

## 2 IGBT, Inverter

### 2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	$T_{vj} = 25^{\circ}\text{C}$	$V_{CES}$	750	V
Implemented collector current		$I_{CN}$	450	A
Continuous DC collector current	$T_C = 120^{\circ}\text{C}$ , $T_{vj\text{ max}} = 175^{\circ}\text{C}$	$I_{C\text{ nom}}$	300	A
Repetitive peak collector current	$t_p = 1\text{ ms}$	$I_{CRM}$	900	A
Total power dissipation	$T_C = 25^{\circ}\text{C}$ , $T_{vj\text{ max}} = 175^{\circ}\text{C}$	$P_{tot}$	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	$I_C = 300\text{ A}$ , $V_{GE} = 15\text{ V}$ $I_C = 300\text{ A}$ , $V_{GE} = 15\text{ V}$ $I_C = 300\text{ A}$ , $V_{GE} = 15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	$V_{CE\text{ sat}}$	1.20 1.27 1.29	1.44	V	
Gate threshold voltage	$I_C = 4.85\text{ mA}$ , $V_{CE} = V_{GE}$	$T_{vj} = 25^{\circ}\text{C}$	$V_{GE\text{ th}}$	4.90	5.80	6.50	V
Gate charge	$V_{GE} = -8\text{ V} \dots 15\text{ V}$ , $V_{CE} = 400\text{ V}$		$Q_G$	2.15		$\mu\text{C}$	
Internal gate resistor		$T_{vj} = 25^{\circ}\text{C}$	$R_{G\text{ int}}$	2.0		$\Omega$	
Input capacitance	$f = 1\text{ MHz}$ , $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{ies}$	38.5		nF	
Reverse transfer capacitance	$f = 1\text{ MHz}$ , $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{res}$	0.18		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	$I_C = 300\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Gon} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	$t_{d\text{ on}}$	0.34 0.36 0.36		$\mu\text{s}$	
Rise time, inductive load	$I_C = 300\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Gon} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	$t_r$	0.06 0.07 0.07		$\mu\text{s}$	
Turn-off delay time, inductive load	$I_C = 300\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Goff} = 2.4\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	$t_{d\text{ off}}$	0.48 0.54 0.56		$\mu\text{s}$	
Fall time, inductive load	$I_C = 300\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8/+15\text{ V}$ $R_{Goff} = 2.4\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	$t_f$	0.07 0.12 0.13		$\mu\text{s}$	
Turn-on energy loss per pulse	$I_C = 300\text{ A}$ , $V_{CE} = 400\text{ V}$ , $L_S = 25\text{ nH}$ $V_{GE} = -8/+15\text{ V}$ , $di/dt = 3400\text{ A}/\mu\text{s}$ ( $T_{vj} = 175^{\circ}\text{C}$ ) $R_{Gon} = 3.6\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	$E_{on}$	11.5 13.5 14.5		mJ	
Turn-off energy loss per pulse	$I_C = 300\text{ A}$ , $V_{CE} = 400\text{ V}$ , $L_S = 25\text{ nH}$ $V_{GE} = -8/+15\text{ V}$ , $du/dt = 3200\text{ V}/\mu\text{s}$ ( $T_{vj} = 175^{\circ}\text{C}$ ) $R_{Goff} = 2.4\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	$E_{off}$	12.0 15.5 17.0		mJ	
SC data	$V_{GE} \leq 15\text{ V}$ , $V_{CE} = 400\text{ V}$ $V_{CE\text{ max}} = V_{CES} - L_{SCE} \cdot di/dt$	$t_p \leq 3\ \mu\text{s}$ , $T_{vj} = 175^{\circ}\text{C}$	$I_{SC}$	2000		A	
Thermal resistance, junction to case	per IGBT		$R_{thJC}$		0.090 <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 $F = 700\text{ N}$		$R_{thCH}$		0.100 <sup>1)</sup>	K/W	
Temperature under switching conditions	$t_{op}$ continuous for 10s within a period of 30s, occurrence maximum 3000 times over lifetime		$T_{vj\text{ op}}$	-40 150	150 175	$^{\circ}\text{C}$	

<sup>1)</sup> 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	$T_{vj} = 25^{\circ}\text{C}$	$V_{RRM}$	750	V
Implemented forward current		$I_{FN}$	450	A
Continuous DC forward current		$I_F$	300	A
Repetitive peak forward current	$t_P = 1 \text{ ms}$	$I_{FRM}$	900	A
$I^2t$ - value	$V_R = 0 \text{ V}, t_P = 10 \text{ ms}, T_{vj} = 150^{\circ}\text{C}$	$I^2t$	8500	$\text{A}^2\text{s}$

#### 3.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit
Forward voltage	$I_F = 300 \text{ A}, V_{GE} = 0 \text{ V}$ $I_F = 300 \text{ A}, V_{GE} = 0 \text{ V}$ $I_F = 300 \text{ A}, V_{GE} = 0 \text{ V}$	$V_F$		1.55 1.45 1.40	1.83	V
Peak reverse recovery current	$I_F = 300 \text{ A}, -di_F/dt = 3400 \text{ A}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	$I_{RM}$		170 235 250		A
Recovered charge	$I_F = 300 \text{ A}, -di_F/dt = 3400 \text{ A}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	$Q_r$		12.0 26.0 31.0		$\mu\text{C}$
Reverse recovery energy	$I_F = 300 \text{ A}, -di_F/dt = 3400 \text{ A}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	$E_{rec}$		2.90 6.60 8.00		mJ
Thermal resistance, junction to case	per diode	$R_{thJC}$			0.145 <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 $F = 700\text{N}$	$R_{thCH}$		0.140 <sup>1)</sup>		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	$^{\circ}\text{C}$

### 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	$d_{Creep}$	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
Terminal connection torque	Screw M5	M	-	Nm
Mounting force per clamp		F	-	750
Weight		G	31	g

### 5 Temperature Sensor

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Forward voltage	$I_{TS} = 0.22 \text{ mA}, T_{vj} = 25^{\circ}\text{C}$	$V_{TS}$	2.220 <sup>2)</sup>	2.280	2.340 <sup>2)</sup>	V
temperature coefficient (tcr)	$I_{TS} = 0.22 \text{ mA}$	$TC_{TS}$		-5.50		mV/K

<sup>1)</sup> with double sided cooling, evaluation according to HybridPACK cool application note

<sup>2)</sup> Verified by design, not by test