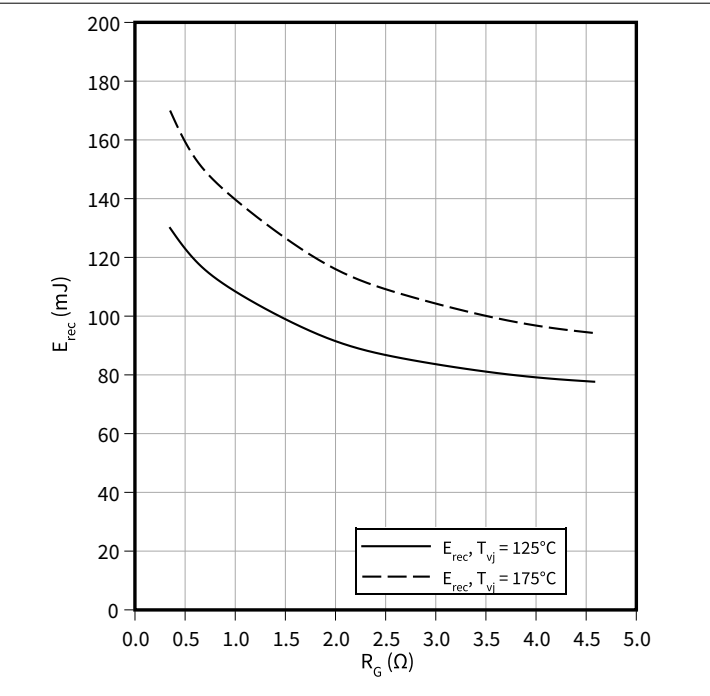
Switching losses (typical), Diode, Inverter

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



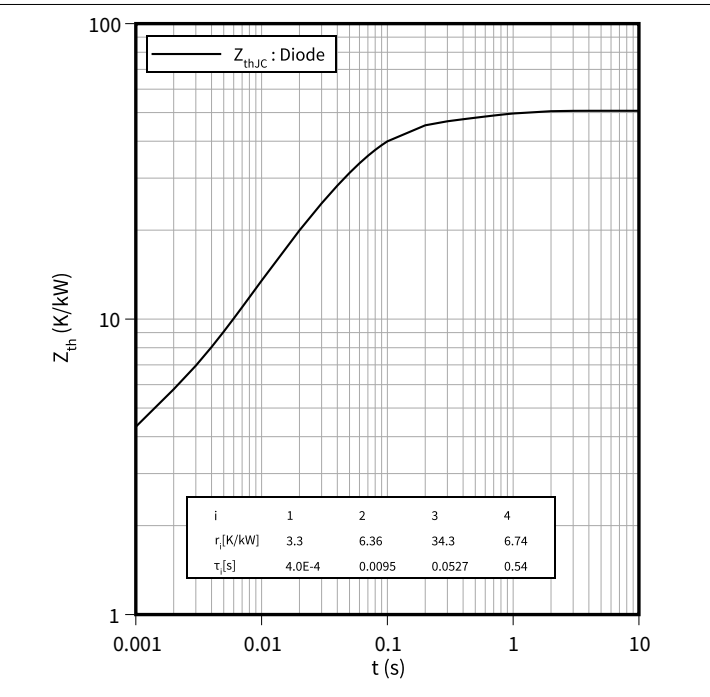
Switching losses (typical), Diode, Inverter

$E_{rec} = f(R_G)$
 $I_F = 1600\text{ A}, V_{CC} = 600\text{ V}$



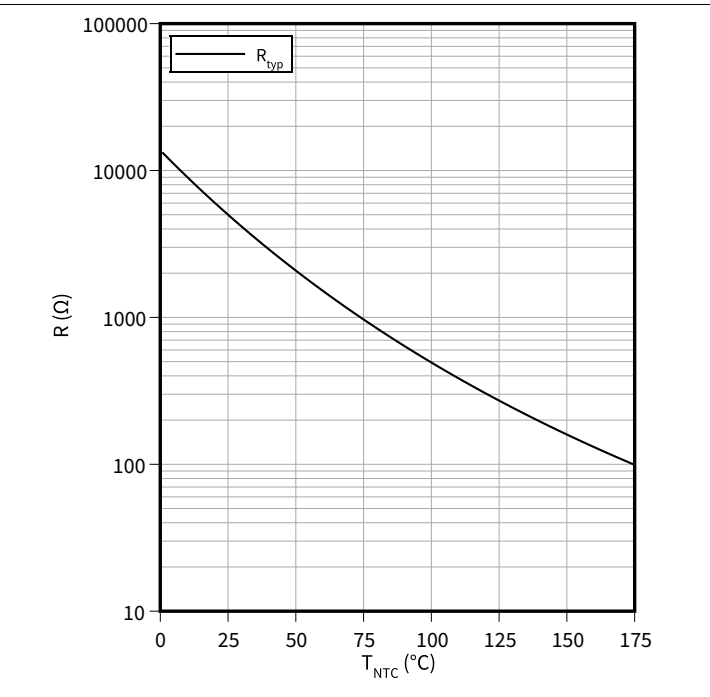
Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 **Circuit diagram**

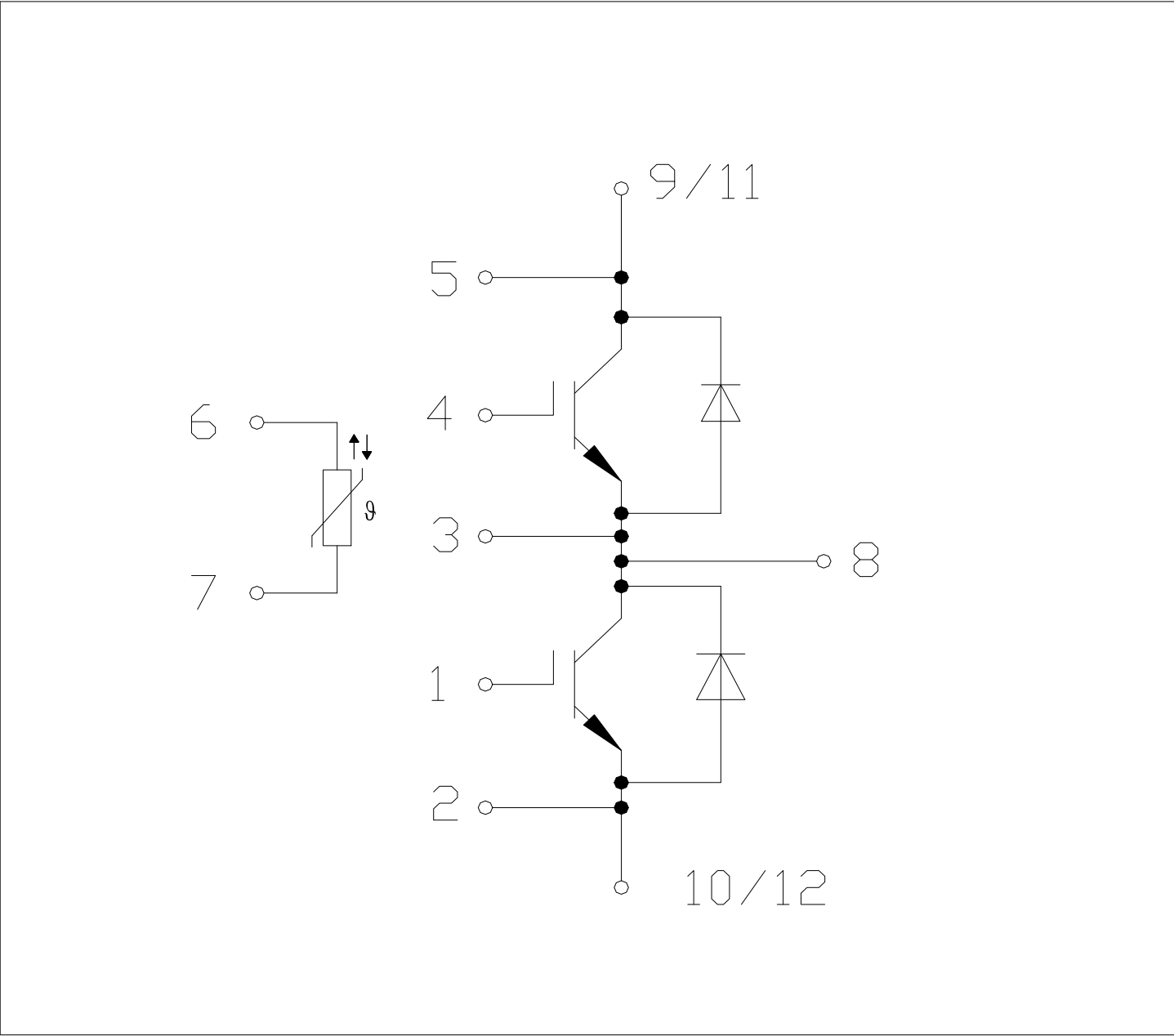


Figure 1

7 Package outlines

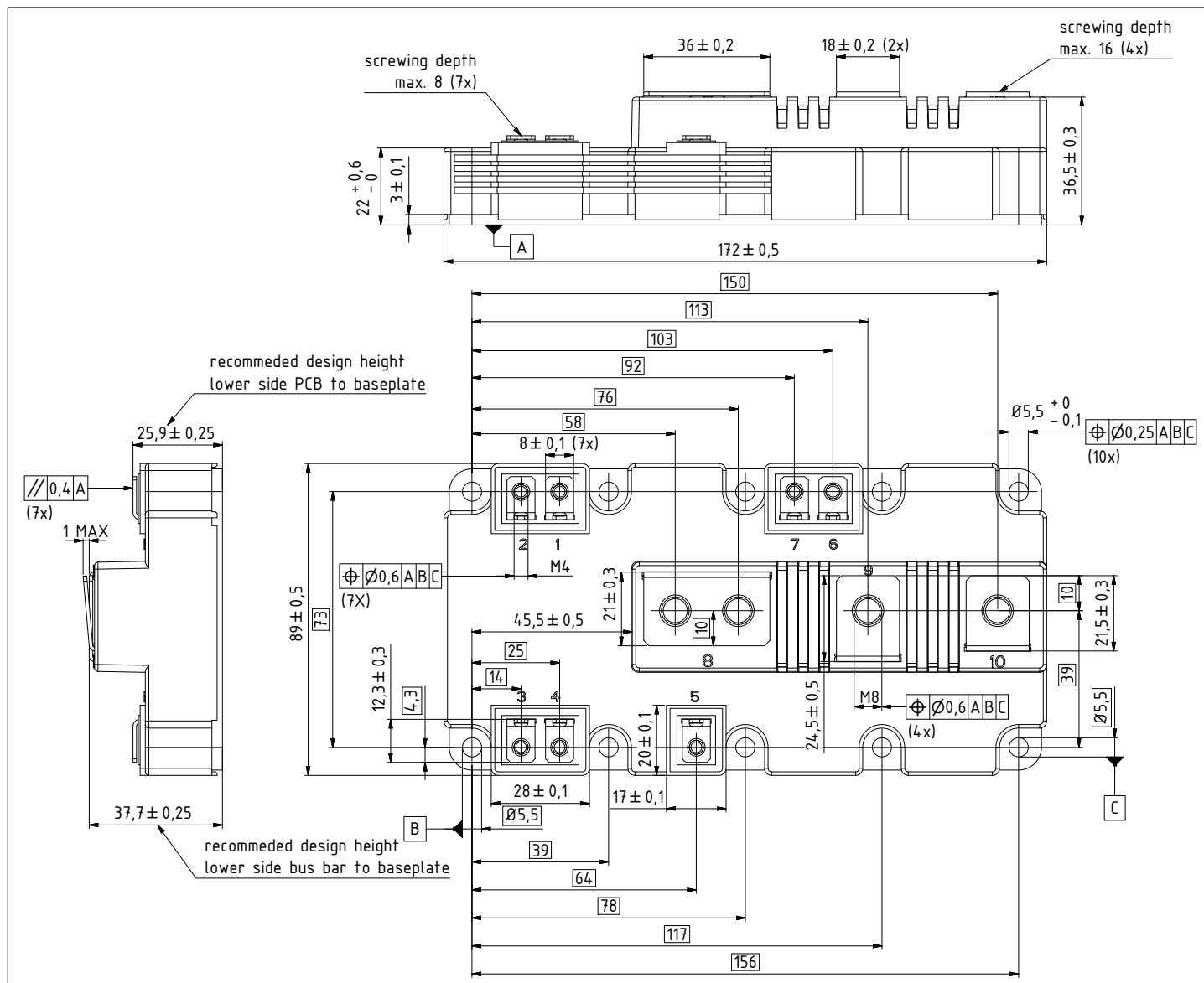


Figure 2

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	<i>Content</i>	<i>Digit</i>	<i>Example</i>
	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	2020-02-18	Target datasheet
V1.1	2020-08-21	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
1.10	2020-11-18	
1.11	2022-05-17	Final datasheet

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