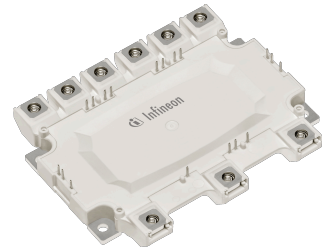


## HybridPACK™ DC6 module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode and NTC

### Features

- Electrical features
  - $V_{CES} = 700\text{ V}$
  - $I_{C\text{nom}} = 400\text{ A} / I_{CRM} = 800\text{ A}$
  - Increased blocking voltage capability to 705 V
  - $V_{CE,sat}$  with positive temperature coefficient
  - Low  $V_{CE,sat}$
  - Low switching losses
  - Low inductive design
  - $T_{vj,op} = 150^{\circ}\text{C}$
  - Short-time extended operation temperature  $T_{vj,op} = 175^{\circ}\text{C}$
- Mechanical features
  - 2.5 kV AC 1 minute insulation
  - $\text{Al}_2\text{O}_3$  substrate with low thermal resistance
  - Integrated NTC temperature sensor
  - High mechanical robustness
  - RoHS compliant



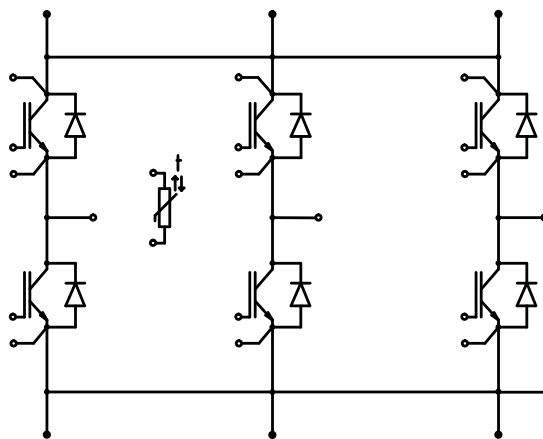
### Potential applications

- (Hybrid) electrical vehicles (H)EV
- Motor drives
- Optimized for automotive applications with DC link voltages up to 450 V

### Description

Infineon's HybridPACK™ 1 DC6 is a variant of the HybridPACK™ 1 power module family with increased continuous current capability and a reduced stray inductance.

Like all HybridPACK™ 1 products the HybridPACK™ 1 DC6 is an automotive qualified powermodule designed for electric vehicle applications. Designed for a  $150^{\circ}\text{C}$  junction operation temperature, with a 30 hour limited  $175^{\circ}\text{C}$  capacity the module accommodates a 3-phase Six-Pack configuration of Trench-Field-Stop IGBT3 and matching emitter controlled diodes. The HybridPACK™ 1 power module family is built on Infineon's long time experience in the development of IGBT power modules, intense research efforts of new material combinations and assembly technologies. HybridPACK™ 1 DC6 is suitable for air or liquid cooling. The copper base plate combined with high-performance ceramic substrate and Infineon's enhanced wire-bonding process provides unparalleled thermal and power cycling capability and highest reliability for mild hybrid inverter or generator applications. For a compact design the driver stage PCB can easily be soldered on top of the module. All power connections are realized with screw terminals.



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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	2.5	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	Al <sub>2</sub> O <sub>3</sub>	
Creepage distance	$d_{creep}$	terminal to heatsink	12.0	mm
Creepage distance	$d_{creep}$	terminal to terminal	6.1	mm
Clearance	$d_{clear}$	terminal to heatsink	12.0	mm
Clearance	$d_{clear}$	terminal to terminal	6.1	mm
Comparative tracking index	$CTI$		>200	

**Table 2 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Maximum RMS module terminal current <sup>1)</sup>	$I_{t,rms}$	$T_{terminal} = 150\text{ °C}$ , $T_c = 25\text{ °C}$	320	A

1) DC-collector current limited by internal busbar.

**Table 3 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray inductance module	$L_{s,CE}$			16.0		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T = 25°C, per switch		1.00		mΩ
Storage temperature	$T_{stg}$		-40		125	°C
Mounting torque for module mounting	$M$	Screw M5 baseplate to heatsink	3.0		6.0	Nm
Terminal connection torque	$M$	Screw M6	3.0		6.0	Nm
Weight	$G$			510		g

Note: Mounting according to valid application note AN 2010-08 Mounting Instruction HybridPACK™ 1.

## 2 IGBT, Inverter

**Table 4 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	$V_{CES}$	$T_{vj} = 25\text{ °C}$	705	V

(table continues...)

**Table 4 (continued) Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Continuous DC collector current	$I_{C,nom}$	$T_c = 65\text{ °C}, T_{vj,max} = 175\text{ °C}$	400	A
Continuous DC collector current	$I_C$	$T_c = 25\text{ °C}, T_{vj,max} = 175\text{ °C}$	500	A
Repetitive peak collector current	$I_{CRM}$	$t_p = 1\text{ ms}$	800	A
Total power dissipation	$P_{tot}$	$T_c = 25\text{ °C}, T_{vj,max} = 175\text{ °C}$	1250	W
Gate-emitter peak voltage	$V_{GES}$		±20	V

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Collector-emitter saturation voltage	$V_{CE,sat}$	$I_C = 400\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.45	1.70	V	
			$T_{vj} = 125\text{ °C}$	1.60			
			$T_{vj} = 150\text{ °C}$	1.70			
Gate threshold voltage	$V_{GE,th}$	$I_C = 6.4\text{ mA}, V_{CE} = V_{GE}$	$T_{vj} = 25\text{ °C}$	4.9	5.8	6.5	V
Gate charge	$Q_G$	$V_{GE} = \pm 15\text{ V}$		4.3			μC
Internal gate resistor	$R_{G,int}$		$T_{vj} = 25\text{ °C}$	1.0			Ω
Input capacitance	$C_{ies}$	$f = 1\text{ MHz}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	26.0			nF
Reverse transfer capacitance	$C_{res}$	$f = 1\text{ MHz}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	0.76			nF
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 450\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			0.1	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	$t_{d,on}$	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, V_{GE} = \pm 15\text{ V}, R_{G,on} = 1.8\text{ } \Omega$	$T_{vj} = 25\text{ °C}$	0.12			μs
			$T_{vj} = 125\text{ °C}$	0.12			
			$T_{vj} = 150\text{ °C}$	0.12			
Rise time, inductive load	$t_r$	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, V_{GE} = \pm 15\text{ V}, R_{G,on} = 1.8\text{ } \Omega$	$T_{vj} = 25\text{ °C}$	0.08			μs
			$T_{vj} = 125\text{ °C}$	0.08			
			$T_{vj} = 150\text{ °C}$	0.08			
Turn-off delay time, inductive load	$t_{d,off}$	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, V_{GE} = \pm 15\text{ V}, R_{G,off} = 1.8\text{ } \Omega$	$T_{vj} = 25\text{ °C}$	0.36			μs
			$T_{vj} = 125\text{ °C}$	0.40			
			$T_{vj} = 150\text{ °C}$	0.40			

(table continues...)

**Table 5 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Fall time, inductive load	$t_f$	$I_C = 400\text{ A}$ , $V_{CE} = 300\text{ V}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{G,off} = 1.8\ \Omega$	$T_{vj} = 25\text{ °C}$	0.02		$\mu\text{s}$
			$T_{vj} = 125\text{ °C}$	0.03		
			$T_{vj} = 150\text{ °C}$	0.03		
Turn-on energy loss per pulse	$E_{on}$	$I_C = 400\text{ A}$ , $V_{CE} = 300\text{ V}$ , $L_\sigma = 16\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{G,on} = 1.8\ \Omega$	$T_{vj} = 25\text{ °C}$	5.1		mJ
			$T_{vj} = 125\text{ °C}$	6.8		
			$T_{vj} = 150\text{ °C}$ , $di/dt = 4500\text{ A}/\mu\text{s}$	7.3		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 400\text{ A}$ , $V_{CE} = 300\text{ V}$ , $L_\sigma = 16\text{ nH}$ , $V_{GE} = \pm 15\text{ V}$ , $R_{G,off} = 1.8\ \Omega$	$T_{vj} = 25\text{ °C}$	9.1		mJ
			$T_{vj} = 125\text{ °C}$	12.0		
			$T_{vj} = 150\text{ °C}$ , $du/dt = 3400\text{ V}/\mu\text{s}$	12.5		
SC data	$I_{SC}$	$V_{CC} = 360\text{ V}$ , $V_{CEmax} =$ $V_{CES} - L_{SCE} \cdot di/dt$	$T_{vj} = 25\text{ °C}$ , $t_p \leq$ $8\ \mu\text{s}$	2800		A
			$T_{vj} = 150\text{ °C}$ , $t_p \leq$ $6\ \mu\text{s}$	2000		
Thermal resistance, junction to case	$R_{th,j-c}$	per IGBT			0.120	K/W
Thermal resistance, case to heat sink	$R_{th,c-h}$	per IGBT $\lambda_{paste} = 1\text{ W}/(\text{m}\cdot\text{K})$ / $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{K})$		0.080		K/W
Temperature under switching conditions	$T_{vj,op}$	$t_{op}$ continuous	-40		150	$^{\circ}\text{C}$
		$t_{op,max}$ 30h over life time, for 10s within period of 10min	150		175	

Note: DC-collector current limited by power terminals.

### 3 Diode, Inverter

**Table 6 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25\text{ °C}$	705	V
Continuous DC forward current	$I_{F,nom}$		400	A
Repetitive peak forward current	$I_{FRM}$	$t_p = 1\text{ ms}$	800	A

(table continues...)

**Table 6 (continued) Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
I <sup>2</sup> t - value	I <sup>2</sup> t	V <sub>R</sub> = 0 V, t <sub>p</sub> = 10 ms	T <sub>vj</sub> = 125 °C	8800	A <sup>2</sup> s
			T <sub>vj</sub> = 150 °C	8500	

**Table 7 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	V <sub>F</sub>	I <sub>F</sub> = 400 A, V <sub>GE</sub> = 0 V	T <sub>vj</sub> = 25 °C		1.55	1.95	V
			T <sub>vj</sub> = 125 °C		1.50		
			T <sub>vj</sub> = 150 °C		1.45		
Peak reverse recovery current	I <sub>rm</sub>	I <sub>F</sub> = 400 A, V <sub>GE</sub> = -15 V, V <sub>R</sub> = 300 V	T <sub>vj</sub> = 25 °C		205		A
			T <sub>vj</sub> = 125 °C		295		
			T <sub>vj</sub> = 150 °C, -di <sub>F</sub> /dt = 4500 A/μs		305		
Recovered charge	Q <sub>r</sub>	I <sub>F</sub> = 400 A, V <sub>GE</sub> = -15 V, V <sub>R</sub> = 300 V	T <sub>vj</sub> = 25 °C		15.0		μC
			T <sub>vj</sub> = 125 °C		32.0		
			T <sub>vj</sub> = 150 °C, -di <sub>F</sub> /dt = 4500 A/μs		34.0		
Reverse recovery energy	E <sub>rec</sub>	I <sub>F</sub> = 400 A, V <sub>GE</sub> = -15 V, V <sub>R</sub> = 300 V	T <sub>vj</sub> = 25 °C		3.35		mJ
			T <sub>vj</sub> = 125 °C		6.90		
			T <sub>vj</sub> = 150 °C, -di <sub>F</sub> /dt = 4500 A/μs		8.10		
Thermal resistance, junction to case	R <sub>th,j-c</sub>	per diode			0.200	K/W	
Thermal resistance, case to heat sink	R <sub>th,c-h</sub>	per diode λ <sub>Paste</sub> = 1 W/(m·K) / λ <sub>grease</sub> = 1 W/(m·K)		0.085		K/W	
Temperature under switching conditions	T <sub>vj,op</sub>	t <sub>op</sub> continuous	-40		150	°C	
		t <sub>op,max</sub> 30h over life time, for 10s within period of 10min	150		175		

Note: Diode forward current limited by power terminals.

## 4 NTC-Thermistor

**Table 8 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R <sub>25</sub>	T <sub>NTC</sub> = 25 °C		5		kΩ

(table continues...)

**Table 8** (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Deviation of $R_{100}$	$\Delta R/R$	$T_{NTC} = 100\text{ °C}$ , $R_{100} = 493\ \Omega$	-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

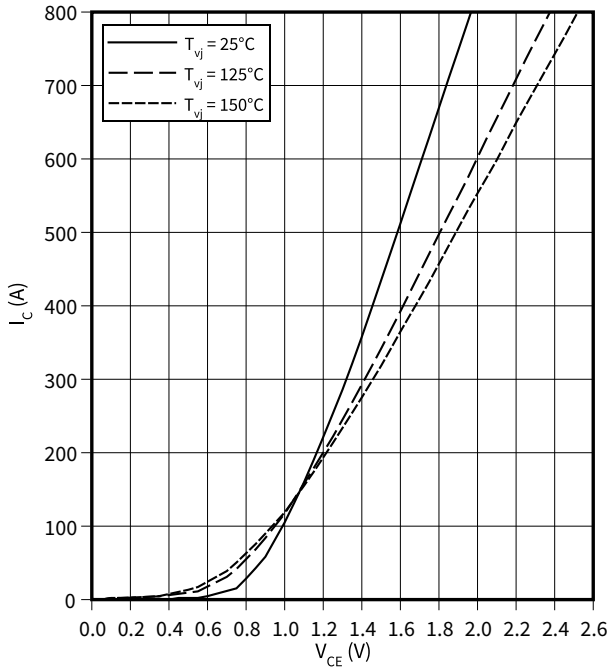
Note: Specification according to the valid application note.

## 5 Characteristics diagrams

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

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

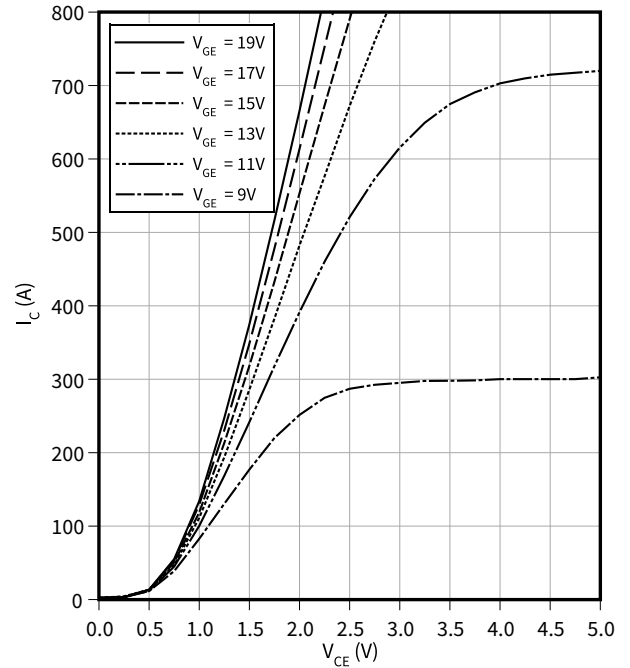
$$V_{GE} = 15 \text{ V}$$



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

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

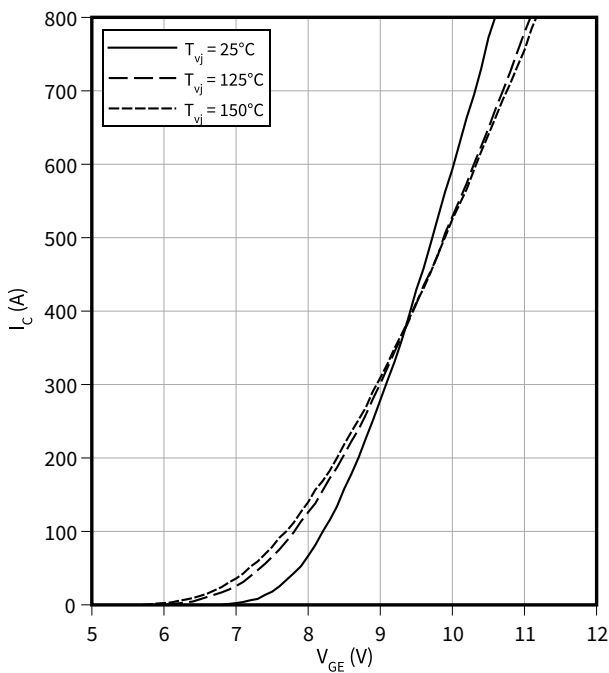
$$T_{vj} = 150 \text{ °C}$$



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

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

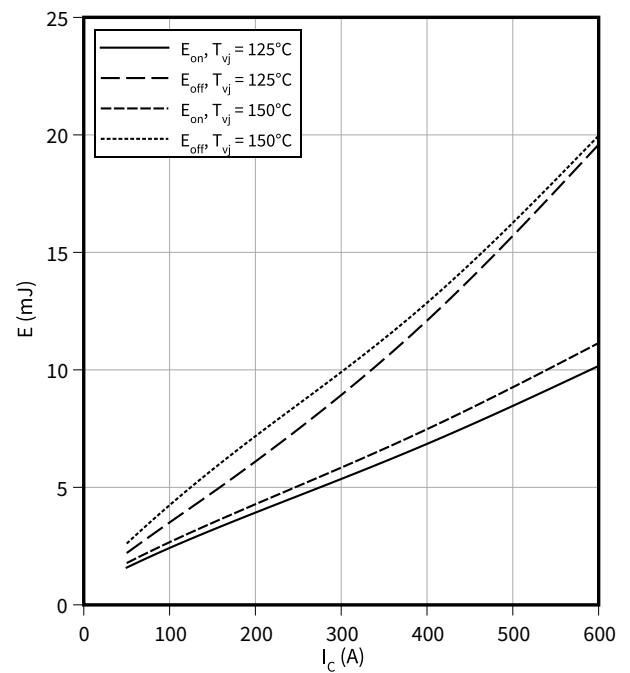
$$V_{CE} = 20 \text{ V}$$



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

$$E = f(I_C)$$

$$R_{G,off} = 1.8 \text{ } \Omega, R_{G,on} = 1.8 \text{ } \Omega, V_{CE} = 300 \text{ V}, V_{GE} = \pm 15 \text{ V}$$



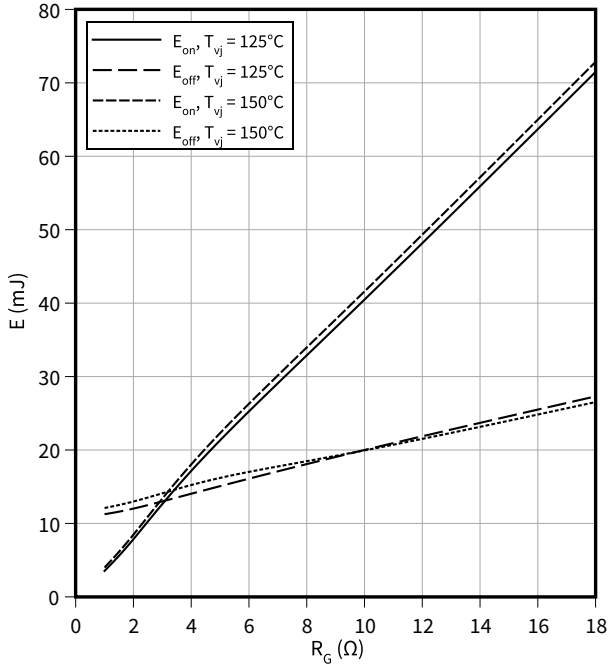


5 Characteristics diagrams

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

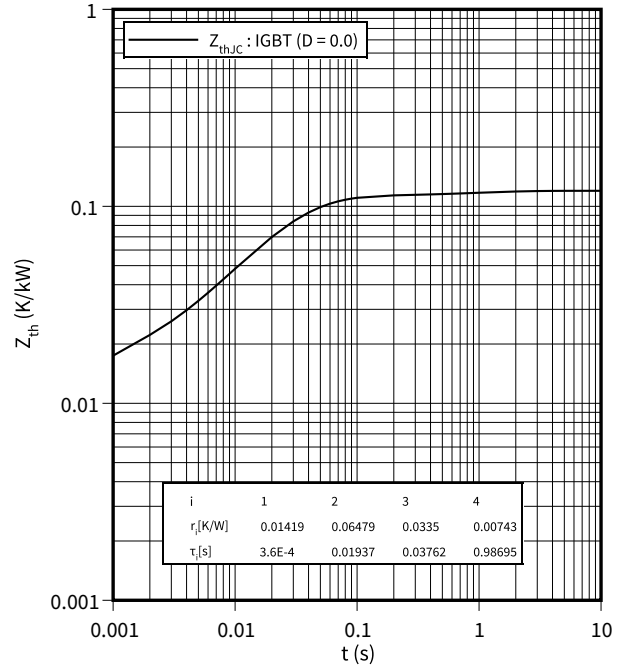
$E = f(R_G)$

$V_{CE} = 300\text{ V}$ ,  $V_{GE} = \pm 15\text{ V}$ ,  $I_C = 400\text{ A}$



**Transient thermal impedance, IGBT, Inverter**

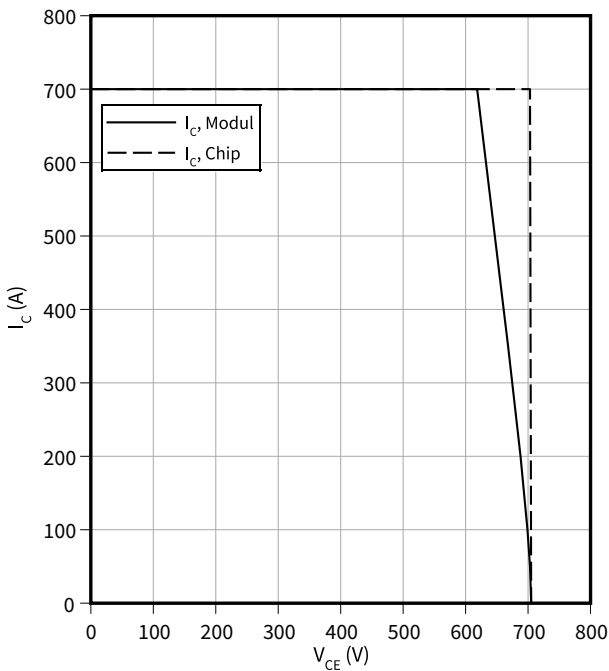
$Z_{th} = f(t)$



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

$I_C = f(V_{CE})$

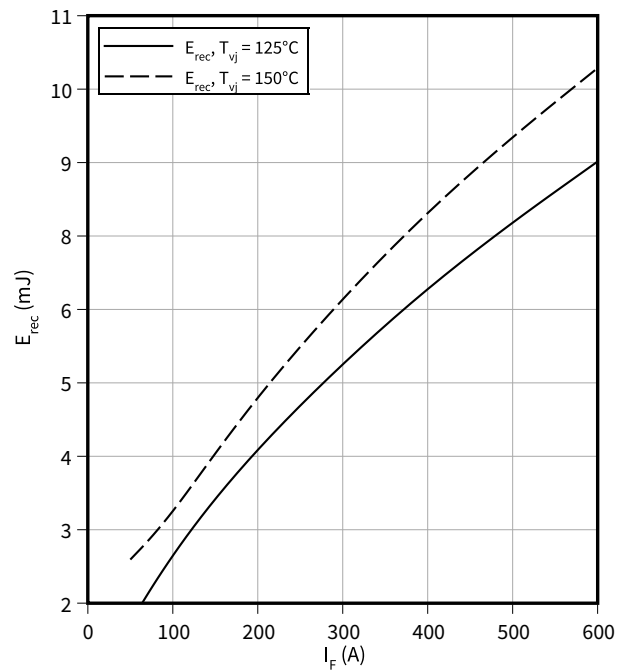
$T_{vj} = 150\text{ °C}$ ,  $R_{G,off} = 1.8\text{ Ω}$ ,  $V_{GE} = \pm 15\text{ V}$



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

$E_{rec} = f(I_F)$

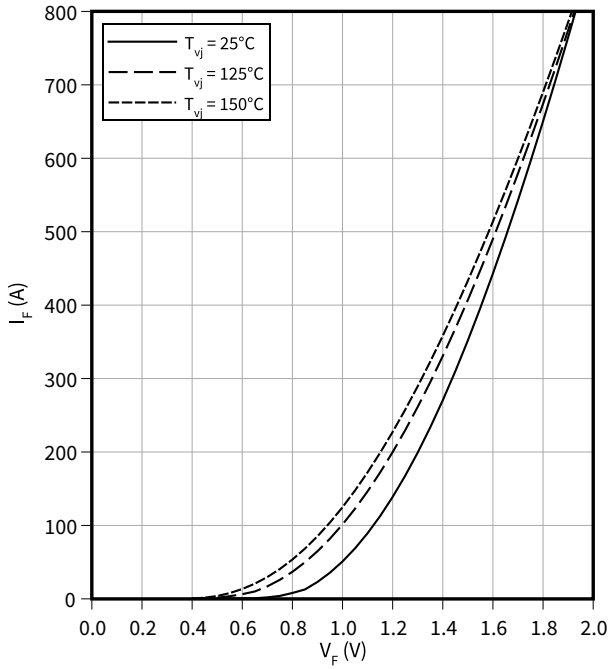
$R_{Gon} = 1.8\text{ Ω}$ ,  $V_{CE} = 300\text{ V}$



5 Characteristics diagrams

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

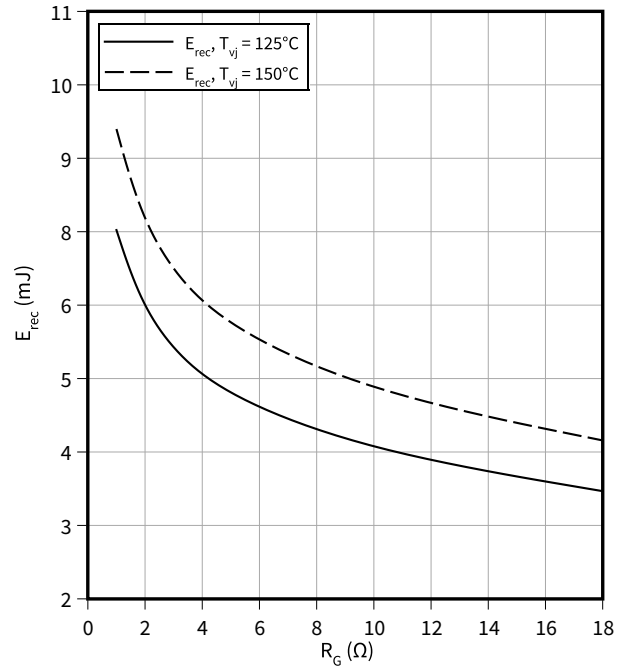
$I_F = f(V_F)$



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

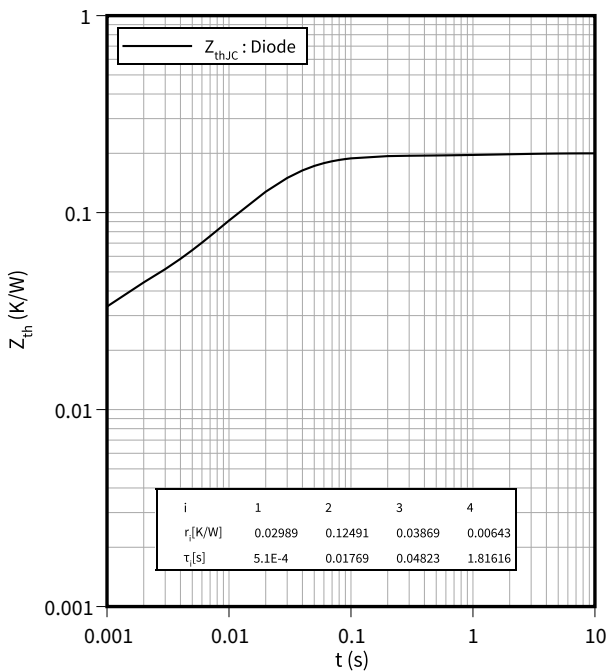
$E_{rec} = f(R_G)$

$V_{CE} = 300\text{ V}, I_F = 400\text{ A}$



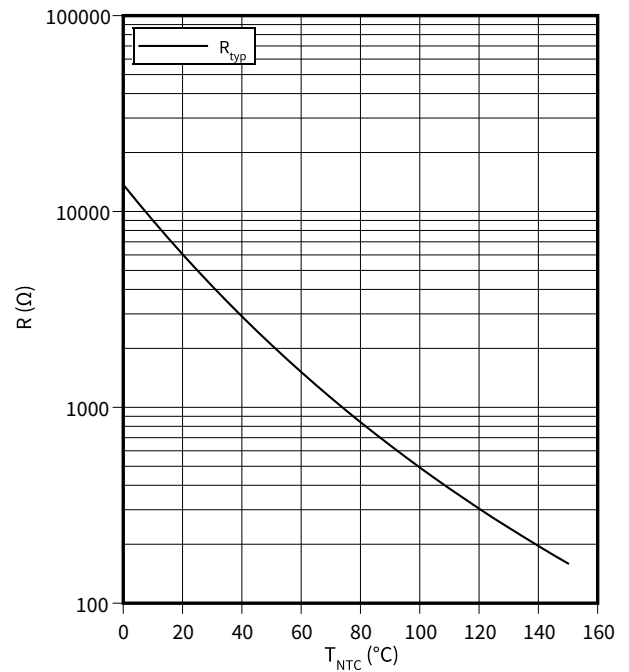
**Transient thermal impedance, Diode, Inverter**

$Z_{th} = f(t)$



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

$R = f(T_{NTC})$



## 6 Circuit diagram

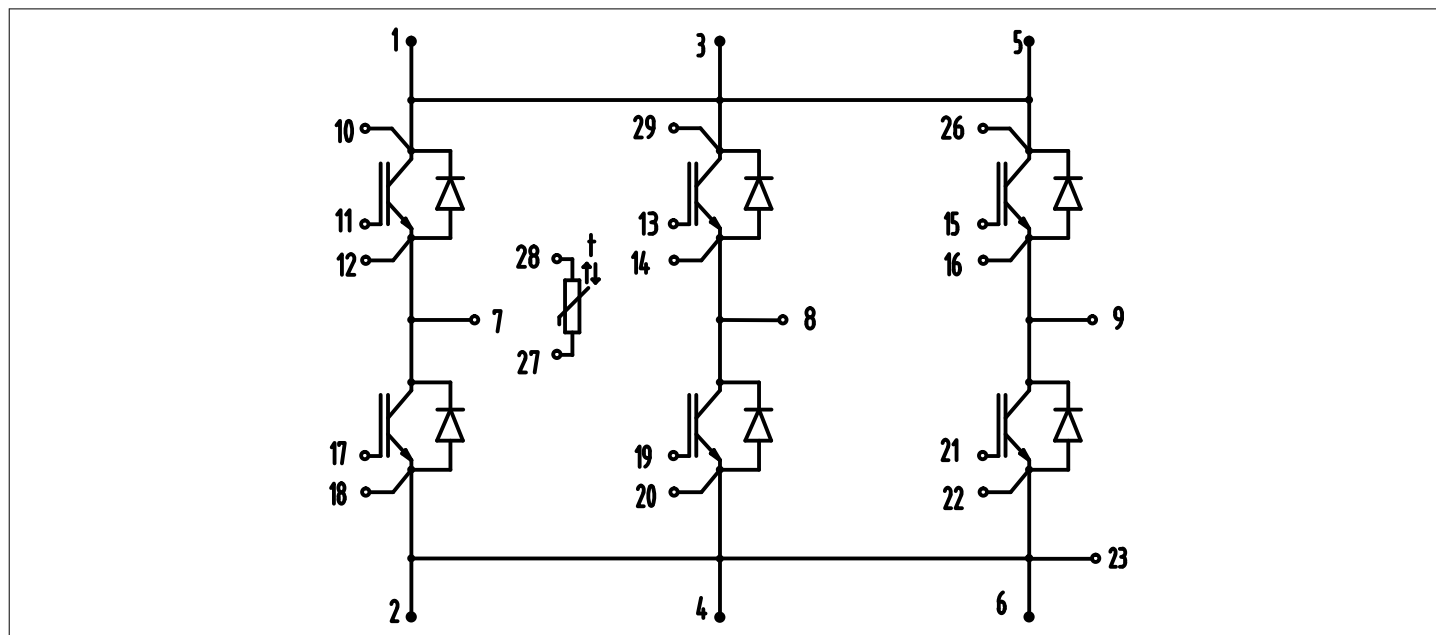





Figure 1



## 8 Module label code

<b>Module label code</b>				
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	
<b>Packing label code</b>				
Code format	Barcode Code128			
Encoding	Code Set A			
Symbol size	34 digits			
Standard	IEC8859-1			
Code content	<i>Content</i>	<i>Identifier</i>	<i>Digit</i>	<i>Example</i>
	Module serial number	X	2 - 9	95056609
	Module material number	1T	12 - 19	2X0003E0
	Production order number	S	21 - 25	754389
	Date code (production year)	9D	28 - 31	1139
	Date code (production week)	Q	33 - 34	15
Example				
	X950566091T2X0003E0S754389D1139Q15			

**Figure 3**

## Revision history

Document revision	Date of release	Description of changes
V1.0	2015-04-24	
V2.0	2015-11-09	
V3.0	2017-03-07	
n/a	2020-10-05	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	2021-12-21	Adjustment of package outline