Preliminary datasheet
EconoPIM™3 module with TRENCHSTOP™IGBT7 and emitter controlled 7 diode and NTC

Features


Typical appearance

- Electrical features
  - V_{CES} = 1200 V
  - $I_{C\ nom}$ = 75 A / I_{CRM} = 150 A
  - TRENCHSTOP™ IGBT7
  - Overload operation up to 175°C
  - Low $V_{CE,sat}$
- Mechanical features
  - High power and thermal cycling capability
  - Integrated NTC temperature sensor
  - Copper base plate
  - Solder contact technology
  - Standard housing
  - Al_2O_3 substrate with low thermal resistance

Potential applications

- Auxiliary inverters
- Motor drives
- Servo drives

Product validation

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

Description

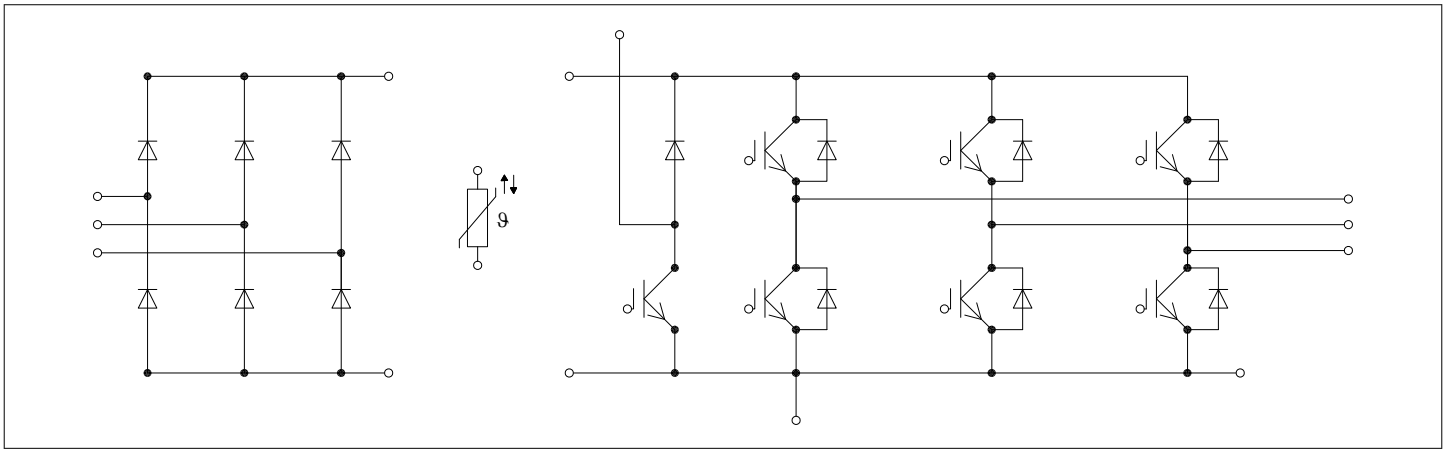


Table of contents

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	2.5	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	d_{Creep}	terminal to heatsink	10.0	mm
Clearance	d_{Clear}	terminal to heatsink	7.5	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}				35		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	T_C=25°C, per switch			2.9		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_C=25°C, per switch			3.9		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
Weight	*G*				300		g

Note: The current under continuous operation is limited to 50A 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 °C	1200	V
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_C = 100 °C	75	A
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\,op}$		150	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 = 75 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.55	1.80	V
			T_{vj} = 125 °C		1.69		
			T_{vj} = 175 °C		1.77		
Gate threshold voltage	V_{GEth}	I_C = 1.7 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.15	5.80	6.45	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 600 V			1.25		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			2		Ω
Input capacitance	C_{ies}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			15.1		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			0.053		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 1200 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.013	mA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V, T_{vj} = 25 °C				100	nA
Turn-on delay time (inductive load)	t_{don}	I_C = 75 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Gon} = 5.6 Ω	T_{vj} = 25 °C		0.145		µs
			T_{vj} = 125 °C		0.157		
			T_{vj} = 175 °C		0.167		
Rise time (inductive load)	t_r	I_C = 75 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Gon} = 5.6 Ω	T_{vj} = 25 °C		0.060		µs
			T_{vj} = 125 °C		0.064		
			T_{vj} = 175 °C		0.066		
Turn-off delay time (inductive load)	t_{doff}	I_C = 75 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Goff} = 5.6 Ω	T_{vj} = 25 °C		0.289		µs
			T_{vj} = 125 °C		0.372		
			T_{vj} = 175 °C		0.424		
Fall time (inductive load)	t_f	I_C = 75 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Goff} = 5.6 Ω	T_{vj} = 25 °C		0.112		µs
			T_{vj} = 125 °C		0.216		
			T_{vj} = 175 °C		0.281		
Turn-on energy loss per pulse	E_{on}	I_C = 75 A, V_{CE} = 600 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Gon} = 5.6 Ω, di/dt = 910 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		9.09		mJ
			T_{vj} = 125 °C		11.8		
			T_{vj} = 175 °C		13.4		
Turn-off energy loss per pulse	E_{off}	I_C = 75 A, V_{CE} = 600 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Goff} = 5.6 Ω, dv/dt = 3200 V/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		5		mJ
			T_{vj} = 125 °C		8.09		
			T_{vj} = 175 °C		9.74		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
SC data	I_{SC}	$V_{GE} \le 15$ V, $V_{CC} = 800$ V, $V_{CEmax}=V_{CES}-L_{sCE}*di/dt$	$t_P \le 8$ µs, $T_{vj} = 150$ °C		260		A
			$t_P \le 7$ µs, $T_{vj} = 175$ °C		250		
Thermal resistance, junction to case	R_{thJC}	per IGBT				0.486	K/W
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, $\lambda_{grease}= 1$ W/(m*K)			0.0706		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		175	°C

Note: $T_{vj\,op} > 150$°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}		$T_{vj} = 25$ °C	1200	V
Continuous DC forward current	I_F			75	A
Repetitive peak forward current	I_{FRM}	$t_P = 1$ ms		150	A
I^2t - value	I^2t	$t_P = 10$ ms, $V_R = 0$ V	$T_{vj} = 125$ °C	820	A^2s
			$T_{vj} = 175$ °C	630	

Table 6 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	$I_F = 75$ A, $V_{GE} = 0$ V	$T_{vj} = 25$ °C		1.72	2.10	V
			$T_{vj} = 125$ °C		1.59		
			$T_{vj} = 175$ °C		1.52		
Peak reverse recovery current	I_{RM}	$V_R = 600$ V, $I_F = 75$ A, $V_{GE} = -15$ V, $-di_F/dt = 910$ A/µs ($T_{vj} = 175$ °C)	$T_{vj} = 25$ °C		32		A
			$T_{vj} = 125$ °C		43		
			$T_{vj} = 175$ °C		50		

(table continues...)

Table 6 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Recovered charge	Q_r	V_R = 600 V, I_F = 75 A, V_{GE} = -15 V, -di$_F$/dt = 910 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		4.82		µC
			T_{vj} = 125 °C		10.2		
			T_{vj} = 175 °C		13.7		
Reverse recovery energy	E_{rec}	V_R = 600 V, I_F = 75 A, V_{GE} = -15 V, -di$_F$/dt = 910 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		1.32		mJ
			T_{vj} = 125 °C		3.09		
			T_{vj} = 175 °C		4.36		
Thermal resistance, junction to case	R_{thJC}	per diode				0.728	K/W
Thermal resistance, case to heat sink	R_{thCH}	per diode, λ_{grease}= 1 W/(m*K)			0.0871		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		175	°C

Note: $T_{vj\,op}$ > 150°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 °C		1600	V
Maximum RMS forward current per chip	I_{FRMSM}	T_C = 100 °C		95	A
Maximum RMS current at rectifier output	I_{RMSM}	T_C = 100 °C		150	A
Surge forward current	I_{FSM}	t_P = 10 ms	T_{vj} = 25 °C	720	A
			T_{vj} = 150 °C	565	
I^{2}t - value	I^2t	t_P = 10 ms	T_{vj} = 25 °C	2590	A^{2}s
			T_{vj} = 150 °C	1600	

Table 8 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 75 A	T_{vj} = 150 °C		1.00		V
Reverse current	I_r	T_{vj} = 150 °C, V_R = 1600 V			1		mA

(table continues...)

Table 8 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Thermal resistance, junction to case	R_{thJC}	per diode			0.602	K/W
Thermal resistance, case to heat sink	R_{thCH}	per diode, λ_{grease}= 1 W/(m*K)		0.0770		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 °C	1200	V
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_C = 110 °C	50	A
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\,op}$		100	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 = 50 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.50	1.80	V
			T_{vj} = 125 °C		1.64		
			T_{vj} = 175 °C		1.72		
Gate threshold voltage	V_{GEth}	I_C = 1.28 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.15	5.80	6.45	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 600 V			0.92		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0		Ω
Input capacitance	C_{ies}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			11.1		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			0.039		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 1200 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.0062	mA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V, T_{vj} = 25 °C				100	nA

(table continues...)

Table 10 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-on delay time (inductive load)	t_{don}	I_C = 50 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Gon} = 7.5 Ω	T_{vj} = 25 °C		0.052		µs
			T_{vj} = 125 °C		0.059		
			T_{vj} = 175 °C		0.060		
Rise time (inductive load)	t_r	I_C = 50 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Gon} = 7.5 Ω	T_{vj} = 25 °C		0.060		µs
			T_{vj} = 125 °C		0.062		
			T_{vj} = 175 °C		0.064		
Turn-off delay time (inductive load)	t_{doff}	I_C = 50 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Goff} = 7.5 Ω	T_{vj} = 25 °C		0.269		µs
			T_{vj} = 125 °C		0.365		
			T_{vj} = 175 °C		0.404		
Fall time (inductive load)	t_f	I_C = 50 A, V_{CE} = 600 V, V_{GE} = ±15 V, R_{Goff} = 7.5 Ω	T_{vj} = 25 °C		0.110		µs
			T_{vj} = 125 °C		0.207		
			T_{vj} = 175 °C		0.269		
Turn-on energy loss per pulse	E_{on}	I_C = 50 A, V_{CE} = 600 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Gon} = 7.5 Ω, di/dt = 625 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		5.36		mJ
			T_{vj} = 125 °C		6.34		
			T_{vj} = 175 °C		6.79		
Turn-off energy loss per pulse	E_{off}	I_C = 50 A, V_{CE} = 600 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Goff} = 7.5 Ω, dv/dt = 3045 V/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		3.41		mJ
			T_{vj} = 125 °C		5.36		
			T_{vj} = 175 °C		6.57		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 800 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 8 µs, T_{vj}=150 °C		190		A
			t_P ≤ 7 µs, T_{vj}=175 °C		180		
Thermal resistance, junction to case	R_{thJC}	per IGBT				0.598	K/W
Thermal resistance, case to heat sink	R_{thCH}	per IGBT, λ_{grease}= 1 W/(m*K)			0.0764		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		175	°C

Note: $T_{vj\,op}$ > 150°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 °C	1200	V
Continuous DC forward current	I_F			25	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		50	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	80	A^2s
			T_{vj} = 175 °C	70	

Table 12 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 25 A	T_{vj} = 25 °C		1.83	2.30	V
			T_{vj} = 125 °C		1.70		
			T_{vj} = 150 °C		1.63		
Peak reverse recovery current	I_{RM}	V_R = 600 V, I_F = 25 A, V_{GE} = -15 V, -di$_F$/dt = 685 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		16		A
			T_{vj} = 125 °C		21		
			T_{vj} = 175 °C		23		
Recovered charge	Q_r	V_R = 600 V, I_F = 25 A, V_{GE} = -15 V, -di$_F$/dt = 685 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		1.67		µC
			T_{vj} = 125 °C		3.26		
			T_{vj} = 175 °C		4.23		
Reverse recovery energy	E_{rec}	V_R = 600 V, I_F = 25 A, V_{GE} = -15 V, -di$_F$/dt = 685 A/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		0.54		mJ
			T_{vj} = 125 °C		1.17		
			T_{vj} = 175 °C		1.58		
Thermal resistance, junction to case	R_{thJC}	per diode				1.43	K/W
Thermal resistance, case to heat sink	R_{thCH}	per diode, λ_{grease}= 1 W/(m*K)			0.182		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		175	°C

Note: $T_{vj\,op}$ > 150°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 °C		5		kΩ
Deviation of R_{100}	$\Delta R/R$	T_{NTC} = 100 °C, R_{100} = 493 Ω	-5		5	%
Power dissipation	P_{25}	T_{NTC} = 25 °C			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2-1/(298{,}15\ K))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2-1/(298{,}15\ K))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2-1/(298{,}15\ K))]$		3433		K

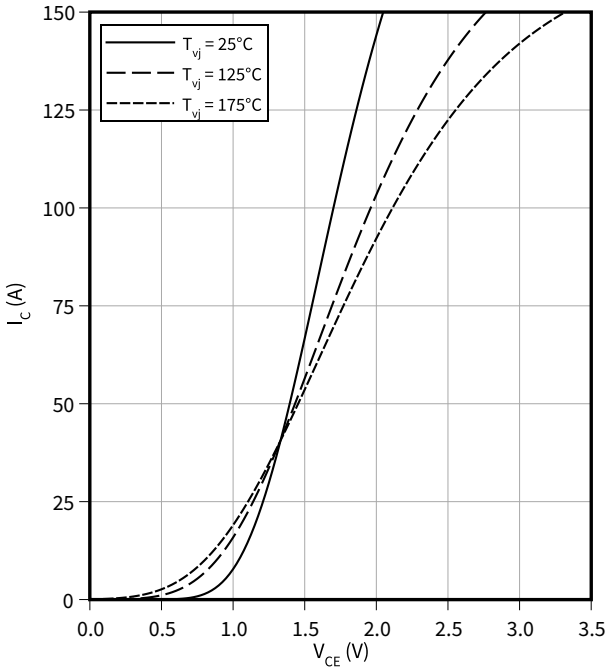
Note: Specification according to the valid application note.

8 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

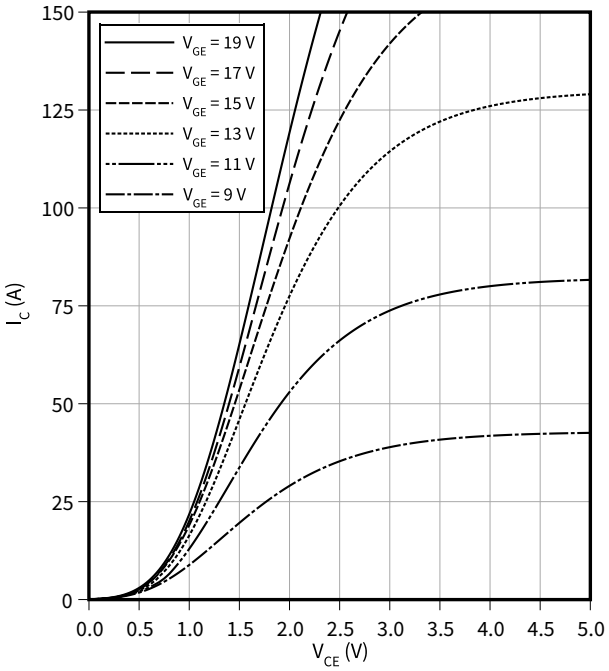
V_{GE} = 15 V



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

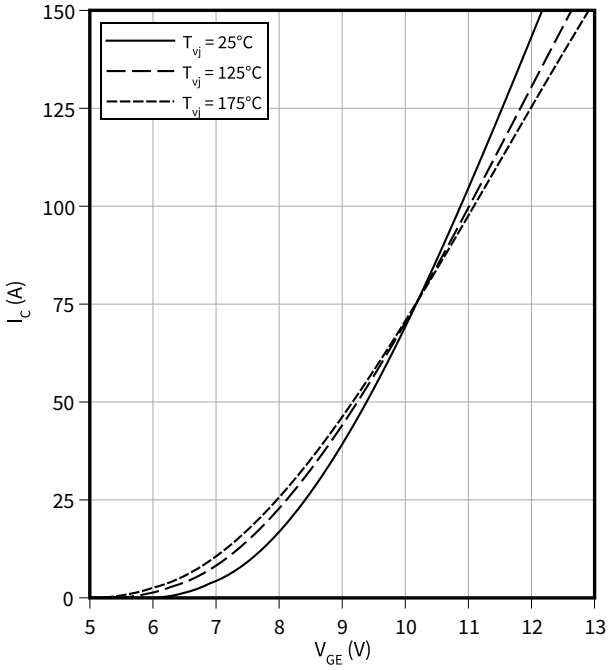
T_{vj} = 175 °C



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

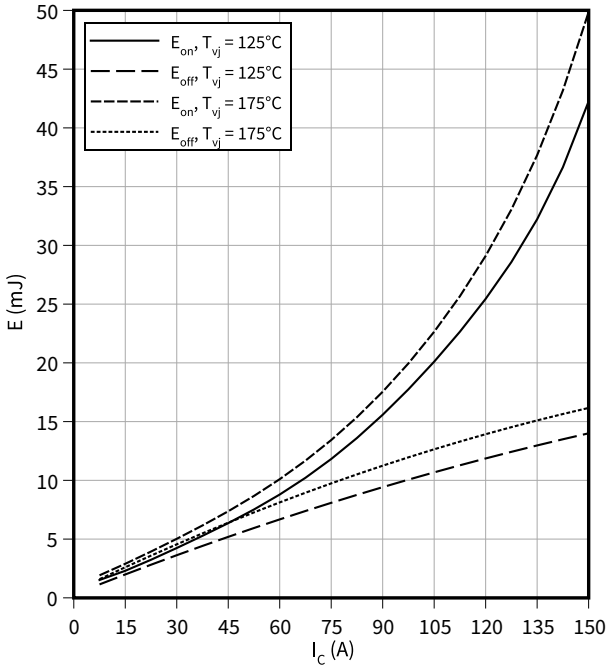
V_{CE} = 20 V



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

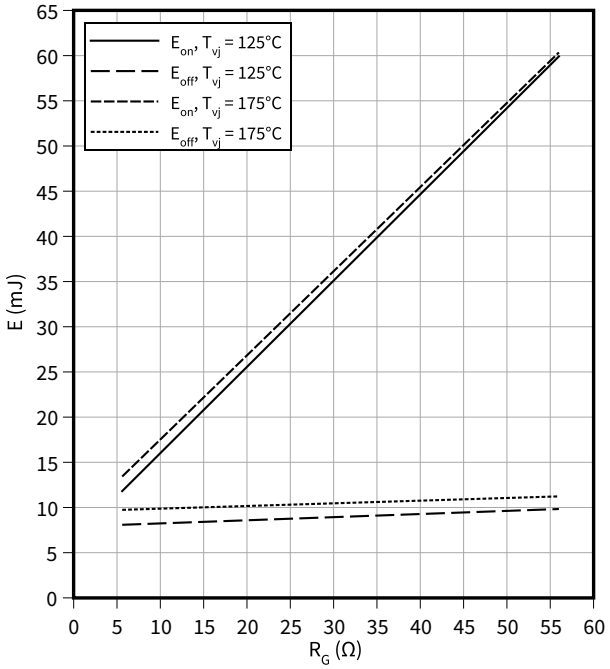
R_{Goff} = 5.6 Ω, R_{Gon} = 5.6 Ω, V_{GE} = ±15 V, V_{CE} = 600 V



Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

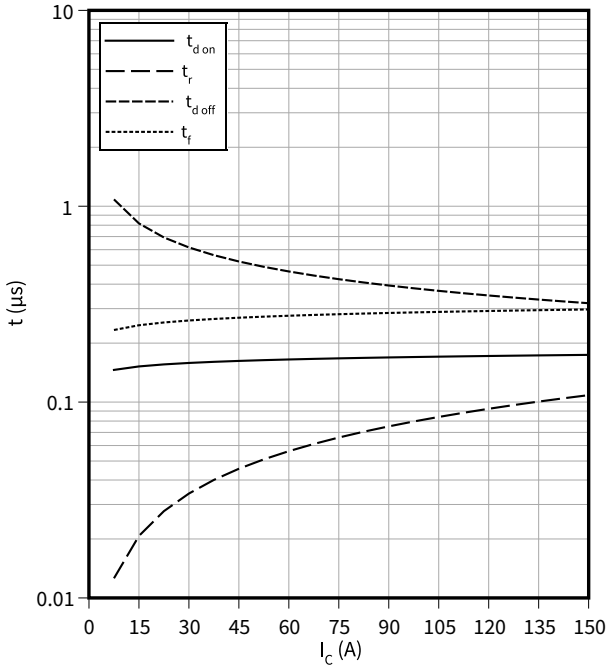
$V_{GE} = \pm 15$ V, $I_C = 75$ A, $V_{CE} = 600$ V



Switching times (typical), IGBT, Inverter

$t = f(I_C)$

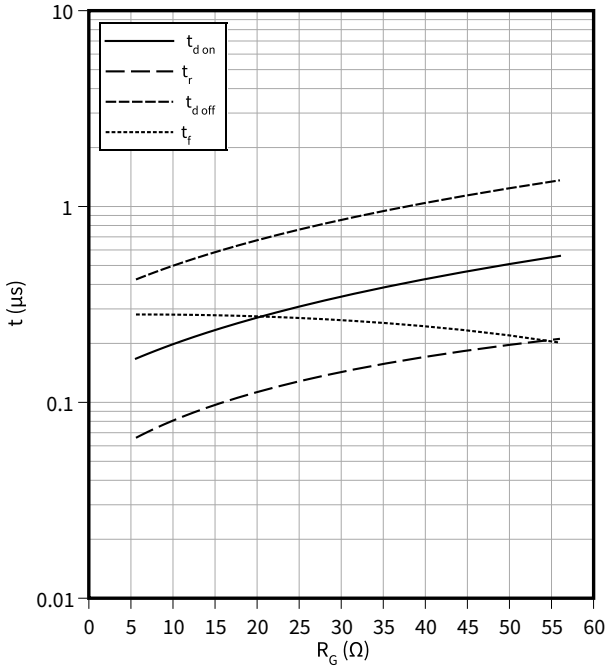
$R_{Goff} = 5.6\ \Omega$, $R_{Gon} = 5.6\ \Omega$, $V_{GE} = \pm 15$ V, $V_{CE} = 600$ V, $T_{vj} = 175$ °C



Switching times (typical), IGBT, Inverter

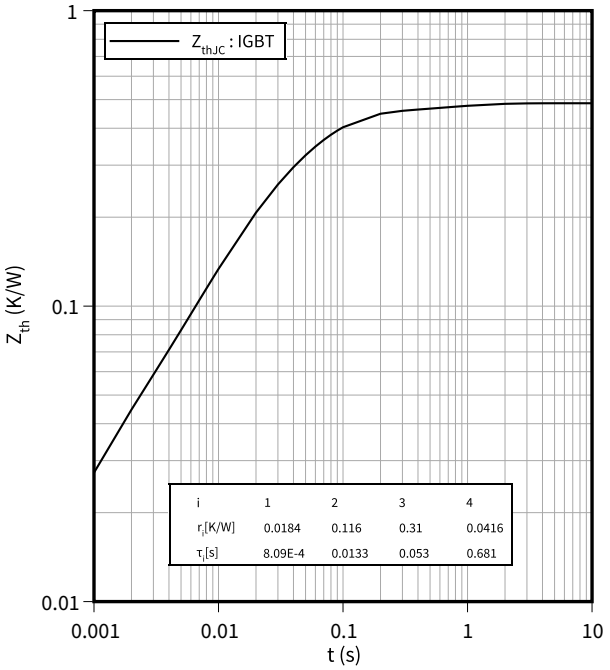
$t = f(R_G)$

$V_{GE} = \pm 15$ V, $I_C = 75$ A, $V_{CE} = 600$ V, $T_{vj} = 175$ °C



Transient thermal impedance , IGBT, Inverter

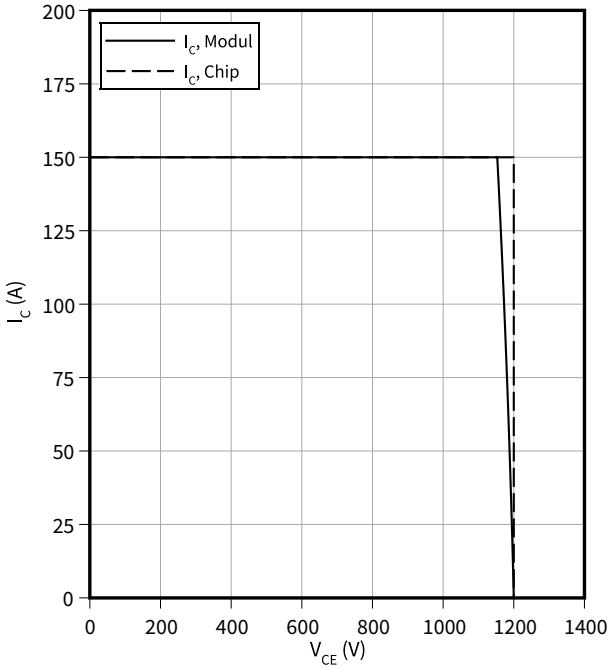
$Z_{th} = f(t)$



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

$I_C = f(V_{CE})$

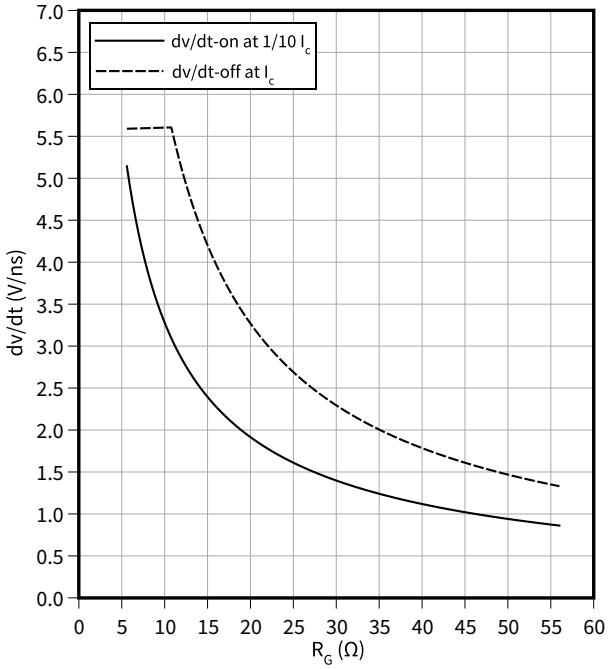
$R_{Goff} = 5.6\ \Omega$, $V_{GE} = \pm 15$ V, $T_{vj} = 175$ °C



Voltage slope (typical), IGBT, Inverter

$dv/dt = f(R_G)$

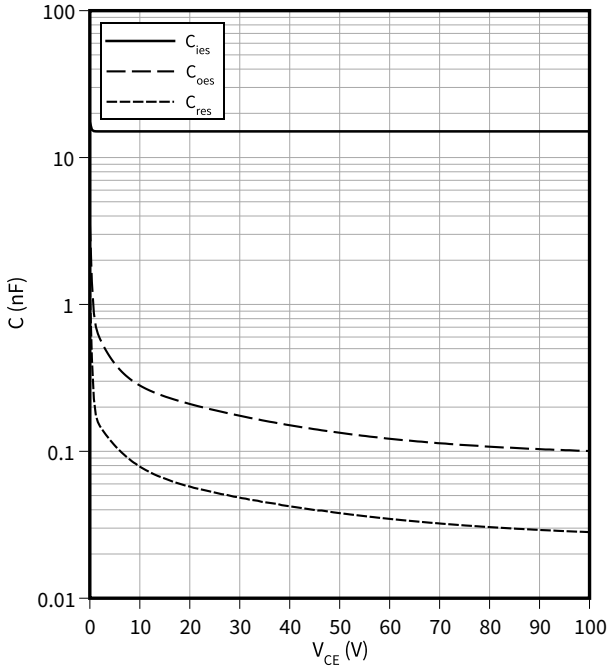
$I_C = 75$ A, $V_{CE} = 600$ V, $V_{GE} = \pm 15$ V, $T_{vj} = 25$ °C



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

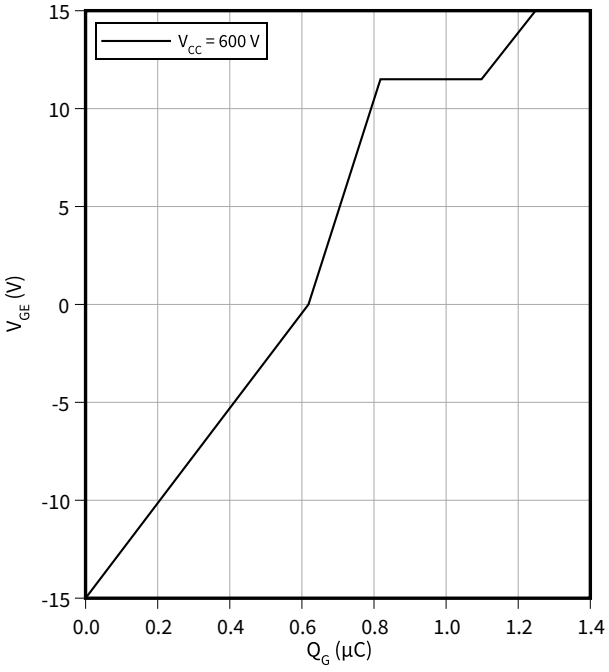
$f = 100$ kHz, $V_{GE} = 0$ V, $T_{vj} = 25$ °C



Gate charge characteristic (typical), IGBT, Inverter

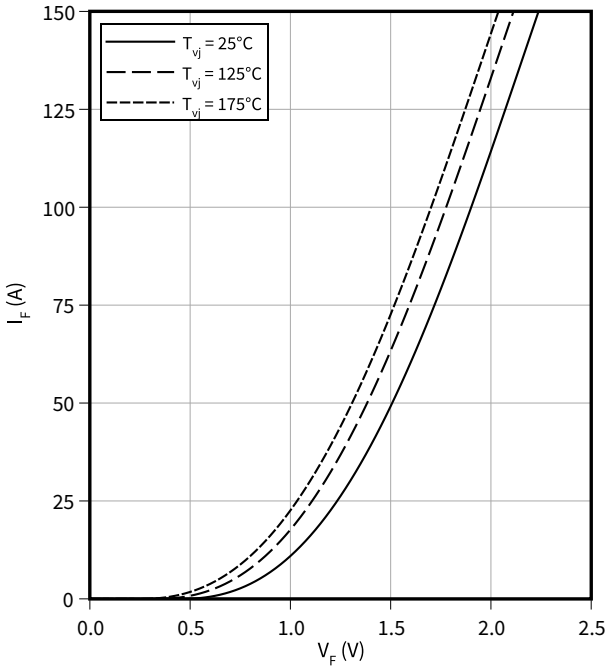
$V_{GE} = f(Q_G)$

$I_C = 75$ A, $T_{vj} = 25$ °C



Forward characteristic (typical), Diode, Inverter

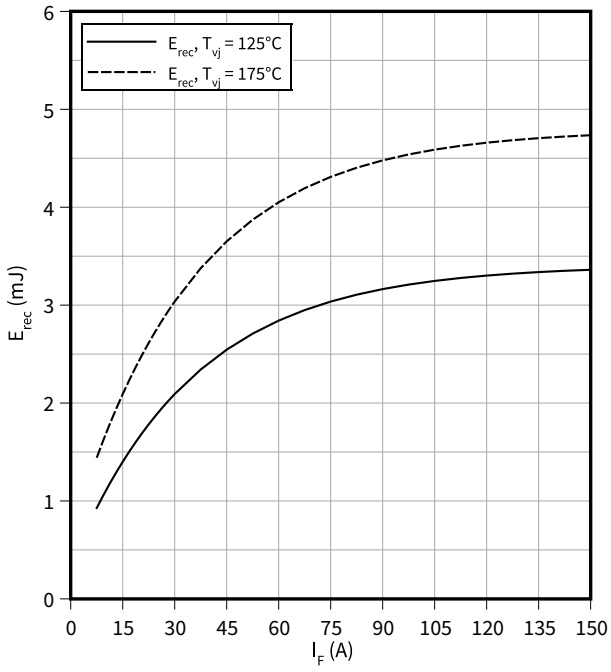
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

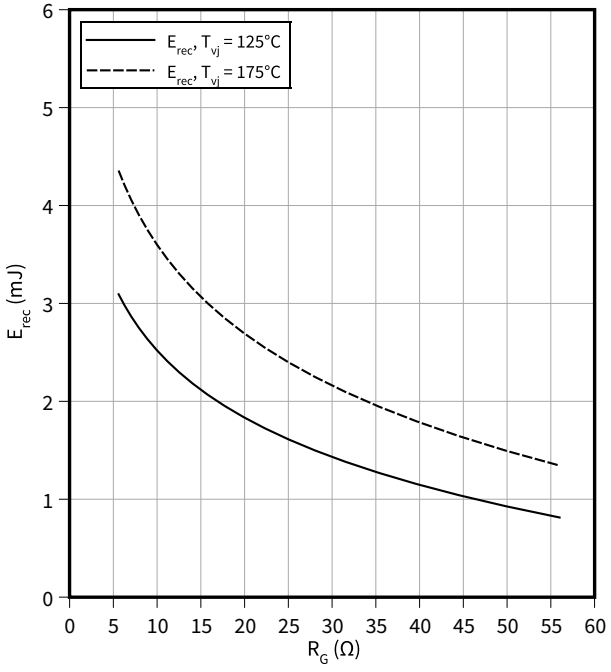
$R_{Gon} = 5.6\ \Omega$, $V_R = 600$ V



Switching losses (typical), Diode, Inverter

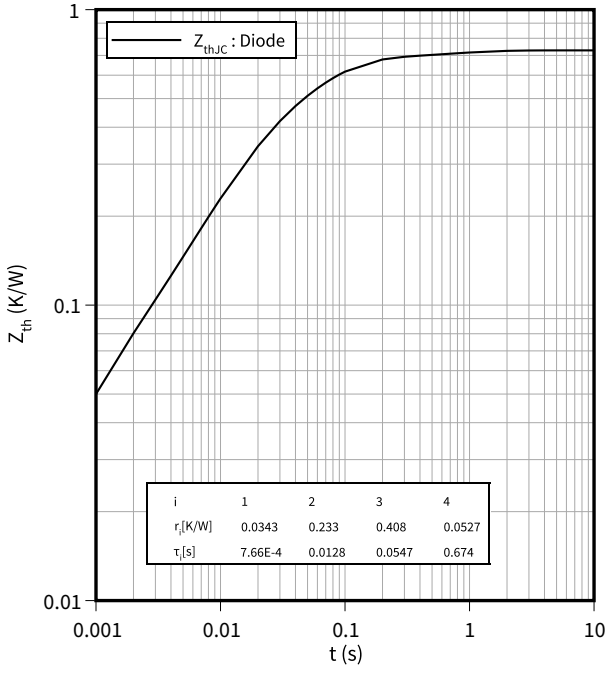
$E_{rec} = f(R_G)$

$I_F = 75$ A, $V_R = 600$ V



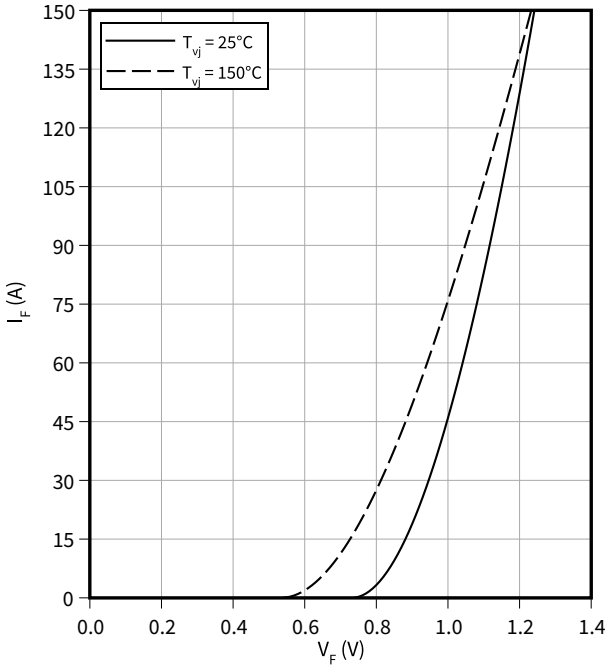
Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



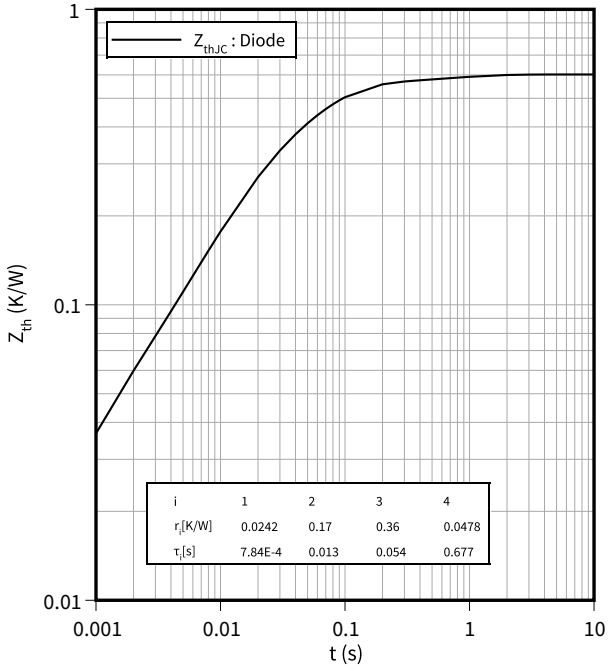
Forward characteristic (typical), Diode, Rectifier

$I_F = f(V_F)$



Transient thermal impedance, Diode, Rectifier

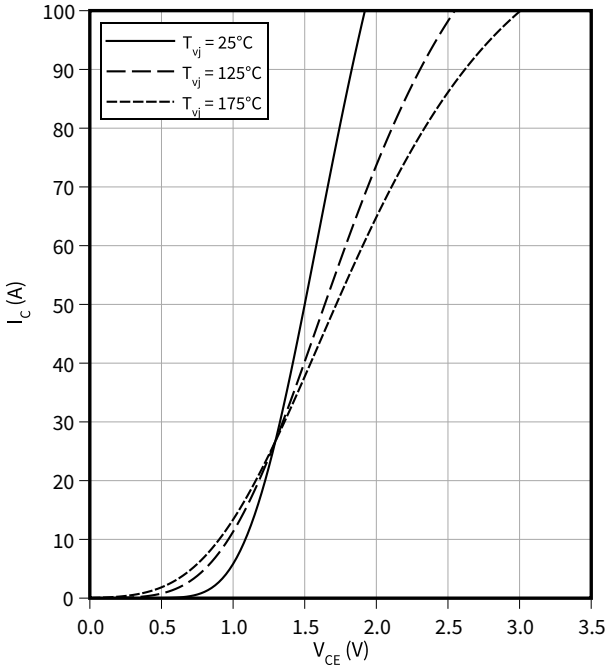
$Z_{th} = f(t)$



Output characteristic (typical), IGBT, Brake-Chopper

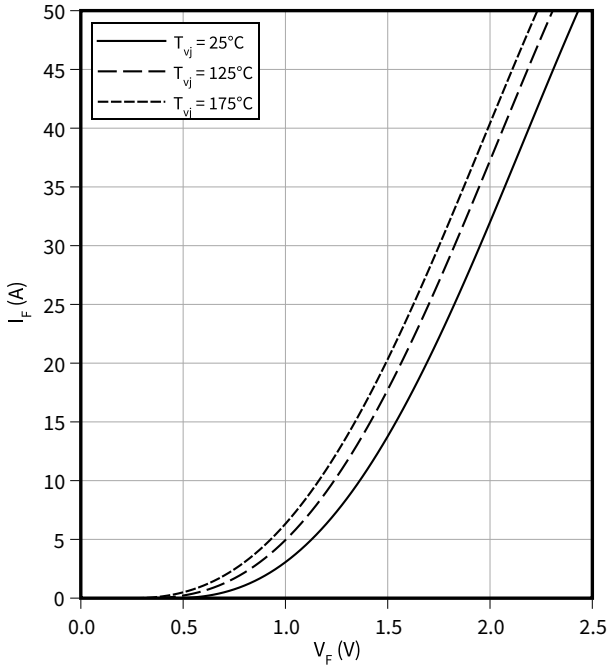
$I_C = f(V_{CE})$

$V_{GE} = 15\ V$



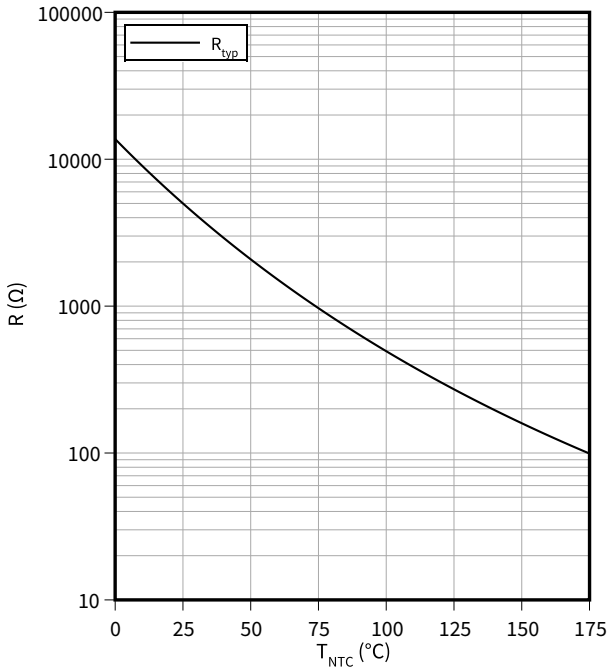
Forward characteristic (typical), Diode, Brake-Chopper

$I_F = f(V_F)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



9 Circuit diagram

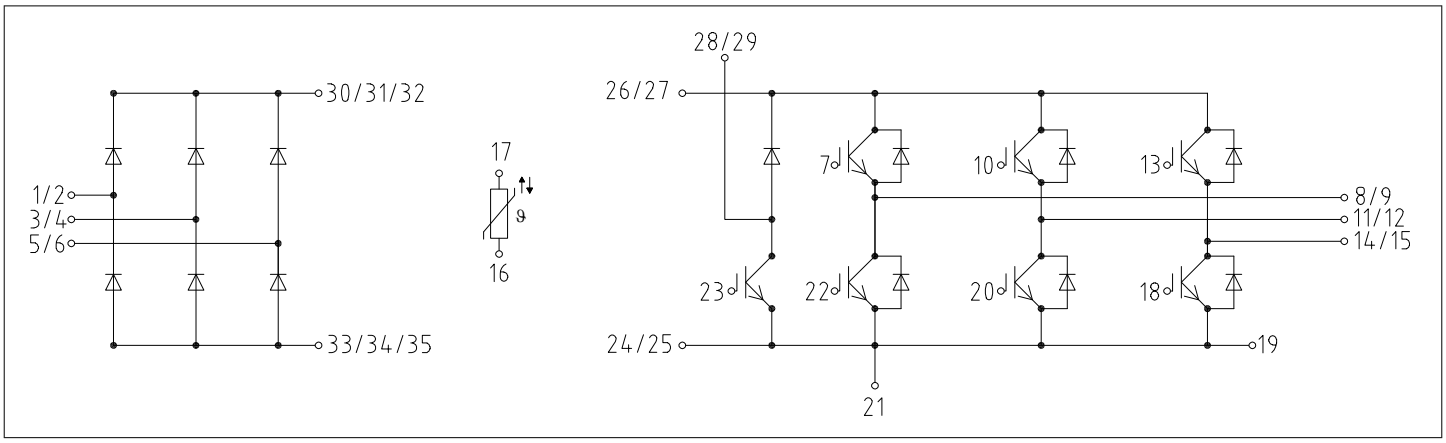


Figure 1

10 Package outlines

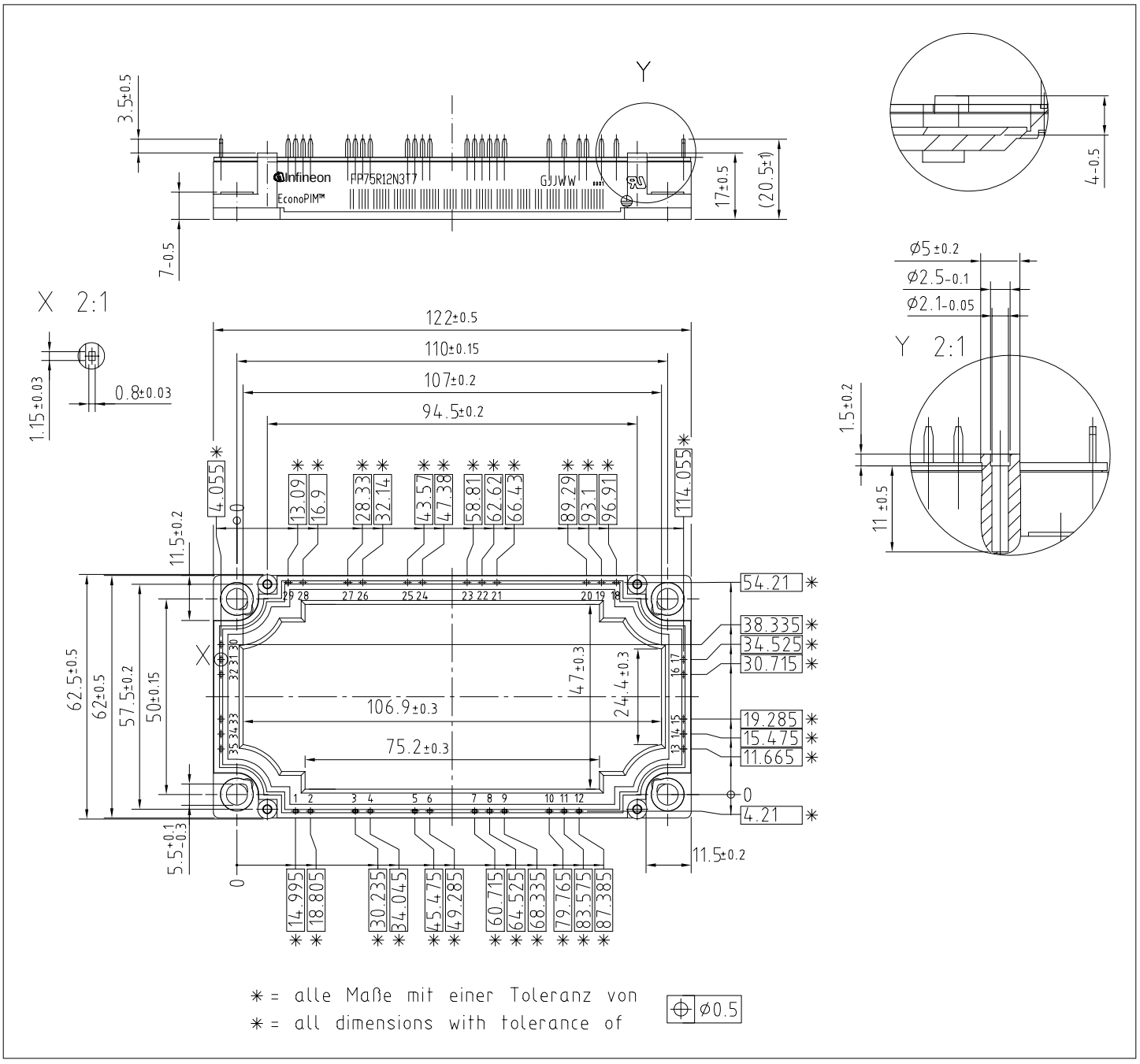


Figure 2

11 Module label code

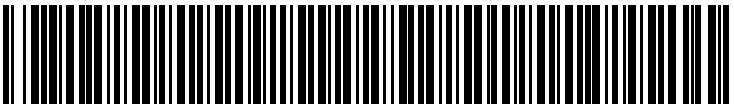
Module label code			
Code format	Data Matrix		Barcode Code128
Encoding	ASCII text		Code Set A
Symbol size	16x16		23 digits
Standard	IEC24720 and IEC16022		IEC8859-1
Code content	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production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

Figure 3

Revision history

Document revision	Date of release	Description of changes
0.10	2021-12-23	Initial version
0.20	2022-03-02	Preliminary datasheet

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2022-03-02

Published by

Infineon Technologies AG

81726 Munich, Germany

Do you have a question about any aspect of this document?

Email: erratum@infineon.com

Document reference
IFX-ABB809-002

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.