Double Side Cooled Module

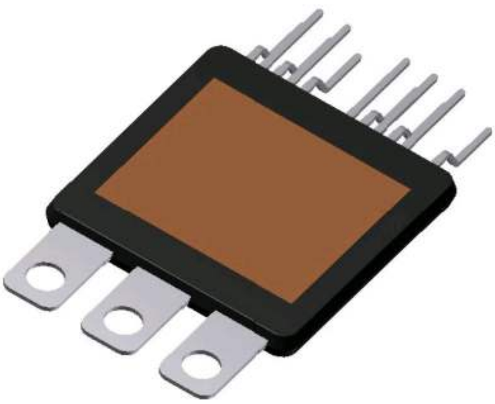
FF450R08A03P2

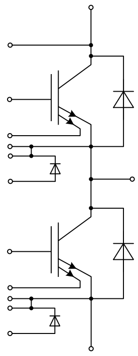
Final Data Sheet

V3.0, 2020-05-11

Automotive High Power

1 Features / Description





V_{CES} = 750 V
I_C = 450 A

Typical Applications

- Automotive Applications
- Hybrid Electrical Vehicles (H)EV
- Optimized for automotive applications with DC link voltages up to 450 V and gate driver voltage level of -8 V / +15 V

Electrical Features

- Integrated Current Sensor
- Integrated Temperature Sensor
- Low Inductive Design
- Blocking voltage 750V
- Low Switching Losses
- Short-time extended Operation Temperature $T_{vj\ op}$ = 175°C

Mechanical Features

- 2.5kV AC 1min Insulation
- Double sided cooling
- Compact design
- RoHS compliant

Description

The HybridPACK^{TM} DSC S2 is a very compact half-bridge module targeting hybrid and electric vehicles.
The module is based on Infineon's long-term experience developing IGBT power modules and implements the EDT2 IGBT generation, which is an automotive Micro-Pattern Trench-Field-Stop cell design optimized for electric drive train applications. The chipset has benchmark current density combined with short circuit ruggedness and increased blocking voltage for reliable inverter operation under harsh environmental conditions. The EDT2 IGBTs also show excellent light load power losses, which helps to improve System efficiency over a real driving cycle. The EDT2 IGBT was optimized for applications with switching frequencies in the range of 10 kHz. Additionally, on-die integrated current sensor and temperature sensor allow precise monitoring of IGBT state. These features enable enhanced protection and intelligent control of the system.

The innovative and small package is designed for Double Sided Cooling (DSC) with superior thermal performance. The low stray inductance and increased blocking voltage support the design of systems with a very high efficiency. Furthermore, new material combinations and assembly technologies enable best thermal and electrical performance at highest reliability and mechanical robustness.

Product Name	**Ordering Code**
FF450R08A03P2	SP001630036

2 IGBT,Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	750	V
Implemented collector current		I_{CN}	450	A
Continuous DC collector current	T_C = 120°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$	300	A
Repetitive peak collector current	t_P = 1 ms	I_{CRM}	900	A
Total power dissipation	T_C = 25°C, $T_{vj\,max}$ = 175°C	P_{tot}	1667	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 Characteristic Values

Parameter	Conditions		Symbol	min.	typ.	max.	Unit
Collector-emitter saturation voltage	I_C = 300 A, V_{GE} = 15 V I_C = 300 A, V_{GE} = 15 V I_C = 300 A, V_{GE} = 15 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	$V_{CE\,sat}$		1.20 1.27 1.29	1.44	V
Gate threshold voltage	I_C = 4.85 mA, V_{CE} = V_{GE}	T_{vj} = 25°C	V_{GEth}	4.90	5.80	6.50	V
Gate charge	V_{GE} = -8 V ... 15 V, V_{CE} = 400V		Q_G		2.15		µC
Internal gate resistor		T_{vj} = 25°C	R_{Gint}		2.0		Ω
Input capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{ies}		38.5		nF
Reverse transfer capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{res}		0.18		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 = 300 A, V_{CE} = 400 V V_{GE} = -8/+15 V R_{Gon} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	$t_{d\,on}$		0.34 0.36 0.36		µs
Rise time, inductive load	I_C = 300 A, V_{CE} = 400 V V_{GE} = -8/+15 V R_{Gon} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	t_r		0.06 0.07 0.07		µs
Turn-off delay time, inductive load	I_C = 300 A, V_{CE} = 400 V V_{GE} = -8/+15 V R_{Goff} = 2.4 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	$t_{d\,off}$		0.48 0.54 0.56		µs
Fall time, inductive load	I_C = 300 A, V_{CE} = 400 V V_{GE} = -8/+15 V R_{Goff} = 2.4 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	t_f		0.07 0.12 0.13		µs
Turn-on energy loss per pulse	I_C = 300 A, V_{CE} = 400 V, L_S = 25 nH V_{GE} = -8/+15 V, di/dt = 3400 A/µs (T_{vj} = 175°C) R_{Gon} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	E_{on}		11.5 13.5 14.5		mJ
Turn-off energy loss per pulse	I_C = 300 A, V_{CE} = 400 V, L_S = 25 nH V_{GE} = -8/+15 V, du/dt = 3200 V/µs (T_{vj} = 175°C) R_{Goff} = 2.4 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	E_{off}		12.0 15.5 17.0		mJ
SC data	V_{GE} ≤ 15 V, V_{CC} = 400 V V_{CEmax} = V_{CES} -L_{sCE} ·di/dt	t_P ≤ 3 µs, T_{vj} = 175°C	I_{SC}		2000		A
Thermal resistance, junction to case	per IGBT		R_{thJC}			0.090[1]	K/W
Thermal resistance, case to heatsink	per IGBT λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K) Clamping Force F = 700N		R_{thCH}		0.100[1]		K/W
Temperature under switching conditions	t_{op} continuous for 10s within a period of 30s, occurrence maximum 3000 times over lifetime		$T_{vj\,op}$	-40 150		150 175	°C

[1] with double sided cooling, evaluation according to HybridPACK cool application note

3 Diode, Inverter

3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj} = 25°C	V_{RRM}	750	V
Implemented forward current		I_{FN}	450	A
Continuous DC forward current		I_F	300	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	900	A
I²t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 150°C	I²t	8500	A²s

3.2 Characteristic Values

Parameter	Conditions		Symbol	min.	typ.	max.	Unit
Forward voltage	I_F = 300 A, V_{GE} = 0 V I_F = 300 A, V_{GE} = 0 V I_F = 300 A, V_{GE} = 0 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	V_F		1.55 1.45 1.40	1.83	V
Peak reverse recovery current	I_F = 300 A, - di_F/dt = 3400 A/µs (T_{vj} = 175°C) V_R = 400 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	I_{RM}		170 235 250		A
Recovered charge	I_F = 300 A, - di_F/dt = 3400 A/µs (T_{vj} = 175°C) V_R = 400 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	Q_r		12.0 26.0 31.0		µC
Reverse recovery energy	I_F = 300 A, - di_F/dt = 3400 A/µs (T_{vj} = 175°C) V_R = 400 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	E_{rec}		2.90 6.60 8.00		mJ
Thermal resistance, junction to case	per diode		R_{thJC}			0.145[1]	K/W
Thermal resistance, case to heatsink	per diode λ_{Paste} = 1 W/(m·K) / λ_{grease} = 1 W/(m·K) Clamping Force F = 700N		R_{thCH}		0.140[1]		K/W
Temperature under switching conditions	t_{op} continuous for 10s within a period of 30s, occurrence maximum 3000 times over lifetime		$T_{vj\ op}$	-40 150		150 175	°C

4 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}		 3.5		mm
Clearance	terminal to heatsink terminal to terminal	d_{Clear}		 3.5		mm
Comperative tracking index		CTI		> 600		
			min.	typ.	max.	
Stray inductance module		L_{sCE}		15		nH
Storage temperature		T_{stg}	-40		125	°C
Terminal connection torque	Screw M5	M		-		Nm
Mounting force per clamp		F		-	750	N
Weight		G		31		g

5 Temperature Sensor

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Forward voltage	I_{TS} = 0.22 mA, T_{vj} = 25°C	V_{TS}	2.220[2]	2.280	2.340[2]	V
temperature coefficient (tcr)	I_{TS} = 0.22 mA	TC_{TS}		-5.50		mV/K

[1] with double sided cooling, evaluation according to HybridPACK cool application note
[2] Verified by design, not by test

6 Current Sensor

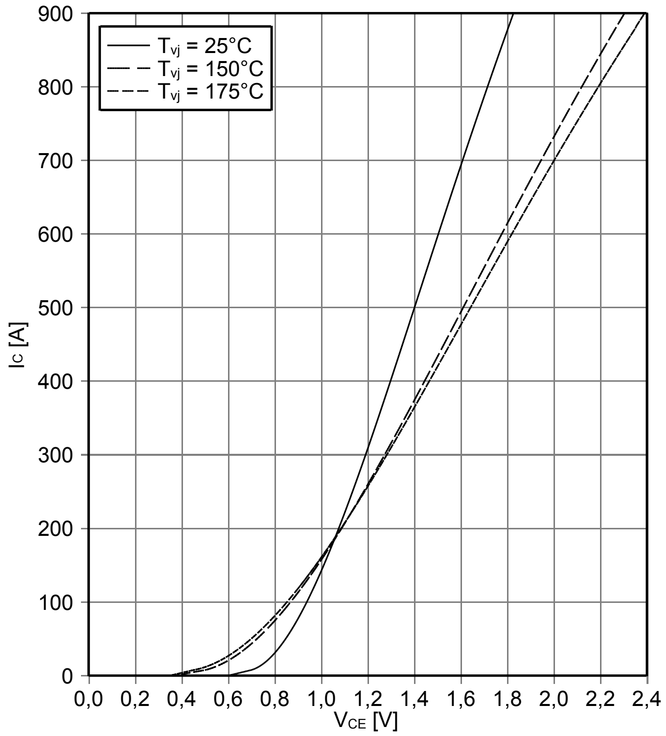
Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Output voltage	V_{CE} = 1.85 V, I_C = 900 A R_{sense} = 2.40 Ω, T_{vj} = 25°C V_{GE} = 15 V	V_{sense}		0.55		V

7 Customized

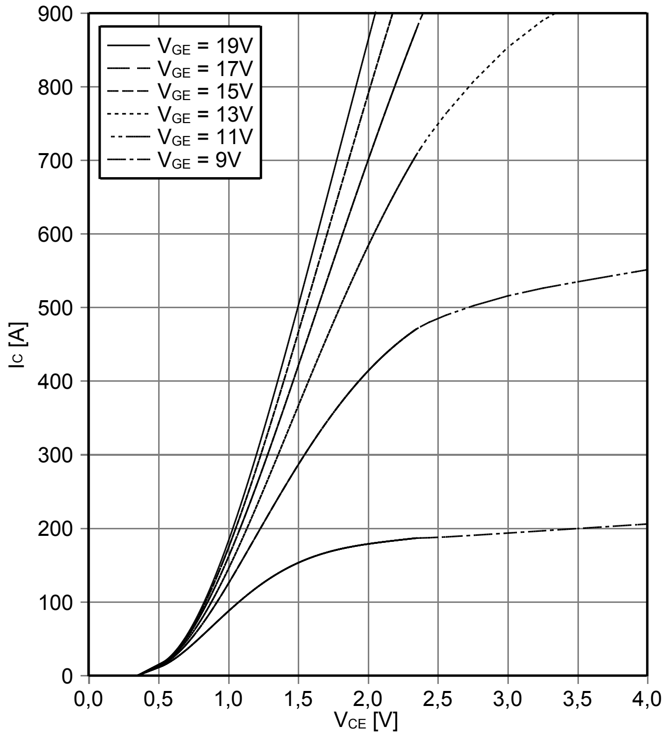
			min.	typ.	max.	
Current Sensor Output Current	IC = 100 A, Tvj = 175°C, evaluation according to HybridPACK™ DSC application note	Ics	80	100	120	mA

8 Characteristics Diagrams

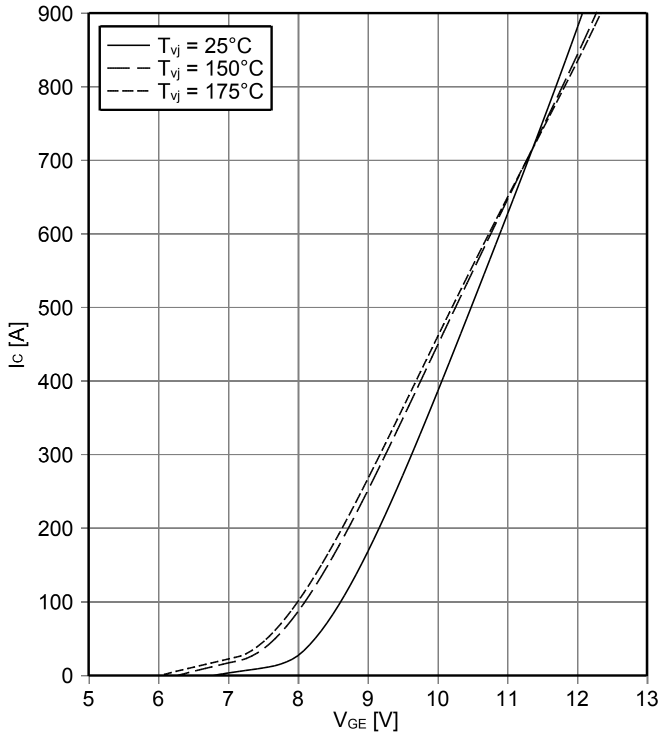
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



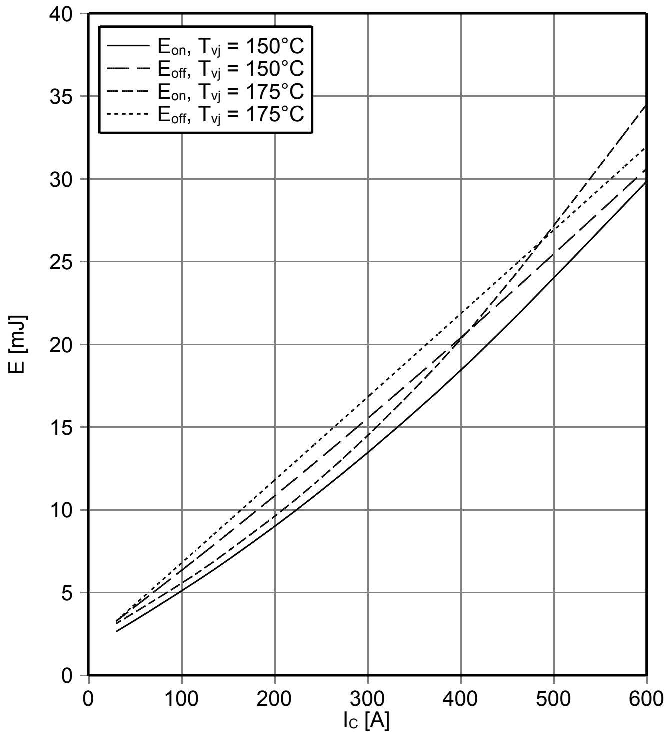
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 175°C$



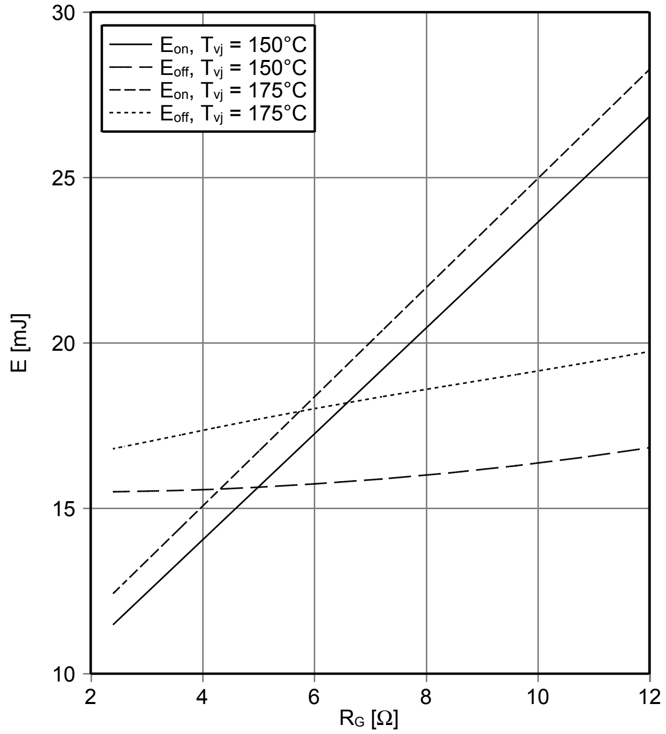
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



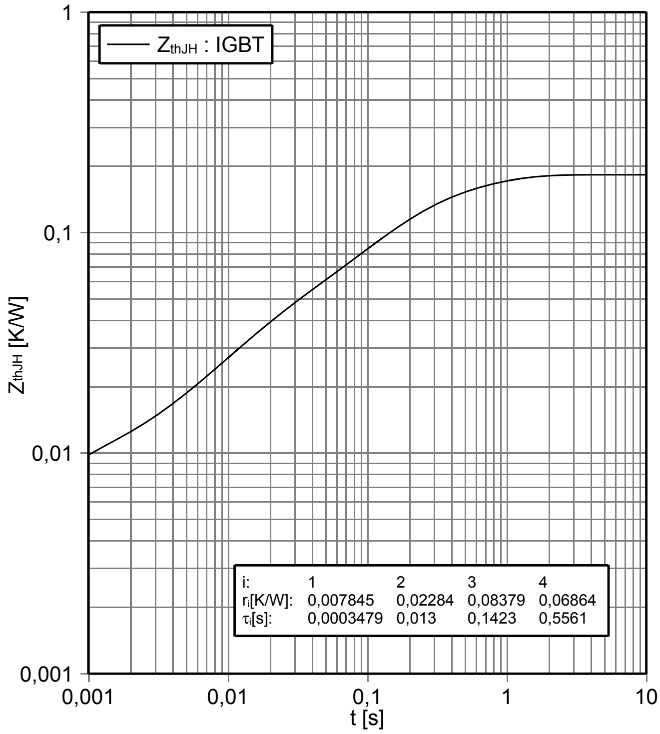
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
$V_{GE} = -8 / +15$ V, $R_{Gon} = 3.6\ \Omega$, $R_{Goff} = 2.4\ \Omega$, $V_{CE} = 400$ V



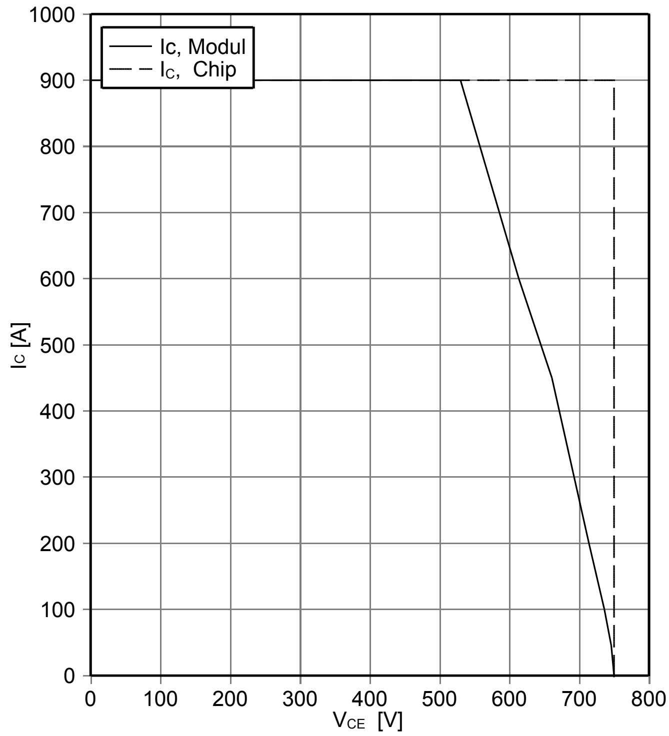
switching losses IGBT,Inverter (typical)
$E_{on} = f\ (R_G)$, $E_{off} = f\ (R_G)$
V_{GE} = -8 / +15 V, I_C = 300 A, V_{CE} = 400 V



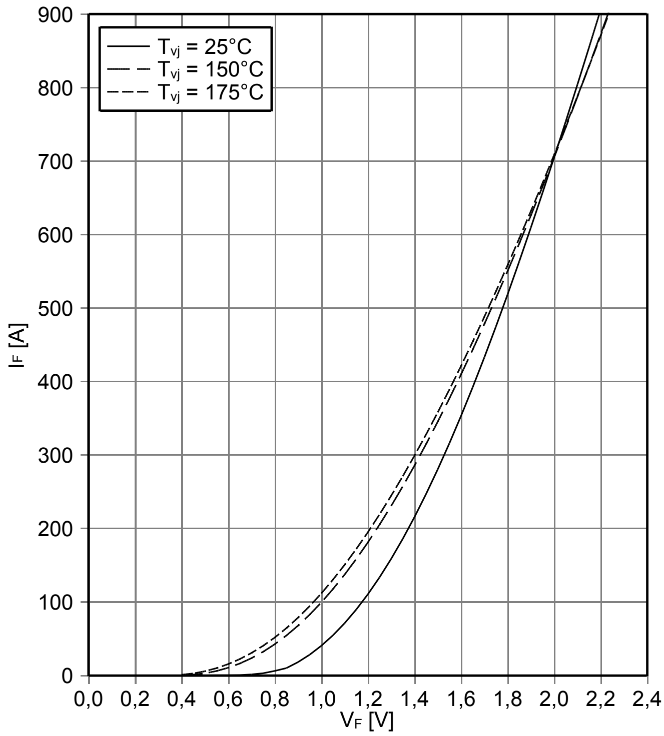
transient thermal impedance IGBT,Inverter
$Z_{thJH} = f\ (t)$



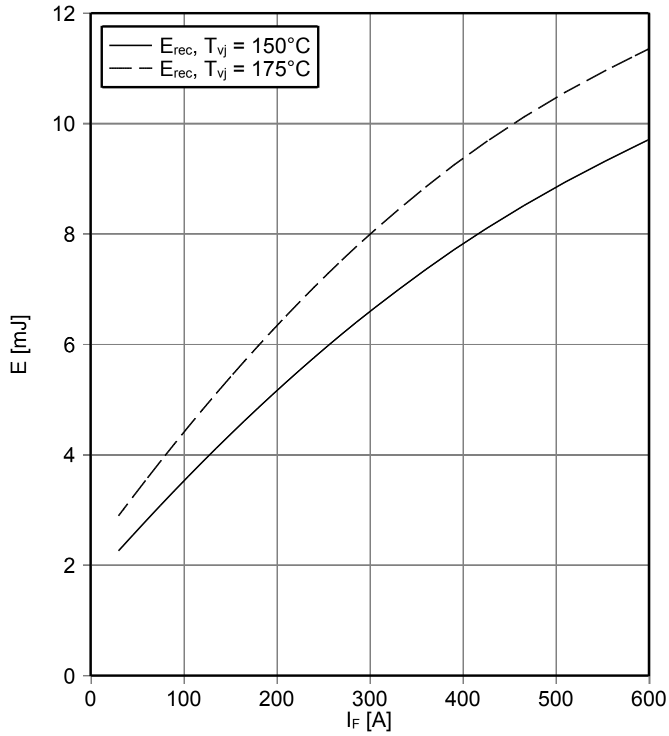
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f\ (V_{CE})$
V_{GE} = ±15 V, R_{Goff} = 2.4 Ω, T_{vj} = 175°C



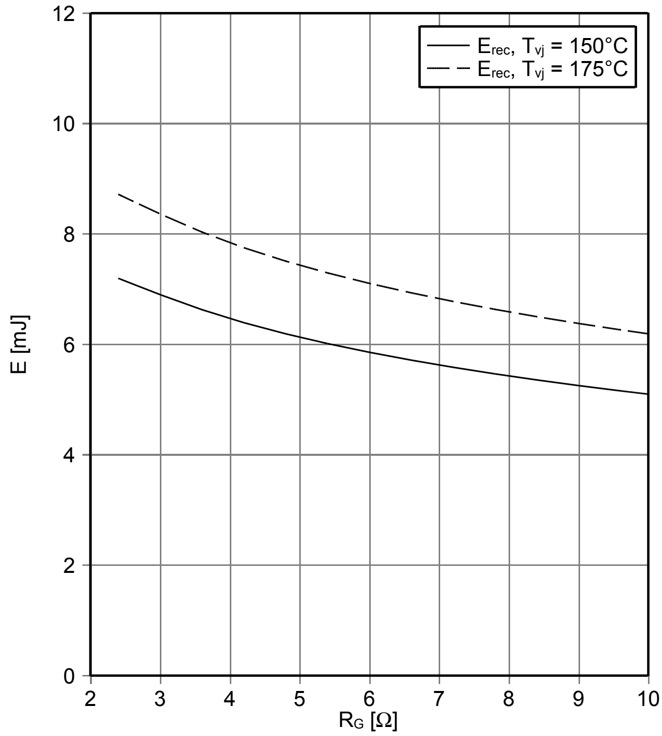
forward characteristic of Diode, Inverter (typical)
$I_F = f\ (V_F)$



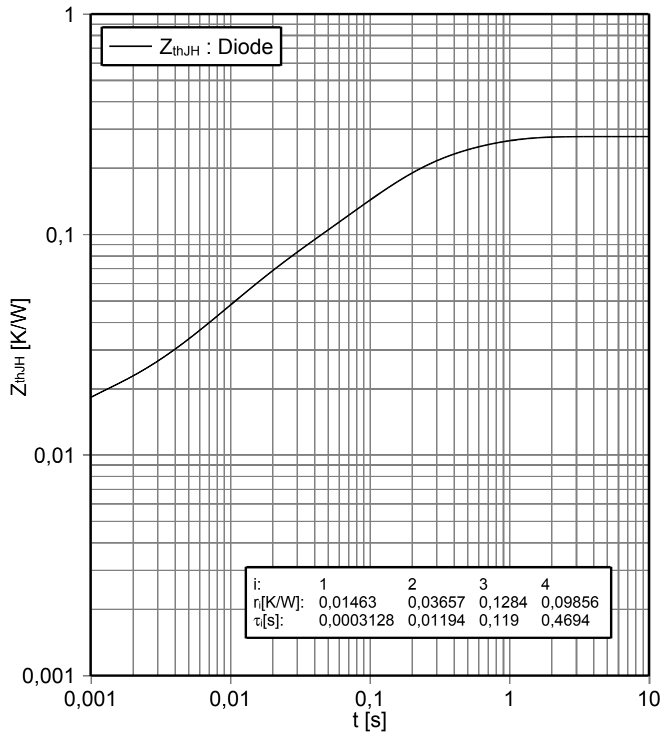
switching losses Diode, Inverter (typical)
$E_{rec} = f\ (I_F)$
$R_{Gon} = 3.6\ \Omega$, $V_{CE} = 400$ V



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

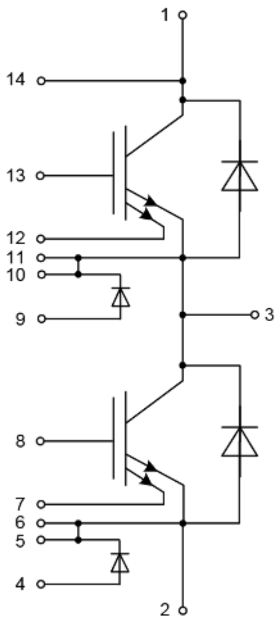


transient thermal impedance Diode, Inverter
$Z_{thJH} = f\ (t)$



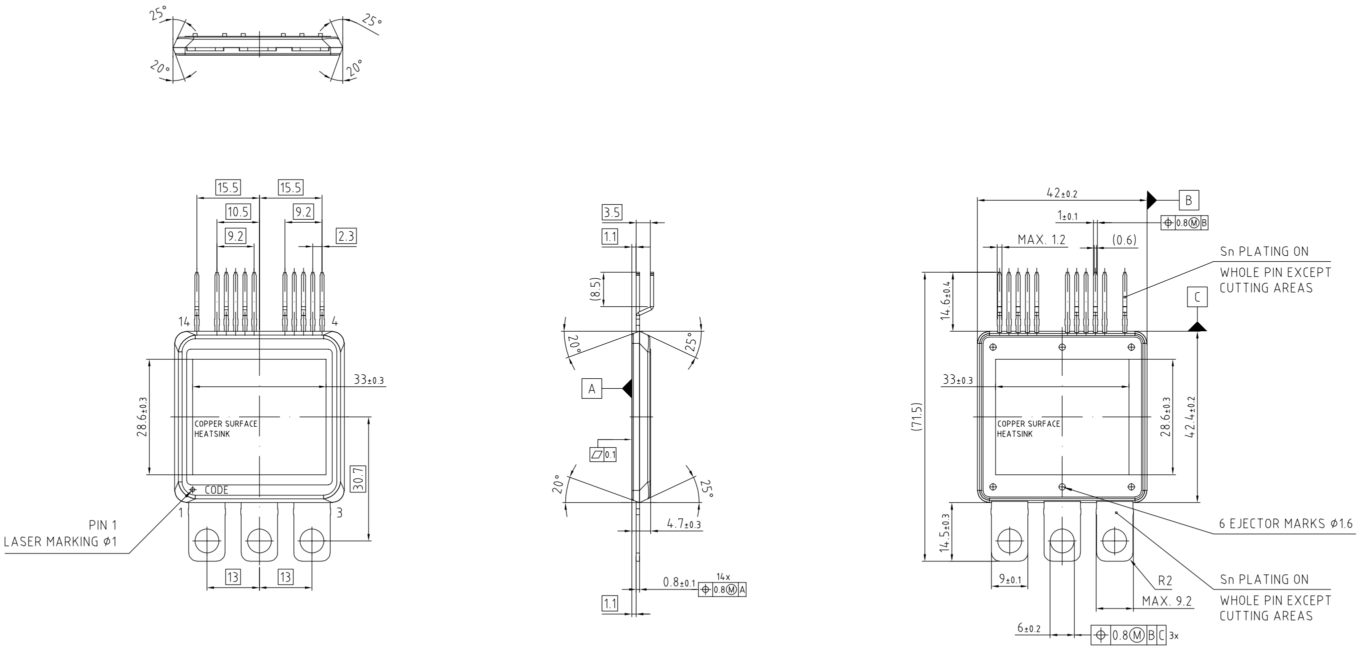
i:	1	2	3	4
r_i[K/W]:	0,01463	0,03657	0,1284	0,09856
τ_i[s]:	0,0003128	0,01194	0,119	0,4694

9 Circuit diagram



Pin Number	Symbol	I/O	Function
1	P	DC Supply (+)	Positive Supply
2	N	DC Supply (-)	Negative Supply
3	U	AC Output	U Phase Output
4	T+L	Input	Temperature Sensor Plus Low Side
5	T-L	Output	Temperature Sensor Minus Low Side
6	EL	Output	IGBT Emitter Output Low Side
7	CSL	Output	IGBT Current Sensor Output Low Side
8	GL	Input	Gate Input Low Side
9	T+H	Input	Temperature Sensor Plus High Side
10	T-H	Output	Temperature Sensor Minus High Side
11	EH	Output	IGBT Emitter Output High Side
12	CSH	Output	IGBT Current Sensor output High Side
13	GH	Input	Gate Input High Side
14	PS	Output	P-Terminal Voltage Sensing / IGBT Collector Output

10 Package outlines



Drawing:	Drawing according to	General tolerances:
Z8B00172542 POL 000 09	ISO 8015	ISO 2768-mK

Revision History

Major changes since previous revision

Revision History		
Reference	**Date**	**Description**
V2.0	2018-12-06	-
V2.1	2020-04-16	Correction of package outlines
V3.0	2020-05-11	Final datasheet

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