

HybridPACK™ DC6 Module

FS400R07A3E3_H6

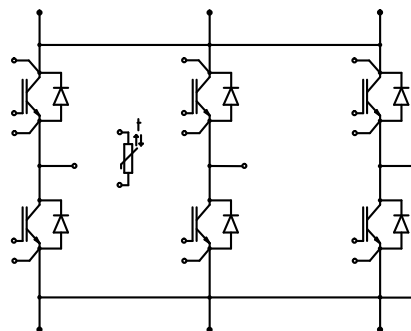
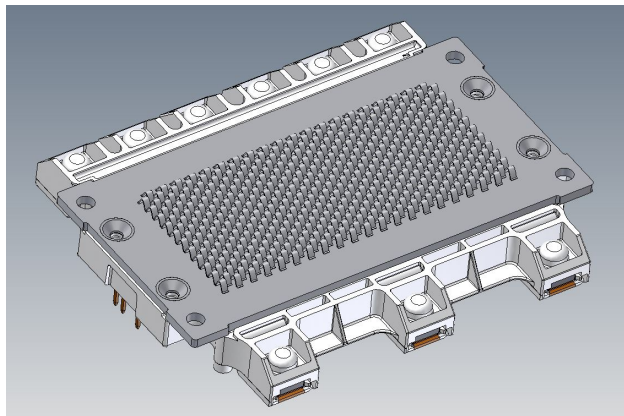
Final Data Sheet

V3.0, 2018-03-26

Automotive High Power

1 Features / Description

HybridPACK™ DC6 module with Trench/Fieldstop IGBT3 and Emitter Controlled 3 diode and NTC



$V_{CES} = 700V$

$I_{C\ nom} = 400A$

Typical Applications

- Automotive Applications
- Hybrid Electrical Vehicles (H)EV
- Commercial Agriculture Vehicles
- Motor Drives

Electrical Features

- Low Switching Losses
- Low V_{CESat}
- $T_{vj\ op} = 150^{\circ}C$
- V_{CESat} with positive Temperature Coefficient
- Increased blocking voltage capability to 705V

Mechanical Features

- 2.5kV AC 1min Insulation
- Al_2O_3 Substrate with Low Thermal Resistance
- Direct Cooled PinFin Base Plate
- High mechanical robustness
- Integrated NTC temperature sensor
- Copper Base Plate
- RoHS compliant

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, with a 30 hour limited 175°C capacity 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 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.

Product Name	Ordering Code
FS400R07A3E3_H6	SP001632430

2 IGBT, Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	$T_{vj} = 25^{\circ}\text{C}$	V_{CES}	705	V
Continuous DC collector current	$T_F = 75^{\circ}\text{C}, T_{vj\text{ max}} = 175^{\circ}\text{C}$ $T_F = 25^{\circ}\text{C}, T_{vj\text{ max}} = 175^{\circ}\text{C}$	$I_{C\text{ nom}}$ I_C	400 ¹⁾ 500 ¹⁾	A A
Repetitive peak collector current	$t_P = 1\text{ ms}$	I_{CRM}	800	A
Total power dissipation	$T_F = 25^{\circ}\text{C}, T_{vj\text{ max}} = 175^{\circ}\text{C}$	P_{tot}	811	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 Characteristic Values

			min.	typ.	max.	
Collector-emitter saturation voltage	$I_C = 400\text{ A}, V_{GE} = 15\text{ V}$ $I_C = 400\text{ A}, V_{GE} = 15\text{ V}$ $I_C = 400\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$V_{CE\text{ sat}}$	1.45 1.60 1.70	1.70	V
Gate threshold voltage	$I_C = 6.40\text{ mA}, V_{CE} = V_{GE}$	$T_{vj} = 25^{\circ}\text{C}$	$V_{GE\text{ th}}$	4.90	5.80	6.50 V
Gate charge	$V_{GE} = -15\text{ V} \dots 15\text{ V}$		Q_G	4.30		μC
Internal gate resistor		$T_{vj} = 25^{\circ}\text{C}$	$R_{G\text{int}}$	1.0		Ω
Input capacitance	$f = 1\text{ MHz}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	C_{ies}	26.0		nF
Reverse transfer capacitance	$f = 1\text{ MHz}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	C_{res}	0.76		nF
Collector-emitter cut-off current	$V_{CE} = 705\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	I_{CES}		0.1	mA
Gate-emitter leakage current	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	I_{GES}		400	nA
Turn-on delay time, inductive load	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = \pm 15\text{ V}$ $R_{G\text{on}} = 1.8\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{ on}}$	0.12 0.12 0.12		μs
Rise time, inductive load	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = \pm 15\text{ V}$ $R_{G\text{on}} = 1.8\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	t_r	0.08 0.08 0.08		μs
Turn-off delay time, inductive load	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = \pm 15\text{ V}$ $R_{G\text{off}} = 1.8\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{ off}}$	0.36 0.40 0.40		μs
Fall time, inductive load	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = \pm 15\text{ V}$ $R_{G\text{off}} = 1.8\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	t_f	0.02 0.03 0.03		μs
Turn-on energy loss per pulse	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, L_S = 25\text{ nH}$ $V_{GE} = \pm 15\text{ V}, di/dt = 5500\text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $R_{G\text{on}} = 1.8\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	E_{on}	5.10 6.80 7.30		mJ
Turn-off energy loss per pulse	$I_C = 400\text{ A}, V_{CE} = 300\text{ V}, L_S = 25\text{ nH}$ $V_{GE} = \pm 15\text{ V}, du/dt = 3000\text{ V}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $R_{G\text{off}} = 1.8\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	E_{off}	9.10 12.0 12.5		mJ
SC data	$V_{GE} \leq 15\text{ V}, V_{CC} = 360\text{ V}$ $V_{CE\text{ max}} = V_{CES} - L_{SCE} \cdot di/dt$	$t_P \leq 8\text{ }\mu\text{s}, T_{vj} = 25^{\circ}\text{C}$ $t_P \leq 6\text{ }\mu\text{s}, T_{vj} = 150^{\circ}\text{C}$	I_{SC}	2800 2000		A
Thermal resistance, junction to cooling fluid	per IGBT; $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$		R_{thJF}	0.170	0.185	K/W
Temperature under switching conditions	$t_{op}\text{ continuous}$		$T_{vj\text{ op}}$	-40	150	$^{\circ}\text{C}$

¹⁾ DC-collector current limited by power terminals.

3 Diode, Inverter

3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	$T_{vj} = 25^{\circ}\text{C}$	V_{RRM}	705	V
Continuous DC forward current		I_F	400 ¹⁾	A
Repetitive peak forward current	$t_P = 1 \text{ ms}$	I_{FRM}	800	A
I^2t - value	$V_R = 0 \text{ V}$, $t_P = 10 \text{ ms}$, $T_{vj} = 125^{\circ}\text{C}$ $V_R = 0 \text{ V}$, $t_P = 10 \text{ ms}$, $T_{vj} = 150^{\circ}\text{C}$	I^2t	8800 8500	A^2s A^2s

3.2 Characteristic Values

			min.	typ.	max.	
Forward voltage	$I_F = 400 \text{ A}$, $V_{GE} = 0 \text{ V}$ $I_F = 400 \text{ A}$, $V_{GE} = 0 \text{ V}$ $I_F = 400 \text{ A}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	V_F	1.55 1.50 1.45	1.95	V
Peak reverse recovery current	$I_F = 400 \text{ A}$, $-di_F/dt = 5500 \text{ A}/\mu\text{s}$ ($T_{vj} = 150^{\circ}\text{C}$) $V_R = 300 \text{ V}$ $V_{GE} = -15 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	I_{RM}	205 295 305		A
Recovered charge	$I_F = 400 \text{ A}$, $-di_F/dt = 5500 \text{ A}/\mu\text{s}$ ($T_{vj} = 150^{\circ}\text{C}$) $V_R = 300 \text{ V}$ $V_{GE} = -15 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	Q_r	15.0 32.0 34.0		μC
Reverse recovery energy	$I_F = 400 \text{ A}$, $-di_F/dt = 5500 \text{ A}/\mu\text{s}$ ($T_{vj} = 150^{\circ}\text{C}$) $V_R = 300 \text{ V}$ $V_{GE} = -15 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	E_{rec}	3.35 6.90 8.10		mJ
Thermal resistance, junction to cooling fluid	per diode; $\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}$	R_{thJF}		0.270	0.300	K/W
Temperature under switching conditions	t_{op} continuous	$T_{vj op}$	-40		150	$^{\circ}\text{C}$

4 NTC-Thermistor

			min.	typ.	max.	
Parameter	Conditions	Symbol	Value			Unit
Rated resistance	$T_C = 25^{\circ}\text{C}$	R_{25}		5.00		$\text{k}\Omega$
Deviation of R_{100}	$T_C = 100^{\circ}\text{C}$, $R_{100} = 493 \Omega$	$\Delta R/R$	5		5	%
Power dissipation	$T_C = 25^{\circ}\text{C}$	P_{25}			20.0	mW
B-value	$R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298,15 \text{ K}))]$	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298,15 \text{ K}))]$	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298,15 \text{ K}))]$	$B_{25/100}$		3433		K

Specification according to the valid application note.

¹⁾ DC-collector current limited by power terminals.

5 Module

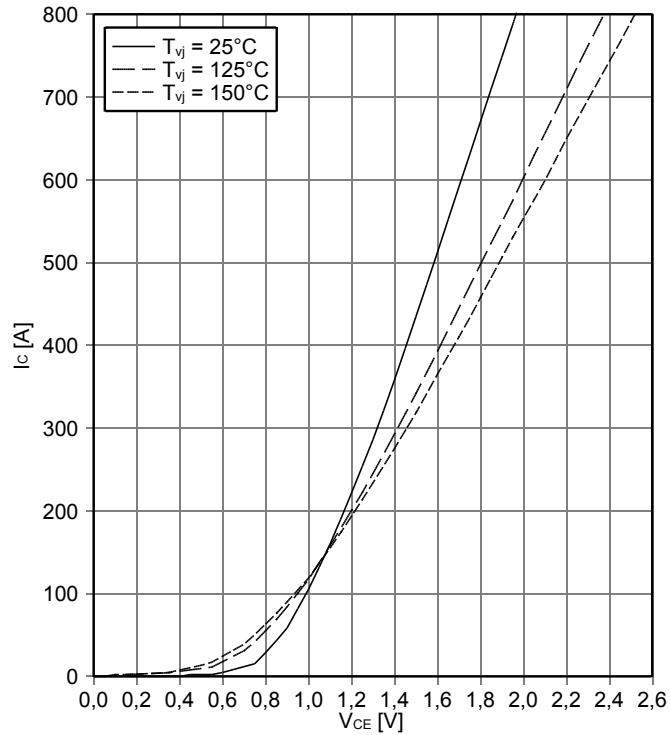
Parameter	Conditions	Symbol	Value			Unit
Isolation test voltage	RMS, f = 50 Hz, t = 1 min.	V _{ISOL}	2.5			kV
Maximum RMS module terminal current	T _F = 25°C, T _{Ct} = 150°C	I _{IRMS}	320 ¹⁾			A
Material of module baseplate			Cu			
Internal isolation	basic insulation (class 1, IEC 61140)		Al ₂ O ₃			
Creepage distance	terminal to heatsink terminal to terminal	d _{Creep}	12.0 6.1			mm
Clearance	terminal to heatsink terminal to terminal	d _{Clear}	12.0 6.1			mm
Comperative tracking index		CTI	> 200			
			min.	typ.	max.	
Pressure drop in cooling circuit	ΔV/Δt = 10.0 dm³/min; T _F = 25°C	Δp		100		mbar
Maximum pressure in cooling circuit		p			2.0	bar
Stray inductance module		L _{sCE}		15		nH
Module lead resistance, terminals - chip	T _F = 25 °C, per switch	R _{CC'+EE'}		1.00		mΩ
Storage temperature		T _{stg}	-40		125	°C
Mounting torque for modul mounting	Screw M5 baseplate to heatsink	M	3.00		6.00	Nm
Terminal connection torque	Screw M6	M	3.0	-	6.0	Nm
Weight		G		515		g

¹⁾ DC-collector current limited by internal busbar

6 Characteristics Diagrams

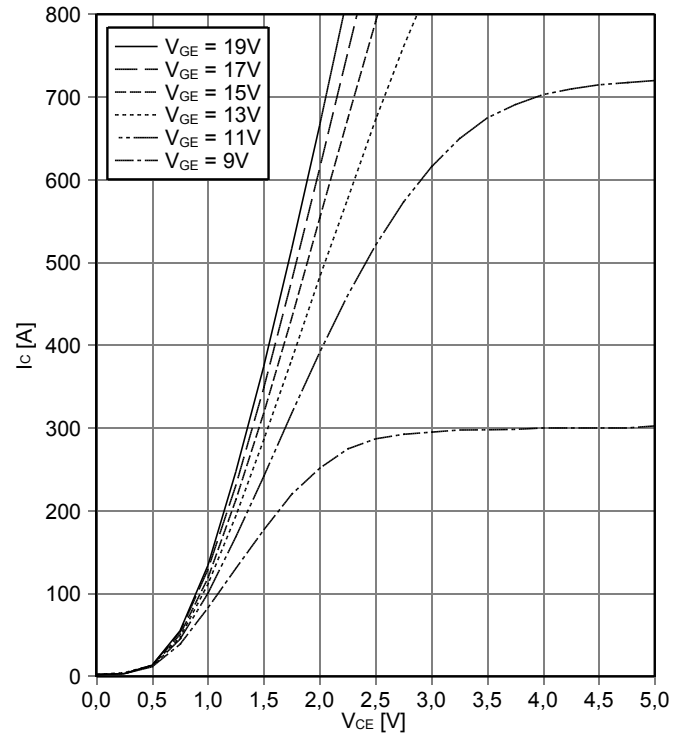
output characteristic IGBT, Inverter (typical)

$I_C = f(V_{CE})$
 $V_{GE} = 15 \text{ V}$



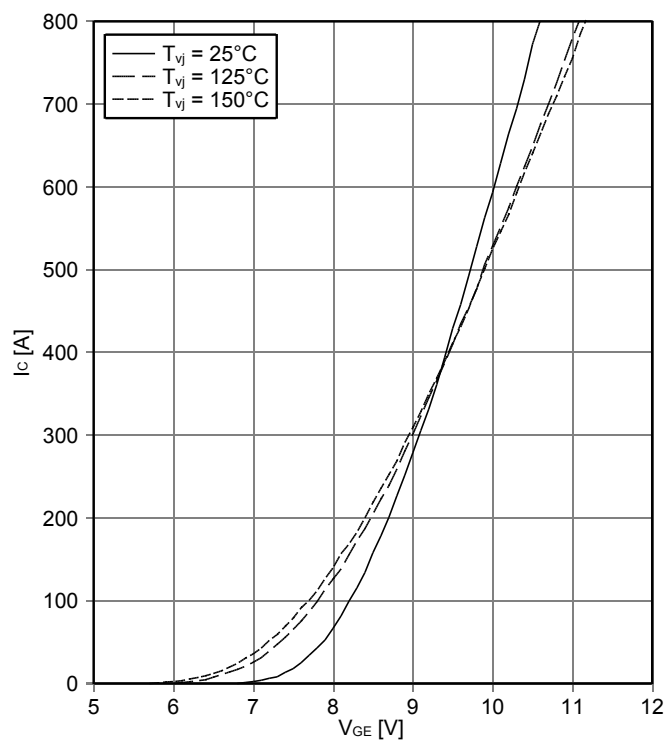
output characteristic IGBT, Inverter (typical)

$I_C = f(V_{CE})$
 $T_{vj} = 150^\circ\text{C}$



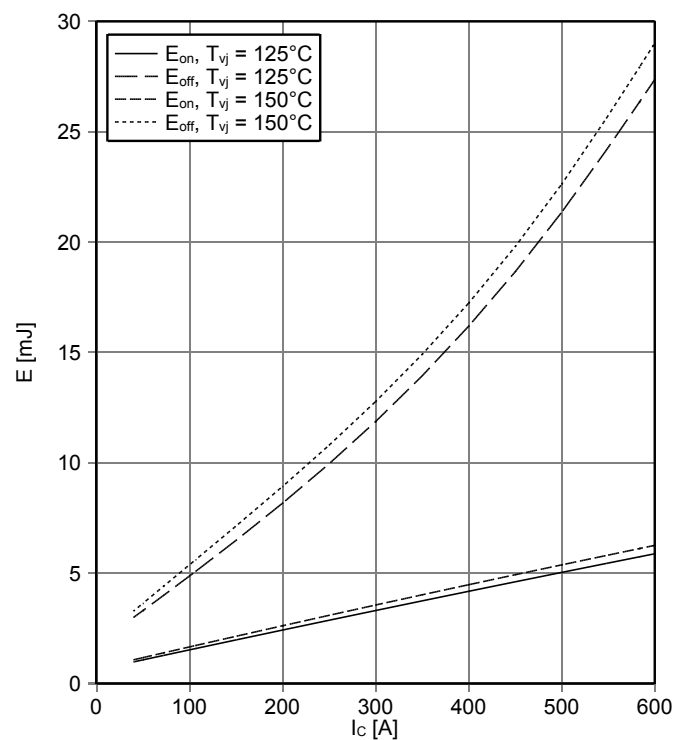
transfer characteristic IGBT, Inverter (typical)

$I_C = f(V_{GE})$
 $V_{CE} = 20 \text{ V}$



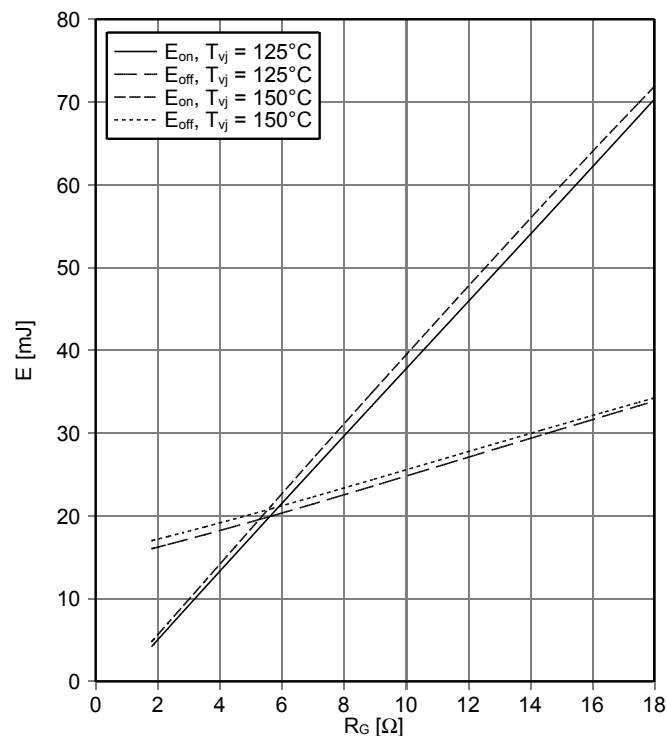
switching losses IGBT, Inverter (typical)

$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
 $V_{GE} = \pm 15 \text{ V}$, $R_{Gon} = 1.8 \Omega$, $R_{Goff} = 1.8 \Omega$, $V_{CE} = 300 \text{ V}$



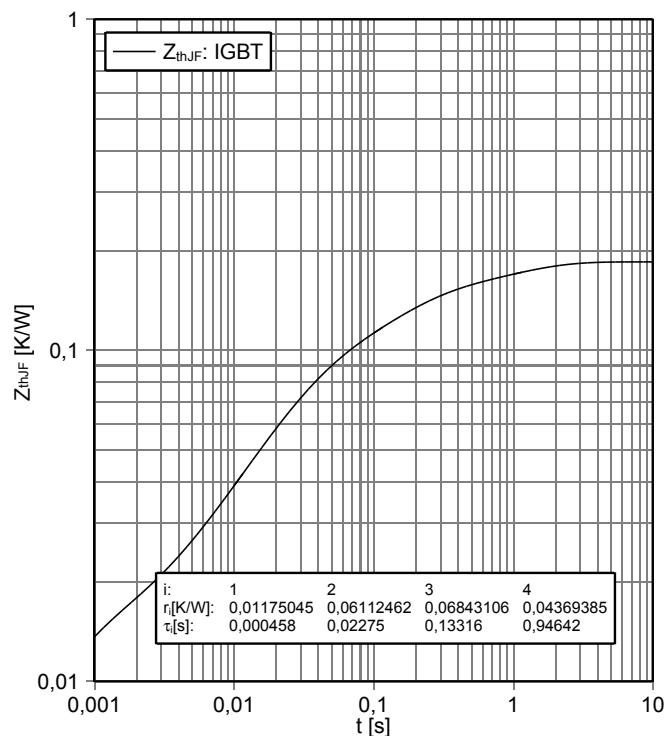
switching losses IGBT, Inverter (typical)

$E_{on} = f(R_G)$, $E_{off} = f(R_G)$
 $V_{GE} = \pm 15 \text{ V}$, $I_C = 400 \text{ A}$, $V_{CE} = 300 \text{ V}$



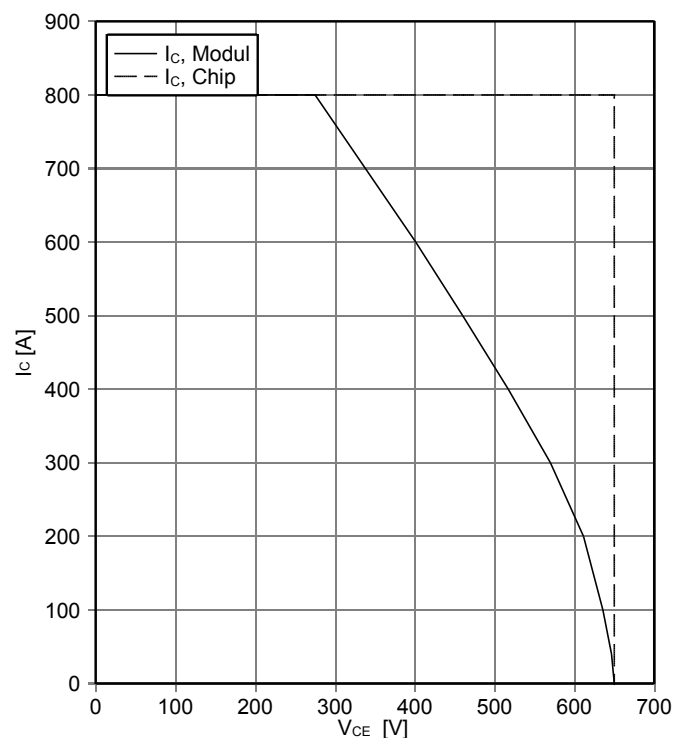
transient thermal impedance IGBT, Inverter

$Z_{thJF} = f(t)$ ($\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}$)



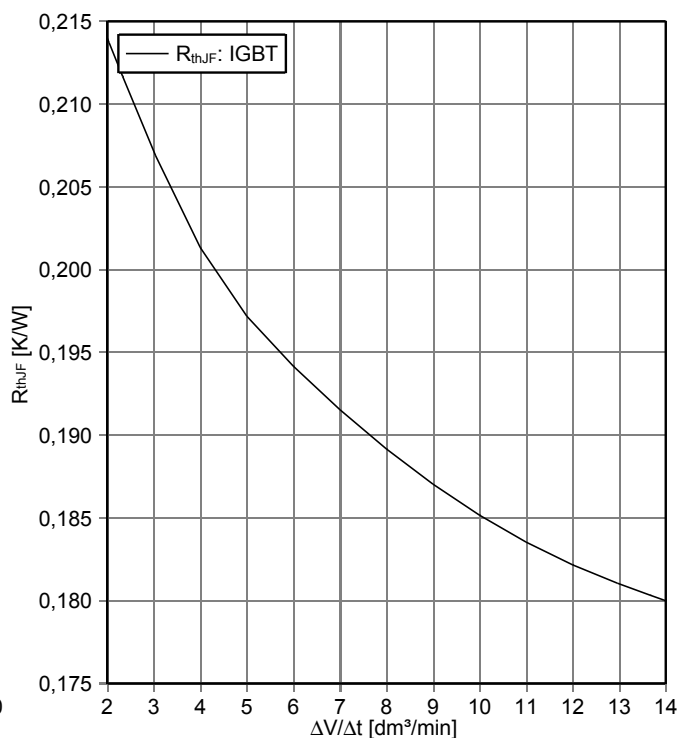
reverse bias safe operating area IGBT, Inverter (RBSOA)

$I_C = f(V_{CE})$
 $V_{GE} = \pm 15 \text{ V}$, $R_{Goff} = 1.8 \Omega$, $T_{vj} = 150^\circ\text{C}$



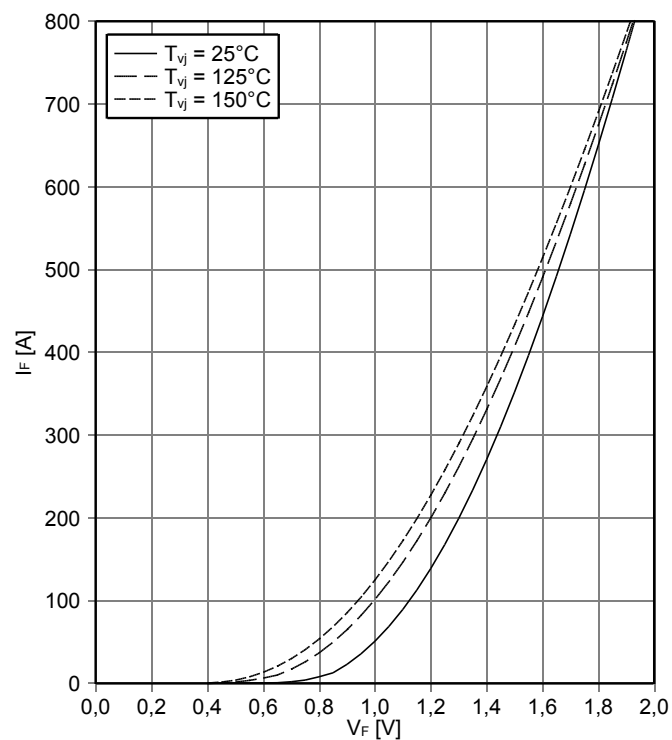
thermal impedance IGBT, Inverter

$R_{thJF} = f(\Delta V/\Delta t)$
cooling fluid = 50% water/50% ethylenglycol



forward characteristic of Diode, Inverter (typical)

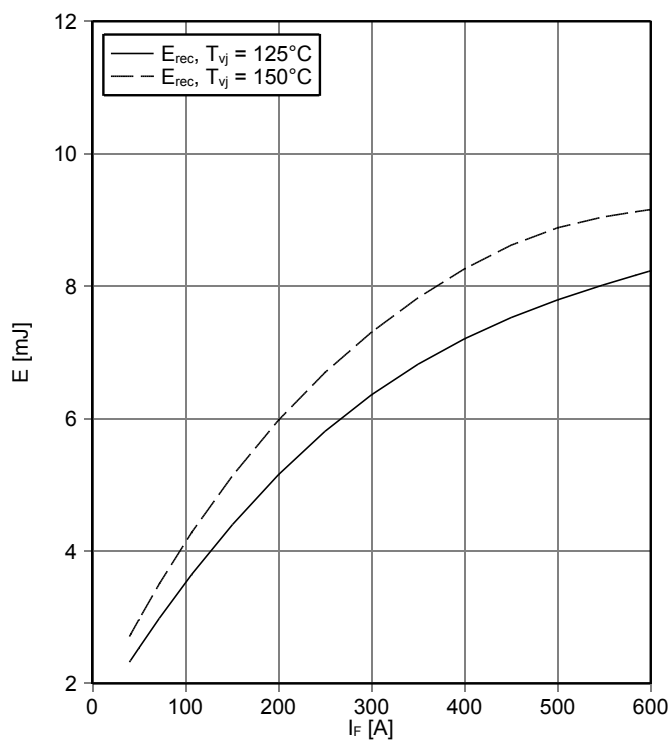
$$I_F = f(V_F)$$



switching losses Diode, Inverter (typical)

$$E_{rec} = f(I_F)$$

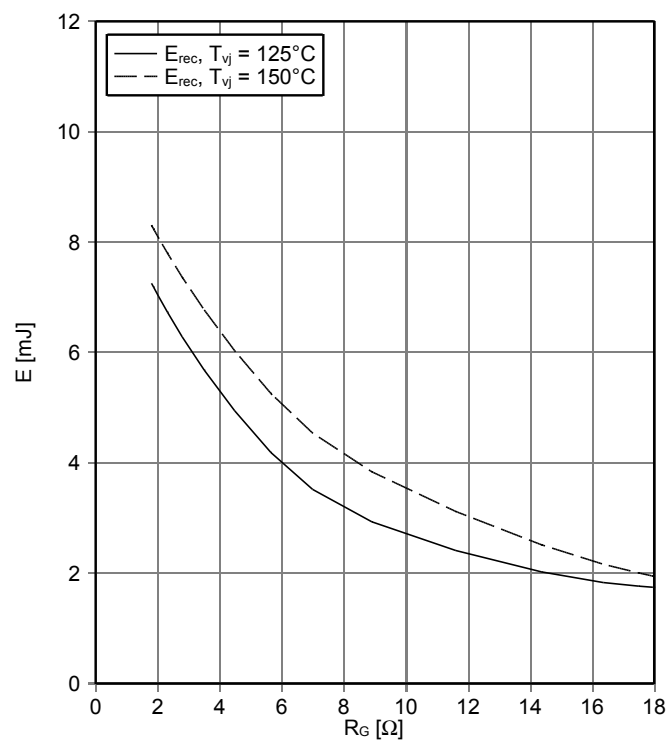
$$R_{Gon} = 1.8 \Omega, V_{CE} = 300 \text{ V}$$



switching losses Diode, Inverter (typical)

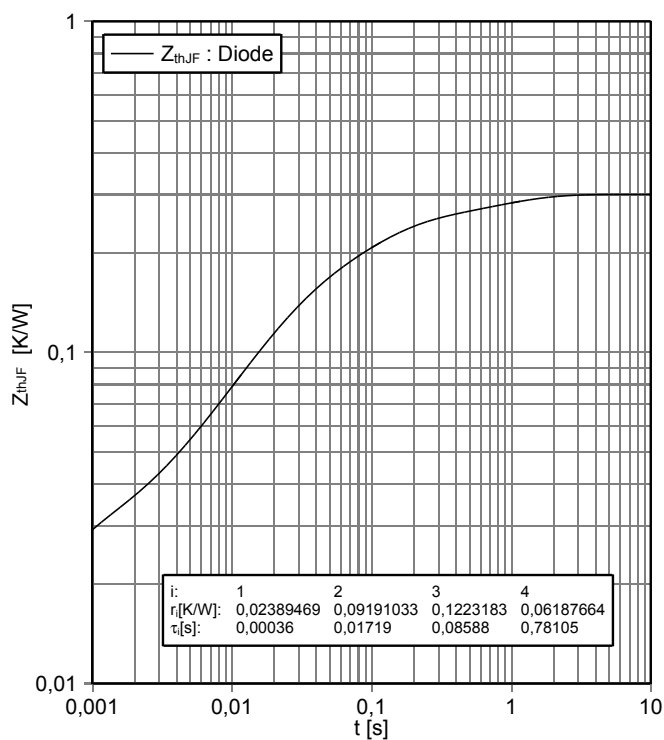
$$E_{rec} = f(R_G)$$

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



transient thermal impedance Diode, Inverter

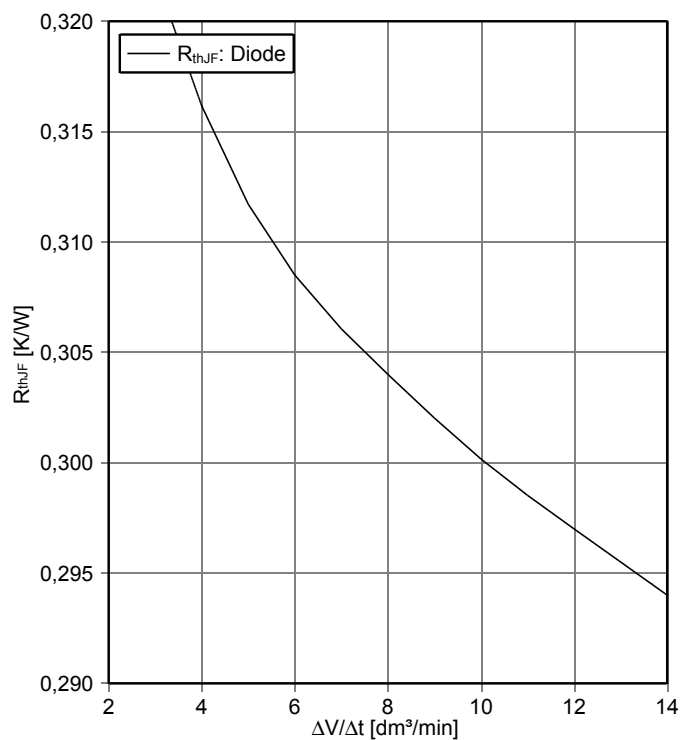
$$Z_{thJF} = f(t) (\Delta V/\Delta t = 10 \text{ dm}^3/\text{min})$$



thermal impedance Diode, Inverter

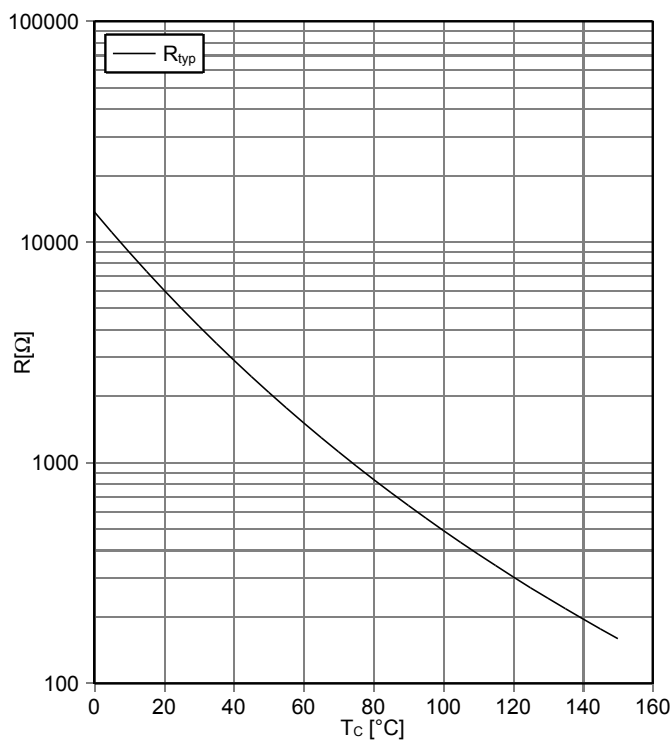
$$R_{thJF} = f(\Delta V/\Delta t)$$

cooling fluid = 50% water/50% ethylenglycol

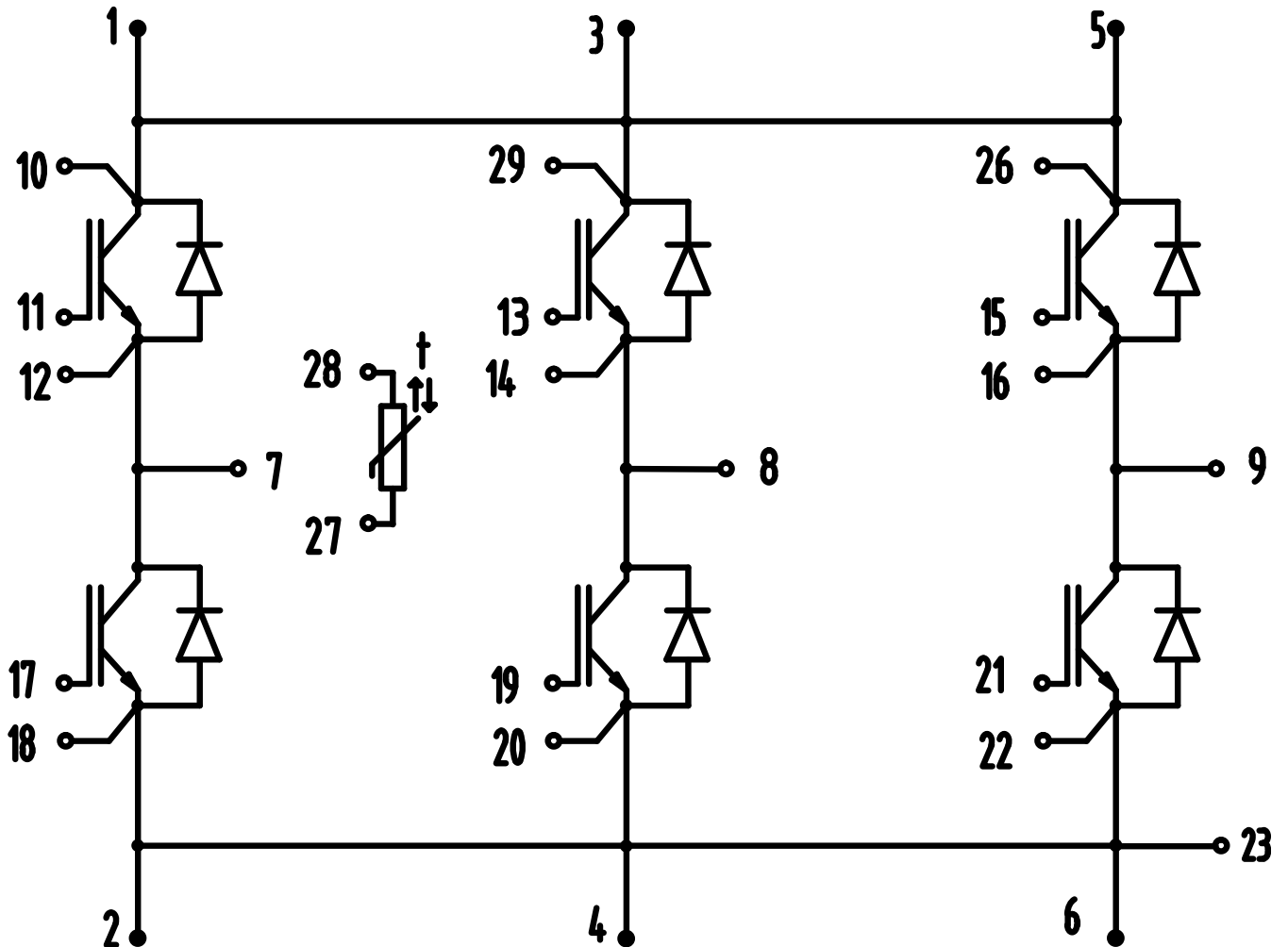


NTC-Thermistor-temperature characteristic (typical)

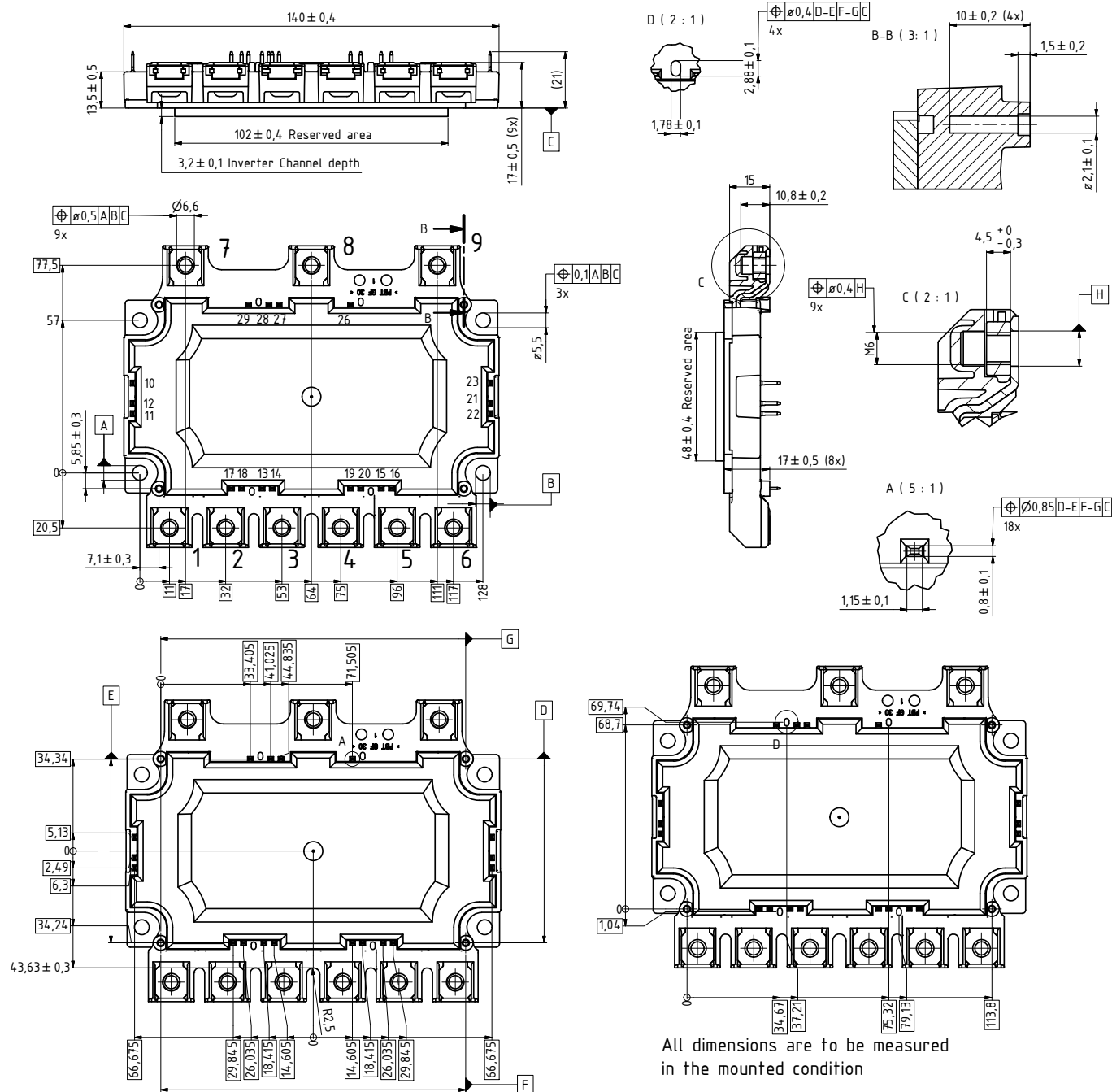
$$R = f(T)$$



7 Circuit diagram

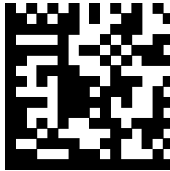


8 Package outlines



9 Label Codes

9.1 Module Code

Code Format	Data Matrix		
Encoding	ASCII Text		
Symbol Size	16x16		
Standard	IEC24720 and IEC16022		
Code Content	Content Module Serial Number Module Material Number Production Order Number Datecode (Production Year) Datecode (Production Week)	Digit 1 - 5 6 - 11 12 - 19 20 - 21 22 - 23	Example (below) 71549 142846 55054991 15 30
Example	 71549142846550549911530		

9.2 Packing Code

Code Format	Code128			
Encoding	Code Set A			
Symbol Size	34 digits			
Standard	IEC8859-1			
Code Content	Content Backend Construction Number Production Lot Number Serial Number Date Code Box Quantity	Identifier X 1T S 9D Q	Digit 2 - 9 12 - 19 21 - 25 28 - 31 33 - 34	Example (below) 95056609 2X0003E0 754389 1139 15
Example	 X950566091T2X0003E0S754389D1139Q15			

Revision History

Major changes since previous revision

Revision History

Reference	Date	Description
V1.0	2017-04-06	-
V2.0	2018-01-15	-
V3.0	2018-03-26	Final datasheet

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