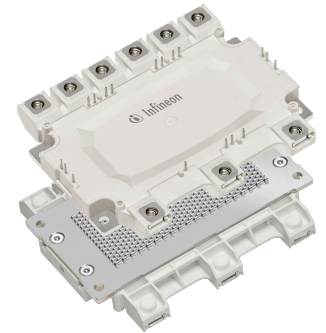


HybridPACK™ DC6 module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode and NTC

Features

- Electrical features
 - $V_{CES} = 700\text{ V}$
 - $I_{C,nom} = 400\text{ A}$
 - Low switching losses
 - Low $V_{CE,sat}$
 - $T_{vj,op} = 150^{\circ}\text{C}$
 - $V_{CE,sat}$ with positive temperature coefficient
 - Increased blocking voltage capability to 705 V
 - Low inductive design
- Mechanical features
 - 2.5 kV AC 1 minute insulation
 - Al_2O_3 substrate with low thermal resistance
 - Direct-cooled base plate with ribbon bonds
 - High mechanical robustness
 - Integrated NTC temperature sensor
 - 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™ DC6 with ribbon bonded cooling structures 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™ DC6 with ribbon bonds is an automotive qualified power module designed for electric vehicle applications. Designed for a 150°C junction operation temperature, the module accommodates a 3-phase Six-Pack configuration of Trench-Field-Stop IGBT3 and matching emitter controlled diodes. The HybridPACK™ DC6 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™ DC6 with ribbon bonds is suitable for direct 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 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.

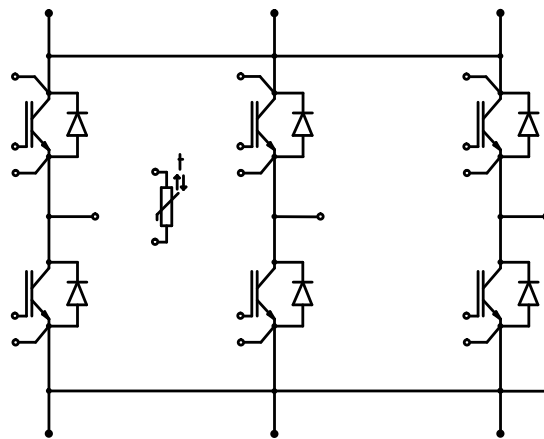


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1 Package

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_2O_3	
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	$I_{t,rms}$	$T_f = 25$, $T_{terminal} = 150$ °C	320 ¹⁾	A

1) DC-collector current limited by internal busbar.

Table 3 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Pressure drop in cooling circuit	Δp	$\Delta V/\Delta t = 10$ dm ³ /min, $T_f = 25$ °C		100		mbar
Maximum pressure in cooling circuit	p				2.0	bar
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			515		g

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
Continuous DC collector current	$I_{C,nom}$	$T_f = 75\text{ °C}, T_{vj,max} = 175\text{ °C}$	400	A
Continuous DC collector current	I_C	$T_f = 25\text{ °C}, T_{vj,max} = 175\text{ °C}$	500	A
Repetitive peak collector current	I_{CRM}	$t_p = 1\text{ ms}$	800	A
Total power dissipation	P_{tot}	$T_f = 25\text{ °C}, T_{vj,max} = 175\text{ °C}$	811	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}	$V_{CE} = 705\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			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	$t_{d,on}$	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, V_{GE} = \pm 15\text{ V}, R_{G,on} = 1.8\text{ Ω}$	$T_{vj} = 25\text{ °C}$	0.12		μs	
			$T_{vj} = 125\text{ °C}$	0.12			
			$T_{vj} = 150\text{ °C}$	0.12			
Rise time, inductive load	t_r	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, V_{GE} = \pm 15\text{ V}, R_{G,on} = 1.8\text{ Ω}$	$T_{vj} = 25\text{ °C}$	0.08		μs	
			$T_{vj} = 125\text{ °C}$	0.08			
			$T_{vj} = 150\text{ °C}$	0.08			
Turn-off delay time, inductive load	$t_{d,off}$	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, V_{GE} = \pm 15\text{ V}, R_{G,off} = 1.8\text{ Ω}$	$T_{vj} = 25\text{ °C}$	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	$I_C = 400 \text{ A}$, $V_{CE} = 300 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_{G,off} = 1.8 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$	0.02		μs
			$T_{vj} = 125 \text{ }^\circ\text{C}$	0.03		
			$T_{vj} = 150 \text{ }^\circ\text{C}$	0.03		
Turn-on energy loss per pulse	E_{on}	$I_C = 400 \text{ A}$, $V_{CE} = 300 \text{ V}$, $L_\sigma = 16 \text{ nH}$, $V_{GE} = \pm 15 \text{ V}$, $R_{G,on} = 1.8 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$	5.1		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	6.8		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $di/dt = 4500 \text{ A}/\mu\text{s}$	7.3		
Turn-off energy loss per pulse	E_{off}	$I_C = 400 \text{ A}$, $V_{CE} = 300 \text{ V}$, $L_\sigma = 16 \text{ nH}$, $V_{GE} = \pm 15 \text{ V}$, $R_{G,off} = 1.8 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$	9.1		mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$	12.0		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $du/dt = 3400 \text{ V}/\mu\text{s}$	12.5		
SC data	I_{SC}	$V_{CC} = 360 \text{ V}$, $V_{GE} \leq 15 \text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} di/dt$	$t_p \leq 8 \mu\text{s}$, $T_{vj} = 25 \text{ }^\circ\text{C}$	2800		A
			$t_p \leq 6 \mu\text{s}$, $T_{vj} = 150 \text{ }^\circ\text{C}$	2000		
Thermal resistance, junction to cooling fluid	$R_{th,j-f}$	per IGBT, $\Delta V/\Delta t = 10.0 \text{ dm}^3/\text{min}$		0.170	0.185	K/W
Temperature under switching conditions	$T_{vj,op}$	t_{op} continuous	-40		150	$^\circ\text{C}$

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}	$T_{vj} = 25 \text{ }^\circ\text{C}$	705	V	
Continuous DC forward current	$I_{F,nom}$		400	A	
Repetitive peak forward current	I_{FRM}	$t_p = 1 \text{ ms}$	800	A	
I^2t - value	I^2t	$V_R = 0 \text{ V}$, $t_p = 10 \text{ ms}$	$T_{vj} = 125 \text{ }^\circ\text{C}$	8800	A^2s
			$T_{vj} = 150 \text{ }^\circ\text{C}$	8500	

Table 7 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 400 \text{ A}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	1.55	1.95	V
			$T_{vj} = 125 \text{ °C}$	1.50		
			$T_{vj} = 150 \text{ °C}$	1.45		
Peak reverse recovery current	I_{rm}	$I_F = 400 \text{ A}, V_{GE} = -15 \text{ V}, V_R = 300$	$T_{vj} = 25 \text{ °C}$	205		A
			$T_{vj} = 125 \text{ °C}$	295		
			$T_{vj} = 150 \text{ °C}, -di_F/dt = 4500 \text{ A}/\mu\text{s}$	305		
Recovered charge	Q_r	$I_F = 400 \text{ A}, V_{GE} = -15 \text{ V}, V_R = 300$	$T_{vj} = 25 \text{ °C}$	15.0		μC
			$T_{vj} = 125 \text{ °C}$	32.0		
			$T_{vj} = 150 \text{ °C}, -di_F/dt = 4500 \text{ A}/\mu\text{s}$	34.0		
Reverse recovery energy	E_{rec}	$I_F = 400 \text{ A}, V_{GE} = -15 \text{ V}, V_R = 300$	$T_{vj} = 25 \text{ °C}$	3.35		mJ
			$T_{vj} = 125 \text{ °C}$	6.90		
			$T_{vj} = 150 \text{ °C}, -di_F/dt = 4500 \text{ A}/\mu\text{s}$	8.10		
Thermal resistance, junction to cooling fluid	$R_{th,j-f}$	per diode, $\Delta V/\Delta t = 10.0 \text{ dm}^3/\text{min}$		0.270	0.300	K/W
Temperature under switching conditions	$T_{vj,op}$	t_{op} continuous	-40		150	°C

Note: DC-collector 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_{25}	$T_{NTC} = 25 \text{ °C}$		5		k Ω
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 25 \text{ °C}, R_{100} = 493 \text{ }\Omega$	-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

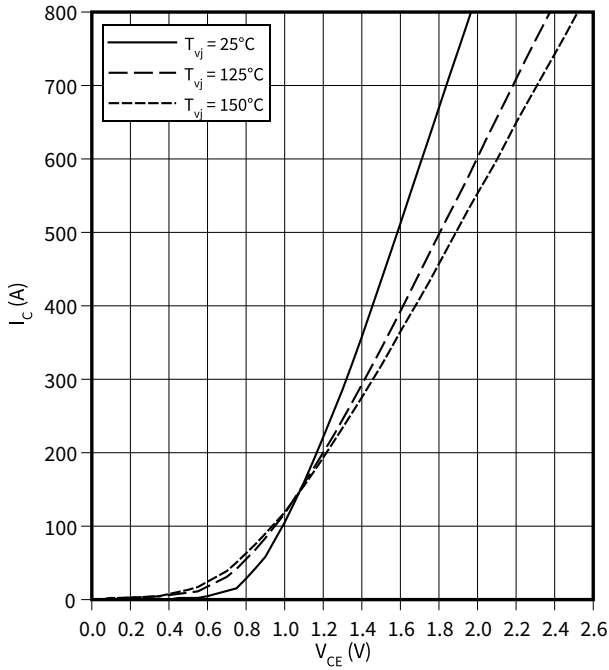
Note: Specification according to the valid application note.

5 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

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

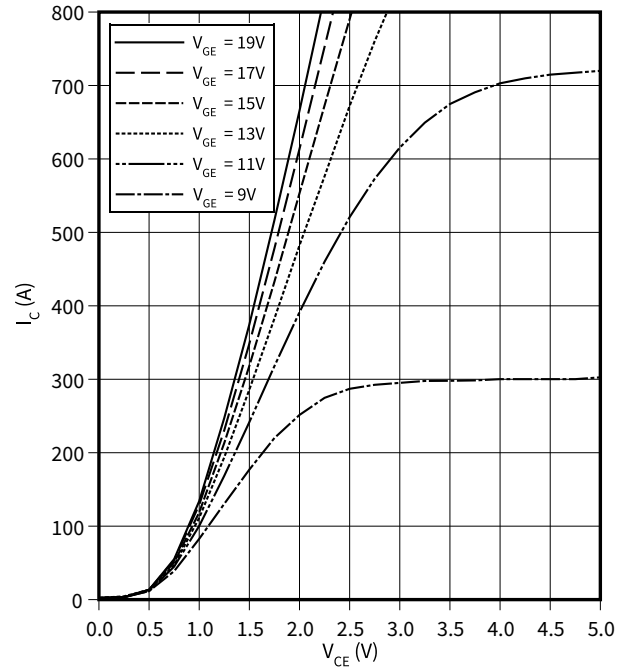
$$V_{GE} = 15 \text{ V}$$



Output characteristic (typical), IGBT, Inverter

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

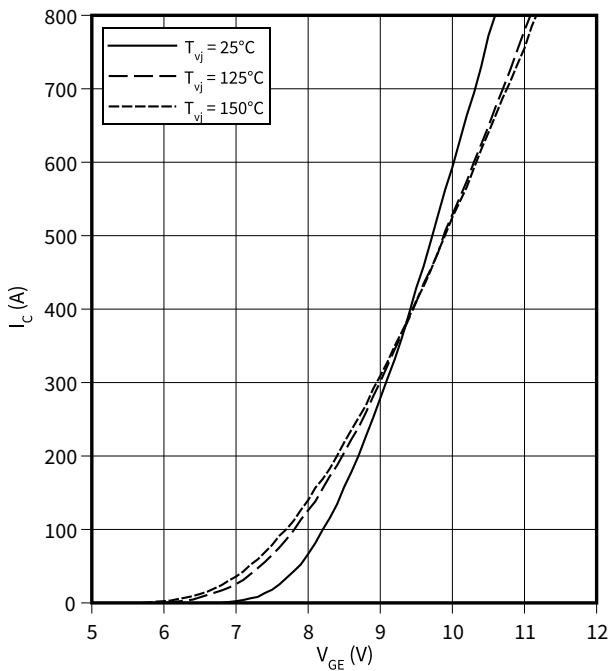
$$T_{vj} = 150 \text{ °C}$$



Transfer characteristic (typical), IGBT, Inverter

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

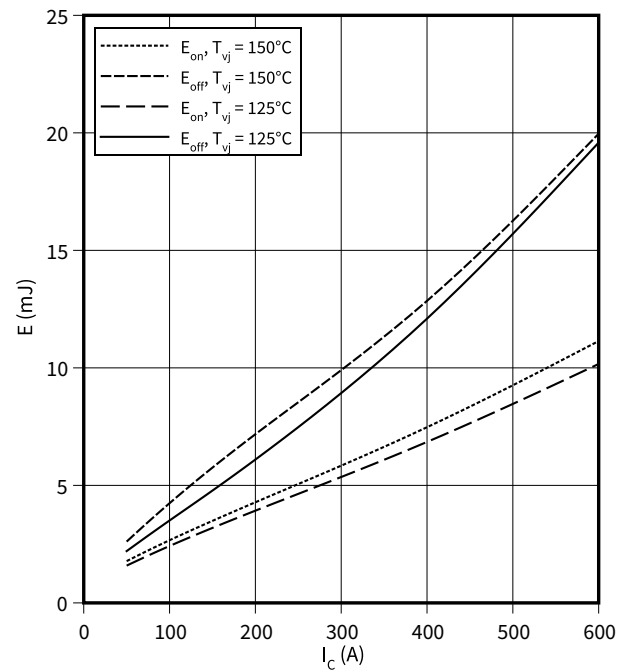
$$V_{CE} = 20 \text{ V}$$



Switching losses (typical), IGBT, Inverter

$$E = f(I_C)$$

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

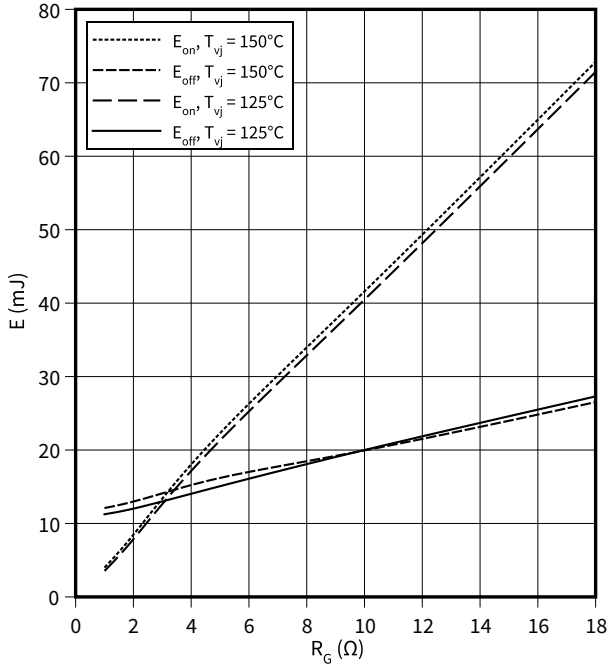


5 Characteristics diagrams

Switching losses (typical), IGBT, Inverter

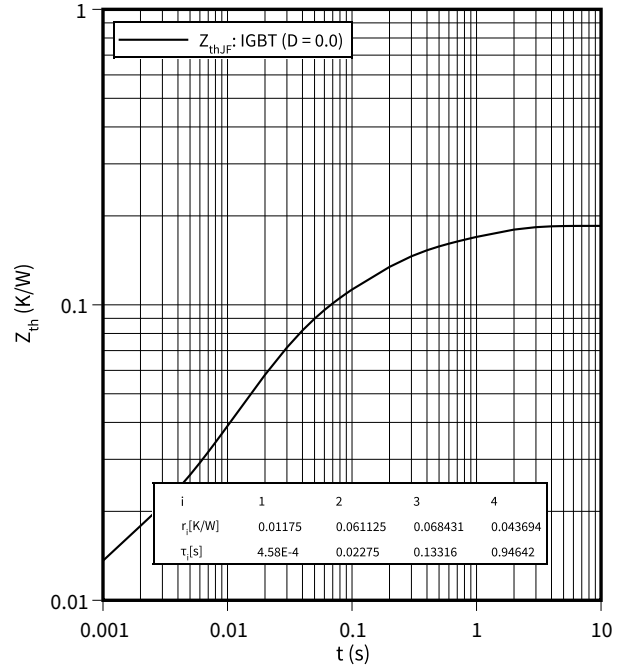
$E = f(R_G)$

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



Transient thermal impedance, IGBT, Inverter

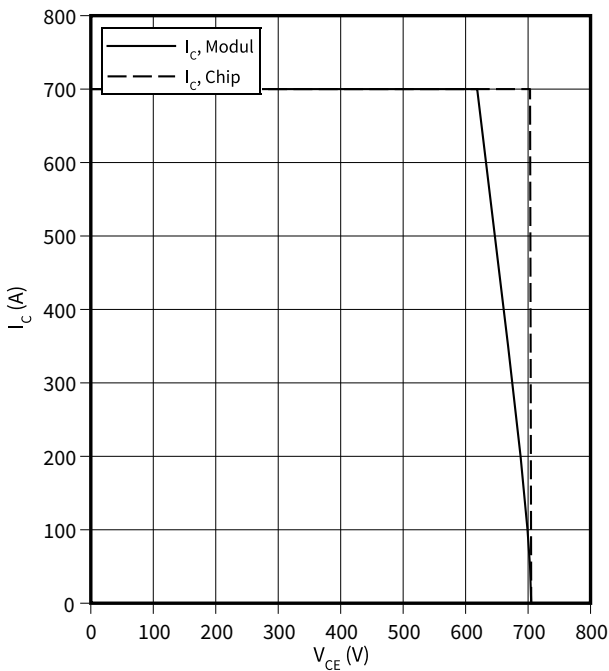
$Z_{th} = f(t)$



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

$I_C = f(V_{CE})$

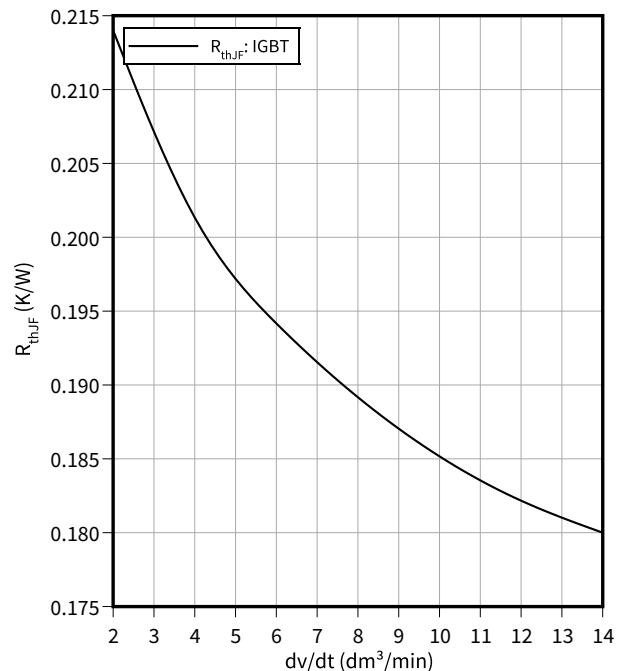
$T_{vj} = 150\text{ °C}, R_{G,off} = 1.8\text{ Ω}, V_{GE} = \pm 15\text{ V}$



Thermal impedance, IGBT, Inverter

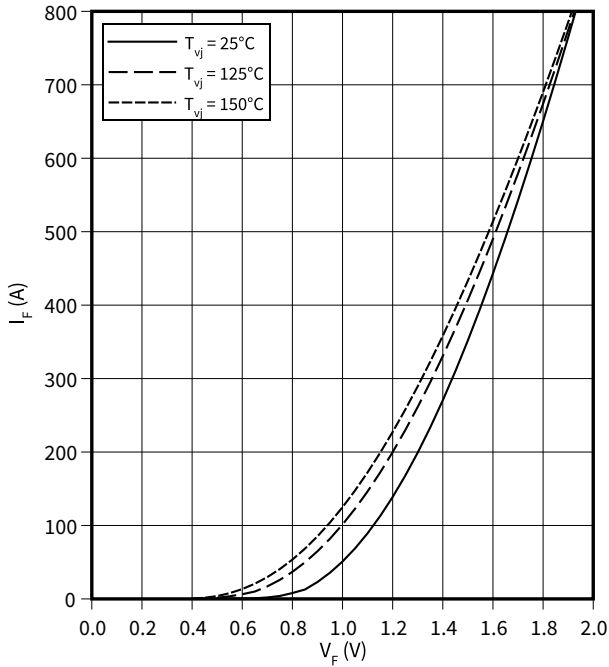
$R_{thJF} = f(dv/dt)$

$T_f = 25\text{ °C}, \text{fluid} = 50\% \text{ water}/50\% \text{ ethylenglycol}$



Forward characteristic (typical), Diode, Inverter

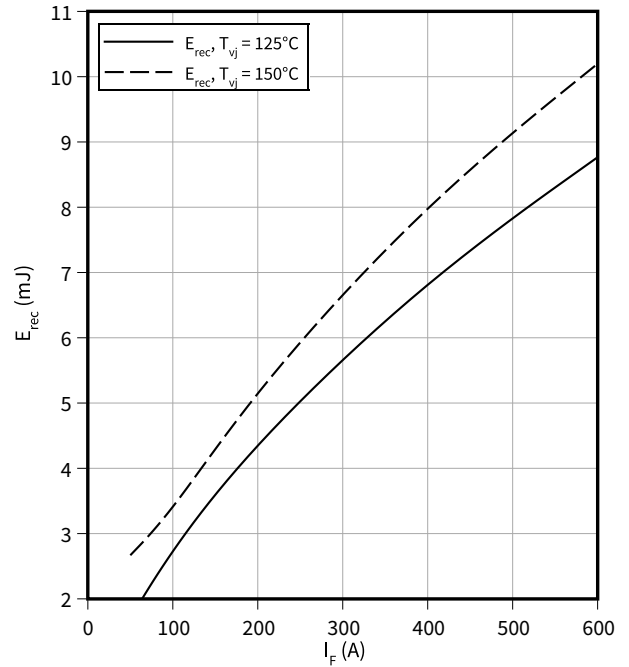
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

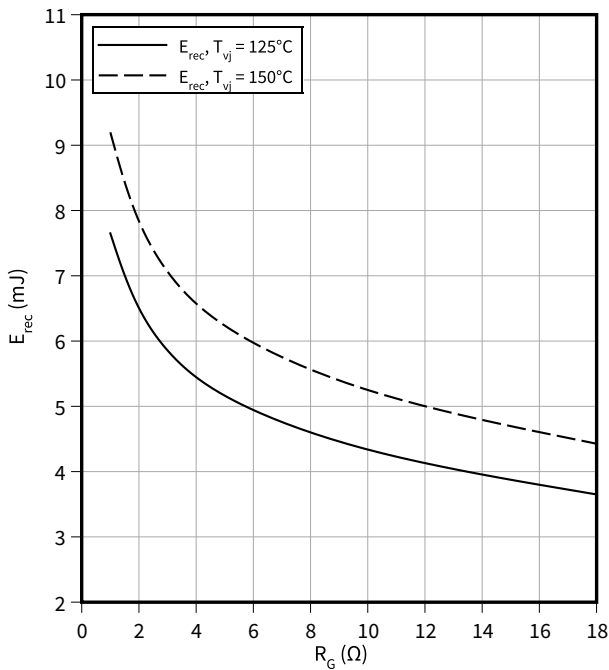
$R_{Gon} = 1.8 \Omega, V_{CE} = 300 \text{ V}$



Switching losses (typical), Diode, Inverter

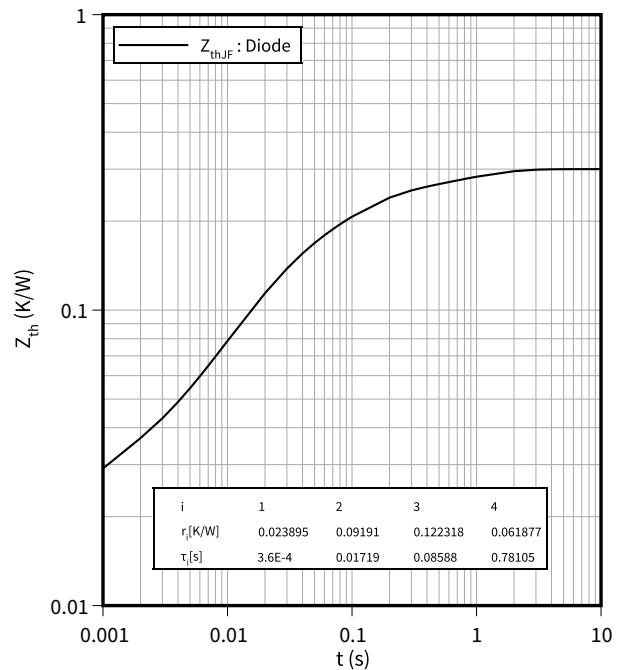
$E_{rec} = f(R_G)$

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



Transient thermal impedance, Diode, Inverter

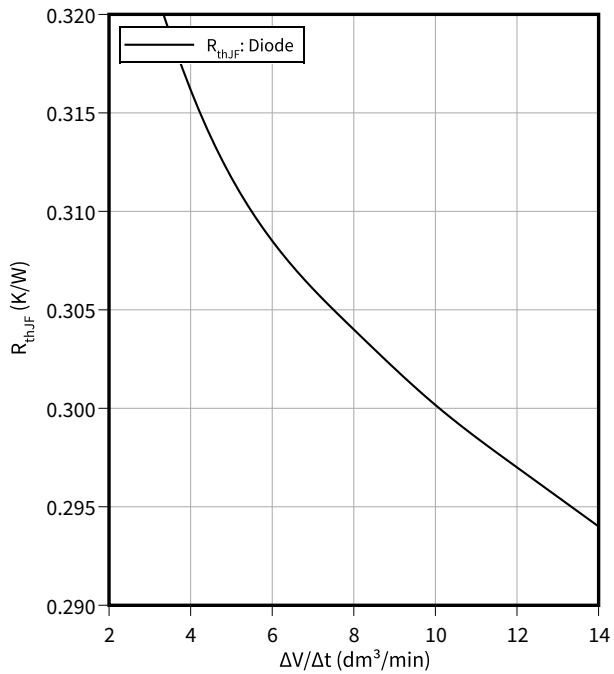
$Z_{th} = f(t)$



Thermal impedance , Diode, Inverter

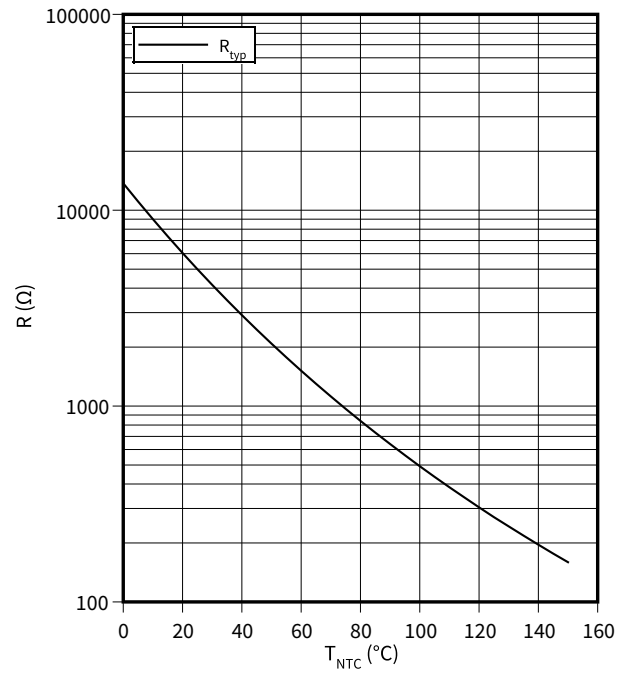
$$R_{thJF} = f(\Delta V/\Delta t)$$

$T_f = 25\text{ °C}$, fluid = 50% water/50% ethylenglycol



Temperature characteristic (typical), NTC-Thermistor

$$R = f(T_{NTC})$$



6 Circuit diagram

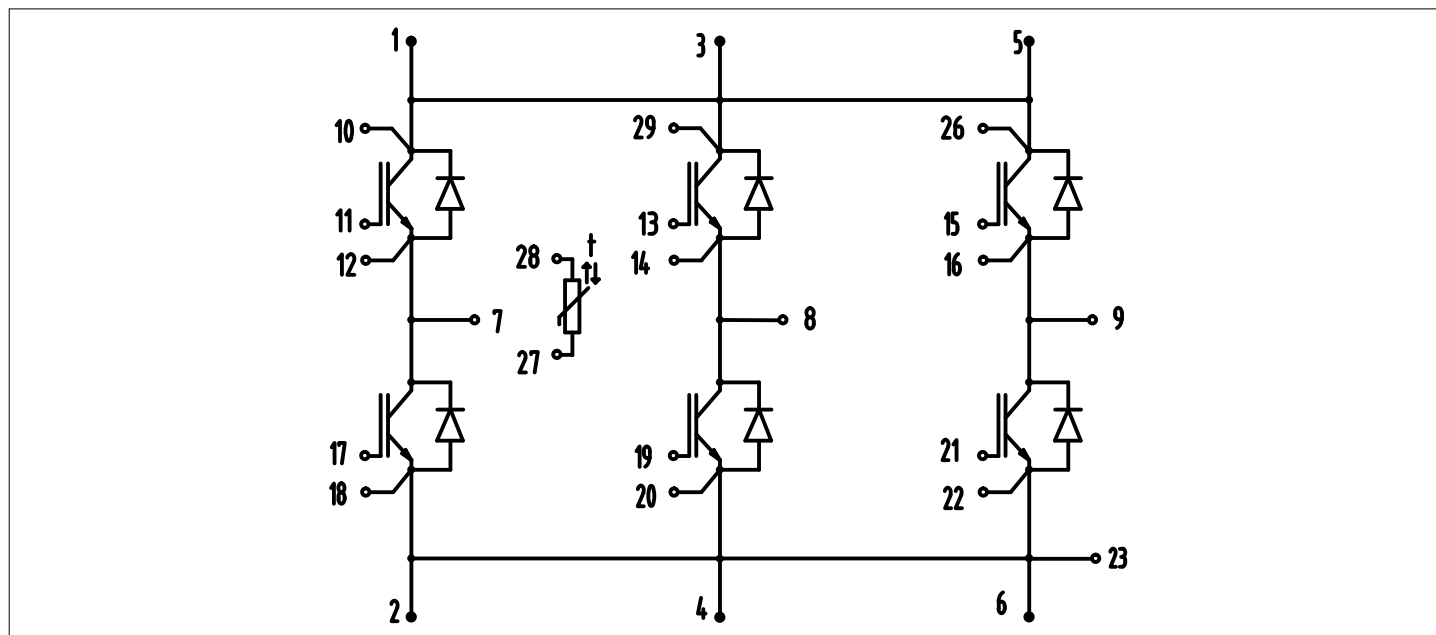


Figure 1

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	
Packing label code				
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	2017-04-06	
V2.0	2018-01-15	
V3.0	2018-03-26	Final datasheet
V3.1	2019-12-19	Correction of mechanical feature
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	2021-03-05	Adaption of electrical features
1.20	2021-12-21	Adjustment of package outline