

Preliminary datasheet

EasyPIM™ module with TRENCHSTOP™ IGBT7 and Emitter Controlled 7 diode and NTC

Features

- Electrical features
 - Overload operation up to 175°C
 - Low V_{CEsat}
 - TRENCHSTOP™ IGBT7
- Mechanical features
 - Solder contact technology
 - 2.5 kV AC 1 min insulation
 - Al_2O_3 substrate with low thermal resistance
 - Compact design
 - High power density



Potential applications

- Auxiliary inverters
- Motor drives
- Air conditioning

Product validation

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

Description

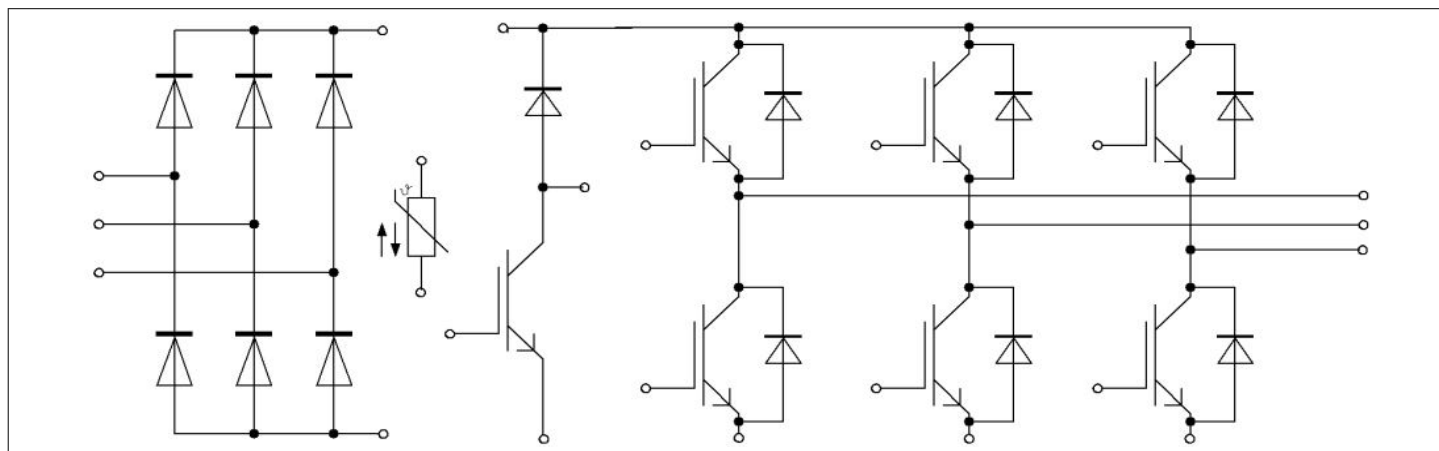


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1 Package

1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50 \text{ Hz}$, $t = 1 \text{ min}$	2.5	kV
Internal Isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	d_{Creep}	terminal to heatsink	11.5	mm
Creepage distance	d_{Creep}	terminal to terminal	6.3	mm
Clearance	d_{Clear}	terminal to heatsink	10.0	mm
Clearance	d_{Clear}	terminal to terminal	5.0	mm
Comparative tracking index	CTI		> 200	
RTI Elec.	RTI	housing	140	°C

Table 2 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray inductance module	L_{SCE}			30		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	$T_H = 25^\circ\text{C}$, per switch		6		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_H = 25^\circ\text{C}$, per switch		8		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting force per clamp	F		20		50	N
Weight	G			24		g

Note: The current under continuous operation is limited to 30A rms per connector pin.

2 IGBT, Inverter

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CES}		$T_{vj} = 25^\circ\text{C}$	1200	V
Continuous DC collector current	I_{CDC}	$T_{vj \text{ max}} = 175^\circ\text{C}$	$T_H = 60^\circ\text{C}$	25	A
Repetitive peak collector current	I_{CRM}	$t_p = 1 \text{ ms}$		50	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	$V_{CE\ sat}$	$I_C = 25\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$		1.60	TBD	V
			$T_{vj} = 125\ ^\circ C$		1.74		
			$T_{vj} = 175\ ^\circ C$		1.82		
Gate threshold voltage	V_{GEth}	$I_C = 0.525\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$		5.15	5.80	6.45	V
Gate charge	Q_G	$V_{GE} = \pm 15\ V, V_{CE} = 600\ V$			0.395		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\ ^\circ C$			0		Ω
Input capacitance	C_{ies}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$			4.77		nF
Reverse transfer capacitance	C_{res}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$			0.017		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 1200\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$			0.0056	mA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\ V, V_{GE} = 20\ V, T_{vj} = 25\ ^\circ C$				100	nA
Turn-on delay time (inductive load)	t_{don}	$I_C = 25\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 6.2\ \Omega$	$T_{vj} = 25\ ^\circ C$		0.037		μs
			$T_{vj} = 125\ ^\circ C$		0.039		
			$T_{vj} = 175\ ^\circ C$		0.040		
Rise time (inductive load)	t_r	$I_C = 25\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 6.2\ \Omega$	$T_{vj} = 25\ ^\circ C$		0.020		μs
			$T_{vj} = 125\ ^\circ C$		0.024		
			$T_{vj} = 175\ ^\circ C$		0.025		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 25\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 6.2\ \Omega$	$T_{vj} = 25\ ^\circ C$		0.186		μs
			$T_{vj} = 125\ ^\circ C$		0.291		
			$T_{vj} = 175\ ^\circ C$		0.334		
Fall time (inductive load)	t_f	$I_C = 25\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 6.2\ \Omega$	$T_{vj} = 25\ ^\circ C$		0.173		μs
			$T_{vj} = 125\ ^\circ C$		0.220		
			$T_{vj} = 175\ ^\circ C$		0.285		
Turn-on energy loss per pulse	E_{on}	$I_C = 25\ A, V_{CE} = 600\ V, L_\sigma = 35\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 6.2\ \Omega, di/dt = 950\ A/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$		1.55		mJ
			$T_{vj} = 125\ ^\circ C$		2.1		
			$T_{vj} = 175\ ^\circ C$		2.45		
Turn-off energy loss per pulse	E_{off}	$I_C = 25\ A, V_{CE} = 600\ V, L_\sigma = 35\ nH, V_{GE} = \pm 15\ V, R_{Goff} = 6.2\ \Omega, dv/dt = 2900\ V/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$		1.58		mJ
			$T_{vj} = 125\ ^\circ C$		2.45		
			$T_{vj} = 175\ ^\circ C$		3.05		
SC data	I_{SC}	$V_{GE} \leq 15\ V, V_{CC} = 800\ V, V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq 8\ \mu s, T_{vj} = 150\ ^\circ C$		80		A
			$t_P \leq 7\ \mu s, T_{vj} = 175\ ^\circ C$		75		

Table 4 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, junction to heatsink	R_{thJH}	per IGBT		1.55		K/W
Temperature under switching conditions	$T_{vj\,op}$		-40		175	°C

Note: $T_{vj\,op} > 150^{\circ}\text{C}$ 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}		$T_{vj} = 25^{\circ}\text{C}$	1200	V
Continuous DC forward current	I_F			25	A
Repetitive peak forward current	I_{FRM}	$t_p = 1\text{ ms}$		50	A
I^2t - value	I^2t	$V_R = 0\text{ V}, t_p = 10\text{ ms}$	$T_{vj} = 125^{\circ}\text{C}$	72.5	A^2s
			$T_{vj} = 175^{\circ}\text{C}$	63	

Table 6 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 25\text{ A}, V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	1.83	TBD	V
			$T_{vj} = 125^{\circ}\text{C}$	1.70		
			$T_{vj} = 175^{\circ}\text{C}$	1.63		
Peak reverse recovery current	I_{RM}	$I_F = 25\text{ A}, V_R = 600\text{ V}, V_{GE} = -15\text{ V}, -di_F/dt = 950\text{ A}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$	$T_{vj} = 25^{\circ}\text{C}$	24.2		A
			$T_{vj} = 125^{\circ}\text{C}$	32.4		
			$T_{vj} = 175^{\circ}\text{C}$	37.6		
Recovered charge	Q_r	$I_F = 25\text{ A}, V_R = 600\text{ V}, V_{GE} = -15\text{ V}, -di_F/dt = 950\text{ A}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$	$T_{vj} = 25^{\circ}\text{C}$	2.25		μC
			$T_{vj} = 125^{\circ}\text{C}$	3.82		
			$T_{vj} = 175^{\circ}\text{C}$	4.95		
Reverse recovery energy	E_{rec}	$I_F = 25\text{ A}, V_R = 600\text{ V}, V_{GE} = -15\text{ V}, -di_F/dt = 950\text{ A}/\mu\text{s} (T_{vj} = 175^{\circ}\text{C})$	$T_{vj} = 25^{\circ}\text{C}$	0.65		mJ
			$T_{vj} = 125^{\circ}\text{C}$	1.41		
			$T_{vj} = 175^{\circ}\text{C}$	1.87		

Table 6 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, junction to heatsink	R_{thJH}	per diode		2.04		K/W
Temperature under switching conditions	$T_{vj\,op}$		-40		175	°C

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

4 Diode, Rectifier

Table 7 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} = 25^{\circ}\text{C}$		1600	V
Maximum RMS forward current per chip	I_{FRMSM}	$T_H = 100^{\circ}\text{C}$		25	A
Maximum RMS current at rectifier output	I_{RMSM}	$T_H = 100^{\circ}\text{C}$		25	A
Surge forward current	I_{FSM}	$t_p = 10\text{ ms}$	$T_{vj} = 25^{\circ}\text{C}$	300	A
			$T_{vj} = 150^{\circ}\text{C}$	245	
I^2t - value	I^2t	$t_p = 10\text{ ms}$	$T_{vj} = 25^{\circ}\text{C}$	450	A^2s
			$T_{vj} = 150^{\circ}\text{C}$	300	

Table 8 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 10\text{ A}$	$T_{vj} = 150^{\circ}\text{C}$		0.80		V
Reverse current	I_r	$T_{vj} = 150^{\circ}\text{C}$, $V_R = 1600\text{ V}$			1		mA
Thermal resistance, junction to heatsink	R_{thJH}	per diode			1.54		K/W
Temperature under switching conditions	$T_{vj,\,op}$			-40		150	°C

5 IGBT, Brake-Chopper

Table 9 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}	$T_{vj\text{ max}} = 175\text{ °C}$	$T_H = 60\text{ °C}$	25	A
Repetitive peak collector current	I_{CRM}	$t_p = 1\text{ ms}$		50	A
Gate-emitter peak voltage	V_{GES}			±20	V

Table 10 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\text{ sat}}$	$I_C = 25\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.60	TBD	V
			$T_{vj} = 125\text{ °C}$		1.74		
			$T_{vj} = 175\text{ °C}$		1.82		
Gate threshold voltage	V_{GEth}	$I_C = 0.525\text{ mA}, V_{CE} = V_{GE}, T_{vj} = 25\text{ °C}$		5.15	5.80	6.45	V
Gate charge	Q_G	$V_{GE} = \pm 15\text{ V}, V_{CE} = 600\text{ V}$			0.395		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\text{ °C}$			0		Ω
Input capacitance	C_{ies}	$f = 100\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$			4.77		nF
Reverse transfer capacitance	C_{res}	$f = 100\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$			0.017		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			0.0056	mA
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}	$I_C = 25\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 10\text{ Ω}$	$T_{vj} = 25\text{ °C}$		0.058		μs
			$T_{vj} = 125\text{ °C}$		0.060		
			$T_{vj} = 175\text{ °C}$		0.061		
Rise time (inductive load)	t_r	$I_C = 25\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 10\text{ Ω}$	$T_{vj} = 25\text{ °C}$		0.055		μs
			$T_{vj} = 125\text{ °C}$		0.057		
			$T_{vj} = 175\text{ °C}$		0.058		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 25\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 10\text{ Ω}$	$T_{vj} = 25\text{ °C}$		0.205		μs
			$T_{vj} = 125\text{ °C}$		0.310		
			$T_{vj} = 175\text{ °C}$		0.353		
Fall time (inductive load)	t_f	$I_C = 25\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Goff} = 10\text{ Ω}$	$T_{vj} = 25\text{ °C}$		0.173		μs
			$T_{vj} = 125\text{ °C}$		0.220		
			$T_{vj} = 175\text{ °C}$		0.285		

Table 10 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on energy loss per pulse	E_{on}	$I_C = 25\text{ A}$, $V_{CE} = 600\text{ V}$, $L_\sigma = 35\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Gon} = 10\ \Omega$, $di/dt = 320\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	2.15		mJ
			$T_{vj} = 125\text{ °C}$	2.65		
			$T_{vj} = 175\text{ °C}$	2.9		
Turn-off energy loss per pulse	E_{off}	$I_C = 25\text{ A}$, $V_{CE} = 600\text{ V}$, $L_\sigma = 35\text{ nH}$, $V_{GE} = \pm 15\text{ V}$, $R_{Goff} = 10\ \Omega$, $dv/dt = 2900\text{ V}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	1.58		mJ
			$T_{vj} = 125\text{ °C}$	2.45		
			$T_{vj} = 175\text{ °C}$	3.05		
SC data	I_{SC}	$V_{GE} \leq 15\text{ V}$, $V_{CC} = 800\text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq 8\ \mu\text{s}$, $T_{vj} = 150\text{ °C}$	80		A
			$t_P \leq 7\ \mu\text{s}$, $T_{vj} = 175\text{ °C}$	75		
Thermal resistance, junction to heatsink	R_{thJH}	per IGBT		1.55		K/W
Temperature under switching conditions	$T_{vj\ op}$		-40		175	°C

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

6 Diode, Brake-Chopper

Table 11 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}		$T_{vj} = 25\text{ °C}$	1200	V
Continuous DC forward current	I_F			10	A
Repetitive peak forward current	I_{FRM}	$t_P = 1\text{ ms}$		20	A
I^2t - value	I^2t	$V_R = 0\text{ V}$, $t_P = 10\text{ ms}$	$T_{vj} = 125\text{ °C}$	27.5	A ² s
			$T_{vj} = 175\text{ °C}$	24	

Table 12 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 10\text{ A}$, $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	1.72	TBD	V
			$T_{vj} = 125\text{ °C}$	1.59		
			$T_{vj} = 175\text{ °C}$	1.52		
Peak reverse recovery current	I_{RM}	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $-di_F/dt = 300\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	8.1		A
			$T_{vj} = 125\text{ °C}$	10.1		
			$T_{vj} = 175\text{ °C}$	11.7		
Recovered charge	Q_r	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $-di_F/dt = 300\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	0.74		μC
			$T_{vj} = 125\text{ °C}$	1.37		
			$T_{vj} = 175\text{ °C}$	1.84		
Reverse recovery energy	E_{rec}	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $-di_F/dt = 300\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	0.26		mJ
			$T_{vj} = 125\text{ °C}$	0.52		
			$T_{vj} = 175\text{ °C}$	0.72		
Thermal resistance, junction to heatsink	R_{thJH}	per diode		2.45		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.

7 NTC-Thermistor

Table 13 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

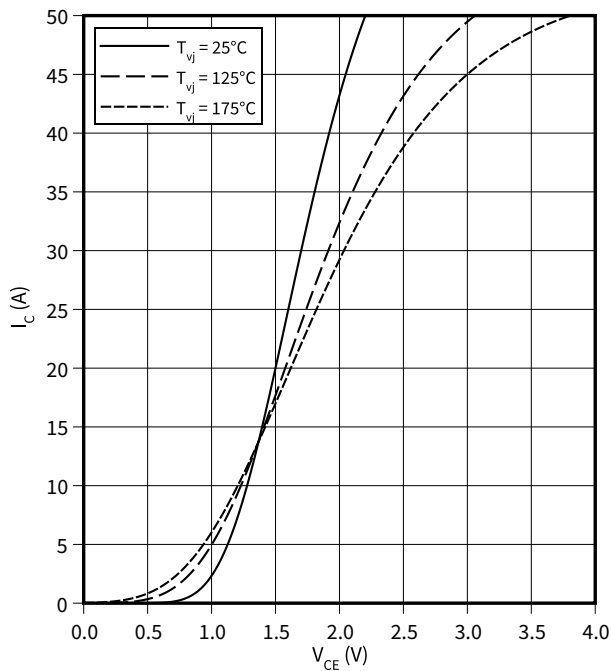
Note: Specification according to the valid application note.

8 Characteristics diagrams

output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

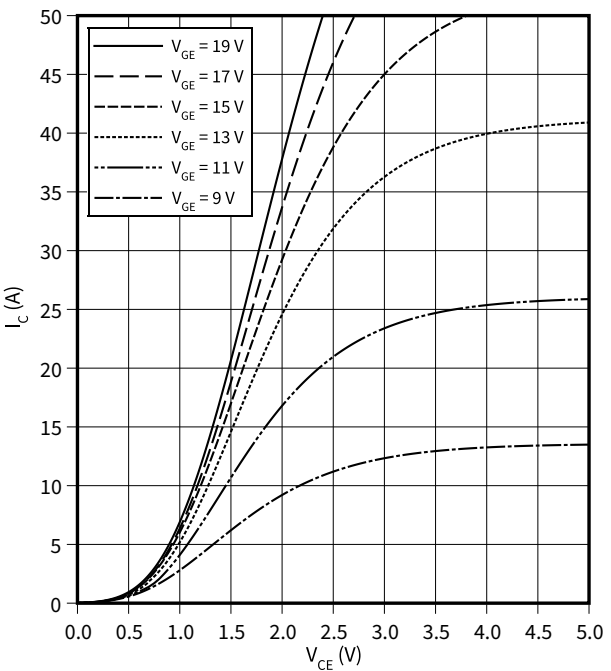
$V_{GE} = 15\text{ V}$



output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

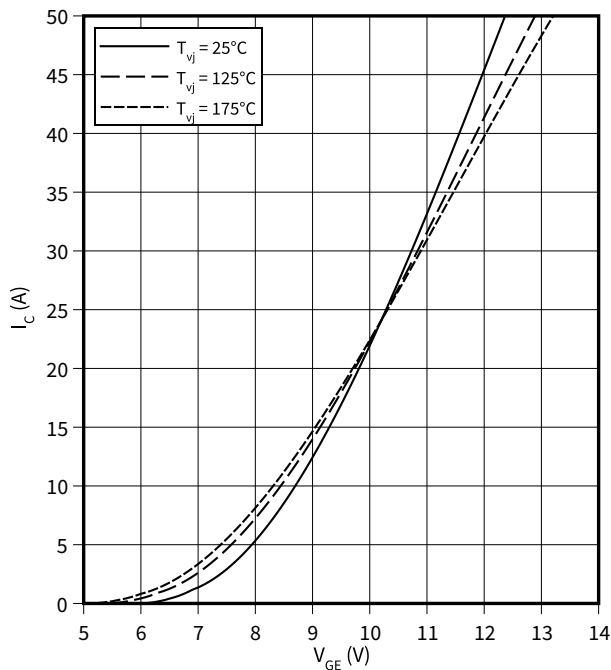
$T_{vj} = 175\text{ °C}$



transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

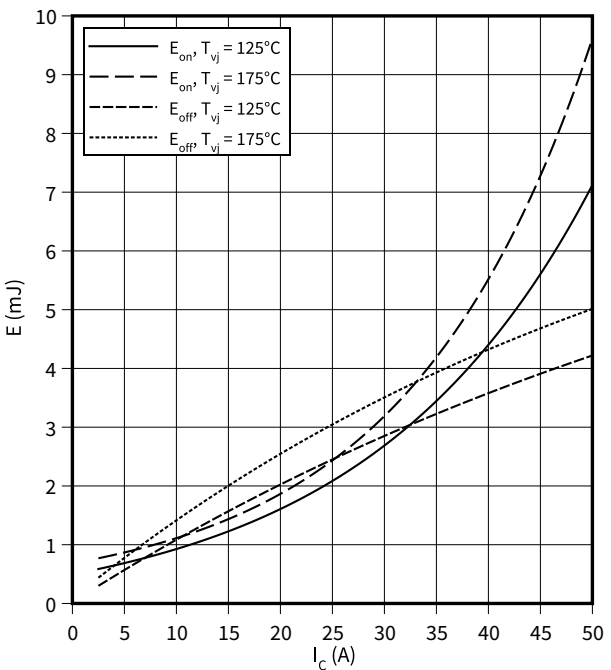
$V_{CE} = 20\text{ V}$



switching losses (typical), IGBT, Inverter

$E = f(I_C)$

$R_{Goff} = 6.2\text{ }\Omega$, $R_{Gon} = 6.2\text{ }\Omega$, $V_{CE} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$

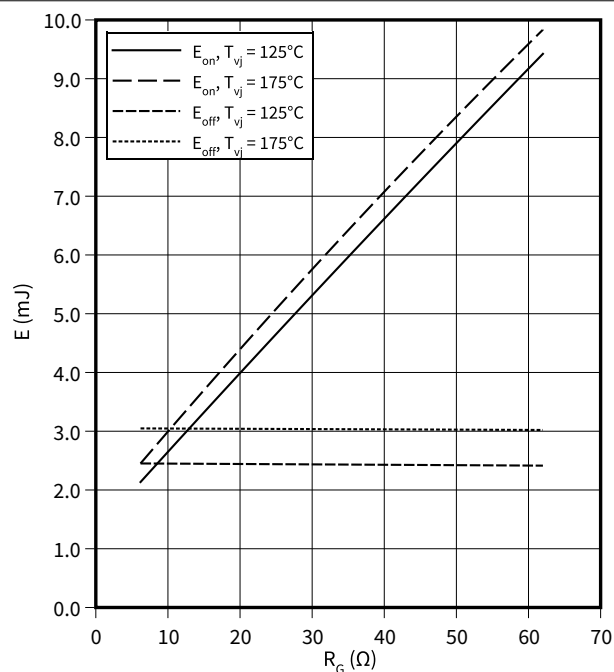


8 Characteristics diagrams

switching losses (typical), IGBT, Inverter

$$E = f(R_G)$$

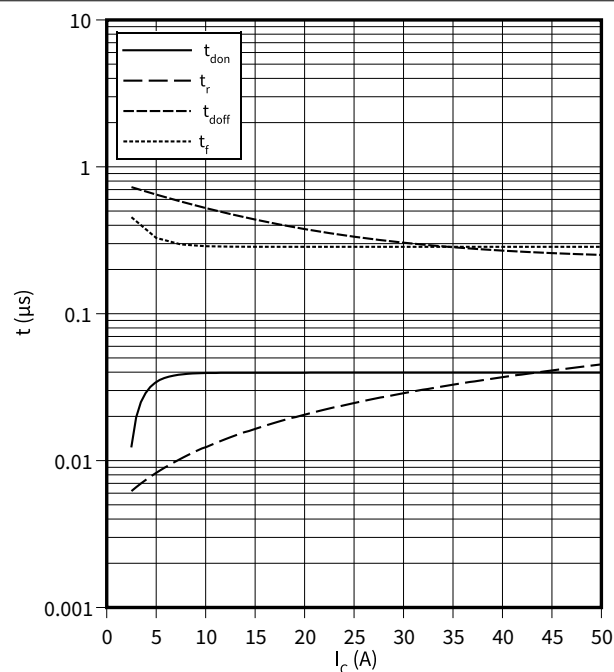
$$I_C = 25 \text{ A}, V_{CE} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}$$



switching times (typical), IGBT, Inverter

$$t = f(I_C)$$

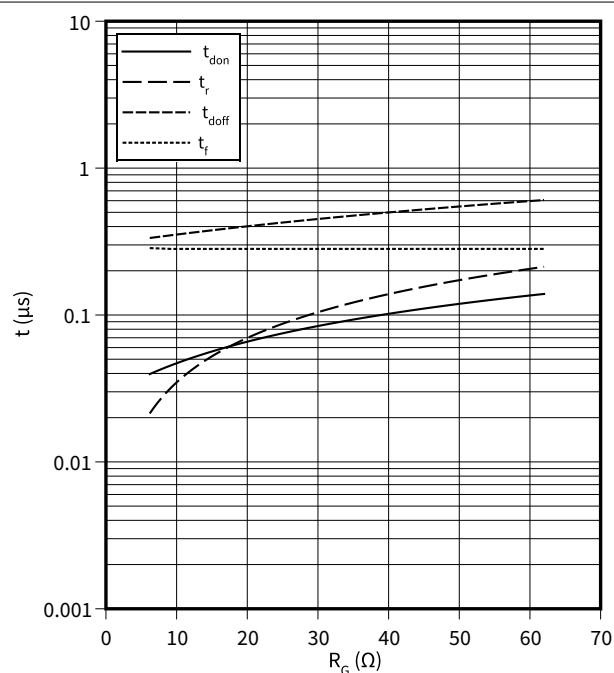
$$R_{Goff} = 6.2 \Omega, R_{Gon} = 6.2 \Omega, V_{CE} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 175^\circ\text{C}$$



switching times (typical), IGBT, Inverter

$$t = f(R_G)$$

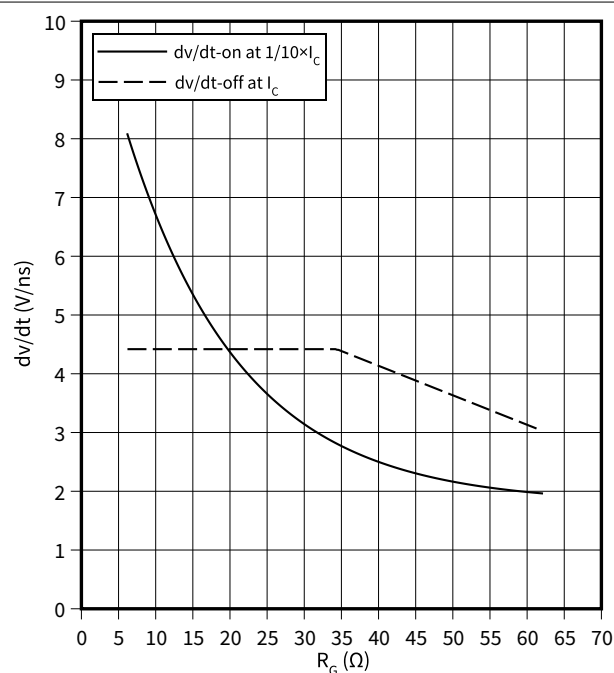
$$I_C = 25 \text{ A}, V_{CE} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 175^\circ\text{C}$$



dv/dt (typical), IGBT, Inverter

$$dv/dt = f(R_G)$$

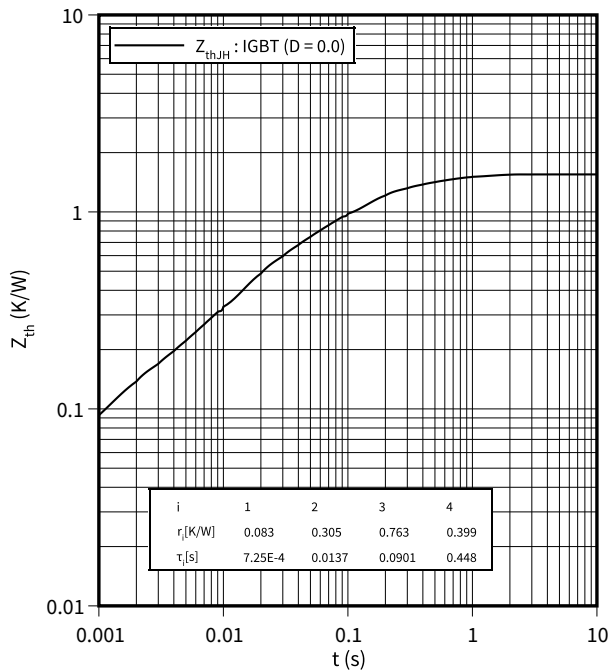
$$I_C = 25 \text{ A}, V_{CE} = 600 \text{ V}, V_{GE} = \pm 15 \text{ V}, T_{vj} = 25^\circ\text{C}$$



8 Characteristics diagrams

transient thermal impedance , IGBT, Inverter

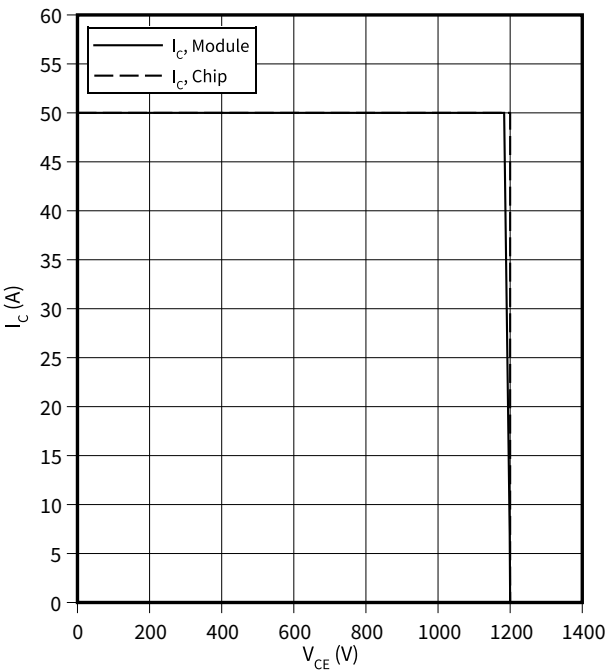
$Z_{th} = f(t)$



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

$I_C = f(V_{CE})$

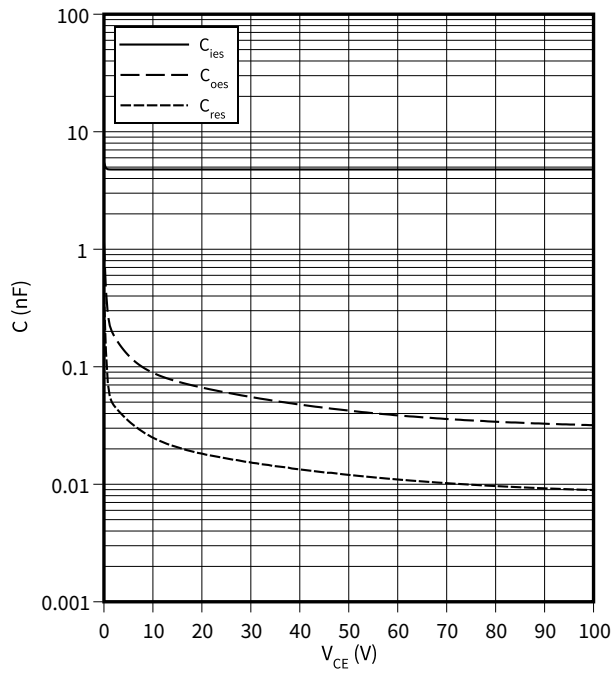
$R_{Goff} = 6.2 \Omega, V_{GE} = \pm 15.0 V, T_{vj} = 175 \text{ }^\circ\text{C}$



capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

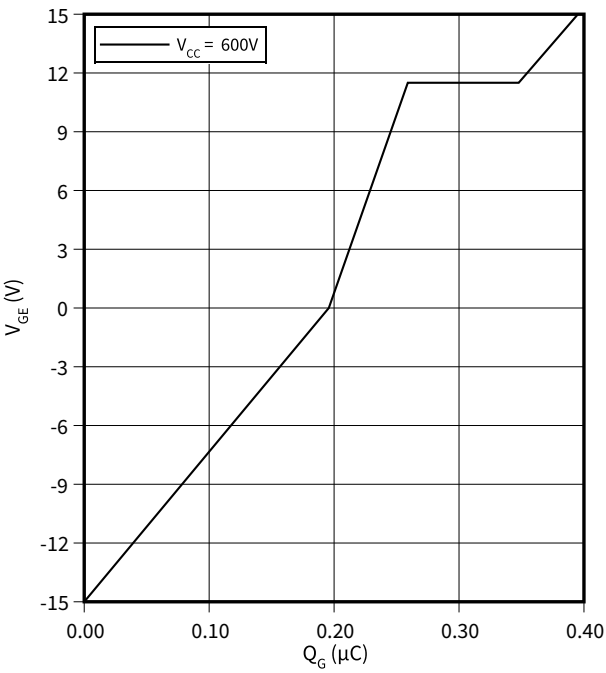
$f = 100 \text{ kHz}, T_{vj} = 25 \text{ }^\circ\text{C}, V_{GE} = 0 V$



gate charge characteristic (typical), IGBT, Inverter

$V_{GE} = f(Q_G)$

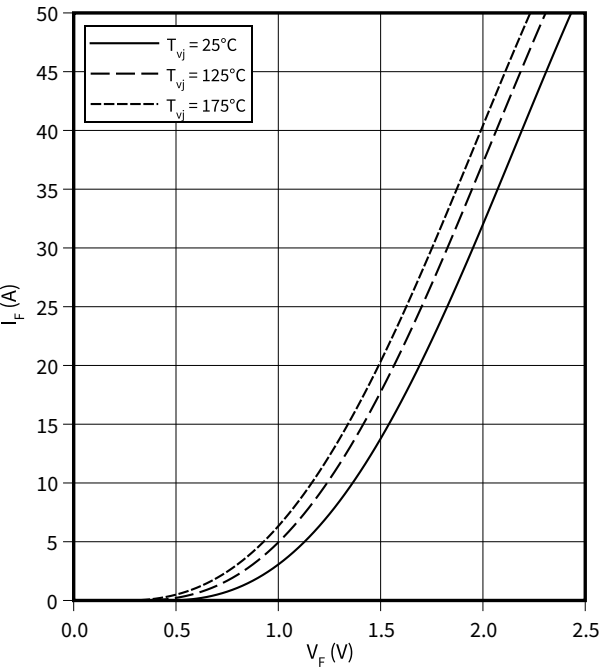
$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 25 A$



8 Characteristics diagrams

forward characteristic (typical), Diode, Inverter

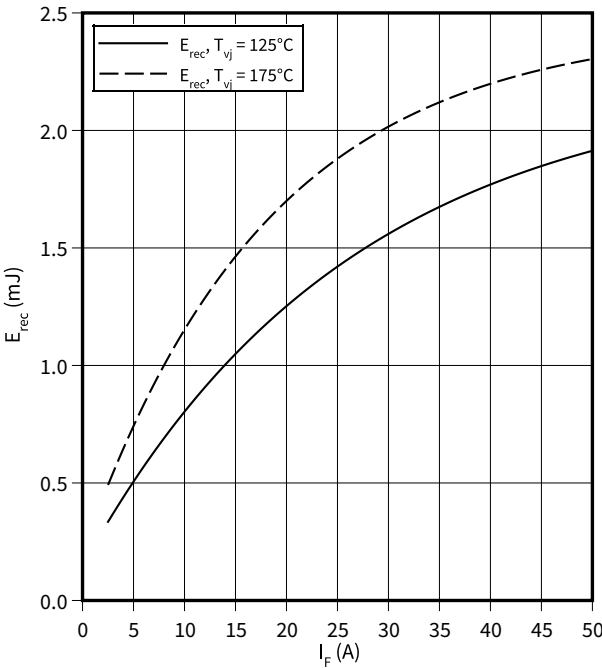
$I_F = f(V_F)$



switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

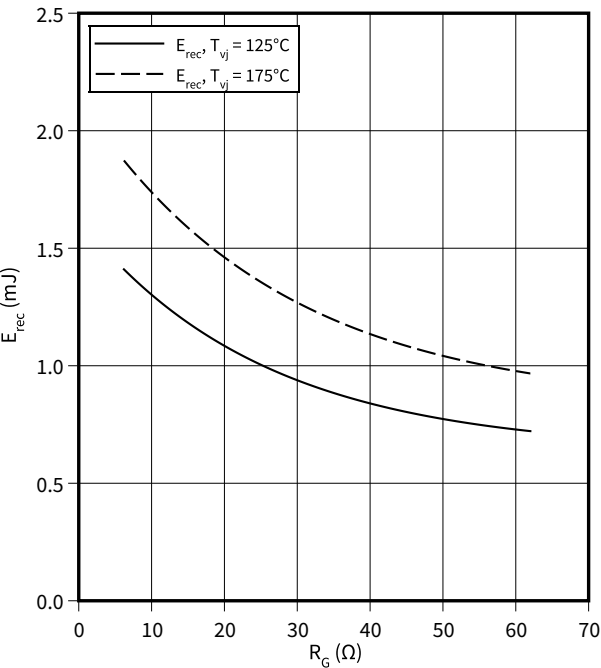
$R_{Gon} = 6.2\ \Omega, V_{CE} = 600\ \text{V}$



switching losses (typical), Diode, Inverter

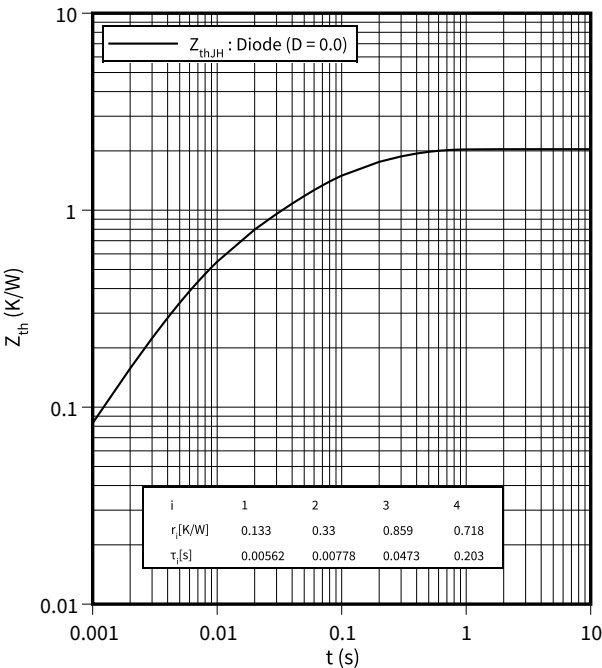
$E_{rec} = f(R_G)$

$V_{CE} = 600\ \text{V}, I_F = 25\ \text{A}$



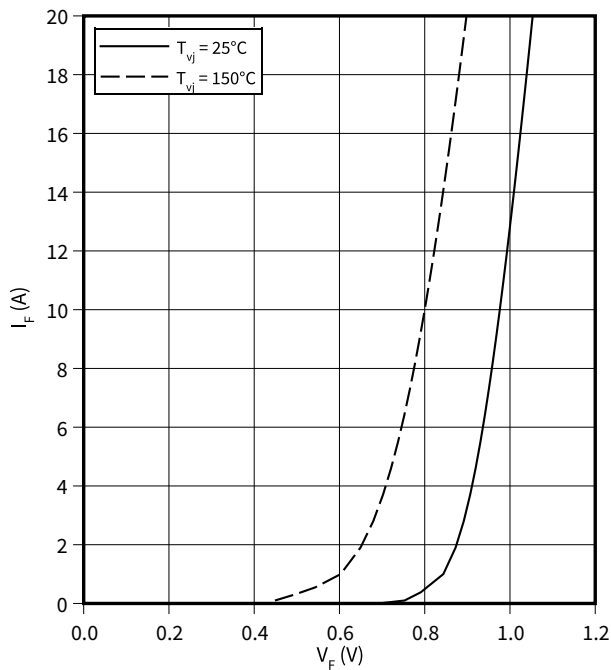
transient thermal impedance , Diode, Inverter

$Z_{th} = f(t)$

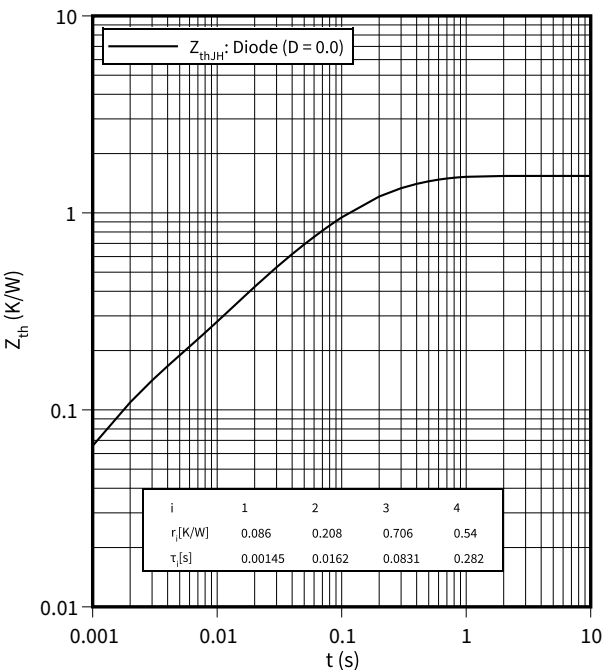


8 Characteristics diagrams

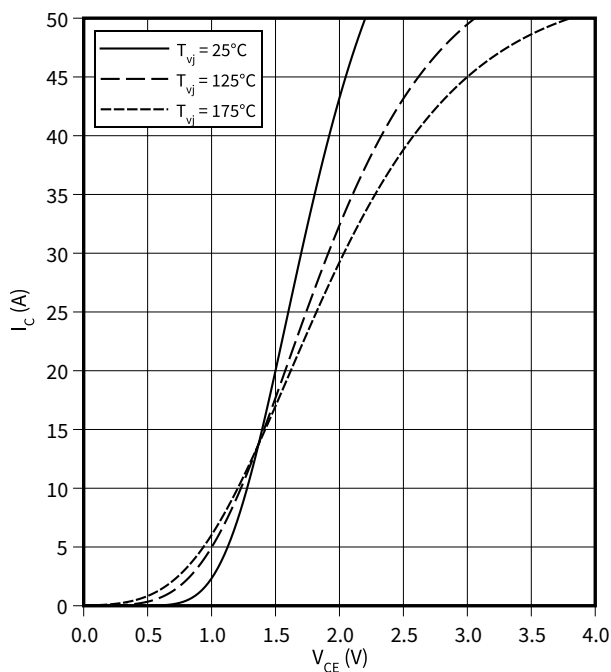
forward characteristic (typical), Diode, Rectifier
 $I_F = f(V_F)$



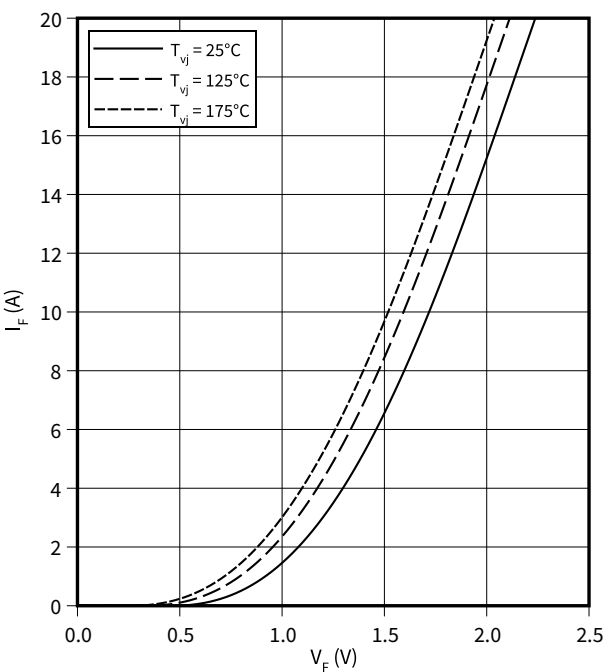
transient thermal impedance , Diode, Rectifier
 $Z_{th} = f(t)$



output characteristic (typical), IGBT, Brake-Chopper
 $I_C = f(V_{CE})$
 $V_{GE} = 15\text{ V}$



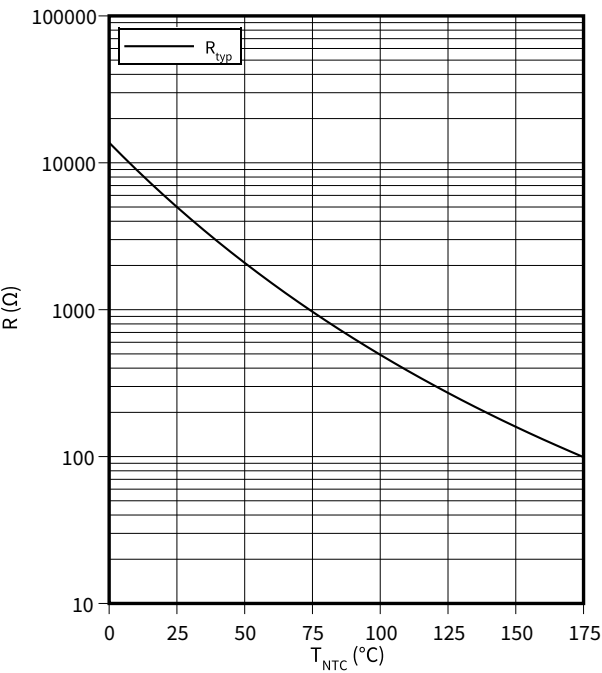
forward characteristic (typical), Diode, Brake-Chopper
 $I_F = f(V_F)$

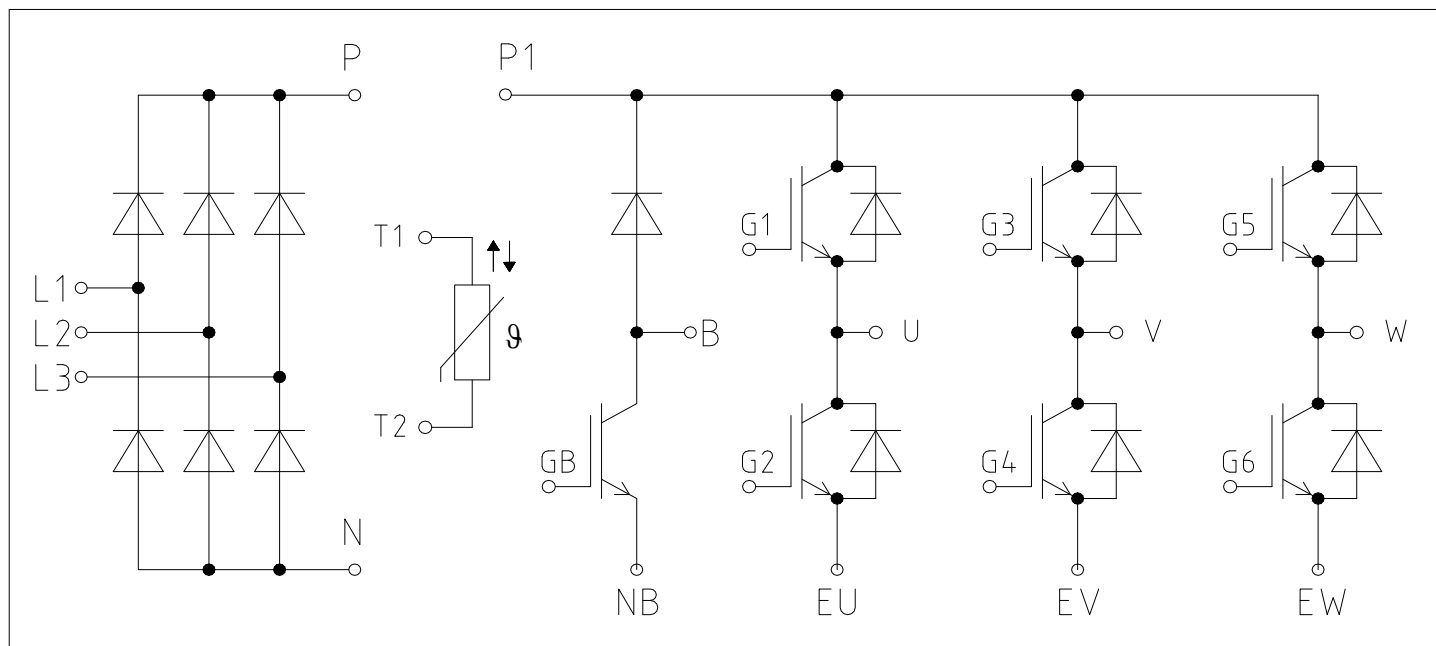


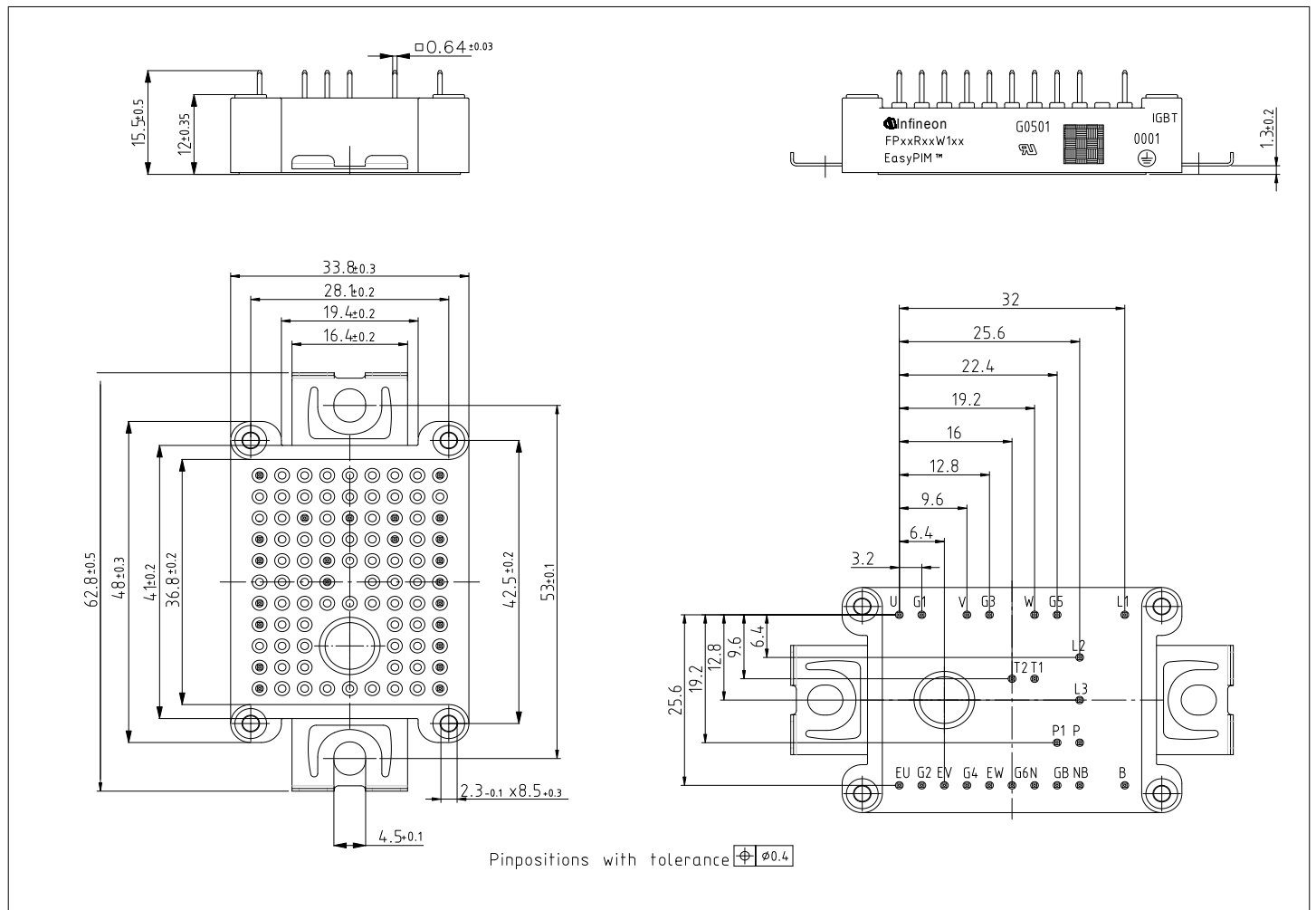
8 Characteristics diagrams

temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$







11 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	<i>Content</i>	<i>Digit</i>	<i>Example</i>
	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 4

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