Double Side Cooled Module

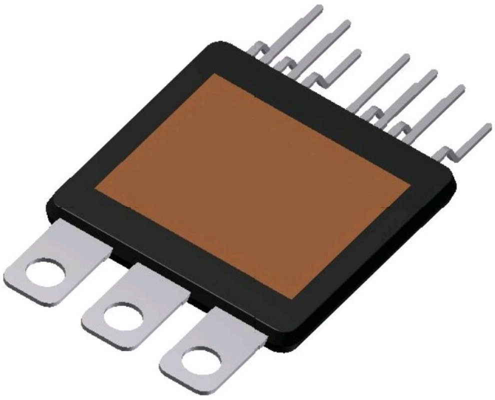
FF400R07A01E3_S6

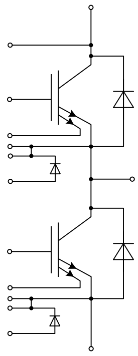
Final Data Sheet

V3.4, 2020-04-15

Automotive High Power

1 Features / Description





V_{CES} = 700 V
I_C = 400 A

Typical Applications
- Automotive Applications
- Hybrid Electrical Vehicles (H)EV

Electrical Features
- Increased Blocking Voltage Capability to 700V
- Integrated Current Sensor
- Integrated Temperature Sensor
- Low Inductive Design
- 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
- Double sided cooling
- Compact design
- RoHS compliant

Description
The HybridPACK^{TM} DSC S1 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 Trench-Field-Stop IGBTs including matching diodes with enhanced softness. 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
FF400R07A01E3_S6	SP001661226

2 IGBT,Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	700	V
Continuous DC collector current	T_C = 75°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$	400	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}	1500	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 = 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	$V_{CE\,sat}$		1.65 1.90 2.00	2.30	V
Gate threshold voltage	I_C = 4.85 mA, V_{CE} = V_{GE}	T_{vj} = 25°C	V_{GEth}	5.00	5.80	6.50	V
Gate charge	V_{GE} = -15 V ... 15 V		Q_G		2.90		µC
Internal gate resistor		T_{vj} = 25°C	R_{Gint}		0.0		Ω
Input capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{ies}		18.0		nF
Reverse transfer capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{res}		0.50		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} = -8/+15 V R_{Gon} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,on}$		0.06 0.06 0.06		µs
Rise time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = -8/+15 V R_{Gon} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_r		0.08 0.08 0.08		µs
Turn-off delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = -8/+15 V R_{Goff} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,off}$		0.43 0.44 0.48		µs
Fall time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = -8/+15 V R_{Goff} = 3.6 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_f		0.04 0.04 0.05		µs
Turn-on energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = -8/+15 V R_{Gon} = 3.6 Ω di/dt = 5.1 kA/µs (Tvj = 150°C)	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{on}		5.70 7.40 7.90		mJ
Turn-off energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = -8/+15 V R_{Goff} = 3.6 Ω du/dt = 3.0 kV/µs (Tvj = 150°C)	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{off}		14.5 16.5 18.0		mJ
SC data	V_{GE} ≤ 15 V, V_{CC} = 360 V V_{CEmax} = V_{CES} -L_{sCE} ·di/dt	t_P ≤ 6 µs, T_{vj} = 150°C	I_{SC}		1900		A
Thermal resistance, junction to case	per IGBT		R_{thJC}			0.100 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}		0.140 1)		K/W
Temperature under switching conditions	t_{op} continuous for 18s within a period of 600s, occurrence maximum 200 times over lifetime		$T_{vj\,op}$	-40 150		150 175	°C

1) with double sided cooling, evaluation according to HybridPack[TM] DSC 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}	700	V
Continuous DC forward current		I_F	400	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	800	A
I²t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C	I²t	9000	A²s

3.2 Characteristic Values

Parameter	Conditions		Symbol	min.	typ.	max.	Unit
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		1.95 1.84 1.80	2.55	V
Peak reverse recovery current	I_F = 400 A, - di_F/dt = 5000 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	I_{RM}		135 210 220		A
Recovered charge	I_F = 400 A, - di_F/dt = 5000 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	Q_r		12.0 23.0 27.0		µC
Reverse recovery energy	I_F = 400 A, - di_F/dt = 5000 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{rec}		2.80 5.80 6.60		mJ
Thermal resistance, junction to case	per diode		R_{thJC}			0.150[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}		0.200[1)]		K/W
Temperature under switching conditions	t_{op} continuous for 18s within a period of 600s, occurrence maximum 200 times over lifetime		$T_{vj\ op}$	-40 150		150 175	°C

4 Module

Parameter	Conditions	Symbol	min.	typ.	max.	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		
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		-	900	N
Weight		G		30		g

5 Temperature Sensor

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Forward voltage	I_{TS} = 1.00 mA, T_{vj} = 150°C I_{TS} = 1.00 mA, T_{vj} = 25°C	V_{TS}		2.120 2.910		V

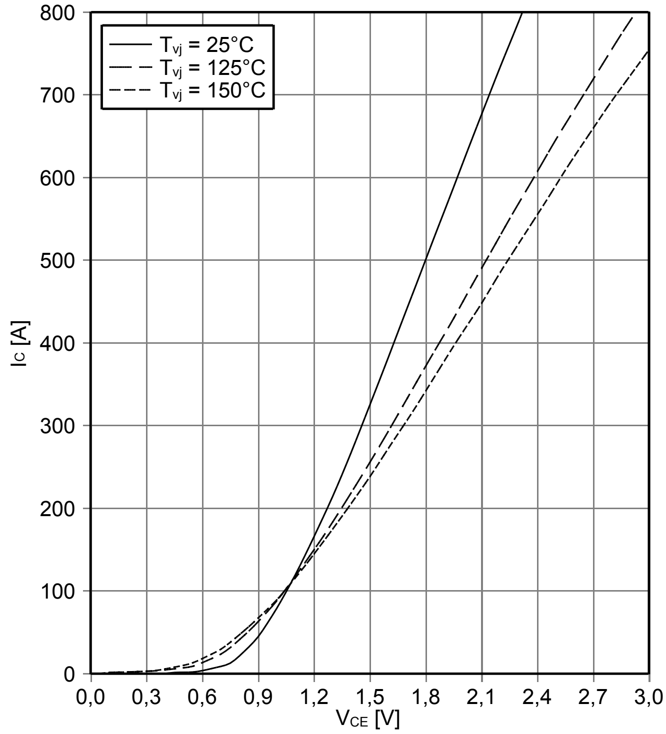
[1)] with double sided cooling, evaluation according to HybridPack™ DSC application note

6 Current Sensor

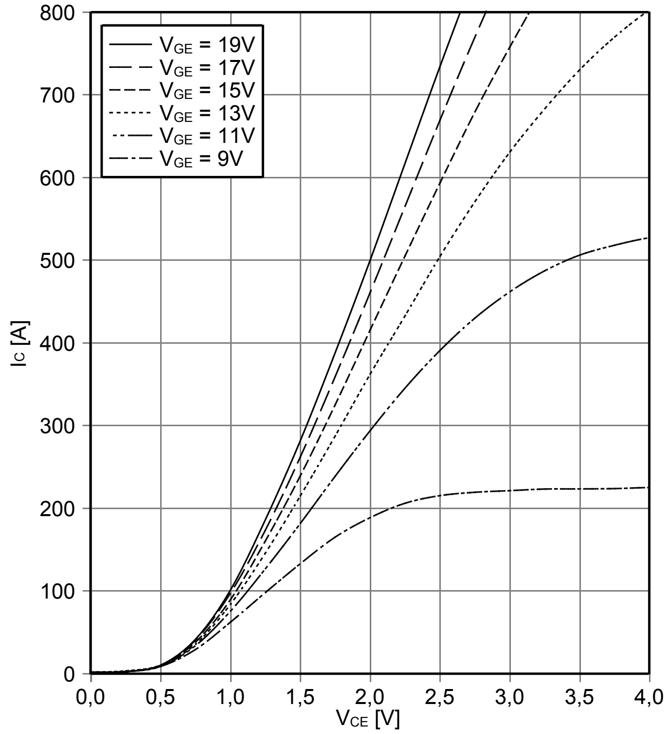
Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Output voltage	V_{CE} = 2.35 V, I_C = 800 A R_{sense} = 1.60 Ω, T_{vj} = 25°C VGE = 15 V	V_{sense}		0.64		V

7 Characteristics Diagrams

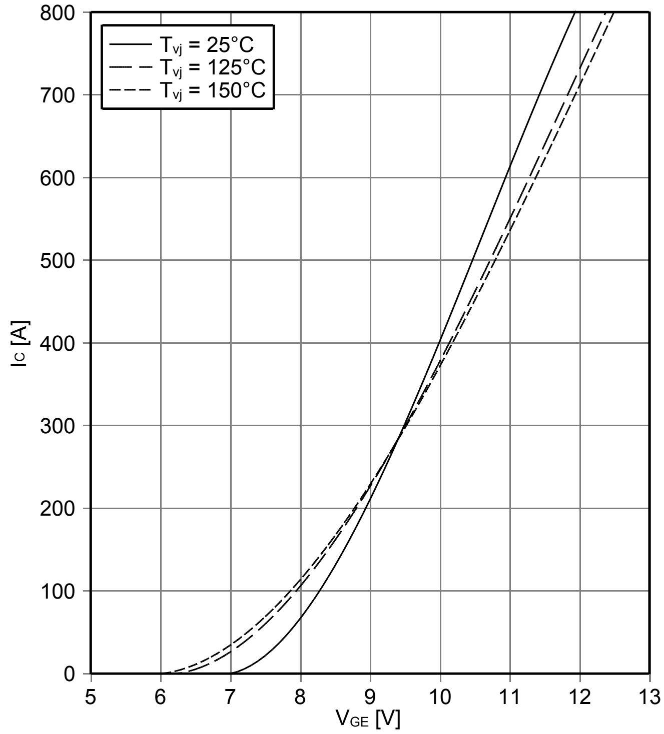
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
V_{GE} = 15 V



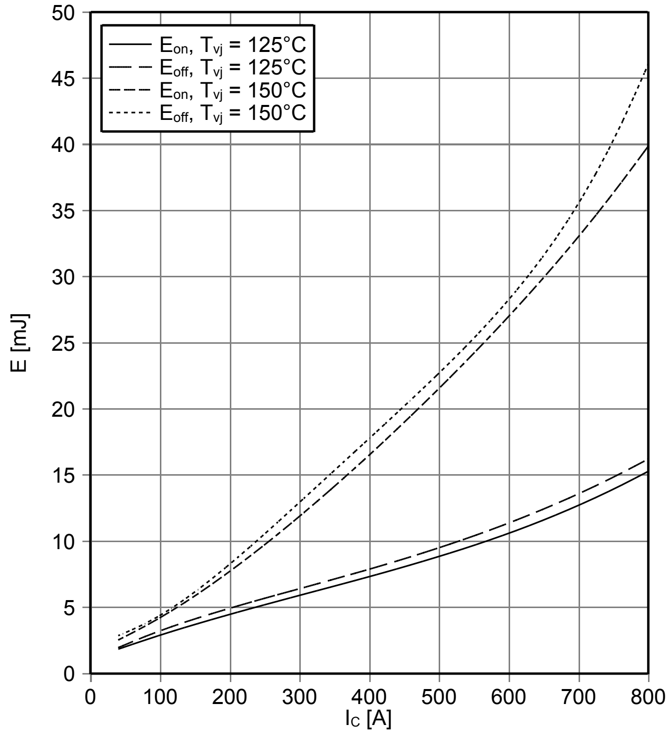
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
T_{vj} = 150°C



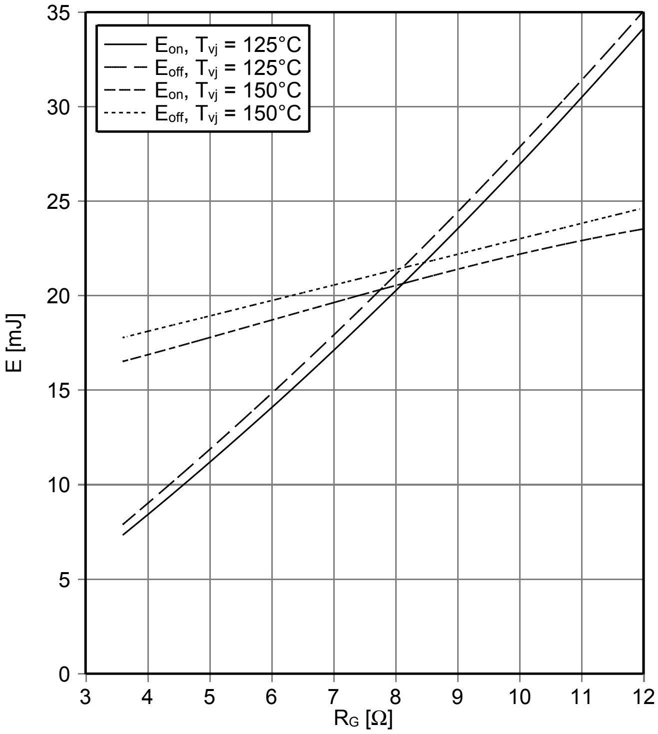
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
V_{CE} = 20 V



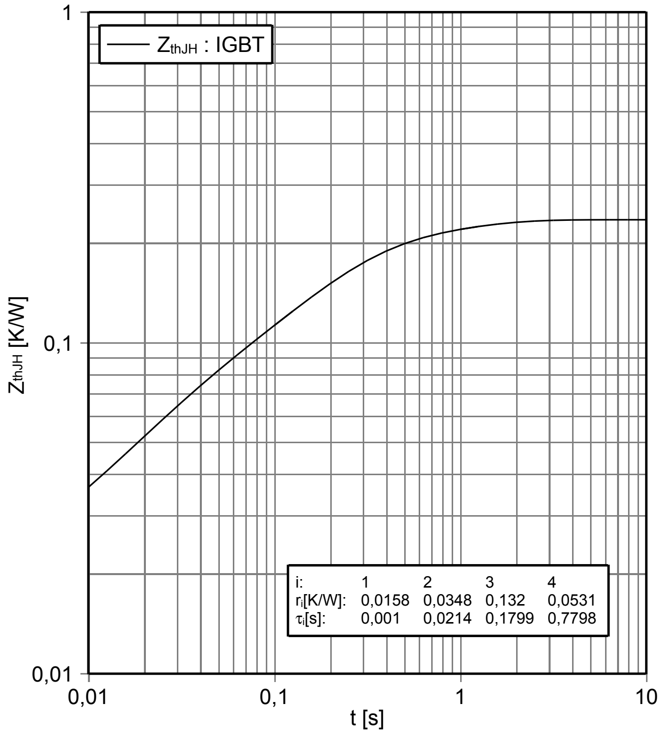
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
V_{GE} = -8 / +15 V, R_{Gon} = 3.6 Ω, R_{Goff} = 3.6 Ω, V_{CE} = 300 V



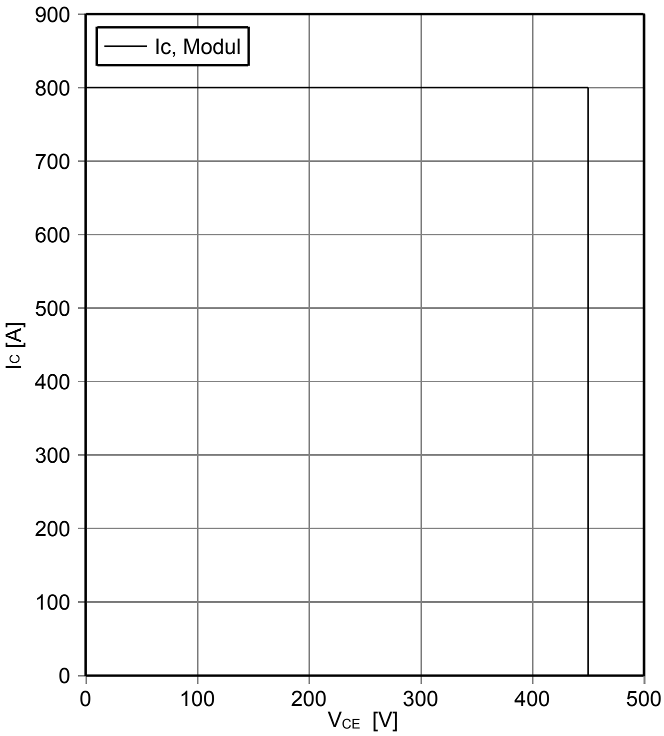
switching losses IGBT,Inverter (typical)
E_{on} = f (R_G), E_{off} = f (R_G)
V_{GE} = -8 / +15 V, I_C = 400 A, V_{CE} = 300 V



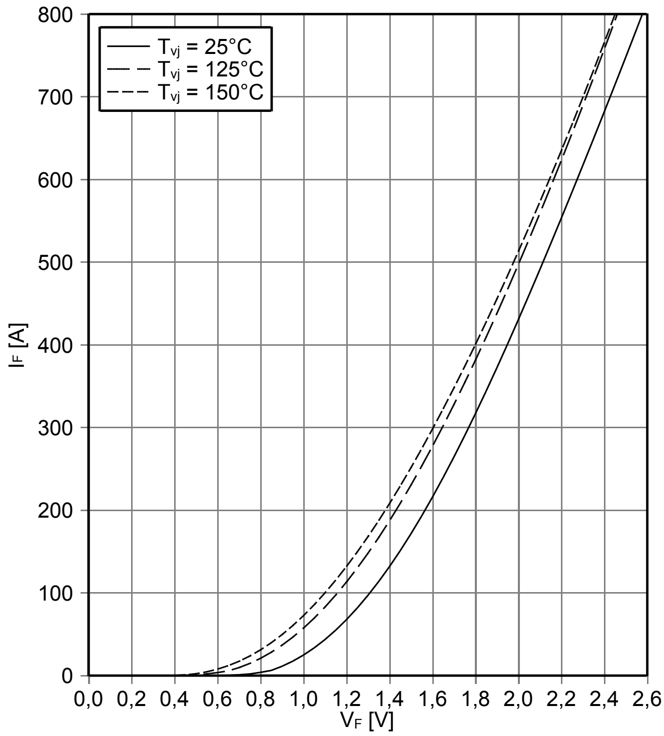
transient thermal impedance IGBT,Inverter
Z_{thJH} = f (t)



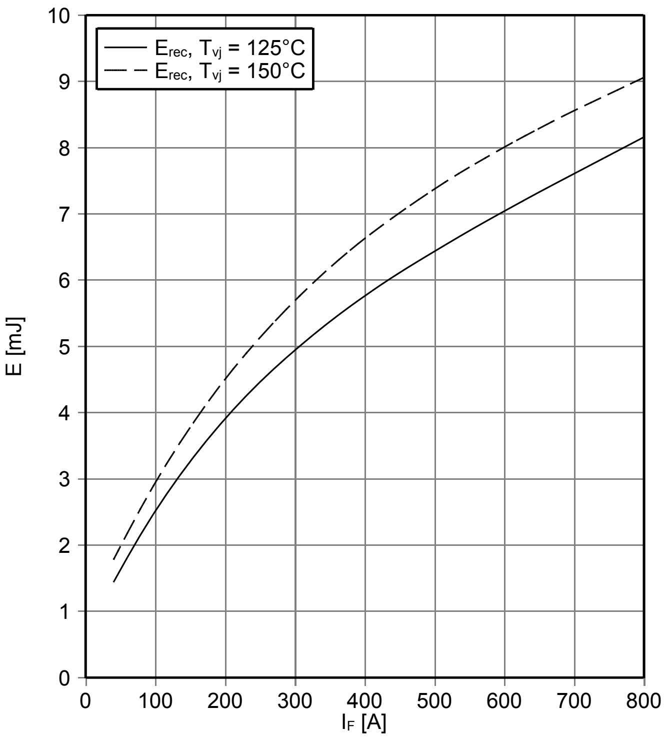
reverse bias safe operating area IGBT,Inverter (RBSOA)
I_C = f (V_{CE})
V_{GE} = ±15 V, R_{Goff} = 3.6 Ω, T_{vj} = 150°C



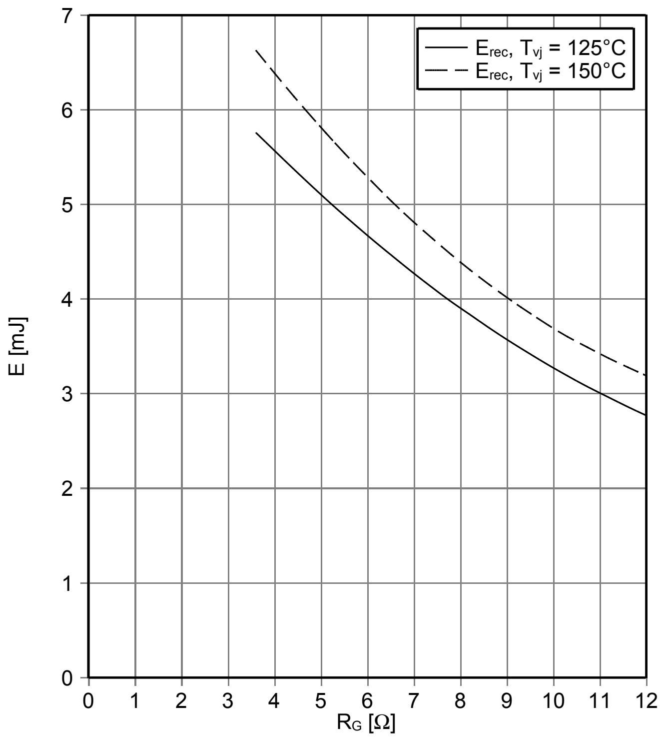
forward characteristic of Diode, Inverter (typical)
I_F = f (V_F)



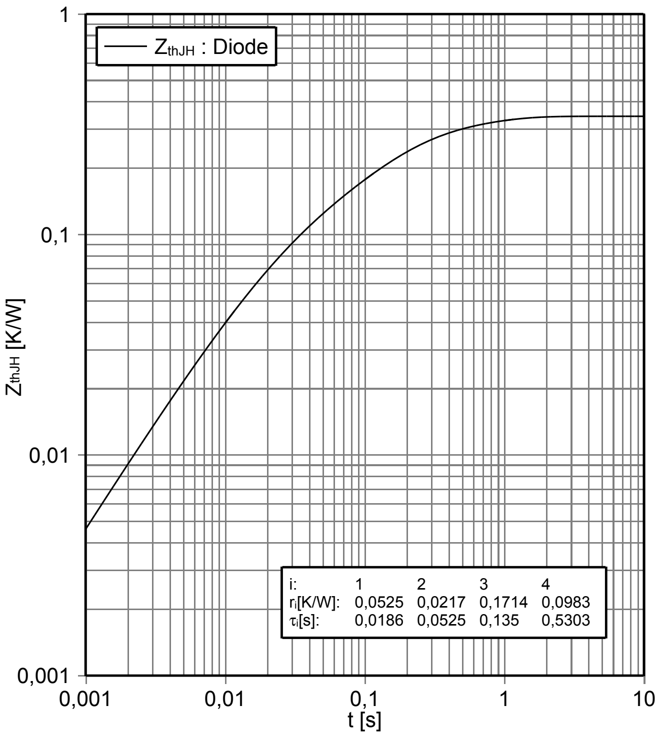
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$
$R_{Gon} = 3.6\ \Omega$, $V_{CE} = 300$ V



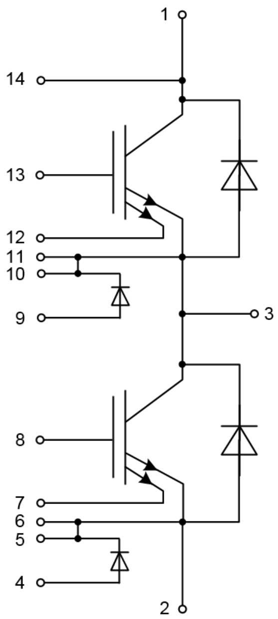
switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$
$I_F = 400$ A, $V_{CE} = 300$ V



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

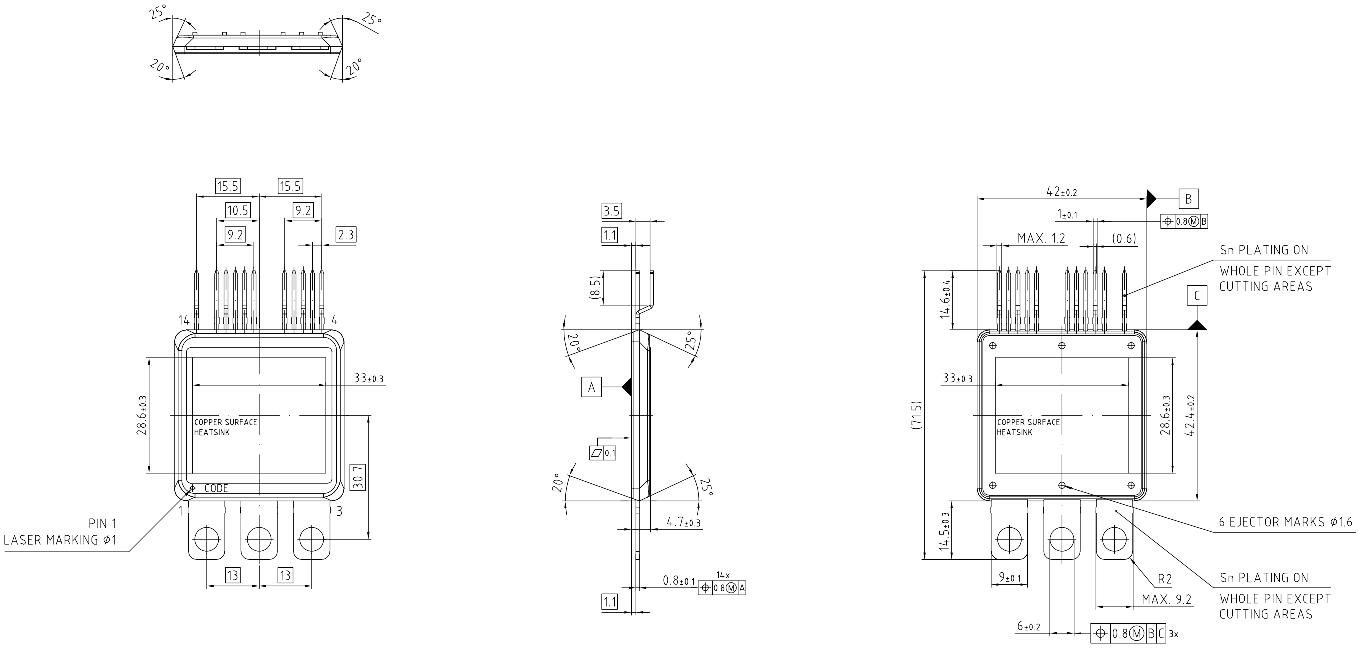


8 Circuit diagram



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

9 Package outlines



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

Revision History

Major changes since previous revision

Revision History		
Reference	**Date**	**Description**
V1.0	2015-03-26	Initial Version
V1.1	2015-04-07	Extension of target data
V2.0	2016-02-02	Update of target data
V3.0	2016-11-07	Final Datasheet
V3.1	2016-11-08	Change of product name in description
V3.2	2016-12-13	Changes in description
V3.3	2017-07-28	Update mechanical drawing
V3.4	2020-04-15	Correction of package outlines

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