

## 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	$t_{op}$ 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