HybridPACK™ 1 Module

FS400R07A1E3_S7

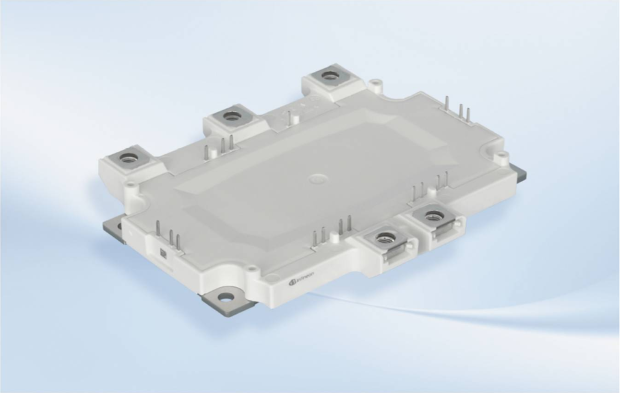
Final Data Sheet

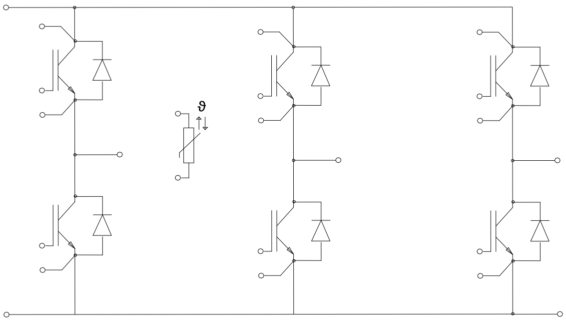
V3.2, 2017-09-28

Automotive High Power

1 Features / Description

HybridPACK™ 1 module with Trench/Fieldstop IGBT3 and Emitter Controlled 3 diode and NTC





V_{CES} = 700V
$I_{C\ nom}$ = 400A

Typical Applications

- Hybrid Electrical Vehicles (H)EV
- Motor Drives
- Optimized for automotive applications with DC link voltages up to 420 V

Electrical Features

- Increased blocking voltage capability to 705V
- V_{CEsat} with positive Temperature Coefficient
- Low V_{CEsat}
- Low Switching Losses
- $T_{vj\ op}$ = 150°C
- Short-time extended Operation Temperature $T_{vj\ op}$ = 175°C

Mechanical Features

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

Description

Infineon®'s HybridPACK™ 1 is an automotive qualified power module designed for electric vehicle applications for a power range up to 20–30kW. 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™ 1 power module 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 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.

Product Name	Ordering Code
FS400R07A1E3_S7	SP001290884

2 IGBT,Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	705	V
Continuous DC collector current	T_C = 65°C, $T_{vj\,max}$ = 175°C T_C = 25°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$ I_C	400[1] 500[1]	A A
Repetitive peak collector current	t_P = 1 ms	I_{CRM}	800	A
Total power dissipation	T_C = 25°C, $T_{vj\,max}$ = 175°C	P_{tot}	1250	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 Characteristic Values

				min.	typ.	max.	
Collector-emitter saturation voltage	I_C = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$V_{CE\,sat}$		1.45 1.60 1.70	1.70	V
Gate threshold voltage	I_C = 6.40 mA, V_{CE} = V_{GE}	T_{vj} = 25°C	V_{GEth}	4.90	5.80	6.50	V
Gate charge	V_{GE} = -15 V ... 15 V		Q_G		4.30		µC
Internal gate resistor		T_{vj} = 25°C	R_{Gint}		1.0		Ω
Input capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{ies}		26.0		nF
Reverse transfer capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{res}		0.76		nF
Collector-emitter cut-off current	V_{CE} = 450 V, V_{GE} = 0 V	T_{vj} = 25°C	I_{CES}			0.1	mA
Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = 20 V	T_{vj} = 25°C	I_{GES}			400	nA
Turn-on delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,on}$		0.10 0.12 0.12		µs
Rise time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_r		0.09 0.10 0.10		µs
Turn-off delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,off}$		0.44 0.47 0.48		µs
Fall time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_f		0.04 0.06 0.06		µs
Turn-on energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = ±15 V, di/dt = 4200 A/µs (T_{vj} = 150°C) R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{on}		5.30 6.90 7.50		mJ
Turn-off energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = ±15 V, du/dt = 3000 V/µs (T_{vj} = 150°C) R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{off}		14.0 17.0 17.5		mJ
SC data	V_{GE} ≤ 15 V, V_{CC} = 360 V V_{CEmax} = V_{CES} -L_{sCE} ·di/dt	t_P ≤ 8 µs, T_{vj} = 25°C t_P ≤ 6 µs, T_{vj} = 150°C	I_{SC}		2800 2000		A
Thermal resistance, junction to case	per IGBT		R_{thJC}			0.120	K/W
Thermal resistance, case to heatsink	per IGBT λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K)		R_{thCH}		0.080		K/W
Temperature under switching conditions	t_{op} continuous $t_{op\,max}$ 30h over life time, for 10s within period of 10min		$T_{vj\,op}$	-40 150		150 175	°C

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[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°C	V_{RRM}	705	V
Continuous DC forward current		I_F	400[1]	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	800	A
I^2t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C V_R = 0 V, t_P = 10 ms, T_{vj} = 150°C	I^2t	8800 8500	A^2s A^2s

3.2 Characteristic Values

				min.	typ.	max.	
Forward voltage	I_F = 400 A, V_{GE} = 0 V I_F = 400 A, V_{GE} = 0 V I_F = 400 A, V_{GE} = 0 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	V_F		1.55 1.50 1.45	1.95	V
Peak reverse recovery current	I_F = 400 A, - di_F/dt = 4200 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	I_{RM}		155 230 245		A
Recovered charge	I_F = 400 A, - di_F/dt = 4200 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	Q_r		12.5 26.5 31.0		µC
Reverse recovery energy	I_F = 400 A, - di_F/dt = 4200 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{rec}		3.40 7.10 8.30		mJ
Thermal resistance, junction to case	per diode		R_{thJC}			0.200	K/W
Thermal resistance, case to heatsink	per diode λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K)		R_{thCH}		0.085		K/W
Temperature under switching conditions	t_{op} continuous $t_{op\ max}$ 30h over life time, for 10s within period of 10min		$T_{vj\ op}$	-40 150		150 175	°C

4 NTC-Thermistor

Parameter	Conditions	Symbol	Value min.	Value typ.	Value max.	Unit
Rated resistance	T_C = 25°C	R_{25}		5.00		kΩ
Deviation of R100	T_C = 100°C, R_{100} = 493 Ω	ΔR/R	5		5	%
Power dissipation	T_C = 25°C	P_{25}			20.0	mW
B-value	$R_2 = R_{25}\ exp\ [B_{25/50}(1/T_2 - 1/(298,15\ K))]$	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25}\ exp\ [B_{25/80}(1/T_2 - 1/(298,15\ K))]$	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25}\ exp\ [B_{25/100}(1/T_2 - 1/(298,15\ K))]$	$B_{25/100}$		3433		K

Specification according to the valid application note.

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(1) Diode forward 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
Material of module baseplate			Cu			
Internal isolation	basic insulation (class 1, IEC 61140)		Al_2O_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.	
Stray inductance module		L_{sCE}		30		nH
Module lead resistance, terminals - chip	T_C = 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[1]		6.00[1]	Nm
Terminal connection torque	Screw M6	M	3.0[1]	-	6.0[1]	Nm
Weight		G		485		g

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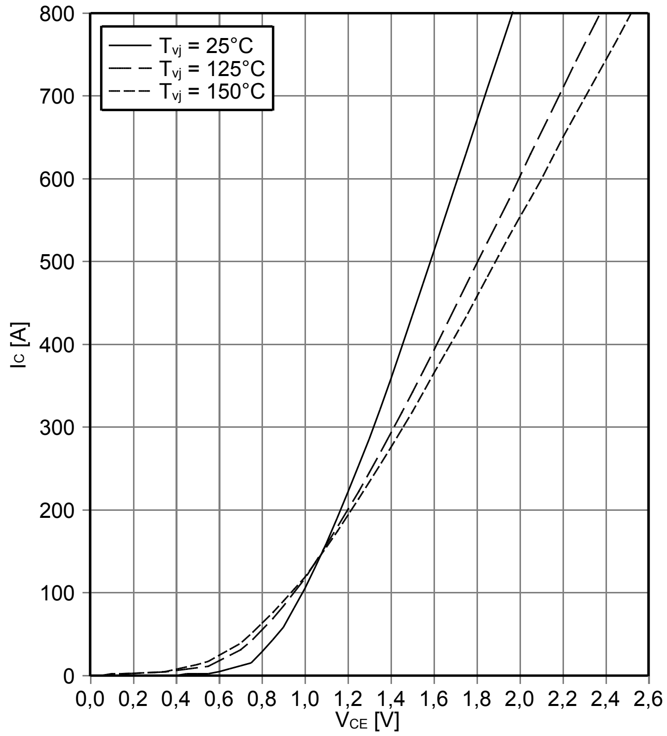
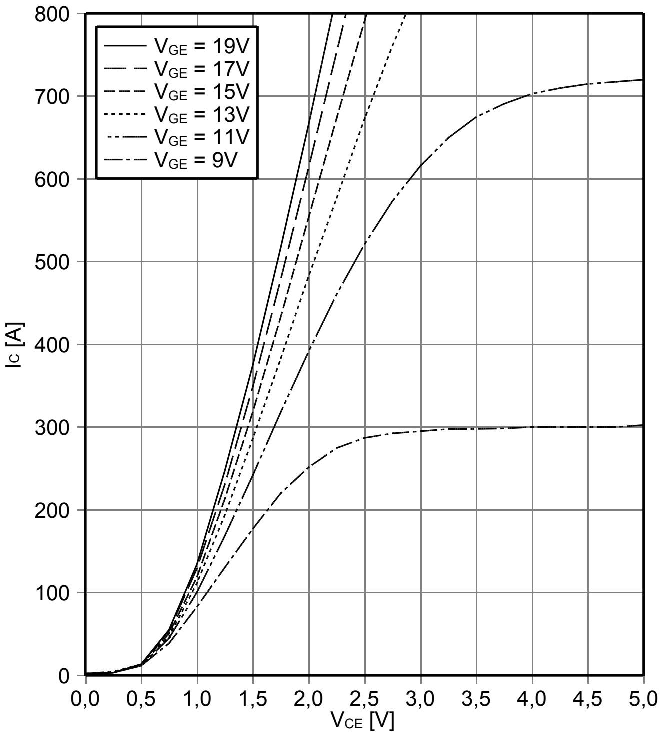
[1] Mounting according to valid application note AN 2010-08 Mounting Instruction HybridPACK 1.

6 Characteristics Diagrams

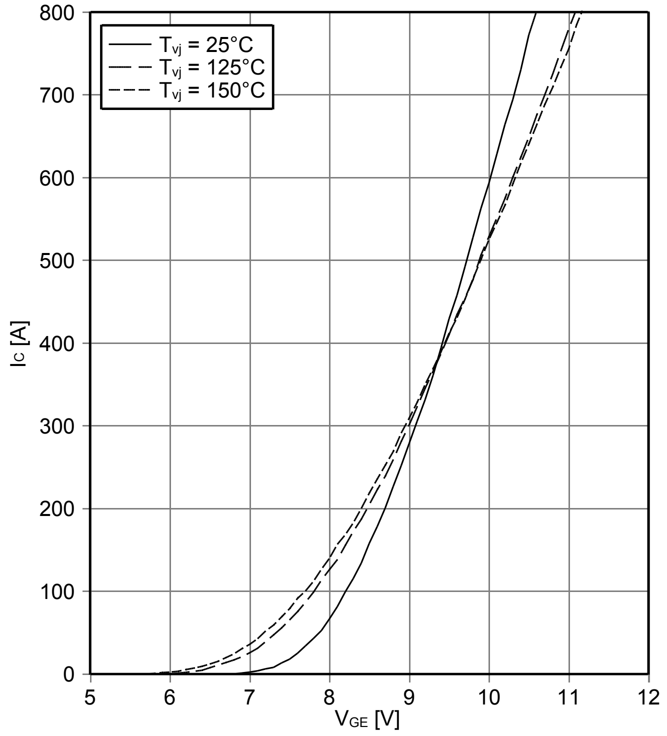
output characteristic IGBT,Inverter (typical)
$I_C = f\ (V_{CE})$
$V_{GE} = 15\ V$



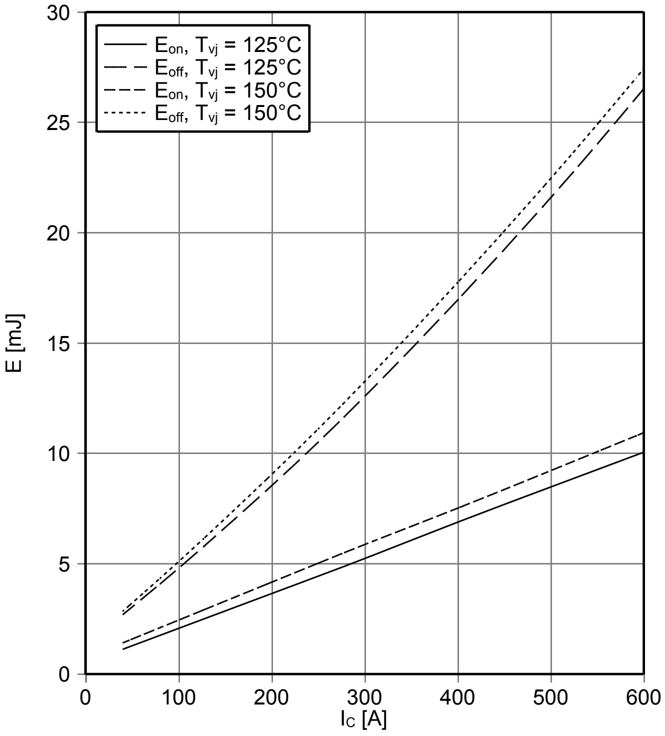
output characteristic IGBT,Inverter (typical)
$I_C = f\ (V_{CE})$
$T_{vj} = 150°C$



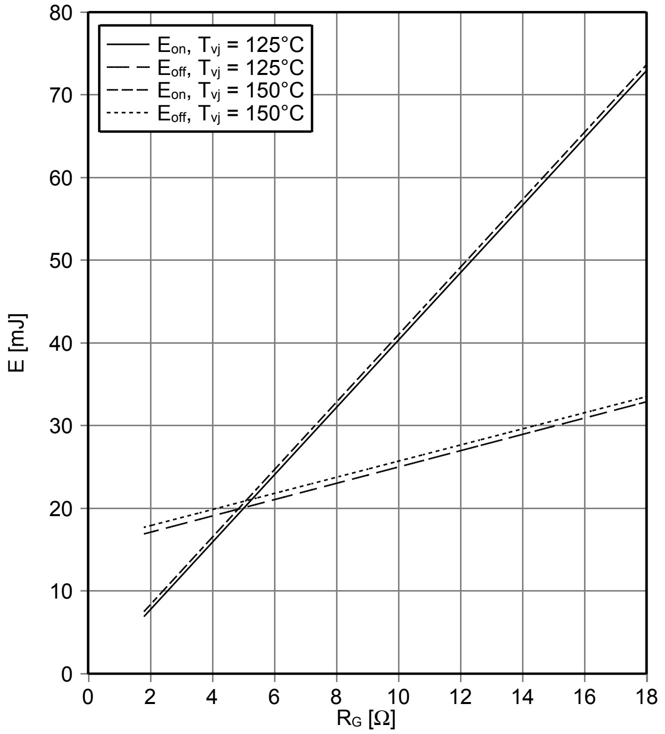
transfer characteristic IGBT,Inverter (typical)
$I_C = f\ (V_{GE})$
$V_{CE} = 20\ V$



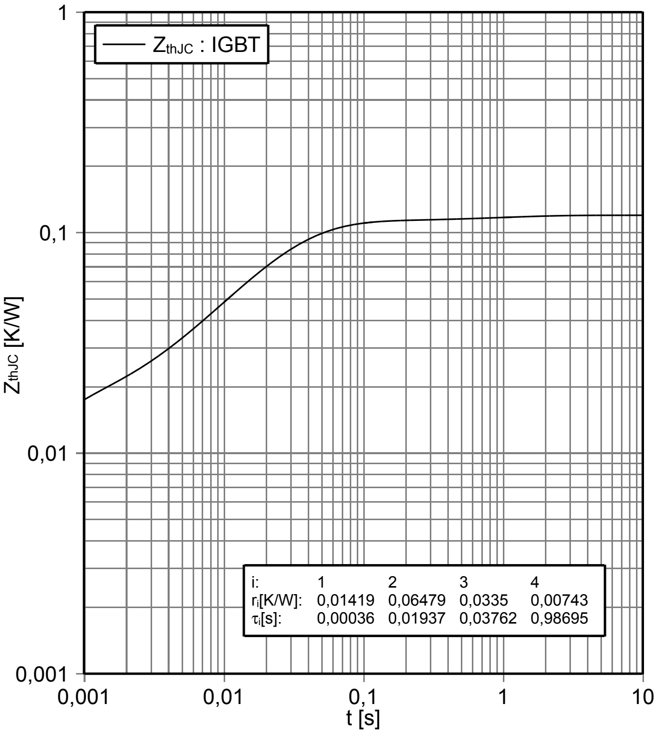
switching losses IGBT,Inverter (typical)
$E_{on} = f\ (I_C)$, $E_{off} = f\ (I_C)$
$V_{GE} = \pm15\ V$, $R_{Gon} = 1.8\ \Omega$, $R_{Goff} = 1.8\ \Omega$, $V_{CE} = 300\ V$



switching losses IGBT,Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$
$V_{GE} = \pm15$ V, $I_C = 400$ A, $V_{CE} = 300$ V

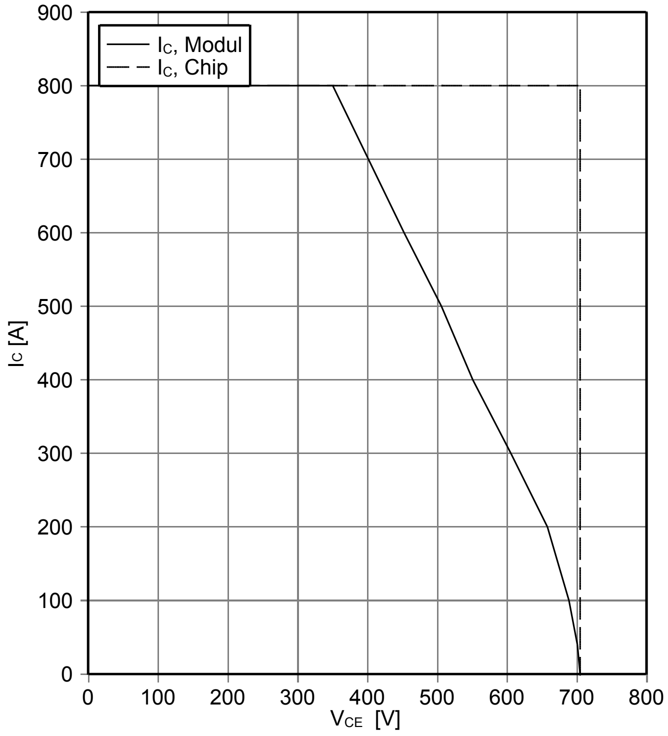


transient thermal impedance IGBT,Inverter
$Z_{thJC} = f(t)$

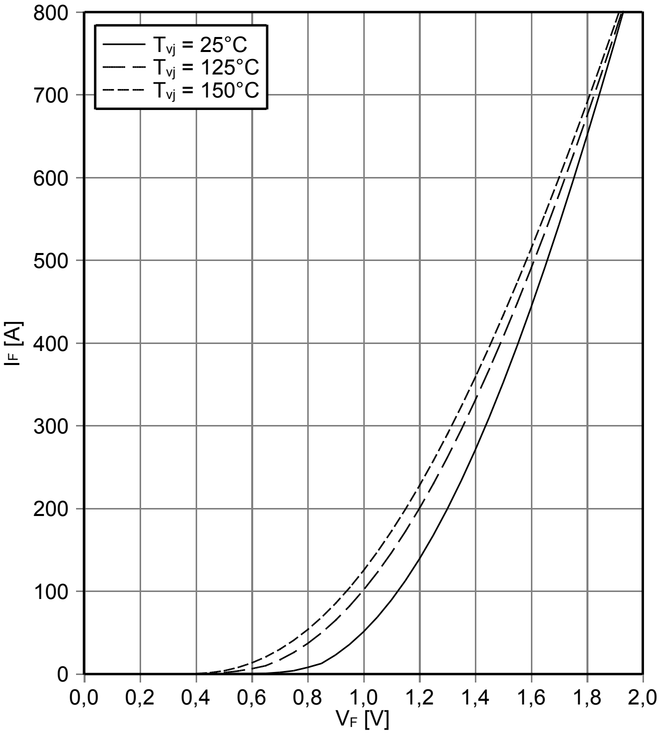


i:	1	2	3	4
r_i[K/W]:	0,01419	0,06479	0,0335	0,00743
τ_i[s]:	0,00036	0,01937	0,03762	0,98695

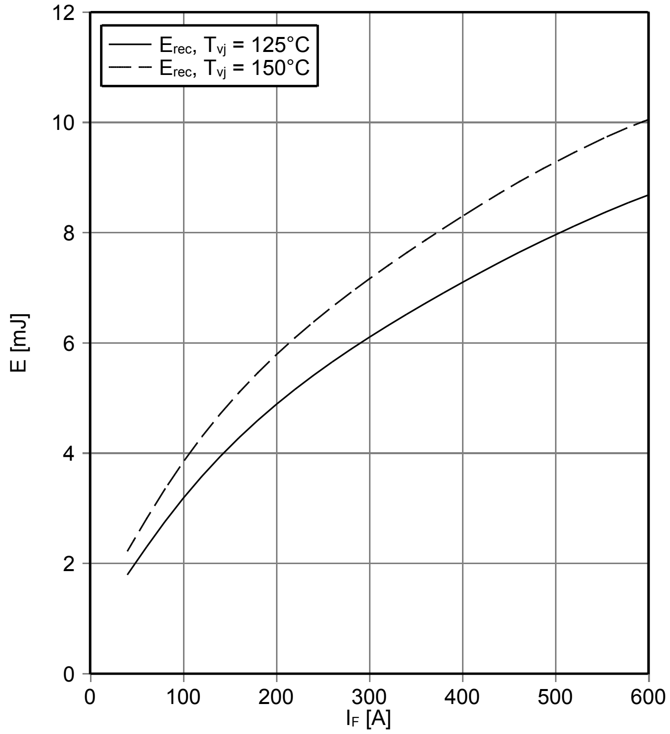
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f(V_{CE})$
$V_{GE} = \pm15$ V, $R_{Goff} = 1.8\ \Omega$, $T_{vj} = 150$°C



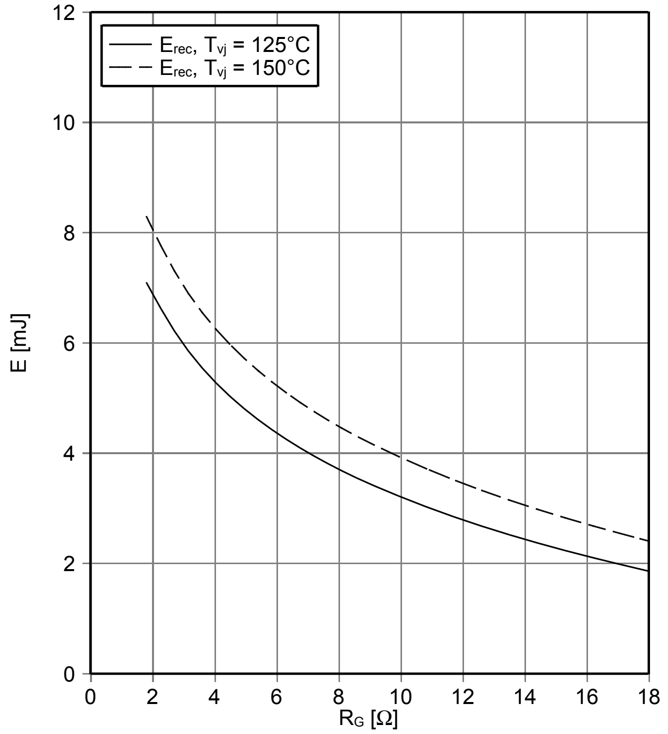
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



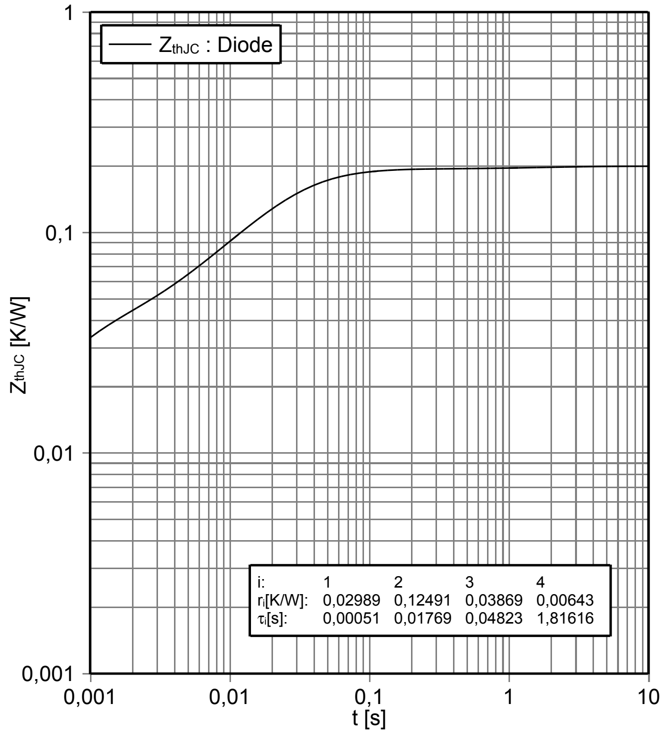
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$
$R_{Gon} = 1.8\ \Omega$, $V_{CE} = 300$ V



switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$
$I_F = 400$ A, $V_{CE} = 300$ V

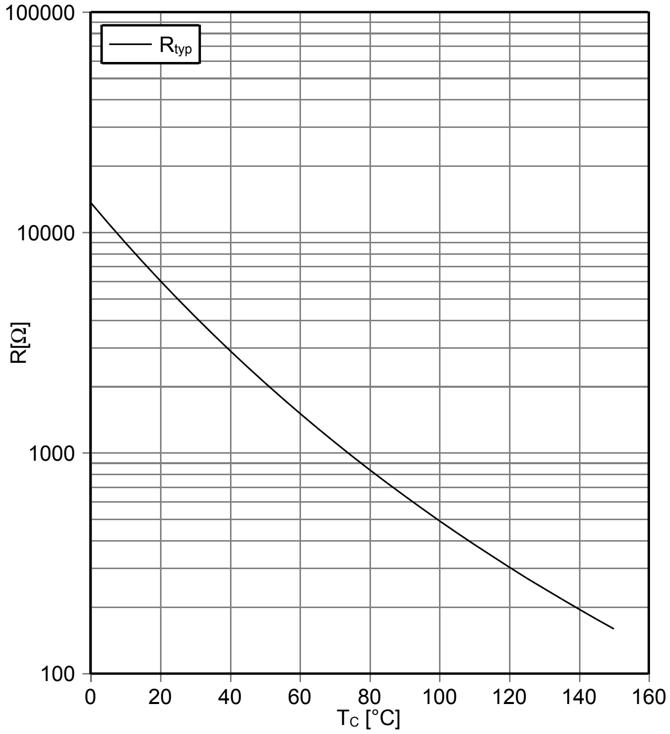


transient thermal impedance Diode, Inverter
$Z_{thJC} = f(t)$

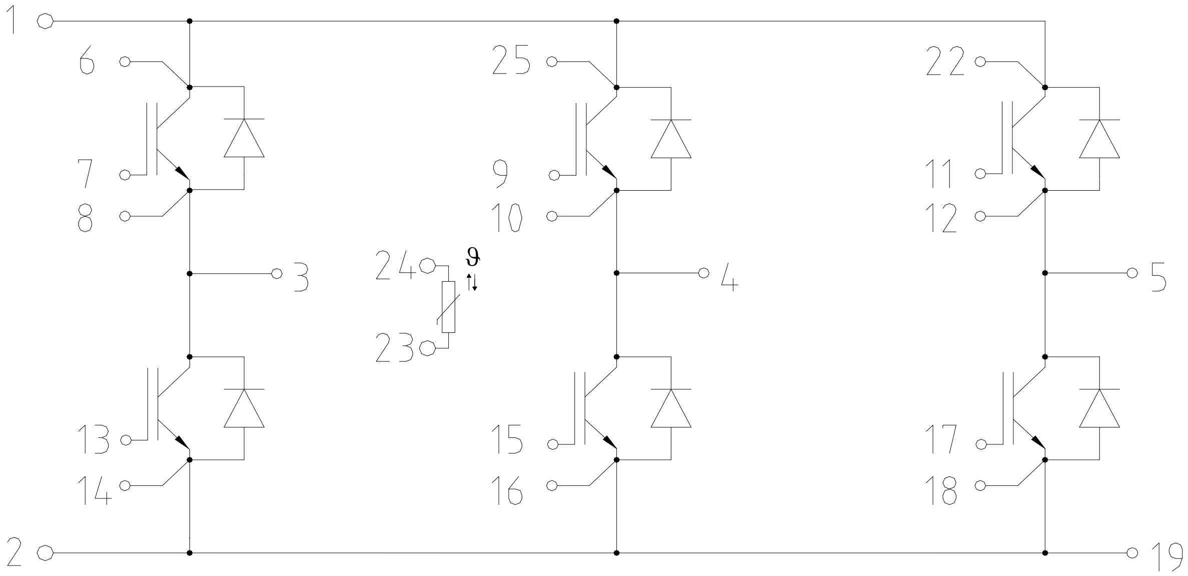


i:	1	2	3	4
r_i[K/W]:	0,02989	0,12491	0,03869	0,00643
τ_i[s]:	0,00051	0,01769	0,04823	1,81616

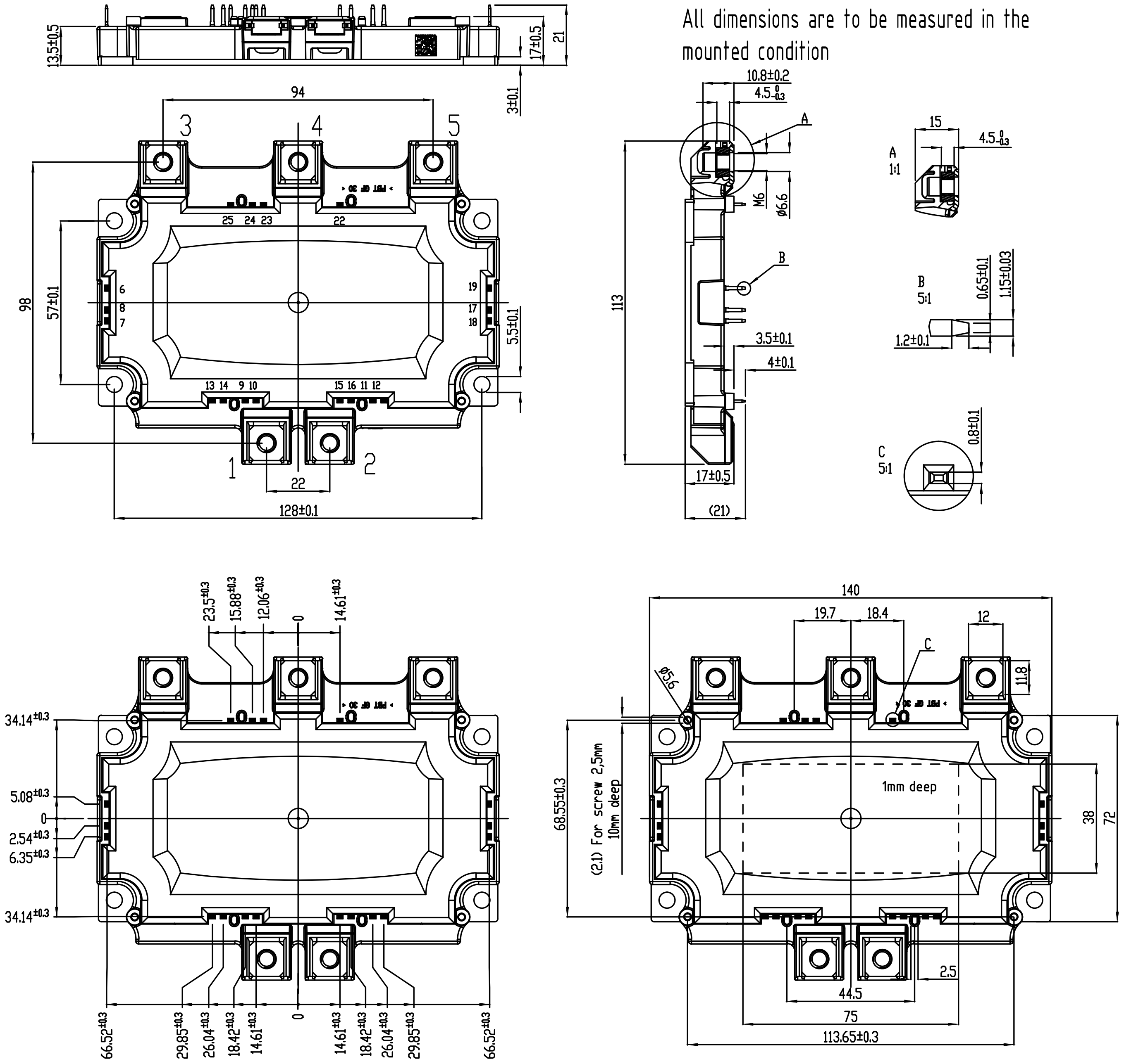
NTC-Thermistor-temperature characteristic (typical)
$R = f(T)$



7 Circuit diagram



8 Package outlines



All dimensions are to be measured in the mounted condition

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	2014-12-03	Initial Version
V2.0	2014-12-16	preliminary data
V3.0	2015-03-30	final datasheet
V3.1	2016-11-08	optimization of datasheet format
V3.2	2017-09-28	Remove the UL approved (E83335) from "Features / Description"

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