

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}	950	A
Continuous DC collector current	$T_F = 95^{\circ}\text{C}$, $T_{vj\text{ max}} = 175^{\circ}\text{C}$	$I_{C\text{ nom}}$	450 ¹⁾	A
Repetitive peak collector current	$t_p = 1\text{ ms}$	I_{CRM}	1900	A
Total power dissipation	$T_F = 75^{\circ}\text{C}$, $T_{vj\text{ max}} = 175^{\circ}\text{C}$	P_{tot}	870 ¹⁾	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit
Collector-emitter saturation voltage	$I_C = 450\text{ A}$, $V_{GE} = 15\text{ V}$ $I_C = 450\text{ A}$, $V_{GE} = 15\text{ V}$ $I_C = 450\text{ A}$, $V_{GE} = 15\text{ V}$	$V_{CE\text{ sat}}$	$T_{vj} = 25^{\circ}\text{C}$	1.10	1.35	V
			$T_{vj} = 150^{\circ}\text{C}$	1.15		
			$T_{vj} = 175^{\circ}\text{C}$	1.15		
	$I_C = 950\text{ A}$, $V_{GE} = 15\text{ V}$ $I_C = 950\text{ A}$, $V_{GE} = 15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	1.35			
		$T_{vj} = 175^{\circ}\text{C}$	1.55			
Gate threshold voltage	$I_C = 9.60\text{ mA}$, $V_{CE} = V_{GE}$	$V_{GE\text{ th}}$	4.90	5.80 4,10	6.50	V
Gate charge	$V_{GE} = -8\text{ V} \dots 15\text{ V}$, $V_{CE} = 400\text{ V}$	Q_G	4.40			μC
Internal gate resistor		$R_{G\text{ int}}$	0.7			Ω
Input capacitance	$f = 1\text{ MHz}$, $V_{CE} = 50\text{ V}$, $V_{GE} = 0\text{ V}$	C_{ies}	80.0			nF
Output capacitance	$f = 1\text{ MHz}$, $V_{CE} = 50\text{ V}$, $V_{GE} = 0\text{ V}$	C_{oes}	1.00			nF
Reverse transfer capacitance	$f = 1\text{ MHz}$, $V_{CE} = 50\text{ V}$, $V_{GE} = 0\text{ V}$	C_{res}	0.30			nF
Collector-emitter cut-off current	$V_{CE} = 750\text{ V}$, $V_{GE} = 0\text{ V}$ $V_{CE} = 750\text{ V}$, $V_{GE} = 0\text{ V}$	I_{CES}	5		1.0	mA
Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = 20\text{ V}$	I_{GES}			400	nA
Turn-on delay time, inductive load	$I_C = 450\text{ A}$, $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{Gon} = 2.4\ \Omega$	$t_{d\text{ on}}$	$T_{vj} = 25^{\circ}\text{C}$	0.28		μs
			$T_{vj} = 150^{\circ}\text{C}$	0.29		
			$T_{vj} = 175^{\circ}\text{C}$	0.30		
Rise time, inductive load	$I_C = 450\text{ A}$, $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{Gon} = 2.4\ \Omega$	t_r	$T_{vj} = 25^{\circ}\text{C}$	0.07		μs
			$T_{vj} = 150^{\circ}\text{C}$	0.08		
			$T_{vj} = 175^{\circ}\text{C}$	0.08		
Turn-off delay time, inductive load	$I_C = 450\text{ A}$, $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{Goff} = 5.1\ \Omega$	$t_{d\text{ off}}$	$T_{vj} = 25^{\circ}\text{C}$	0.94		μs
			$T_{vj} = 150^{\circ}\text{C}$	1.05		
			$T_{vj} = 175^{\circ}\text{C}$	1.05		
Fall time, inductive load	$I_C = 450\text{ A}$, $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{Goff} = 5.1\ \Omega$	t_f	$T_{vj} = 25^{\circ}\text{C}$	0.04		μs
			$T_{vj} = 150^{\circ}\text{C}$	0.05		
			$T_{vj} = 175^{\circ}\text{C}$	0.06		
Turn-on energy loss per pulse	$I_C = 450\text{ A}$, $V_{CE} = 400\text{ V}$, $L_S = 20\text{ nH}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{Gon} = 2.4\ \Omega$ $di/dt (T_{vj} 25^{\circ}\text{C}) = 5500\text{ A}/\mu\text{s}$ $di/dt (T_{vj} 150^{\circ}\text{C}) = 5000\text{ A}/\mu\text{s}$	E_{on}	$T_{vj} = 25^{\circ}\text{C}$	13.5		mJ
			$T_{vj} = 150^{\circ}\text{C}$	17.5		
			$T_{vj} = 175^{\circ}\text{C}$	18.0		
Turn-off energy loss per pulse	$I_C = 450\text{ A}$, $V_{CE} = 400\text{ V}$, $L_S = 20\text{ nH}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{Goff} = 5.1\ \Omega$ $dv/dt (T_{vj} 25^{\circ}\text{C}) = 3100\text{ V}/\mu\text{s}$ $dv/dt (T_{vj} 150^{\circ}\text{C}) = 2500\text{ V}/\mu\text{s}$	E_{off}	$T_{vj} = 25^{\circ}\text{C}$	23.5		mJ
			$T_{vj} = 150^{\circ}\text{C}$	29.0		
			$T_{vj} = 175^{\circ}\text{C}$	30.0		
SC data	$V_{GE} \leq 15\text{ V}$, $V_{CC} = 400\text{ V}$ $V_{CE\text{ max}} = V_{CES} - L_{SCE} \cdot di/dt$	I_{SC}	4800 3900			A
Thermal resistance, junction to cooling fluid	per IGBT; $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$, $T_F = 75^{\circ}\text{C}$	R_{thJF}	0.100 ²⁾	0.115 ²⁾		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 ³⁾ 175	$^{\circ}\text{C}$

¹⁾ Verified by characterization / design not by test.

²⁾ Cooler design and flow direction according to application note AN-HPDPERF-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.

³⁾ For $T_{vj\text{ op}} > 150^{\circ}\text{C}$: Baseplate temperature has to be limited to 125°C .

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}	950	A
Continuous DC forward current		I_F	450 ¹⁾	A
Repetitive peak forward current	$t_p = 1 \text{ ms}$	I_{FRM}	1900	A
I^2t - value	$V_R = 0 \text{ V}, t_p = 10 \text{ ms}, T_{vj} = 150^{\circ}\text{C}$ $V_R = 0 \text{ V}, t_p = 10 \text{ ms}, T_{vj} = 175^{\circ}\text{C}$	I^2t	19000 16000	A^2s A^2s

3.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit	
Forward voltage	$I_F = 450 \text{ A}, V_{GE} = 0 \text{ V}$	V_F		1.45	1.65	V	
	$I_F = 450 \text{ A}, V_{GE} = 0 \text{ V}$			1.30			
	$I_F = 450 \text{ A}, V_{GE} = 0 \text{ V}$			1.25			
	$I_F = 950 \text{ A}, V_{GE} = 0 \text{ V}$			1.80			
Peak reverse recovery current	$I_F = 450 \text{ A}, -di_F/dt = 5000 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	I_{RM}		250		A	
				$T_{vj} = 150^{\circ}\text{C}$			350
				$T_{vj} = 175^{\circ}\text{C}$			370
Recovered charge	$I_F = 450 \text{ A}, -di_F/dt = 5000 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	Q_r		20.0		μC	
				$T_{vj} = 150^{\circ}\text{C}$			40.0
				$T_{vj} = 175^{\circ}\text{C}$			45.0
Reverse recovery energy	$I_F = 450 \text{ A}, -di_F/dt = 5000 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	E_{rec}		7.00		mJ	
				$T_{vj} = 150^{\circ}\text{C}$			13.0
				$T_{vj} = 175^{\circ}\text{C}$			15.0
Thermal resistance, junction to cooling fluid	per diode; $\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}, T_F = 75^{\circ}\text{C}$	R_{thJF}		0.140 ²⁾	0.160 ²⁾	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 ³⁾ 175	$^{\circ}\text{C}$	

4 NTC-Thermistor

Parameter	Conditions	Symbol	min. typ. max.			Unit
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.

¹⁾ Verified by characterization / design not by test.

²⁾ Cooler design and flow direction according to application note AN-HPDPERF-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.

³⁾ For $T_{vj op} > 150^{\circ}\text{C}$: Baseplate temperature has to be limited to 125°C .