

Double Side Cooled Module

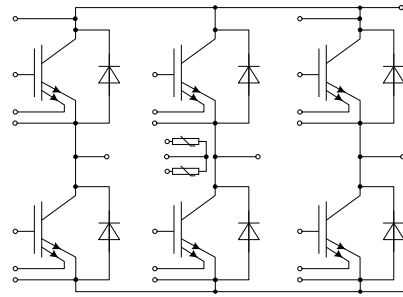
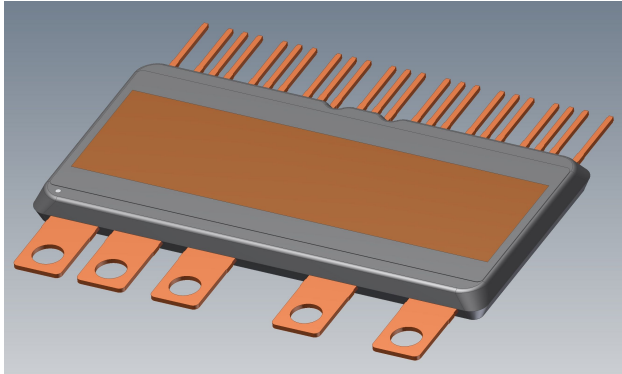
FS200R07A02E3\_S6

Final Data Sheet

V3.0, 2016-12-13

Automotive High Power

## 1 Features / Description



$$V_{CES} = 700V$$

$$I_{C\ nom} = 200A / I_{CRM} = 400A$$

### Typical Applications

- Automotive Applications
- Hybrid Electrical Vehicles (H)EV

### Electrical Features

- Increased Blocking Voltage Capability to 700V
- Integrated Current Sensor
- Low Inductive Design
- $T_{vj\ op} = 150^{\circ}C$

### Mechanical Features

- 2.5kV AC 1min Insulation
- Double sided cooling
- Compact design
- RoHS compliant
- Integrated NTC temperature sensor

### Description

The HybridPACK™ DSC L is a very compact six-pack 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 sensors and module temperature sensors (2 x NTC) support to monitor the IGBT state. These features enable enhanced short-circuit protection and intelligent control of the system.

The extreme compact package is realized by using Double Sided Cooling (DSC). This new assembly technology enables enhanced thermal and electrical performance at high reliability and mechanical robustness.

Furthermore, this module allows combination with other existing Double Sided Cooling packages (e.g. HybridPACK™ DSC S) to extend the single inverter to a dual inverter configuration.

Product Name	Ordering Code
FS200R07A02E3_S6	SP001351216

## 2 IGBT, Inverter

### 2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	$T_{vj} = 25^{\circ}\text{C}$	$V_{CES}$	700	V
Continuous DC collector current	$T_C = 65^{\circ}\text{C}, T_{vj\text{ max}} = 150^{\circ}\text{C}$	$I_{C\text{ nom}}$	200	A
Repetitive peak collector current	$t_p = 1\text{ ms}$	$I_{CRM}$	400	A
Total power dissipation	$T_C = 25^{\circ}\text{C}, T_{vj\text{ max}} = 150^{\circ}\text{C}$	$P_{tot}$	694	W
Gate-emitter peak voltage		$V_{GES}$	+/-20	V

### 2.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit
Collector-emitter saturation voltage	$I_C = 200\text{ A}, V_{GE} = 15\text{ V}$ $I_C = 200\text{ A}, V_{GE} = 15\text{ V}$ $I_C = 200\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$V_{CE\text{ sat}}$	1.45 1.60 1.70	2.25	V
Gate threshold voltage	$I_C = 3.70\text{ mA}, V_{CE} = V_{GE}$	$T_{vj} = 25^{\circ}\text{C}$	$V_{GE\text{ th}}$	5.00 5.80	6.50	V
Gate charge	$V_{GE} = -15\text{ V} \dots 15\text{ V}$		$Q_G$	2.20		$\mu\text{C}$
Internal gate resistor		$T_{vj} = 25^{\circ}\text{C}$	$R_{G\text{ int}}$	2.0		$\Omega$
Input capacitance	$f = 1\text{ MHz}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{ies}$	13.5		nF
Reverse transfer capacitance	$f = 1\text{ MHz}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{res}$	0.36		nF
Collector-emitter cut-off current	$V_{CE} = 450\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$I_{CES}$		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	$I_C = 200\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Gon} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{ on}}$	0.13 0.14 0.15		$\mu\text{s}$
Rise time, inductive load	$I_C = 200\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Gon} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_r$	0.07 0.07 0.07		$\mu\text{s}$
Turn-off delay time, inductive load	$I_C = 200\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Goff} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{ off}}$	0.48 0.52 0.53		$\mu\text{s}$
Fall time, inductive load	$I_C = 200\text{ A}, V_{CE} = 300\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Goff} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_f$	0.03 0.04 0.04		$\mu\text{s}$
Turn-on energy loss per pulse	$I_C = 200\text{ A}, V_{CE} = 300\text{ V}, L_S = 25\text{ nH}$ $V_{GE} = -8/+15\text{ V}, di/dt = 3000\text{ A}/\mu\text{s}$ ( $T_{vj} = 150^{\circ}\text{C}$ ) $R_{Gon} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{on}$	3.90 4.90 5.10		mJ
Turn-off energy loss per pulse	$I_C = 200\text{ A}, V_{CE} = 300\text{ V}, L_S = 25\text{ nH}$ $V_{GE} = -8/+15\text{ V}, du/dt = 2500\text{ V}/\mu\text{s}$ ( $T_{vj} = 150^{\circ}\text{C}$ ) $R_{Goff} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{off}$	6.80 8.20 8.50		mJ
SC data	$V_{GE} \leq 15\text{ V}, V_{CC} = 360\text{ V}$ $V_{CE\text{ max}} = V_{CES} - L_{SCE} \cdot di/dt$	$t_p \leq 6\ \mu\text{s}, T_{vj} = 150^{\circ}\text{C}$	$I_{SC}$	1700		A
Thermal resistance, junction to case	per IGBT Clamping Force $F = 700\text{ N}$		$R_{th\text{ JC}}$		0.180 <sup>1)</sup>	K/W
Thermal resistance, case to heatsink	per IGBT $\lambda_{\text{Paste}} = 1\text{ W}/(\text{m}\cdot\text{K})$ / $\lambda_{\text{grease}} = 1\text{ W}/(\text{m}\cdot\text{K})$ Clamping Force $F = 700\text{ N}$		$R_{th\text{ CH}}$	0.170 <sup>1)</sup>		K/W
Temperature under switching conditions	$t_{p\text{ continuous}}$		$T_{vj\text{ op}}$	-40	150	$^{\circ}\text{C}$

<sup>1)</sup> with double sided cooling, evaluation according to HybridPack™ DSC application note

### 3 Diode, Inverter

#### 3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	$T_{vj} = 25^{\circ}\text{C}$	$V_{RRM}$	700	V
Continuous DC forward current		$I_F$	200	A
Repetitive peak forward current	$t_P = 1 \text{ ms}$	$I_{FRM}$	400	A
$I^2t$ - value	$V_R = 0 \text{ V}$ , $t_P = 10 \text{ ms}$ , $T_{vj} = 125^{\circ}\text{C}$	$I^2t$	1800	$\text{A}^2\text{s}$

#### 3.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit
Forward voltage	$I_F = 200 \text{ A}$ , $V_{GE} = 0 \text{ V}$ $I_F = 200 \text{ A}$ , $V_{GE} = 0 \text{ V}$ $I_F = 200 \text{ A}$ , $V_{GE} = 0 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$V_F$	1.60 1.50 1.50	2.55	V
Peak reverse recovery current	$I_F = 200 \text{ A}$ , $-di_F/dt = 2900 \text{ A}/\mu\text{s}$ ( $T_{vj} = 150^{\circ}\text{C}$ ) $V_R = 300 \text{ V}$ $V_{GE} = -8 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$I_{RM}$	96.0 130 140		A
Recovered charge	$I_F = 200 \text{ A}$ , $-di_F/dt = 2900 \text{ A}/\mu\text{s}$ ( $T_{vj} = 150^{\circ}\text{C}$ ) $V_R = 300 \text{ V}$ $V_{GE} = -8 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$Q_r$	7.20 13.5 16.0		$\mu\text{C}$
Reverse recovery energy	$I_F = 200 \text{ A}$ , $-di_F/dt = 2900 \text{ A}/\mu\text{s}$ ( $T_{vj} = 150^{\circ}\text{C}$ ) $V_R = 300 \text{ V}$ $V_{GE} = -8 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{rec}$	1.70 3.30 3.80		mJ
Thermal resistance, junction to case	per diode Clamping Force $F = 700\text{N}$	$R_{thJC}$			0.280 <sup>1)</sup>	K/W
Thermal resistance, case to heatsink	per diode $\lambda_{Paste} = 1 \text{ W}/(\text{m}\cdot\text{K})$ / $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot\text{K})$ Clamping Force $F = 700\text{N}$	$R_{thCH}$		0.270 <sup>1)</sup>		K/W
Temperature under switching conditions	$t_{op}$ continuous	$T_{vj op}$	-40		150	$^{\circ}\text{C}$

### 4 Module

Parameter	Conditions	Symbol	Value	Unit	
Isolation test voltage	RMS, $f = 50 \text{ Hz}$ , $t = 1 \text{ min}$	$V_{ISOL}$	2.5	kV	
Material of module baseplate			Cu		
Internal isolation	basic insulation (class 1, IEC 61140)		$\text{Al}_2\text{O}_3$		
Creepage distance	terminal to heatsink terminal to terminal	$d_{Creep}$	2.8	mm	
Clearance	terminal to heatsink terminal to terminal	$d_{Clear}$	2.4	mm	
Comperative tracking index		CTI	> 600		
			min. typ. max.		
Stray inductance module		$L_{sCE}$	20	nH	
Storage temperature		$T_{stg}$	-40	125	$^{\circ}\text{C}$
Terminal connection torque	Screw M5	M	-		Nm
Mounting force per clamp		F	400	750	N
Weight		G	72		g

### 5 Current Sensor

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Output voltage	$V_{CE} = 1.95 \text{ V}$ , $I_c = 400 \text{ A}$ $R_{sense} = 1.60 \Omega$ , $T_{vj} = 25^{\circ}\text{C}$ $V_{GE} = 15\text{V}$	$V_{sense}$		0.26		V

<sup>1)</sup> with double sided cooling, evaluation according to HybridPack™ DSC application note

## 6 NTC-Thermistor

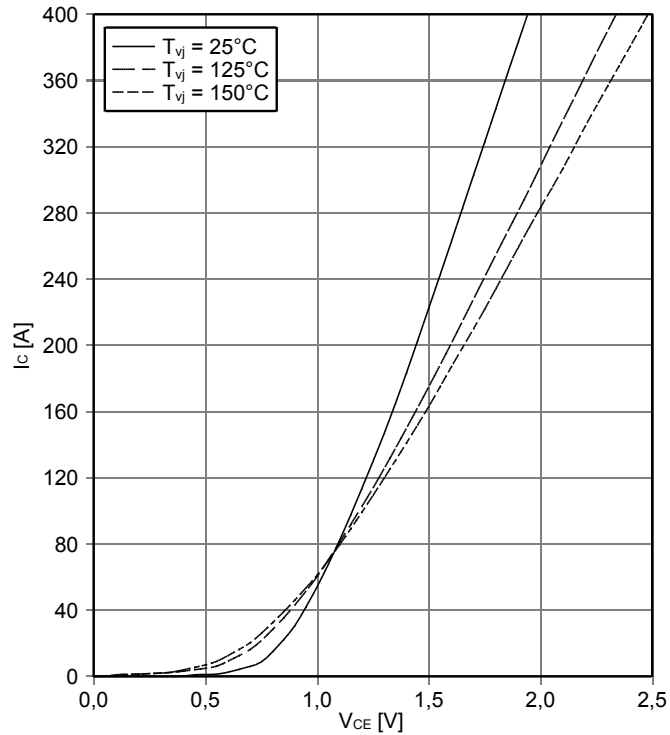
Parameter	Conditions	Symbol	min. typ. max.			Unit
			Value			
Rated resistance	$T_C = 25^\circ\text{C}$	$R_{25}$		5.00		$\text{k}\Omega$
Deviation of R100	$T_C = 100^\circ\text{C}, R_{100} = 493 \Omega$	$\Delta R/R$	5		5	%
Power dissipation	$T_C = 25^\circ\text{C}$	$P_{25}$			20.0	mW
B-value	$R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298,15 \text{ K}))]$	$B_{25/50}$		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.

## 7 Characteristics Diagrams

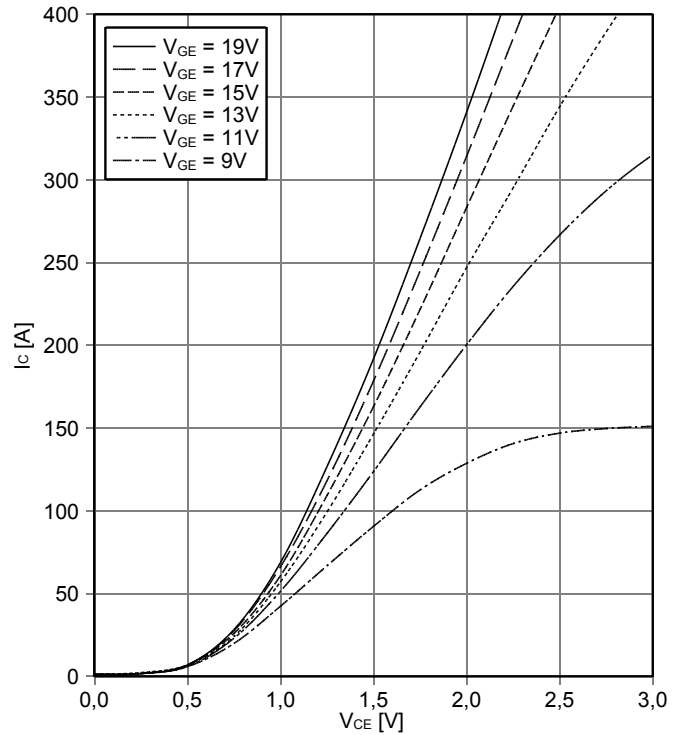
**output characteristic IGBT, Inverter (typical)**

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



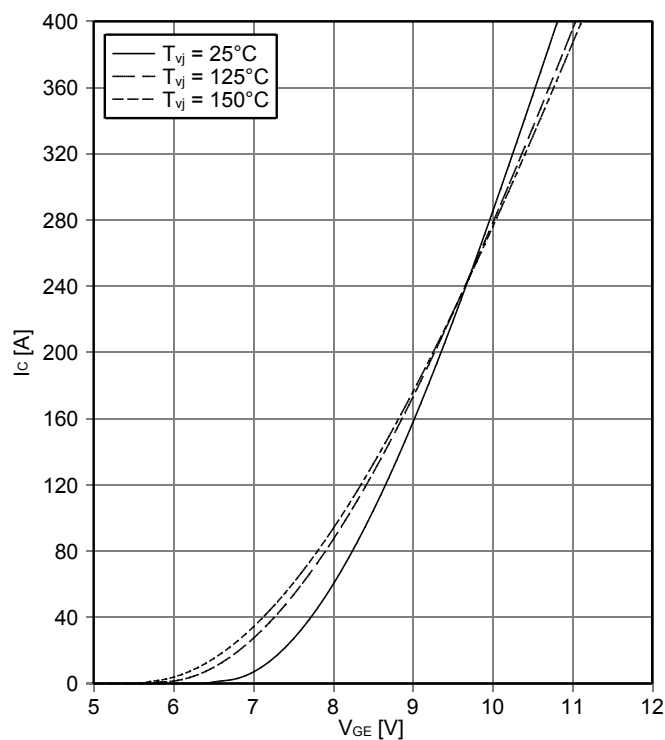
**output characteristic IGBT, Inverter (typical)**

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



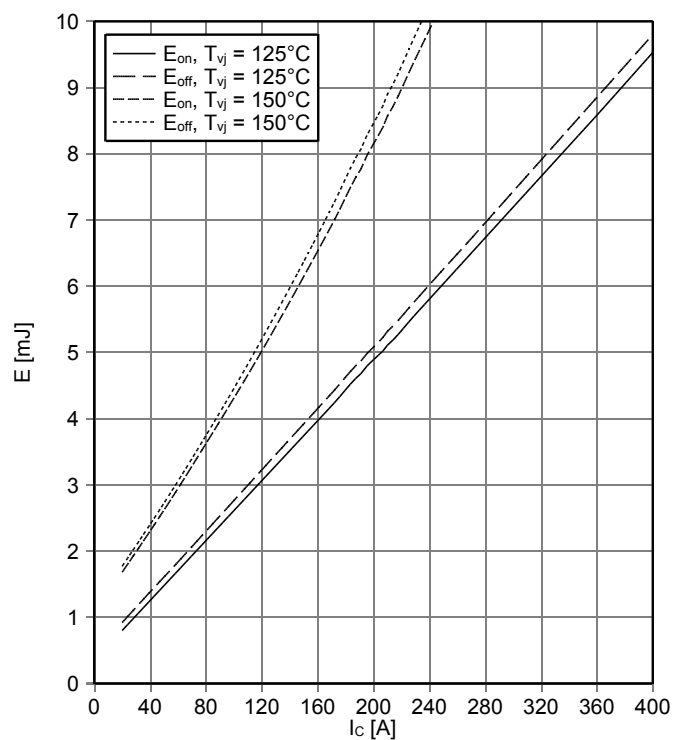
**transfer characteristic IGBT, Inverter (typical)**

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



**switching losses IGBT, Inverter (typical)**

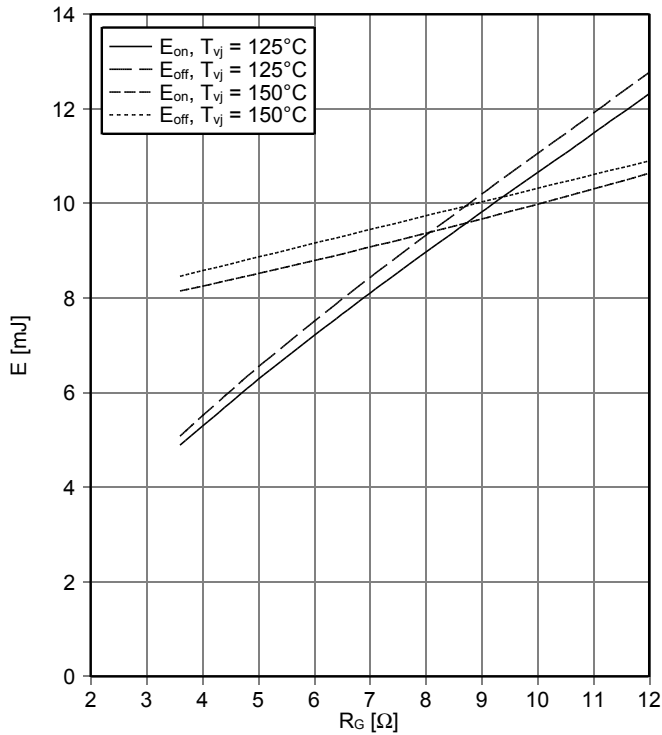
$E_{on} = f(I_C)$ ,  $E_{off} = f(I_C)$   
 $V_{GE} = -8\text{ V} / +15\text{ V}$ ,  $R_{Gon} = 3.6\ \Omega$ ,  $R_{Goff} = 3.6\ \Omega$ ,  $V_{CE} = 300\text{ V}$



### switching losses IGBT, Inverter (typical)

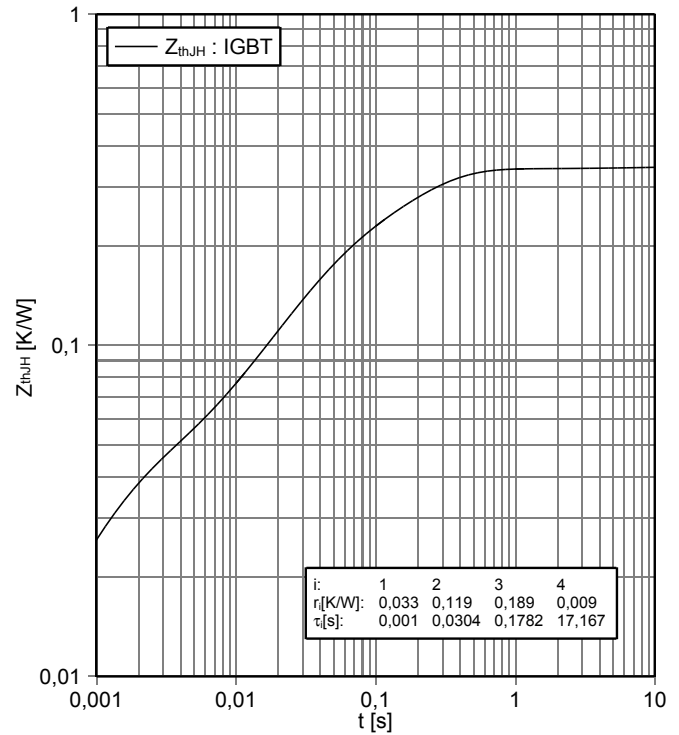
$$E_{on} = f(R_G), E_{off} = f(R_G)$$

$V_{GE} = -8 / +15 \text{ V}, I_C = 200 \text{ A}, V_{CE} = 300 \text{ V}$



### transient thermal impedance IGBT, Inverter

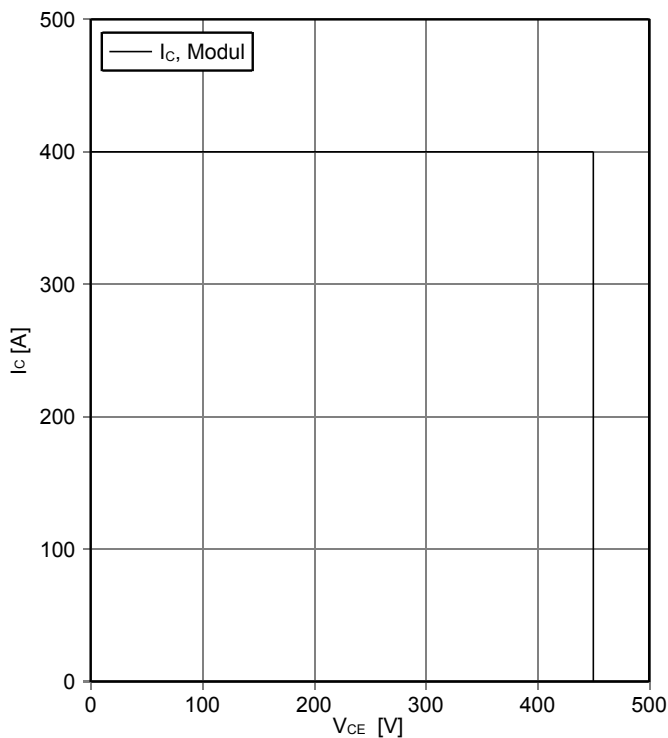
$$Z_{thJH} = f(t)$$



### reverse bias safe operating area IGBT, Inverter (RBSOA)

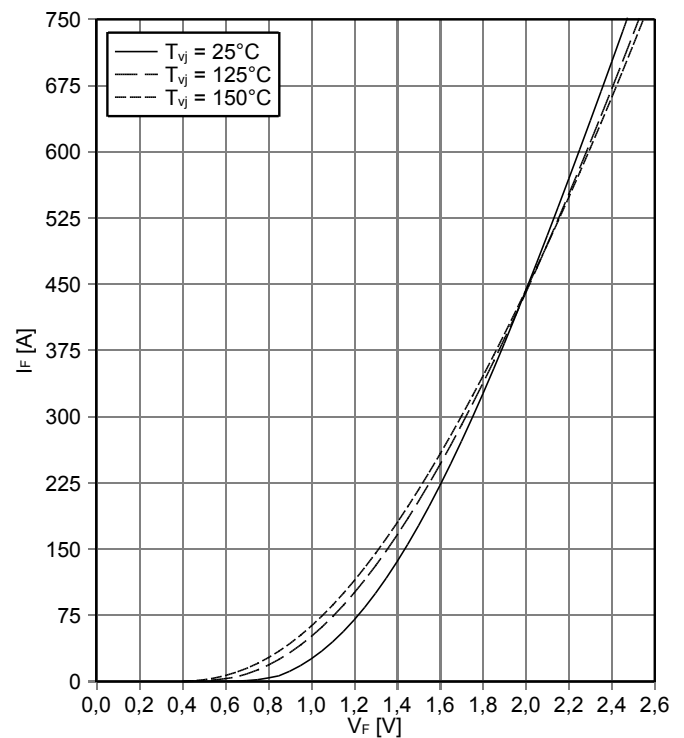
$$I_C = f(V_{CE})$$

$V_{GE} = -8 / +15 \text{ V}, R_{Goff} = 3.6 \Omega, T_{vj} = 150^\circ\text{C}$



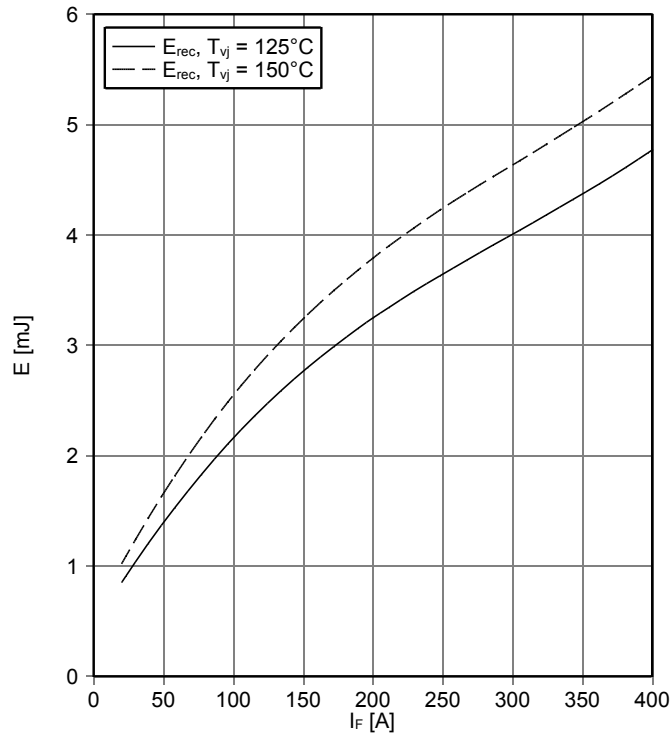
### forward characteristic of Diode, Inverter (typical)

$$I_F = f(V_F)$$



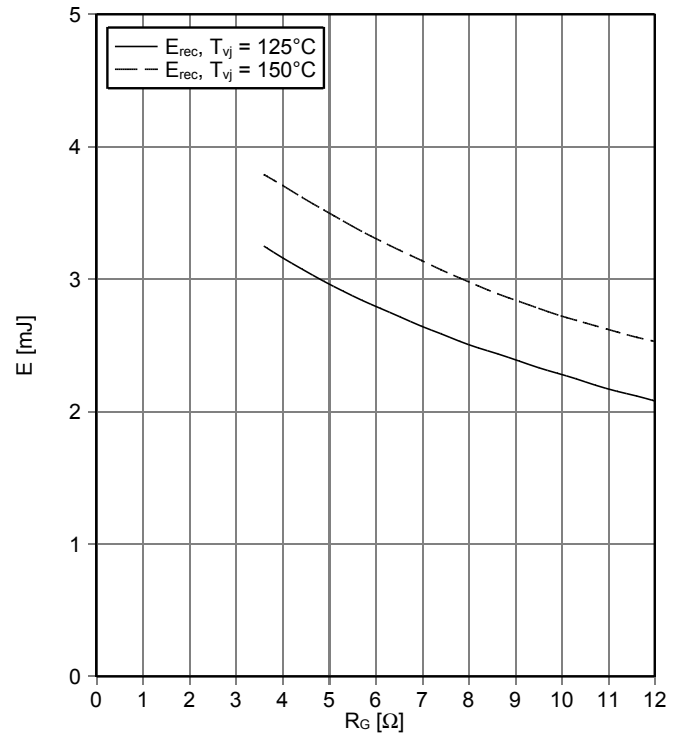
### switching losses Diode, Inverter (typical)

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



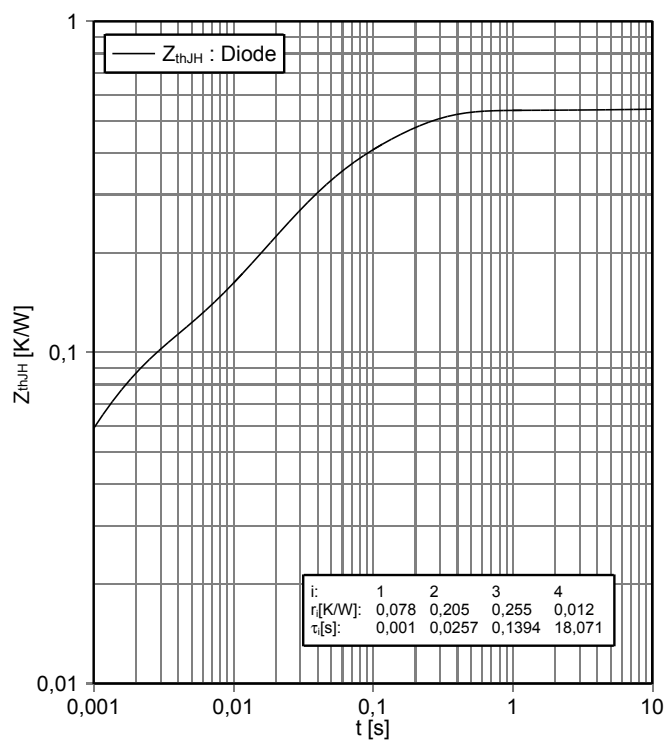
### switching losses Diode, Inverter (typical)

$E_{rec} = f(R_G)$   
 $I_F = 200 A, V_{CE} = 300 V$



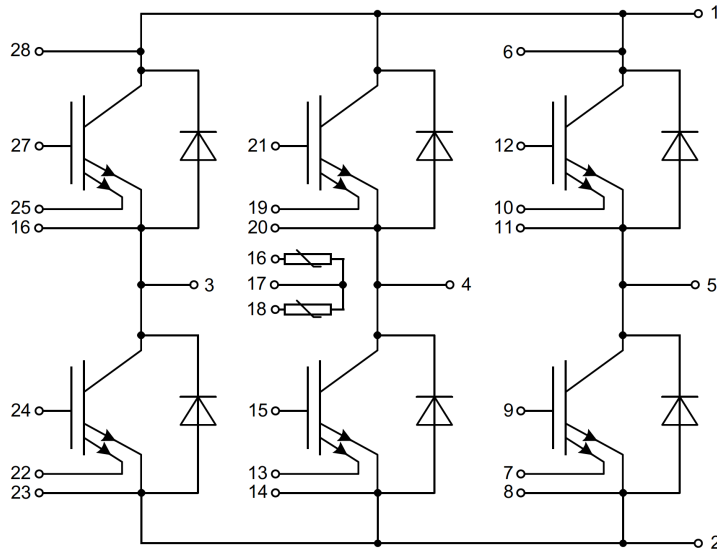
### transient thermal impedance Diode, Inverter

$Z_{thJH} = f(t)$



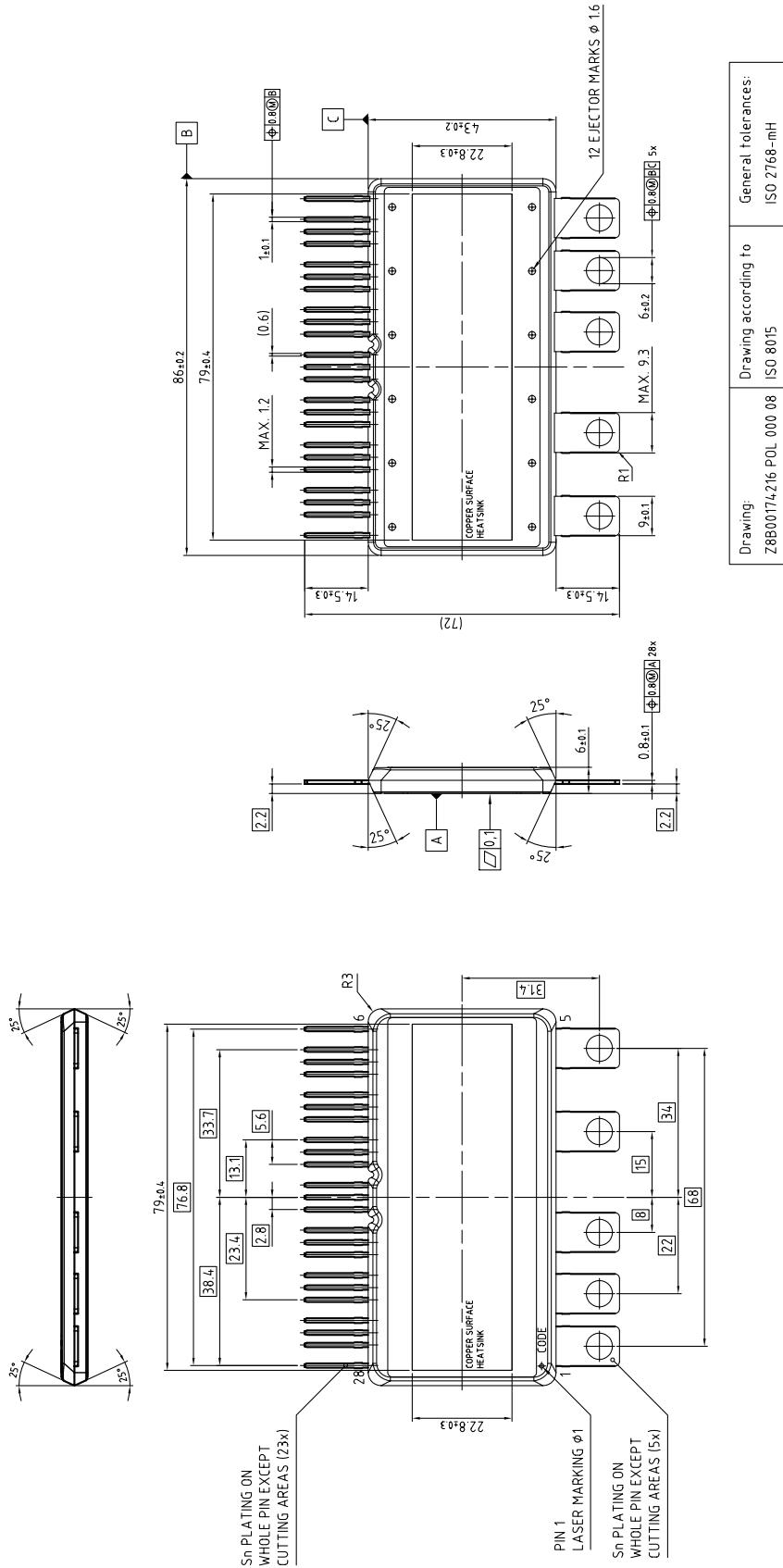


**8 Circuit diagram**



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	V	AC Output	V Phase Output
5	W	AC Output	W Phase Output
6	PS	Output	P Terminal Voltage Sensing (IGBT Collector)
7	CS6	Output	IGBT Current Sensor System 6
8	E6	Output	IGBT Emitter Output System 6
9	G6	Input	Gate Input System 6
10	CS5	Output	IGBT Current Sensor System 5
11	E5	Output	IGBT Emitter Output System 5
12	G5	Input	Gate Input System 5
13	CS4	Output	IGBT Current Sensor System 4
14	E4	Output	IGBT Emitter Output System 4
15	G4	Input	Gate Input System 4
16	T1	Output	NTC 1 + (Top DCB)
17	TG	Ground	NTC Ground
18	T2	Output	NTC 2 + (Bottom DCB)
19	CS3	Output	IGBT Current Sensor System 3
20	E3	Output	IGBT Emitter Output System 3
21	G3	Input	Gate Input System 3
22	CS2	Output	IGBT Current Sensor System 2
23	E2	Output	IGBT Emitter Output System 2
24	G2	Input	Gate Input System 2
25	CS2	Output	IGBT Current Sensor System 1
26	E1	Output	IGBT Emitter Output System 1
27	G1	Input	Gate Input System 1
28	PS	Output	P Terminal Voltage Sensing (IGBT Collector)

**9 Package outlines**





## Revision History

Major changes since previous revision

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### Revision History

Reference	Date	Description
V1.0	2015-07-31	-
V3.0	2016-12-13	final datasheet

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