

Final datasheet

EconoDUAL™3 module with TRENCHSTOP™ IGBT7 and emitter controlled 7 diode and NTC

Features

- Electrical features
 - $V_{CES} = 1200\text{ V}$
 - $I_{C\text{ nom}} = 450\text{ A} / I_{CRM} = 900\text{ A}$
 - $V_{CE,sat}$ with positive temperature coefficient
 - TRENCHSTOP™ IGBT7
 - Integrated temperature sensor
- Mechanical features
 - High power density
 - Isolated base plate
 - PressFIT contact technology
 - Standard housing



Potential applications

- Commercial agriculture vehicles
- High-power converters
- Motor drives
- Servo drives
- UPS systems

Product validation

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

Description

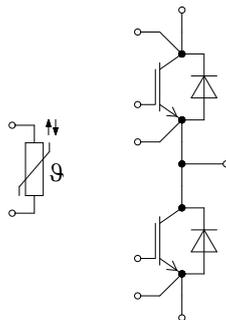


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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50$ Hz, $t = 1$ min	3.4	kV
Isolation test voltage NTC	$V_{ISOL(NTC)}$	RMS, $f = 50$ Hz, $t = 1$ min	3.4	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	$d_{Creep\ nom}$	terminal to baseplate, nom., (PD2, IEC 60664-1, Ed. 3.0)	> 15	mm
Creepage distance	$d_{Creep\ min}$	terminal to baseplate, min., (PD2, IEC 60664-1, Ed. 3.0)	14.7	mm
Creepage distance	$d_{Creep\ nom}$	terminal to terminal, nom., (PD2, IEC 60664-1, Ed. 3.0)	12.1	mm
Creepage distance	$d_{Creep\ min}$	terminal to terminal, min., (PD2, IEC 60664-1, Ed. 3.0)	11.5	mm
Clearance	$d_{Clear\ nom}$	terminal to baseplate, nom.	> 12.5	mm
Clearance	$d_{Clear\ min}$	terminal to baseplate, min.	12.5	mm
Clearance	$d_{Clear\ nom}$	terminal to terminal, nom.	10.0	mm
Clearance	$d_{Clear\ min}$	terminal to terminal, min.	9.6	mm
Comparative tracking index	CTI		> 200	
Relative thermal index (electrical)	RTI	housing	140	°C

Table 2 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray inductance module	L_{sCE}			20		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25$ °C, per switch		0.8		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting torque for module mounting	M	- Mounting according to valid application note	M5, Screw	3	6	Nm
Terminal connection torque	M	- Mounting according to valid application note	M6, Screw	3	6	Nm
Weight	G			345		g

2 IGBT, Inverter

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	V_{CES}	$T_{vj} = 25\text{ °C}$	1200	V
Continuous DC collector current	I_{CDC}	$T_{vj\text{ max}} = 175\text{ °C}$ $T_C = 90\text{ °C}$	450	A
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\text{ op}}$	900	A
Gate-emitter peak voltage	V_{GES}		± 20	V

Table 4 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\text{ sat}}$	$I_C = 450\text{ A}$, $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.50	1.75	V
			$T_{vj} = 125\text{ °C}$	1.65		
			$T_{vj} = 175\text{ °C}$	1.75		
Gate threshold voltage	V_{GETh}	$I_C = 9\text{ mA}$, $V_{CE} = V_{GE}$, $T_{vj} = 25\text{ °C}$	5.15	5.80	6.45	V
Gate charge	Q_G	$V_{GE} = \pm 15\text{ V}$, $V_{CC} = 600\text{ V}$		7.2		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\text{ °C}$		0.8		Ω
Input capacitance	C_{ies}	$f = 100\text{ kHz}$, $T_{vj} = 25\text{ °C}$, $V_{CE} = 25\text{ V}$, $V_{GE} = 0\text{ V}$		69		nF
Reverse transfer capacitance	C_{res}	$f = 100\text{ kHz}$, $T_{vj} = 25\text{ °C}$, $V_{CE} = 25\text{ V}$, $V_{GE} = 0\text{ V}$		0.35		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 1200\text{ V}$, $V_{GE} = 0\text{ V}$ $T_{vj} = 25\text{ °C}$			40	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\text{ V}$, $V_{GE} = 20\text{ V}$, $T_{vj} = 25\text{ °C}$			100	nA
Turn-on delay time (inductive load)	t_{don}	$I_C = 450\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $R_{Gon} = 0.6\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.250		μs
			$T_{vj} = 125\text{ °C}$	0.270		
			$T_{vj} = 175\text{ °C}$	0.290		
Rise time (inductive load)	t_r	$I_C = 450\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $R_{Gon} = 0.6\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.057		μs
			$T_{vj} = 125\text{ °C}$	0.065		
			$T_{vj} = 175\text{ °C}$	0.068		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 450\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$, $R_{Goff} = 0.6\text{ }\Omega$	$T_{vj} = 25\text{ °C}$	0.390		μs
			$T_{vj} = 125\text{ °C}$	0.470		
			$T_{vj} = 175\text{ °C}$	0.510		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Fall time (inductive load)	t_f	$I_C = 450 \text{ A}, V_{CC} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, R_{Goff} = 0.6 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$		0.140	μs
			$T_{vj} = 125 \text{ }^\circ\text{C}$		0.270	
			$T_{vj} = 175 \text{ }^\circ\text{C}$		0.360	
Turn-on energy loss per pulse	E_{on}	$I_C = 450 \text{ A}, V_{CC} = 600 \text{ V}, L_\sigma = 25 \text{ nH}, V_{GE} = \pm 15 \text{ V}, R_{Gon} = 0.6 \Omega, di/dt = 6400 \text{ A}/\mu\text{s} (T_{vj} = 175 \text{ }^\circ\text{C})$	$T_{vj} = 25 \text{ }^\circ\text{C}$		25	mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$		43	
			$T_{vj} = 175 \text{ }^\circ\text{C}$		53	
Turn-off energy loss per pulse	E_{off}	$I_C = 450 \text{ A}, V_{CC} = 600 \text{ V}, L_\sigma = 25 \text{ nH}, V_{GE} = \pm 15 \text{ V}, R_{Goff} = 0.6 \Omega, dv/dt = 3100 \text{ V}/\mu\text{s} (T_{vj} = 175 \text{ }^\circ\text{C})$	$T_{vj} = 25 \text{ }^\circ\text{C}$		35	mJ
			$T_{vj} = 125 \text{ }^\circ\text{C}$		57	
			$T_{vj} = 175 \text{ }^\circ\text{C}$		69	
SC data	I_{SC}	$V_{GE} \leq 15 \text{ V}, V_{CC} = 800 \text{ V}, V_{CEmax} = V_{CES} - L_{sCE} * di/dt$	$t_p \leq 8 \mu\text{s}, T_{vj} = 150 \text{ }^\circ\text{C}$		2000	A
			$t_p \leq 6 \mu\text{s}, T_{vj} = 175 \text{ }^\circ\text{C}$		1900	
Thermal resistance, junction to case	R_{thJC}	per IGBT			0.0875	K/W
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, $\lambda_{grease} = 1 \text{ W}/(\text{m}\cdot\text{K})$			0.0186	K/W
Temperature under switching conditions	$T_{vj op}$		-40		175	$^\circ\text{C}$

Note: $T_{vj op} > 150 \text{ }^\circ\text{C}$ is allowed for operation at overload conditions. For detailed specifications, please refer to AN 2018-14.

3 Diode, Inverter

Table 5 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} = 25 \text{ }^\circ\text{C}$	1200	V	
Continuous DC forward current	I_F		450	A	
Repetitive peak forward current	I_{FRM}	$t_p = 1 \text{ ms}$	900	A	
I^2t - value	I^2t	$t_p = 10 \text{ ms}, V_R = 0 \text{ V}$	$T_{vj} = 125 \text{ }^\circ\text{C}$	17500	A^2s
			$T_{vj} = 175 \text{ }^\circ\text{C}$	12000	

Table 6 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	V_F	$I_F = 450\text{ A}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		1.80	2.10	V
			$T_{vj} = 125\text{ °C}$		1.70		
			$T_{vj} = 175\text{ °C}$		1.60		
Peak reverse recovery current	I_{RM}	$V_{CC} = 600\text{ V}, I_F = 450\text{ A}, V_{GE} = -15\text{ V}, -di_F/dt = 6400\text{ A}/\mu\text{s} (T_{vj} = 175\text{ °C})$	$T_{vj} = 25\text{ °C}$		306		A
			$T_{vj} = 125\text{ °C}$		407		
			$T_{vj} = 175\text{ °C}$		464		
Recovered charge	Q_r	$V_{CC} = 600\text{ V}, I_F = 450\text{ A}, V_{GE} = -15\text{ V}, -di_F/dt = 6400\text{ A}/\mu\text{s} (T_{vj} = 175\text{ °C})$	$T_{vj} = 25\text{ °C}$		30.5		μC
			$T_{vj} = 125\text{ °C}$		60		
			$T_{vj} = 175\text{ °C}$		82.5		
Reverse recovery energy	E_{rec}	$V_{CC} = 600\text{ V}, I_F = 450\text{ A}, V_{GE} = -15\text{ V}, -di_F/dt = 6400\text{ A}/\mu\text{s} (T_{vj} = 175\text{ °C})$	$T_{vj} = 25\text{ °C}$		13.5		mJ
			$T_{vj} = 125\text{ °C}$		27.5		
			$T_{vj} = 175\text{ °C}$		37.5		
Thermal resistance, junction to case	R_{thJC}	per diode			0.164	K/W	
Thermal resistance, case to heat sink	R_{thCH}	per diode, $\lambda_{grease} = 1\text{ W}/(\text{m}\cdot\text{K})$		0.0214		K/W	
Temperature under switching conditions	$T_{vj\text{ op}}$		-40		175	°C	

Note: $T_{vj\text{ op}} > 150\text{ °C}$ is allowed for operation at overload conditions. For detailed specifications, please refer to AN 2018-14.

4 NTC-Thermistor

Table 7 Characteristic values

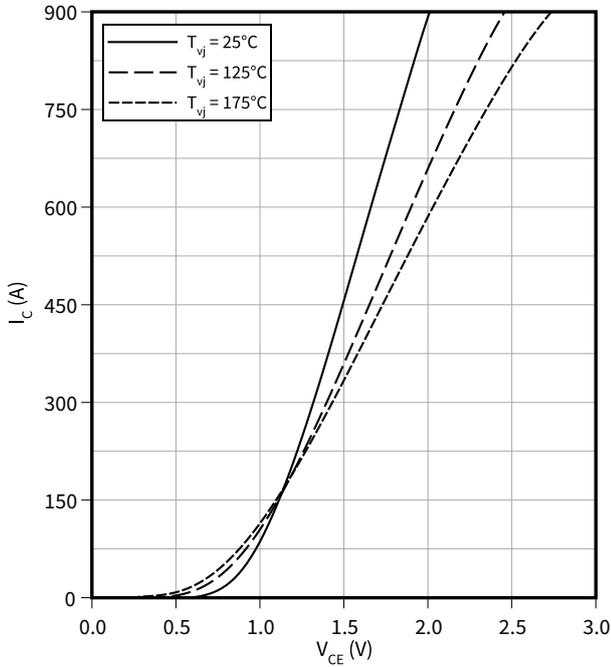
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	$T_{NTC} = 25\text{ °C}$		5		k Ω
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 100\text{ °C}, R_{100} = 493\text{ }\Omega$	-5		5	%
Power dissipation	P_{25}	$T_{NTC} = 25\text{ °C}$			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\text{ K}))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15\text{ K}))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\text{ K}))]$		3433		K

Note: For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4.

5 Characteristics diagrams

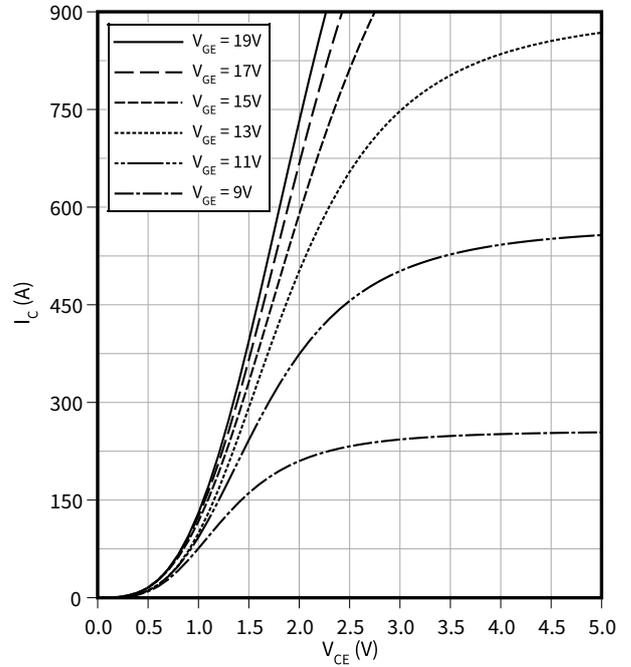
Output characteristic (typical), IGBT, Inverter

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



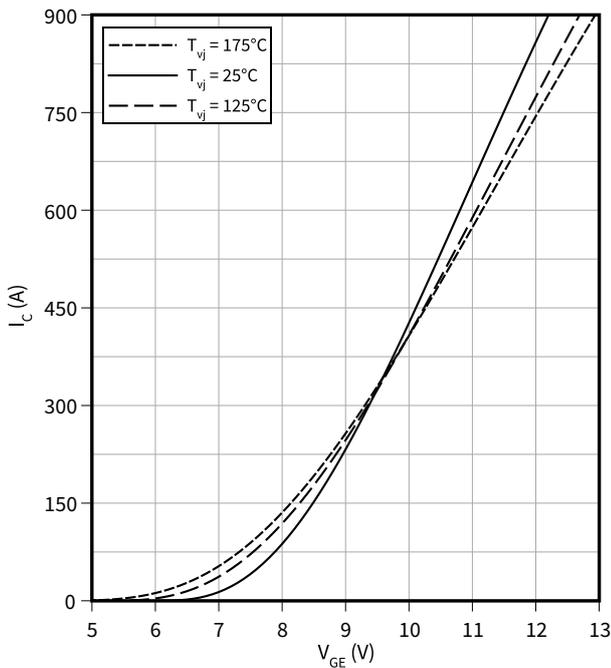
Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$
 $T_{vj} = 175\text{ °C}$



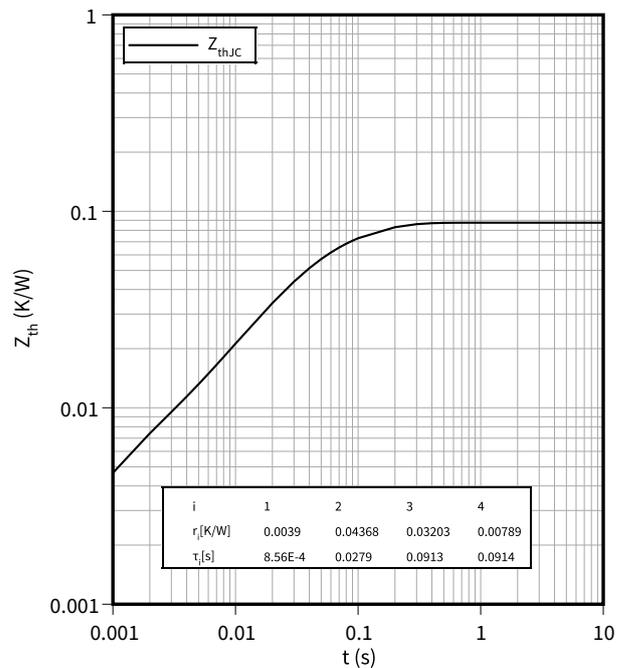
Transfer characteristic (typical), IGBT, Inverter

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



Transient thermal impedance, IGBT, Inverter

$Z_{th} = f(t)$

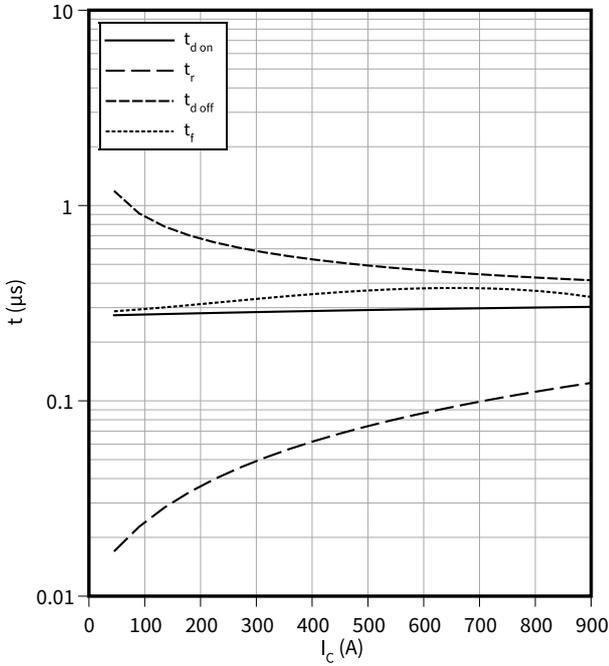


5 Characteristics diagrams

Switching times (typical), IGBT, Inverter

$t = f(I_C)$

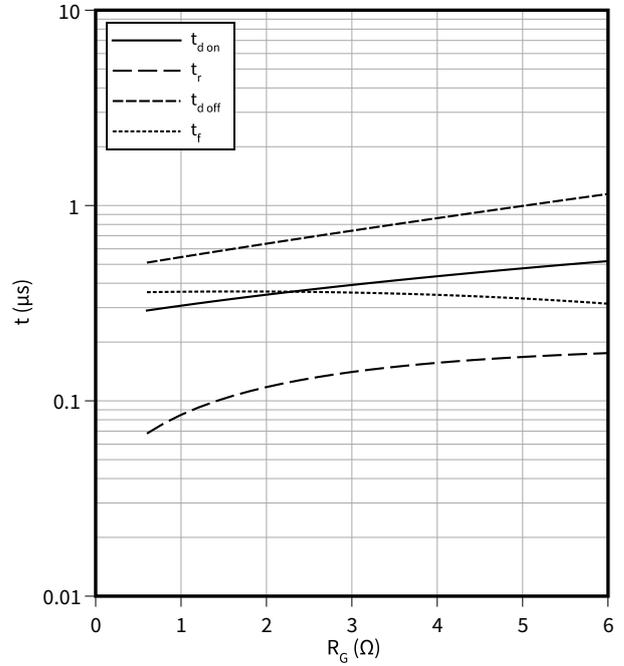
$R_{Goff} = 0.6 \Omega$, $R_{Gon} = 0.6 \Omega$, $V_{GE} = \pm 15 \text{ V}$, $V_{CC} = 600 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$



Switching times (typical), IGBT, Inverter

$t = f(R_G)$

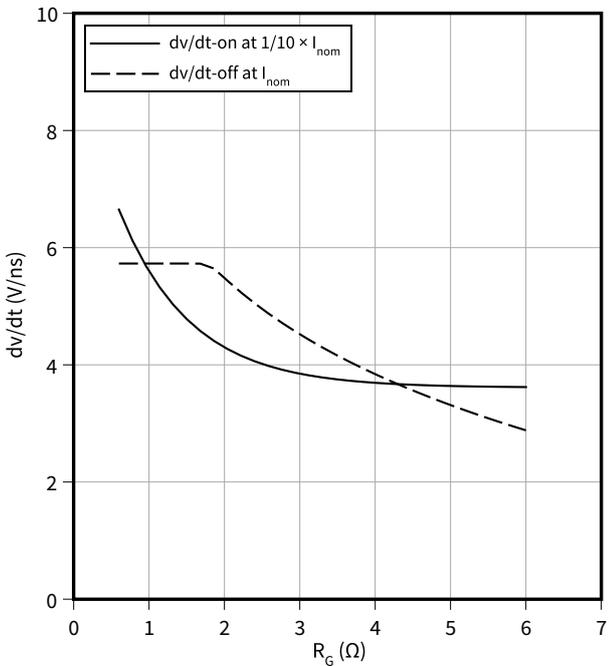
$V_{GE} = \pm 15 \text{ V}$, $I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$



Voltage slope (typical), IGBT, Inverter

$dv/dt = f(R_G)$

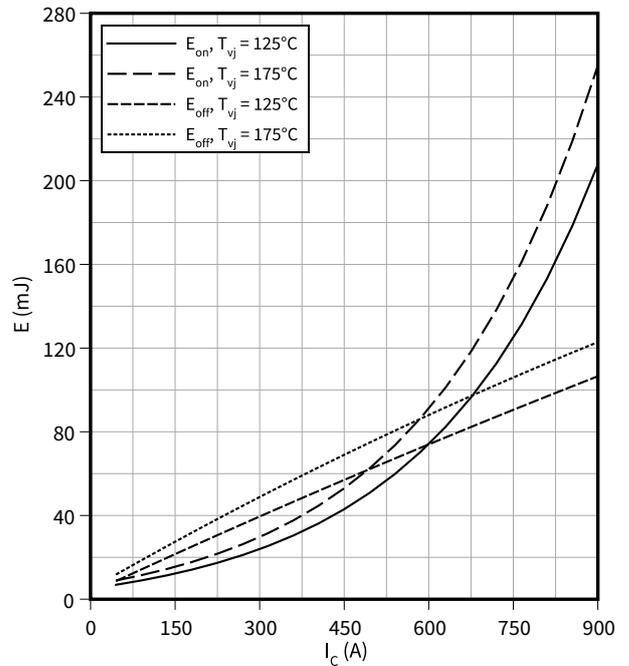
$I_C = 450 \text{ A}$, $V_{CC} = 600 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $T_{vj} = 25 \text{ }^\circ\text{C}$



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

$R_{Goff} = 0.6 \Omega$, $R_{Gon} = 0.6 \Omega$, $V_{GE} = \pm 15 \text{ V}$, $V_{CC} = 600 \text{ V}$

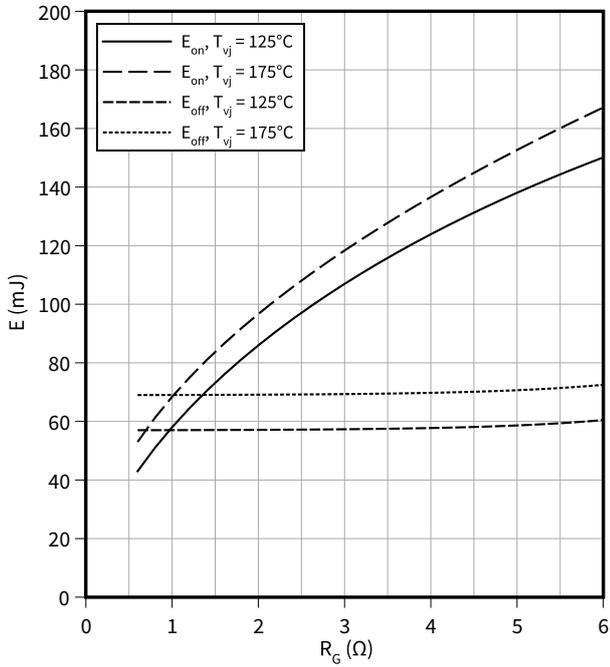


5 Characteristics diagrams

Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

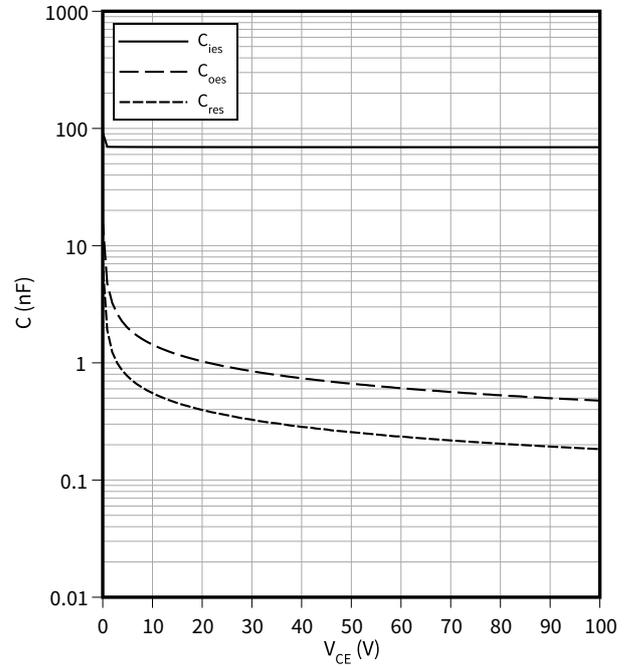
$V_{GE} = \pm 15 \text{ V}, I_C = 450 \text{ A}, V_{CC} = 600 \text{ V}$



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

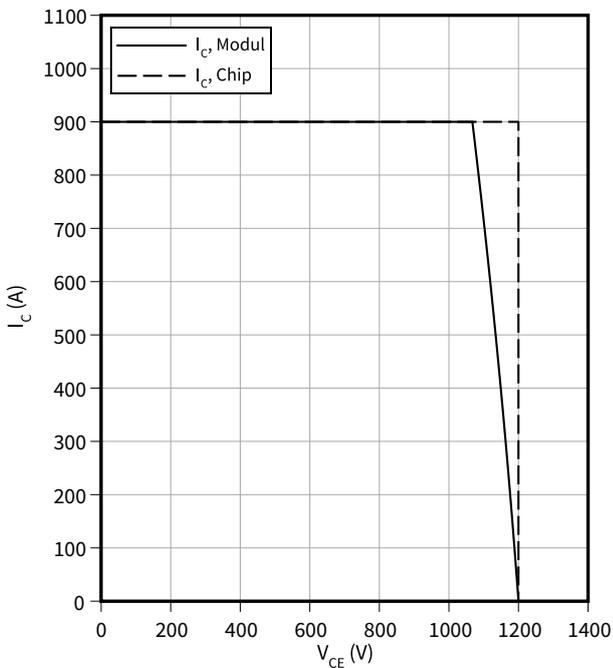
$f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}, T_{vj} = 25 \text{ °C}$



Reverse bias safe operating area (RBSOA), IGBT, Inverter

$I_C = f(V_{CE})$

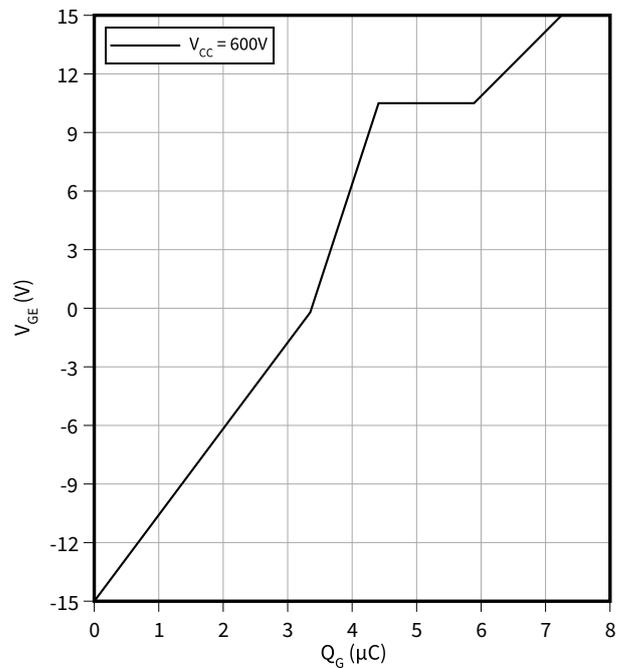
$R_{Goff} = 0.6 \text{ } \Omega, V_{GE} = \pm 15 \text{ V}, T_{vj} = 175 \text{ °C}$



Gate charge characteristic (typical), IGBT, Inverter

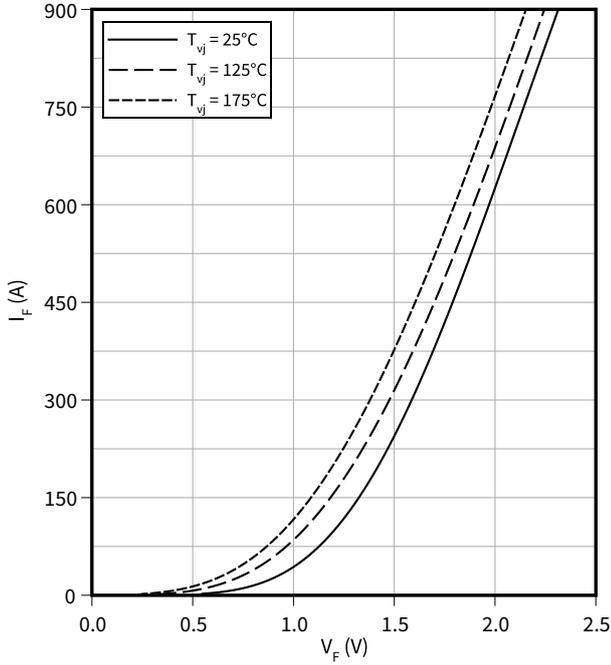
$V_{GE} = f(Q_G)$

$I_C = 450 \text{ A}, T_{vj} = 25 \text{ °C}$



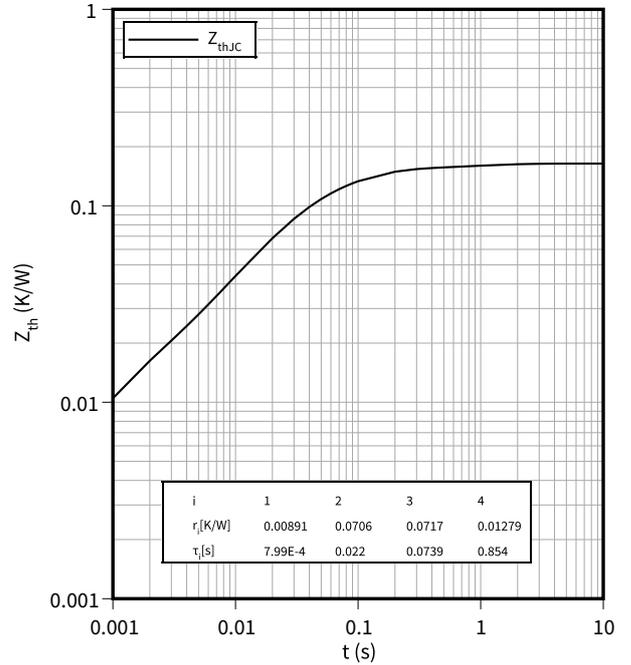
Forward characteristic (typical), Diode, Inverter

$I_F = f(V_F)$



Transient thermal impedance, Diode, Inverter

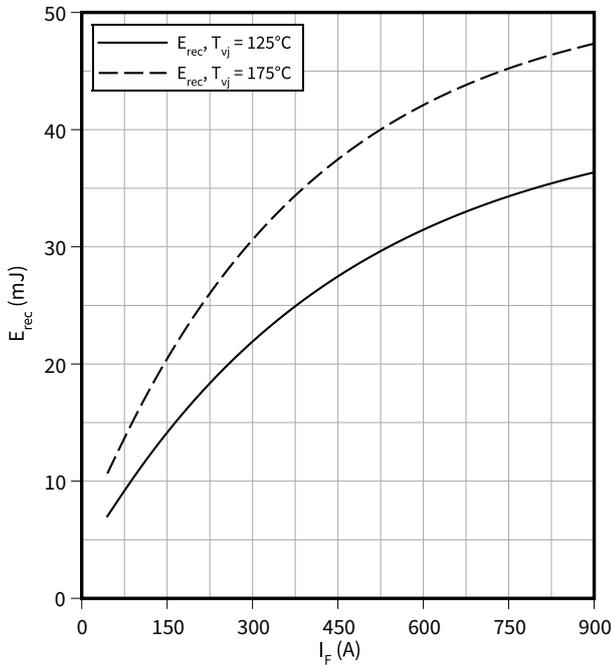
$Z_{th} = f(t)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

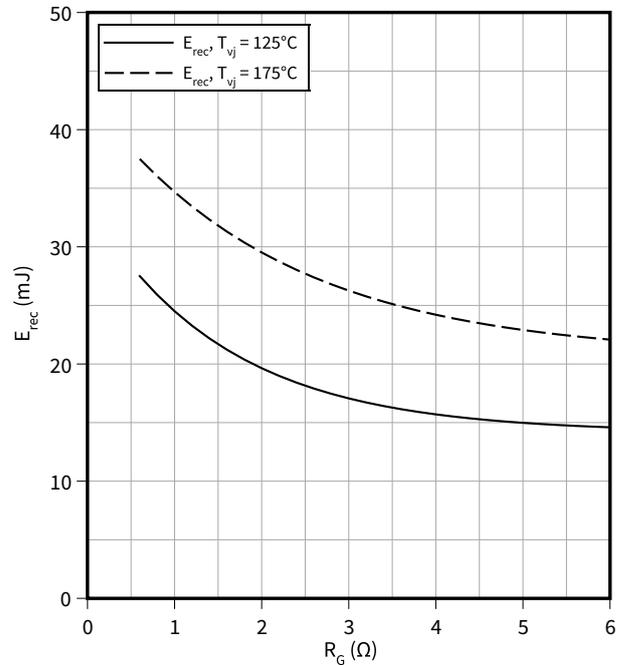
$R_{Gon} = 0.6 \Omega, V_{CC} = 600 \text{ V}$



Switching losses (typical), Diode, Inverter

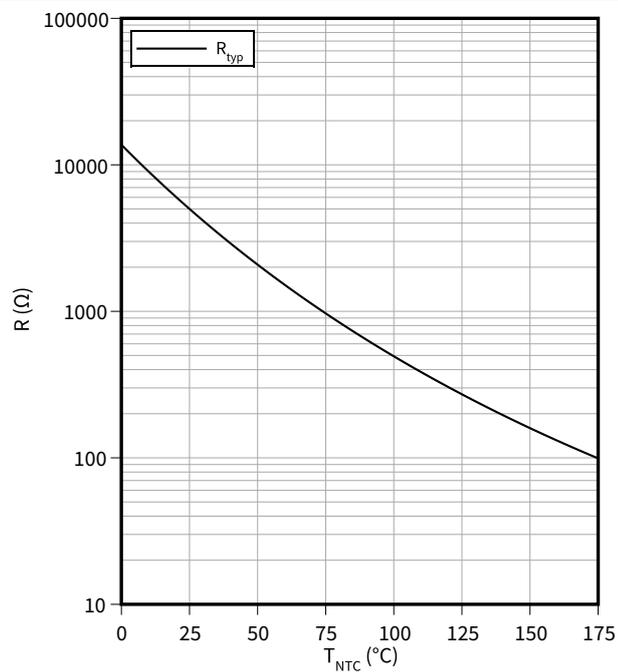
$E_{rec} = f(R_G)$

$I_F = 450 \text{ A}, V_{CC} = 600 \text{ V}$



Temperature characteristic (typical), NTC-Thermistor

$$R = f(T_{NTC})$$



6 Circuit diagram

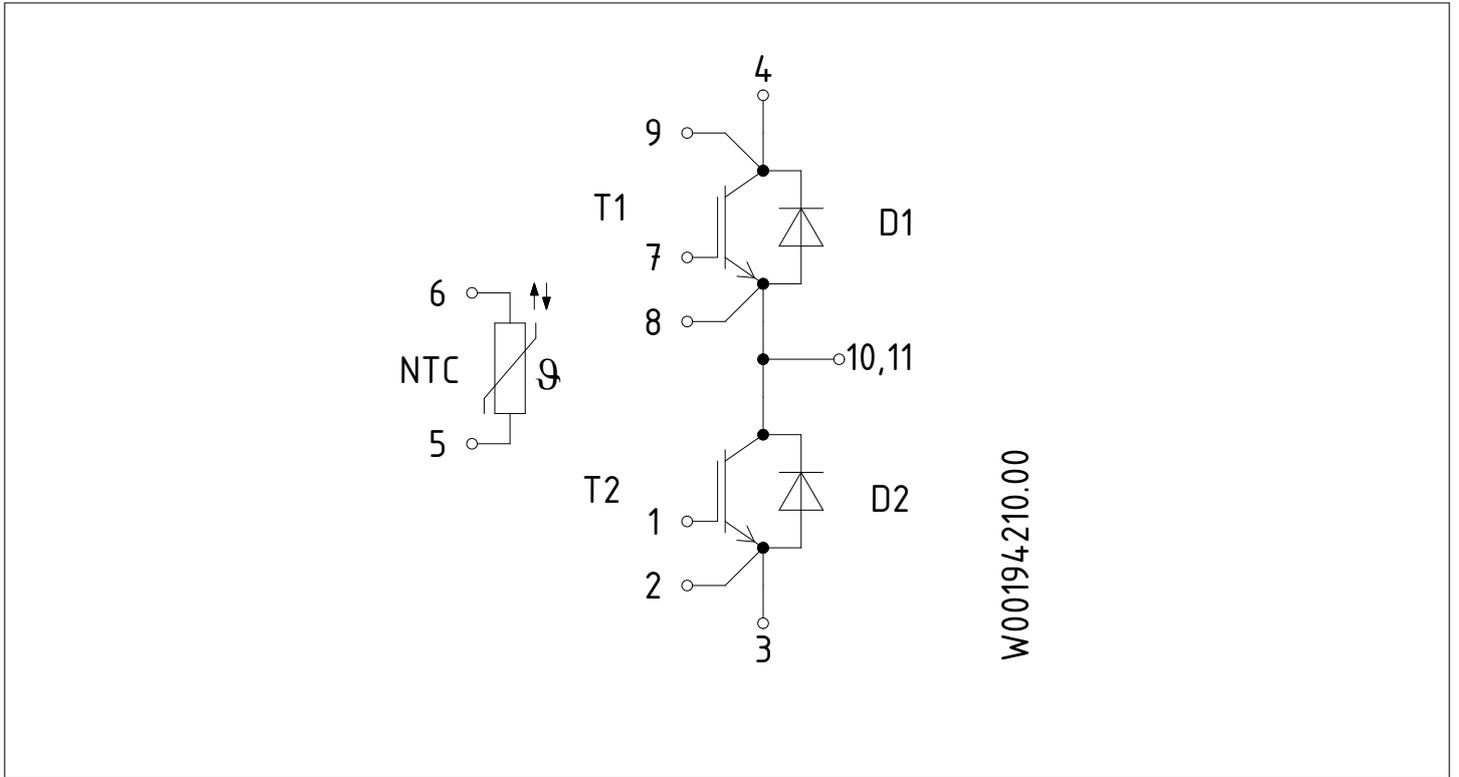


Figure 1

8 Module label code

Module label code			
Code format	Data Matrix	Barcode Code128	
Encoding	ASCII text	Code Set A	
Symbol size	16x16	23 digits	
Standard	IEC24720 and IEC16022	IEC8859-1	
Code content	Content	Digit	Example
	Module serial number	1 - 5	71549
	Module material number	6 - 11	142846
	Production order number	12 - 19	55054991
	Date code (production year)	20 - 21	15
	Date code (production week)	22 - 23	30
Example	 		
	71549142846550549911530		71549142846550549911530

Figure 3

Revision history

Document revision	Date of release	Description of changes
0.10	2020-11-26	Target datasheet
1.00	2021-05-28	Final
1.10	2021-08-05	Final datasheet
1.20	2024-03-15	Final datasheet

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