

Preliminary datasheet

EasyPIM™ module with TRENCHSTOP™ IGBT7 and Emitter Controlled 7 diode and NTC / pre-applied Thermal Interface Material

Features

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



Potential applications

- Motor drives
- Air conditioning
- Auxiliary inverters

Product validation

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

Description

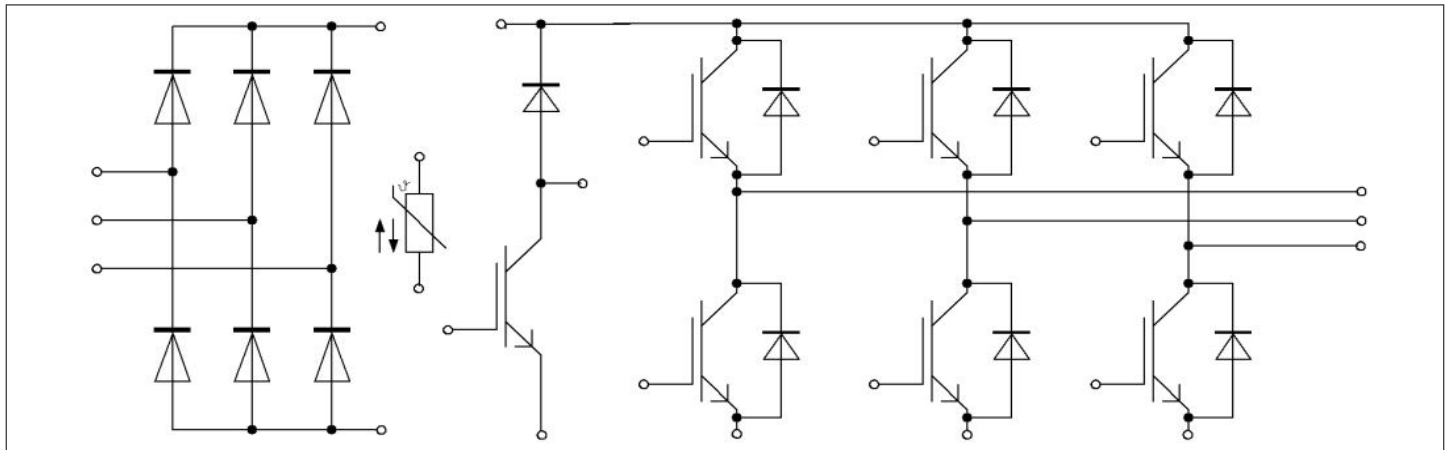


Table of contents

	Description	1
	Features	1
	Potential applications	1
	Product validation	1
	Table of contents	2
1	Package	3
2	IGBT, Inverter	3
3	Diode, Inverter	5
4	Diode, Rectifier	6
5	IGBT, Brake-Chopper	7
6	Diode, Brake-Chopper	8
7	NTC-Thermistor	9
8	Characteristics diagrams	10
9	Circuit diagram	16
10	Package outlines	17
11	Module label code	18
	Disclaimer	19

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
Maximum baseplate operation temperature	T_{BPmax}				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.
 Storage and shipment of modules with TIM => see AN 2012-07

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}	$T_{vj \max} = 175^\circ\text{C}$	$T_H = 110^\circ\text{C}$	15	A
Repetitive peak collector current	I_{CRM}	$t_p = 1 \text{ ms}$		30	A

Table 3 Maximum rated values (continued)

Parameter	Symbol	Note or test condition	Values	Unit
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	$V_{CE\ sat}$	$I_C = 15\ A, V_{GE} = 15\ V$	$T_{vj} = 25\ ^\circ C$	1.60	TBD	V
			$T_{vj} = 125\ ^\circ C$	1.74		
			$T_{vj} = 175\ ^\circ C$	1.82		
Gate threshold voltage	V_{GEth}	$I_C = 0.553\ mA, V_{CE} = V_{GE}, T_{vj} = 25\ ^\circ C$	5.15	5.80	6.45	V
Gate charge	Q_G	$V_{GE} = \pm 15\ V, V_{CE} = 600\ V$		0.234		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\ ^\circ C$		0		Ω
Input capacitance	C_{ies}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		2.82		nF
Reverse transfer capacitance	C_{res}	$f = 100\ kHz, T_{vj} = 25\ ^\circ C, V_{CE} = 25\ V, V_{GE} = 0\ V$		0.0099		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 1200\ V, V_{GE} = 0\ V$	$T_{vj} = 25\ ^\circ C$		0.003	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}	$I_C = 15\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 7.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.023		μs
			$T_{vj} = 125\ ^\circ C$	0.025		
			$T_{vj} = 175\ ^\circ C$	0.026		
Rise time (inductive load)	t_r	$I_C = 15\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Gon} = 7.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.012		μs
			$T_{vj} = 125\ ^\circ C$	0.015		
			$T_{vj} = 175\ ^\circ C$	0.016		
Turn-off delay time (inductive load)	t_{doff}	$I_C = 15\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 7.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.144		μs
			$T_{vj} = 125\ ^\circ C$	0.190		
			$T_{vj} = 175\ ^\circ C$	0.256		
Fall time (inductive load)	t_f	$I_C = 15\ A, V_{CE} = 600\ V, V_{GE} = \pm 15\ V, R_{Goff} = 7.5\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.199		μs
			$T_{vj} = 125\ ^\circ C$	0.301		
			$T_{vj} = 175\ ^\circ C$	0.329		
Turn-on energy loss per pulse	E_{on}	$I_C = 15\ A, V_{CE} = 600\ V, L_\sigma = 35\ nH, V_{GE} = \pm 15\ V, R_{Gon} = 7.5\ \Omega, di/dt = 750\ A/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	0.87		mJ
			$T_{vj} = 125\ ^\circ C$	1.21		
			$T_{vj} = 175\ ^\circ C$	1.45		
Turn-off energy loss per pulse	E_{off}	$I_C = 15\ A, V_{CE} = 600\ V, L_\sigma = 35\ nH, V_{GE} = \pm 15\ V, R_{Goff} = 7.5\ \Omega, dv/dt = 4000\ V/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	0.922		mJ
			$T_{vj} = 125\ ^\circ C$	1.44		
			$T_{vj} = 175\ ^\circ C$	1.8		

Table 4 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
SC data	I_{SC}	$V_{GE} \leq 15 \text{ V}$, $V_{CC} = 800 \text{ V}$, $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$		48		A
				45		
Thermal resistance, junction to heatsink	R_{thJH}	per IGBT, Valid with IFX pre-applied Thermal Interface Material			1.86	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		10	A
Repetitive peak forward current	I_{FRM}	$t_p = 1 \text{ ms}$	20	A
I^2t - value	I^2t	$V_R = 0 \text{ V}$, $t_p = 10 \text{ ms}$	27.5	A^2s
			24	

Table 6 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 10 \text{ A}$, $V_{GE} = 0 \text{ V}$		1.72	TBD	V
				1.59		
				1.52		
Peak reverse recovery current	I_{RM}	$I_F = 10 \text{ A}$, $V_R = 600 \text{ V}$, $V_{GE} = -15 \text{ V}$, $-di_F/dt = 700 \text{ A}/\mu\text{s}$ ($T_{vj} = 175^\circ\text{C}$)		15.5		A
				19.2		
				22.5		

Table 6 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Recovered charge	Q_r	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 700\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	0.82		μC
			$T_{vj} = 125\text{ °C}$	1.46		
			$T_{vj} = 175\text{ °C}$	2.05		
Reverse recovery energy	E_{rec}	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $V_{GE} = -15\text{ V}$, $-di_F/dt = 700\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	0.31		mJ
			$T_{vj} = 125\text{ °C}$	0.57		
			$T_{vj} = 175\text{ °C}$	0.82		
Thermal resistance, junction to heatsink	R_{thJH}	per diode, Valid with IFX pre-applied Thermal Interface Material			2.68	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 Diode, Rectifier

Table 7 Maximum rated values

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

Table 8 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 10\text{ A}$ $T_{vj} = 150\text{ °C}$		0.80		V
Reverse current	I_r	$T_{vj} = 150\text{ °C}$, $V_R = 1600\text{ V}$		1		mA
Thermal resistance, junction to heatsink	R_{thJH}	per diode, Valid with IFX pre-applied Thermal Interface Material			1.58	K/W

Table 8 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
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}	$T_{vj\ max} = 175\text{ °C}$	$T_H = 110\text{ °C}$	15	A
Repetitive peak collector current	I_{CRM}	$t_P = 1\text{ ms}$		30	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	$V_{CE\ sat}$	$I_C = 15\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.60	TBD	V
			$T_{vj} = 125\text{ °C}$		1.74		
			$T_{vj} = 175\text{ °C}$		1.82		
Gate threshold voltage	V_{GEth}	$I_C = 0.553\text{ mA}, V_{CE} = V_{GE}, T_{vj} = 25\text{ °C}$		5.15	5.80	6.45	V
Gate charge	Q_G	$V_{GE} = \pm 15\text{ V}, V_{CE} = 600\text{ V}$			0.234		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\text{ °C}$			0		Ω
Input capacitance	C_{ies}	$f = 100\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$			2.82		nF
Reverse transfer capacitance	C_{res}	$f = 100\text{ kHz}, T_{vj} = 25\text{ °C}, V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$			0.0099		nF
Collector-emitter cut-off current	I_{CES}	$V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			0.003	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}	$I_C = 15\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 7.5\text{ Ω}$	$T_{vj} = 25\text{ °C}$		0.023		μs
			$T_{vj} = 125\text{ °C}$		0.025		
			$T_{vj} = 175\text{ °C}$		0.026		
Rise time (inductive load)	t_r	$I_C = 15\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, R_{Gon} = 7.5\text{ Ω}$	$T_{vj} = 25\text{ °C}$		0.012		μs
			$T_{vj} = 125\text{ °C}$		0.015		
			$T_{vj} = 175\text{ °C}$		0.016		

Table 10 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off delay time (inductive load)	t_{doff}	$I_C = 15 \text{ A}$, $V_{\text{CE}} = 600 \text{ V}$, $V_{\text{GE}} = \pm 15 \text{ V}$, $R_{\text{Goff}} = 7.5 \Omega$	$T_{\text{vj}} = 25^\circ \text{C}$	0.144		μs
			$T_{\text{vj}} = 125^\circ \text{C}$	0.190		
			$T_{\text{vj}} = 175^\circ \text{C}$	0.256		
Fall time (inductive load)	t_f	$I_C = 15 \text{ A}$, $V_{\text{CE}} = 600 \text{ V}$, $V_{\text{GE}} = \pm 15 \text{ V}$, $R_{\text{Goff}} = 7.5 \Omega$	$T_{\text{vj}} = 25^\circ \text{C}$	0.199		μs
			$T_{\text{vj}} = 125^\circ \text{C}$	0.301		
			$T_{\text{vj}} = 175^\circ \text{C}$	0.329		
Turn-on energy loss per pulse	E_{on}	$I_C = 15 \text{ A}$, $V_{\text{CE}} = 600 \text{ V}$, $L_\sigma = 35 \text{ nH}$, $V_{\text{GE}} = \pm 15 \text{ V}$, $R_{\text{Gon}} = 7.5 \Omega$, $di/dt = 750 \text{ A}/\mu\text{s}$ ($T_{\text{vj}} = 175^\circ \text{C}$)	$T_{\text{vj}} = 25^\circ \text{C}$	0.87		mJ
			$T_{\text{vj}} = 125^\circ \text{C}$	1.21		
			$T_{\text{vj}} = 175^\circ \text{C}$	1.45		
Turn-off energy loss per pulse	E_{off}	$I_C = 15 \text{ A}$, $V_{\text{CE}} = 600 \text{ V}$, $L_\sigma = 35 \text{ nH}$, $V_{\text{GE}} = \pm 15 \text{ V}$, $R_{\text{Goff}} = 7.5 \Omega$, $dv/dt = 4000 \text{ V}/\mu\text{s}$ ($T_{\text{vj}} = 175^\circ \text{C}$)	$T_{\text{vj}} = 25^\circ \text{C}$	0.922		mJ
			$T_{\text{vj}} = 125^\circ \text{C}$	1.44		
			$T_{\text{vj}} = 175^\circ \text{C}$	1.8		
SC data	I_{SC}	$V_{\text{GE}} \leq 15 \text{ V}$, $V_{\text{CC}} = 800 \text{ V}$, $V_{\text{CEmax}} = V_{\text{CES}} - L_{\text{sCE}} \cdot di/dt$	$t_p \leq 8 \mu\text{s}$, $T_{\text{vj}} = 150^\circ \text{C}$	48		A
			$t_p \leq 7 \mu\text{s}$, $T_{\text{vj}} = 175^\circ \text{C}$	45		
Thermal resistance, junction to heatsink	R_{thJH}	per IGBT, Valid with IFX pre-applied Thermal Interface Material			1.86	K/W
Temperature under switching conditions	$T_{\text{vj op}}$		-40		175	$^\circ \text{C}$

Note: $T_{\text{vj op}} > 150^\circ \text{C}$ 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}		$T_{\text{vj}} = 25^\circ \text{C}$	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	$V_R = 0 \text{ V}$, $t_p = 10 \text{ ms}$	$T_{\text{vj}} = 125^\circ \text{C}$	27.5	A^2s
			$T_{\text{vj}} = 175^\circ \text{C}$	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}	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $-di_F/dt = 700\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	15.5		A
			$T_{vj} = 125\text{ °C}$	19.2		
			$T_{vj} = 175\text{ °C}$	22.5		
Recovered charge	Q_r	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $-di_F/dt = 700\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	0.82		μC
			$T_{vj} = 125\text{ °C}$	1.46		
			$T_{vj} = 175\text{ °C}$	2.05		
Reverse recovery energy	E_{rec}	$I_F = 10\text{ A}$, $V_R = 600\text{ V}$, $-di_F/dt = 700\text{ A}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	0.31		mJ
			$T_{vj} = 125\text{ °C}$	0.57		
			$T_{vj} = 175\text{ °C}$	0.82		
Thermal resistance, junction to heatsink	R_{thJH}	per diode, Valid with IFX pre-applied Thermal Interface Material			2.68	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

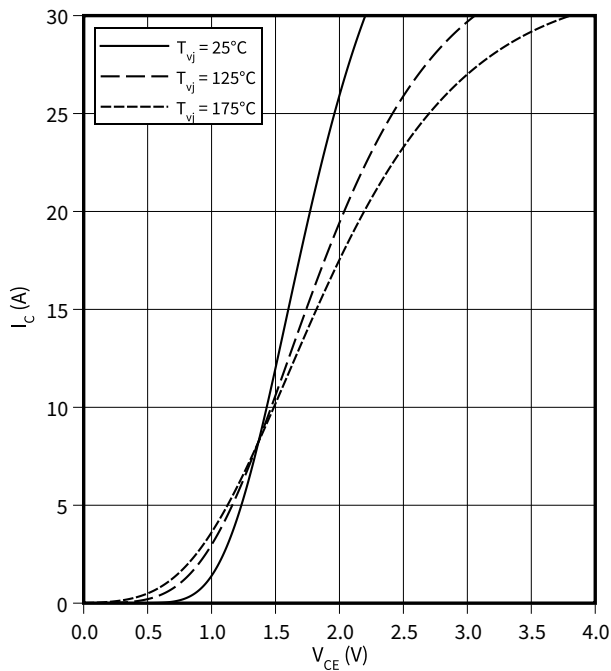
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	$T_{NTC} = 25\text{ °C}$		5		k Ω
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 100\text{ °C}$, $R_{100} = 493\text{ }\Omega$	-5		5	%
Power dissipation	P_{25}	$T_{NTC} = 25\text{ °C}$			20	mW
B-value	$B_{25/50}$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

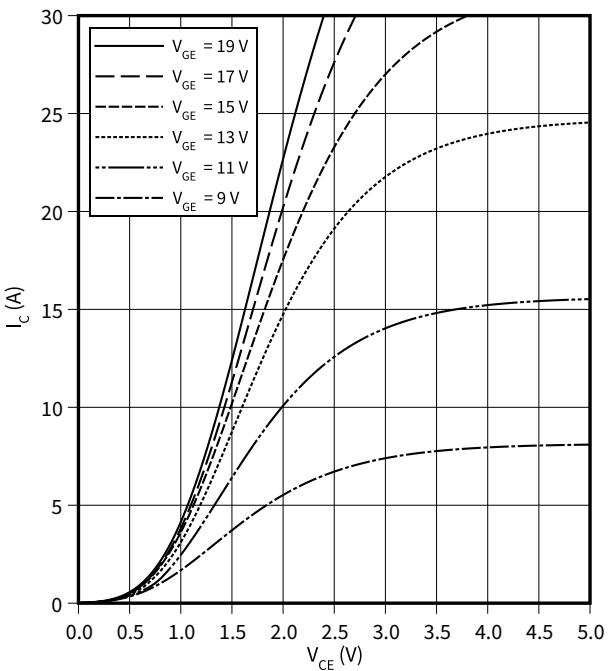
output characteristic (typical), IGBT, Inverter

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



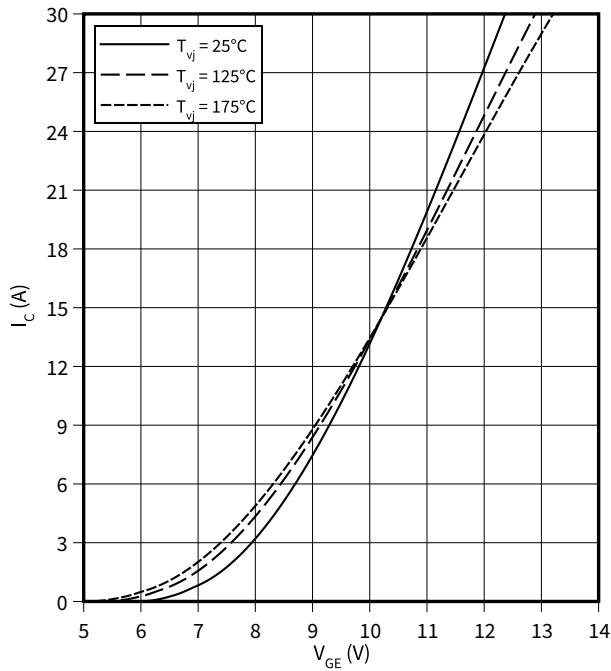
output characteristic (typical), IGBT, Inverter

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



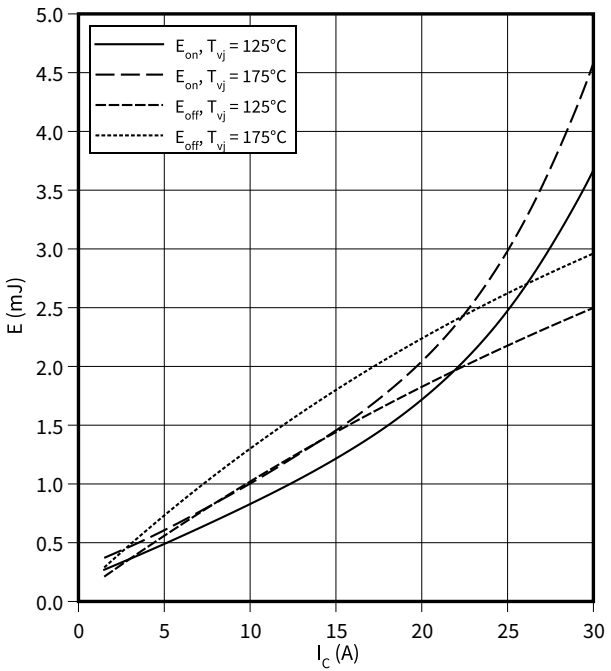
transfer characteristic (typical), IGBT, Inverter

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



switching losses (typical), IGBT, Inverter

$E = f(I_C)$
 $R_{Goff} = 7.5\text{ }\Omega$, $R_{Gon} = 7.5\text{ }\Omega$, $V_{CE} = 600\text{ V}$, $V_{GE} = \pm 15\text{ V}$

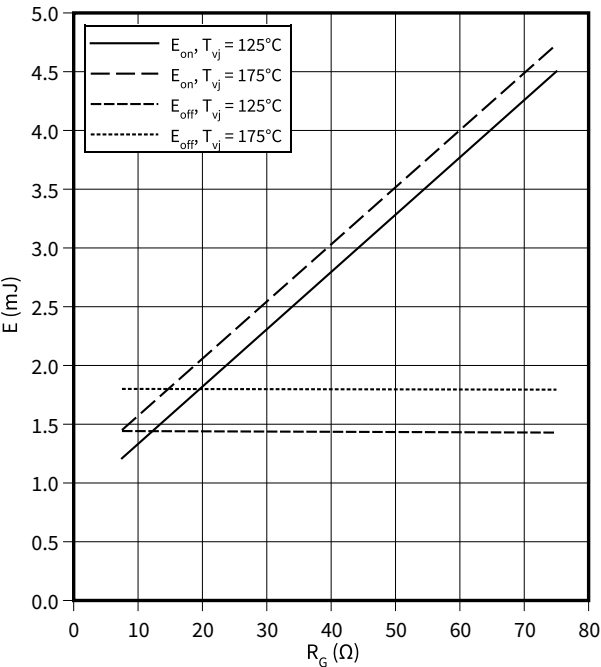


8 Characteristics diagrams

switching losses (typical), IGBT, Inverter

$E = f(R_G)$

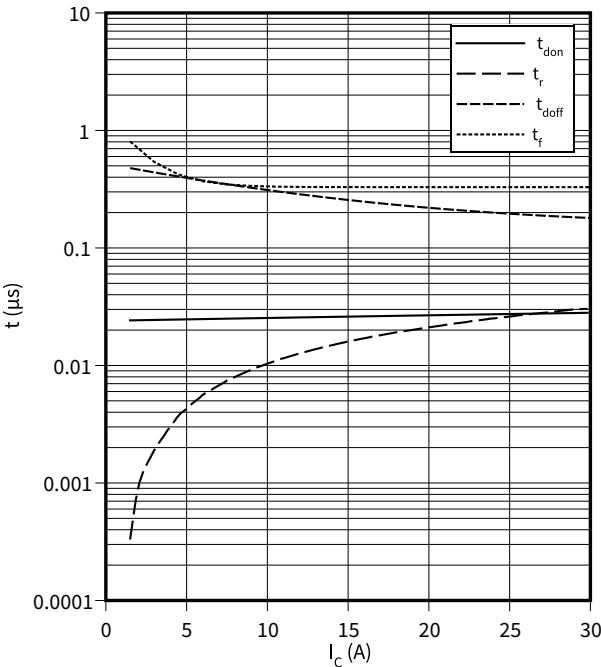
$I_C = 15\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}$



switching times (typical), IGBT, Inverter

$t = f(I_C)$

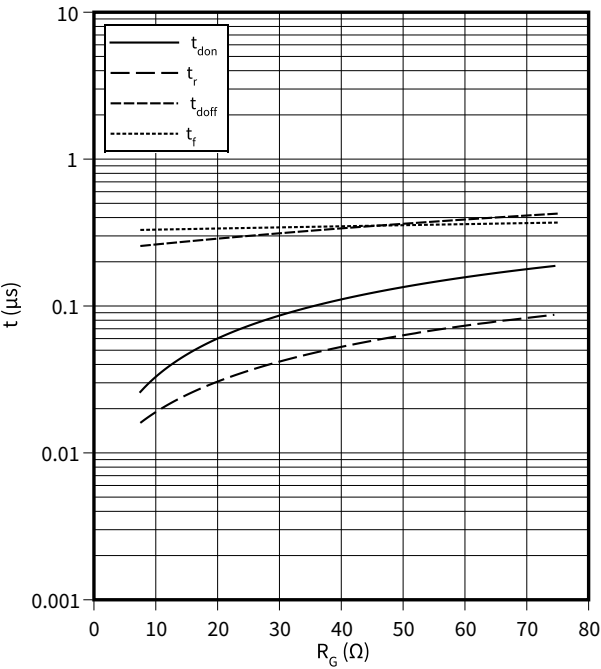
$R_{Goff} = 7.5\ \Omega, R_{Gon} = 7.5\ \Omega, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, T_{vj} = 175^\circ\text{C}$



switching times (typical), IGBT, Inverter

$t = f(R_G)$

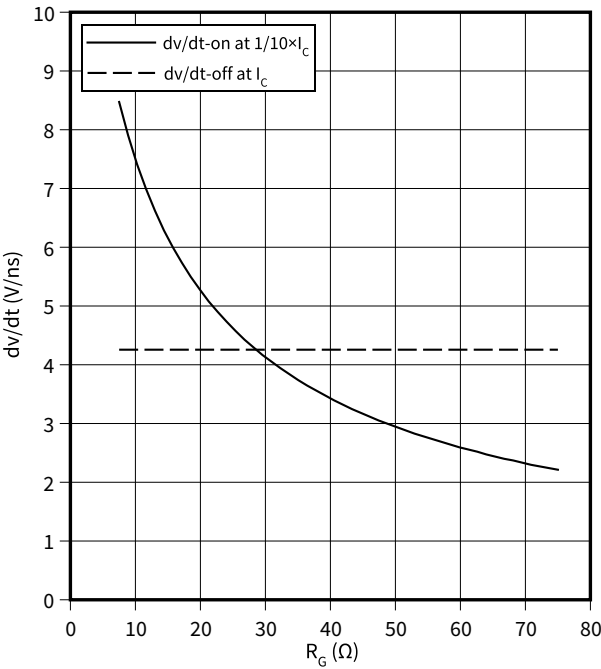
$I_C = 15\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, T_{vj} = 175^\circ\text{C}$



dv/dt (typical), IGBT, Inverter

$dv/dt = f(R_G)$

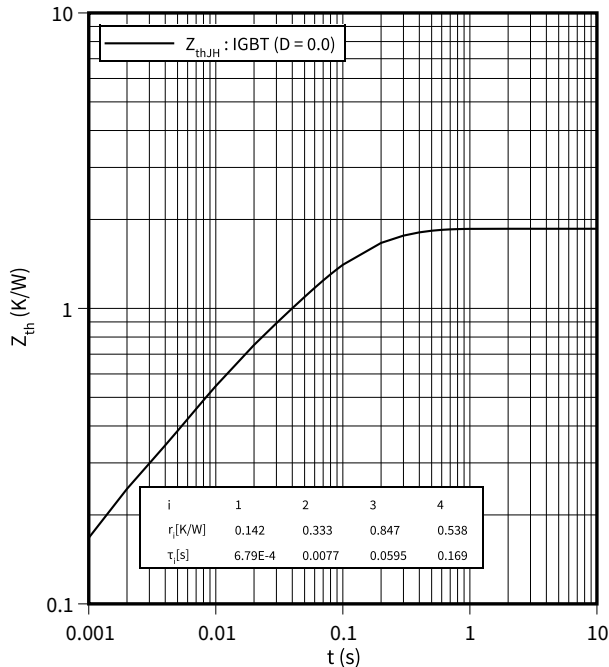
$I_C = 15\text{ A}, V_{CE} = 600\text{ V}, V_{GE} = \pm 15\text{ V}, T_{vj} = 25^\circ\text{C}$



8 Characteristics diagrams

transient thermal impedance , IGBT, Inverter

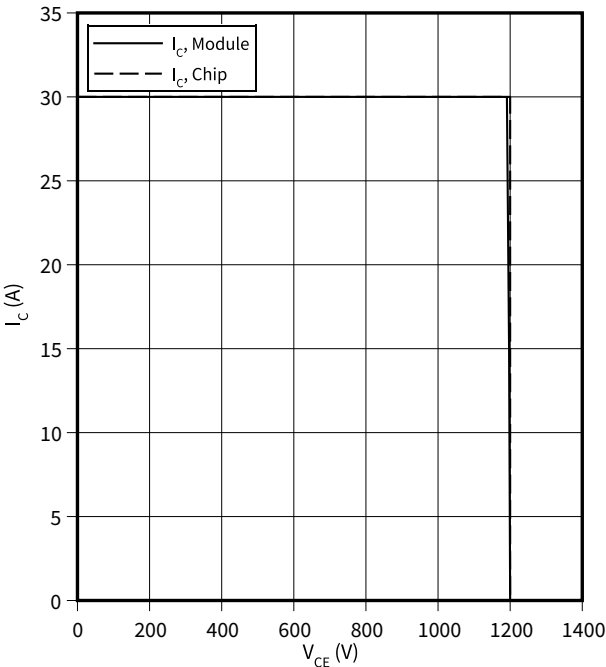
$Z_{th} = f(t)$



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

$I_C = f(V_{CE})$

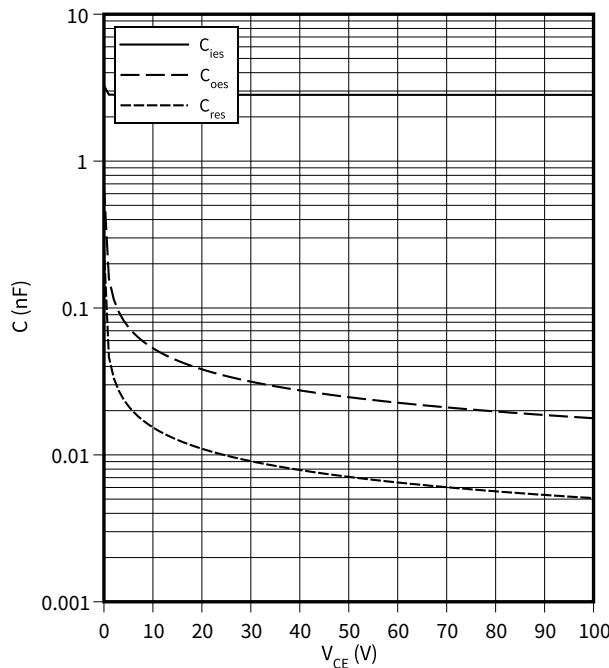
$R_{Goff} = 7.5 \Omega, V_{GE} = \pm 15 V, T_{vj} = 175 \text{ }^\circ\text{C}$



capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

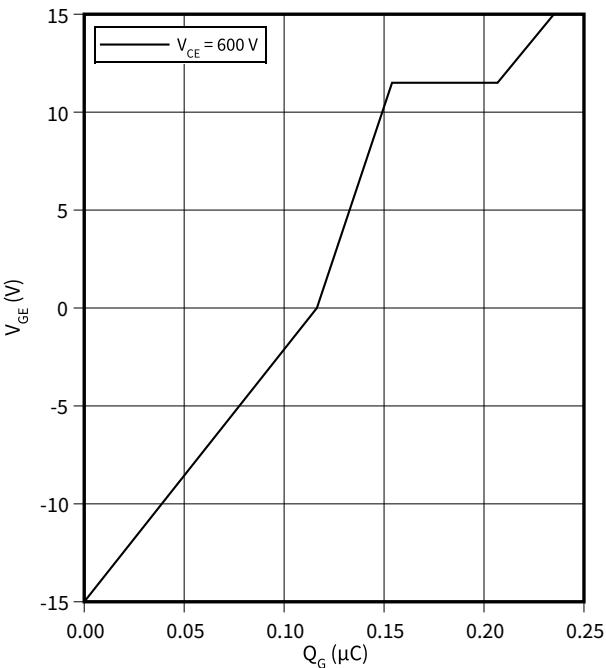
$V_{GE} = 0 V, T_{vj} = 25 \text{ }^\circ\text{C}, f = 100 \text{ kHz}$



gate charge characteristic (typical), IGBT, Inverter

$V_{GE} = f(Q_G)$

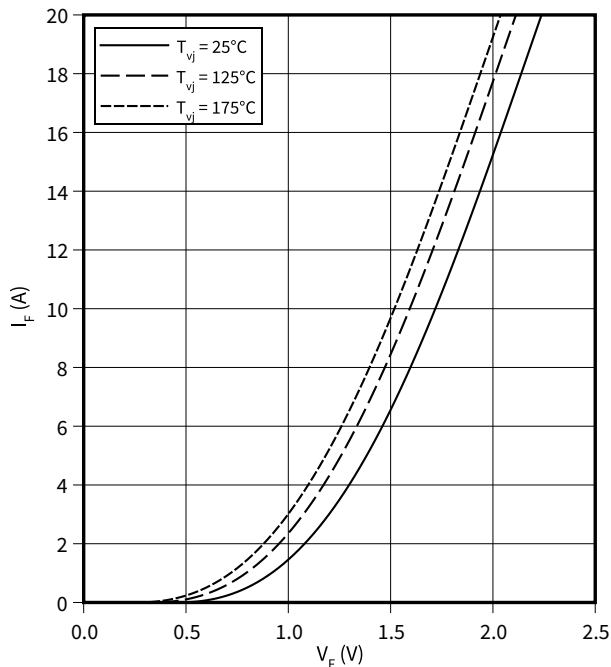
$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 15 A$



8 Characteristics diagrams

forward characteristic (typical), Diode, Inverter

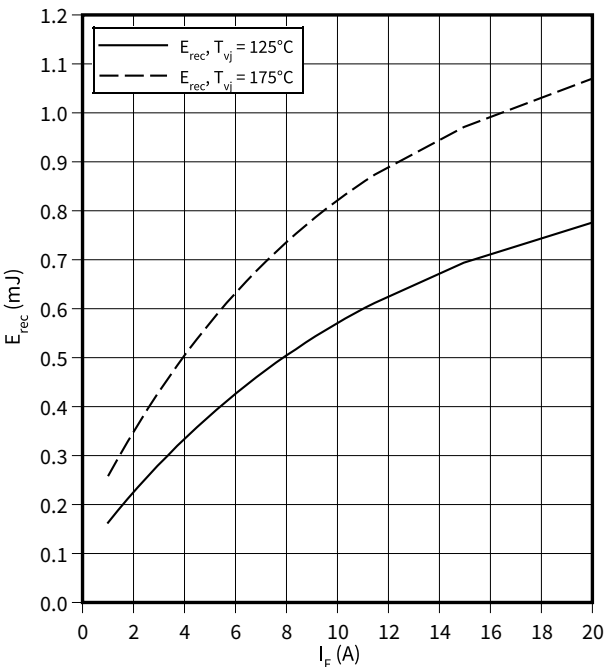
$I_F = f(V_F)$



switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

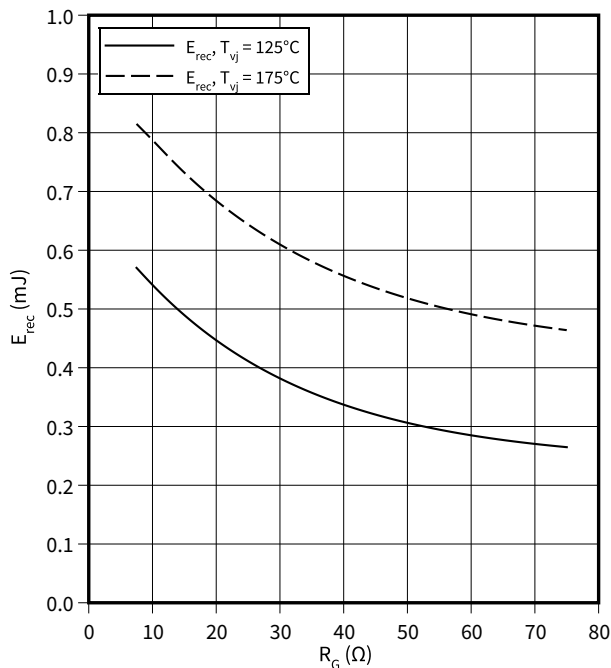
$R_{Gon} = 7.5 \Omega, V_{CE} = 600 \text{ V}$



switching losses (typical), Diode, Inverter

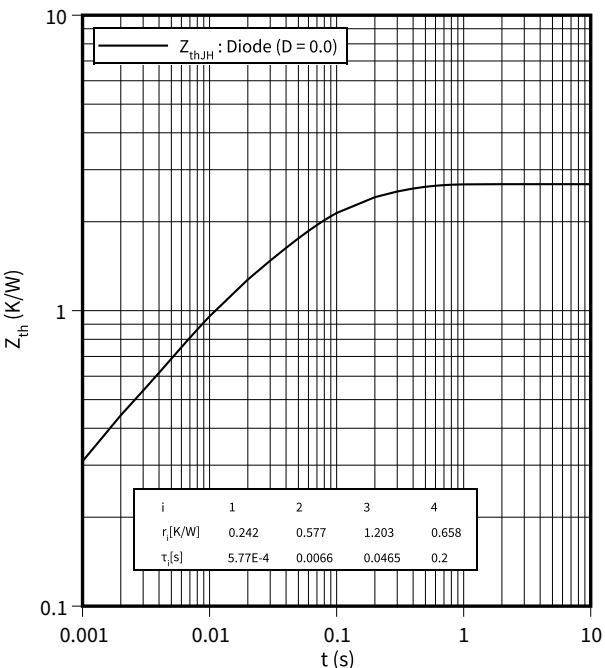
$E_{rec} = f(R_G)$

$V_{CE} = 600 \text{ V}, I_F = 10 \text{ A}$



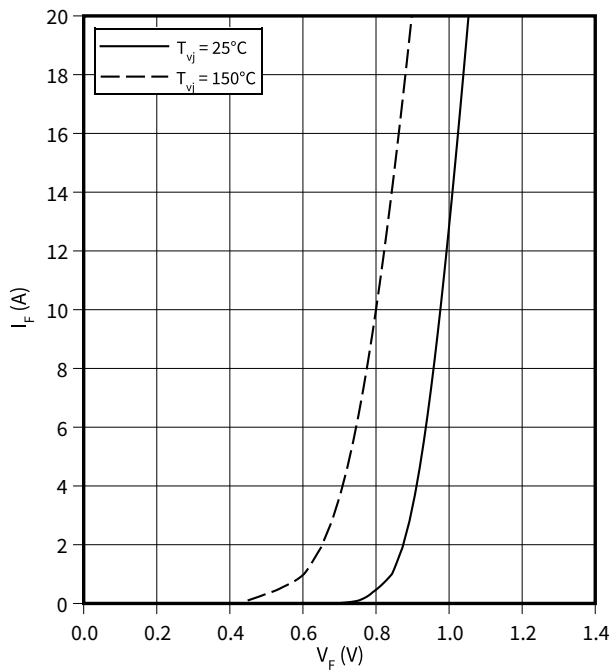
transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$

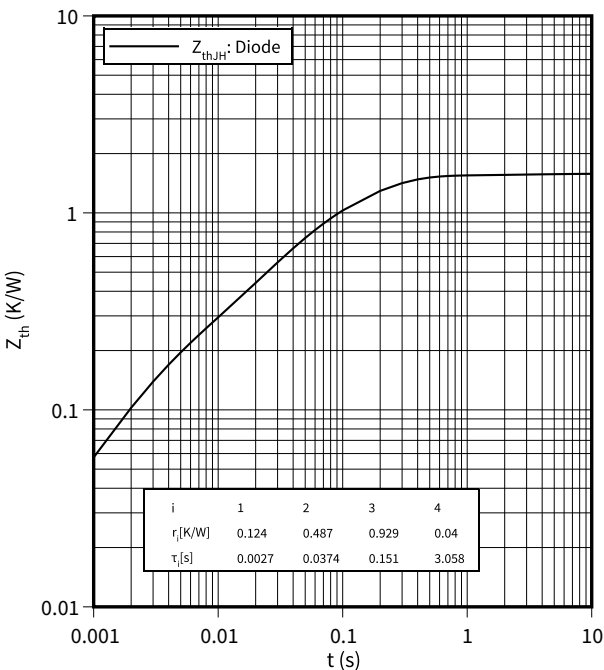


8 Characteristics diagrams

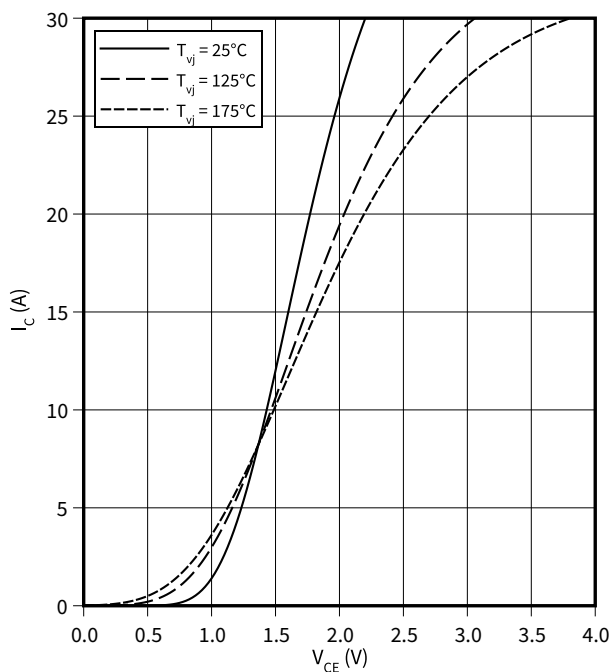
forward characteristic (typical), Diode, Rectifier
 $I_F = f(V_F)$



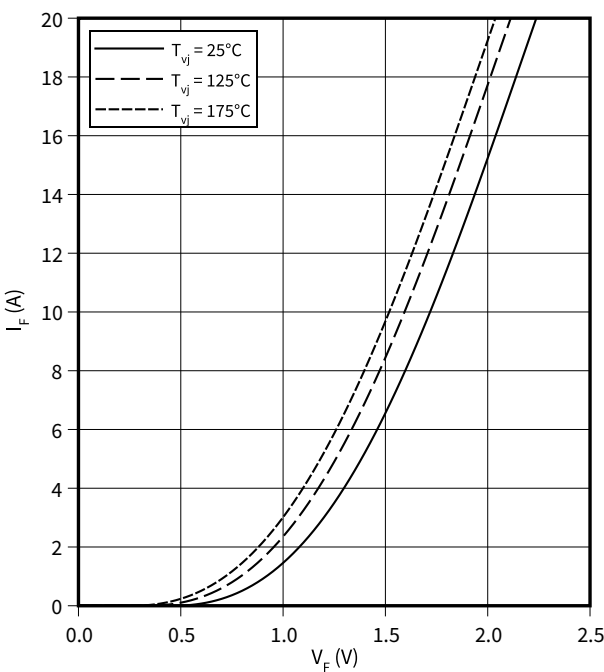
transient thermal impedance , Diode, Rectifier
 $Z_{th} = f(t)$



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



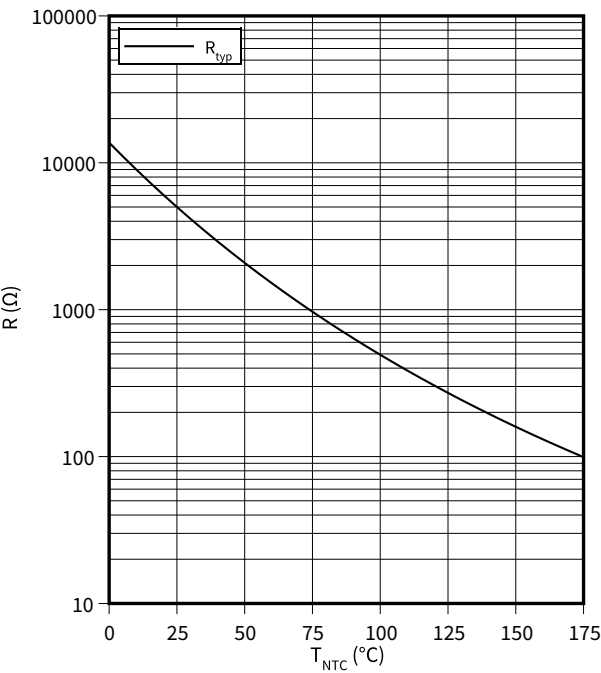
forward characteristic (typical), Diode, Brake-Chopper
 $I_F = f(V_F)$



8 Characteristics diagrams

temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



9 **Circuit diagram**

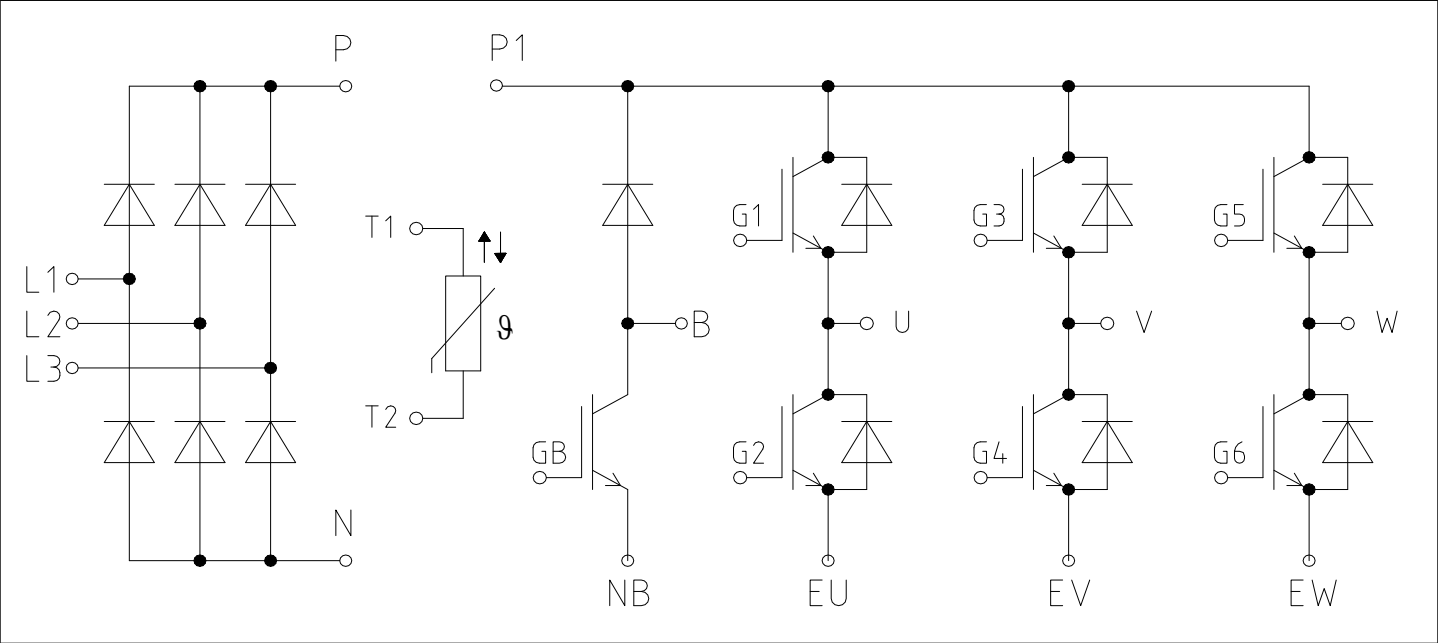


Figure 2

10 Package outlines

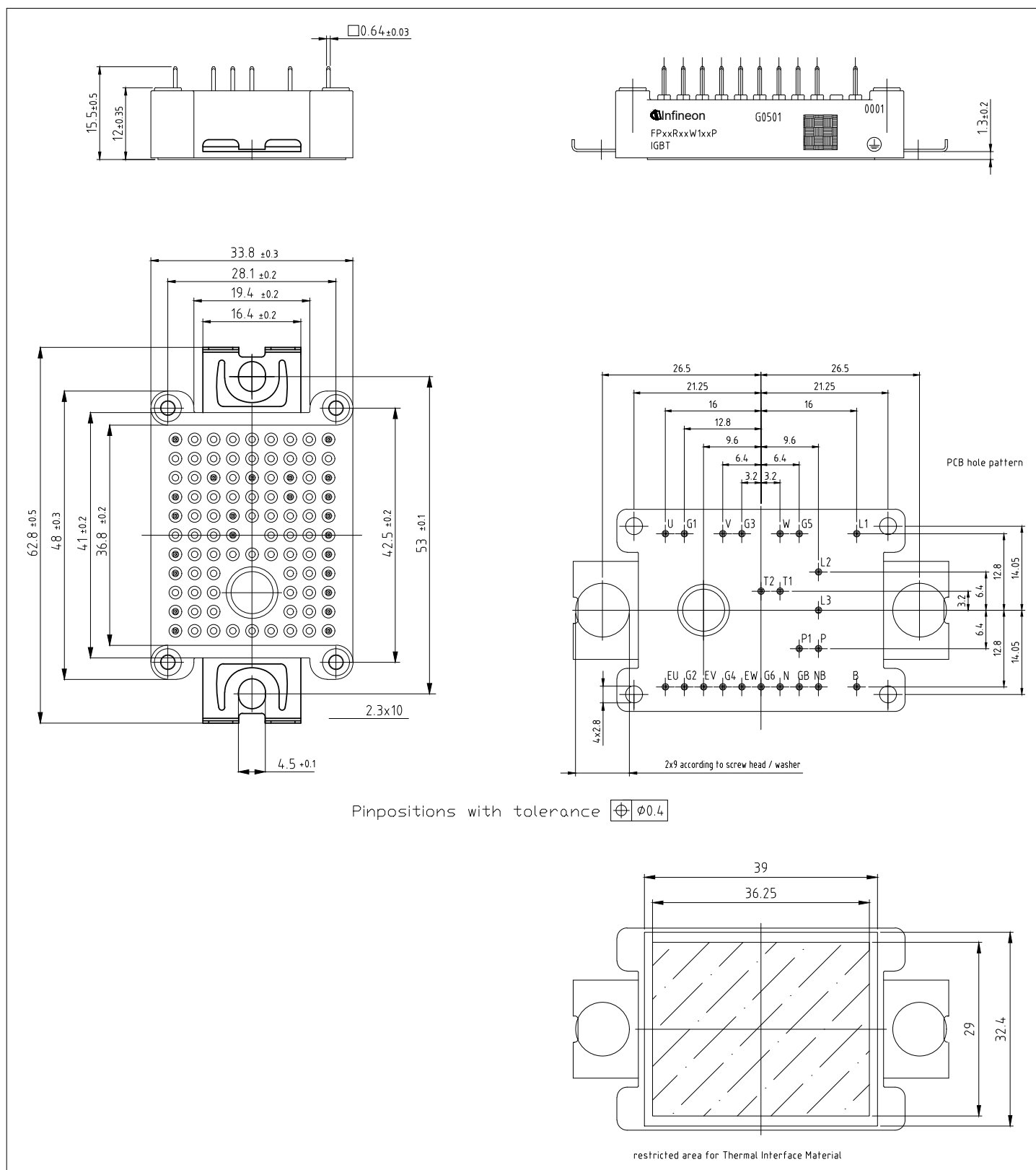


Figure 3

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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