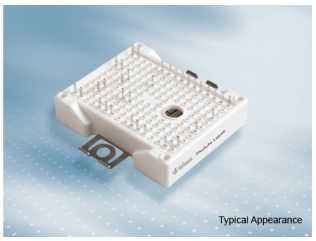
EasyPIM™ module with fast Trench/Fieldstop IGBT3 and emitter controlled 3 diode and PressFIT / NTC



Features

- Electrical features
  - V_{CES} = 650 V
  - $I_{C\ nom}$ = 50 A / I_{CRM} = 100 A
  - Trench IGBT 3
  - Low switching losses
- Mechanical features
  - Al_2O_3 substrate with low thermal resistance
  - Compact design
  - PressFIT contact technology
  - Rugged mounting due to integrated mounting clamps

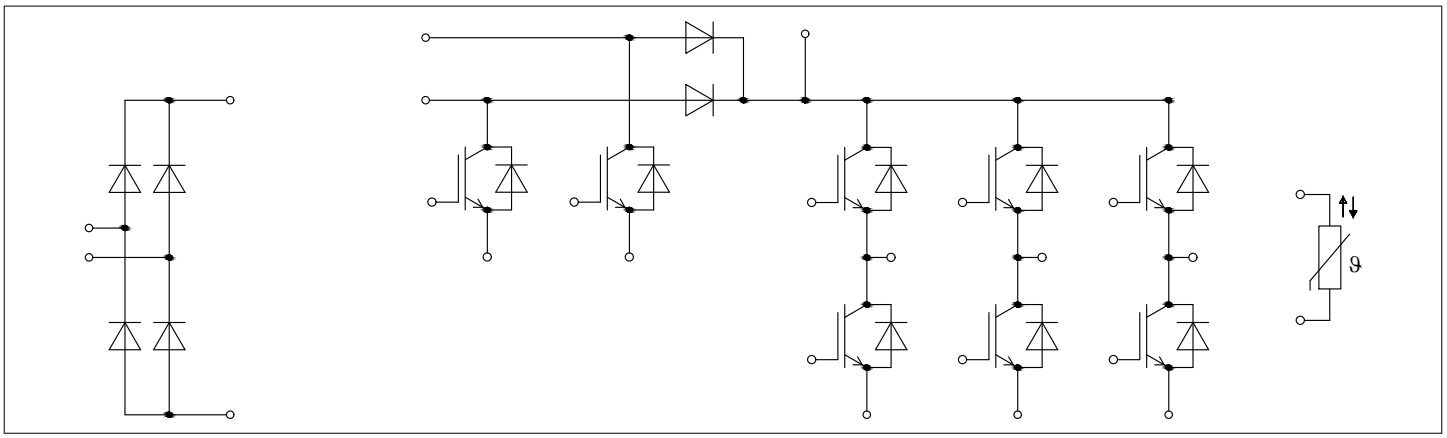
Potential applications

- 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

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
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	
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}			30		nH
Module lead resistance, terminals - chip	$R_{AA'+CC'}$	T_H=25°C, per switch		6		mΩ
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_H=25°C, per switch		5		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting force per clamp	*F*		40		80	N
Weight	*G*			39		g

Note: The current under continuous operation is limited to 25 A 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	650	V
Implemented collector current	I_{CN}			50	A
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_H = 65 °C	45	A
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\,op}$		100	A

(table continues...)

Table 3 (continued) Maximum rated values

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 = 50 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.45	1.90	V
			T_{vj} = 125 °C		1.60		
			T_{vj} = 150 °C		1.70		
Gate threshold voltage	V_{GEth}	I_C = 0.8 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.05	5.80	6.45	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CC} = 400 V			0.5		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0		Ω
Input capacitance	C_{ies}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			3.1		nF
Reverse transfer capacitance	C_{res}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			0.095		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.018	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 = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω	T_{vj} = 25 °C		0.029		µs
			T_{vj} = 125 °C		0.030		
			T_{vj} = 150 °C		0.031		
Rise time (inductive load)	t_r	I_C = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω	T_{vj} = 25 °C		0.059		µs
			T_{vj} = 125 °C		0.060		
			T_{vj} = 150 °C		0.061		
Turn-off delay time (inductive load)	t_{doff}	I_C = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω	T_{vj} = 25 °C		0.180		µs
			T_{vj} = 125 °C		0.210		
			T_{vj} = 150 °C		0.220		
Fall time (inductive load)	t_f	I_C = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω	T_{vj} = 25 °C		0.110		µs
			T_{vj} = 125 °C		0.140		
			T_{vj} = 150 °C		0.150		
Turn-on energy loss per pulse	E_{on}	I_C = 50 A, V_{CC} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω, di/dt = 550 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.37		mJ
			T_{vj} = 125 °C		1.78		
			T_{vj} = 150 °C		1.89		

(table continues...)

Table 4 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off energy loss per pulse	E_{off}	I_C = 50 A, V_{CC} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω, dv/dt = 4000 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.17		mJ
			T_{vj} = 125 °C		1.57		
			T_{vj} = 150 °C		1.66		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 360 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 6 µs, T_{vj}=150 °C		250		A
Thermal resistance, junction to heat sink	R_{thJH}	per IGBT			1.02		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

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	650	V
Continuous DC forward current	I_F			50	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		100	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	370	A^2s
			T_{vj} = 150 °C	330	

Table 6 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 50 A, V_{GE} = 0 V	T_{vj} = 25 °C		1.56	1.95	V
			T_{vj} = 125 °C		1.49		
			T_{vj} = 150 °C		1.45		
Peak reverse recovery current	I_{RM}	V_{CC} = 300 V, I_F = 50 A, V_{GE} = -15 V, -di$_F$/dt = 550 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		34		A
			T_{vj} = 125 °C		48		
			T_{vj} = 150 °C		53		
Recovered charge	Q_r	V_{CC} = 300 V, I_F = 50 A, V_{GE} = -15 V, -di$_F$/dt = 550 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		2.4		µC
			T_{vj} = 125 °C		4.4		
			T_{vj} = 150 °C		5.1		

(table continues...)

Table 6 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Reverse recovery energy	E_{rec}	V_{CC} = 300 V, I_F = 50 A, V_{GE} = -15 V, -di$_F$/dt = 550 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.62		mJ
			T_{vj} = 125 °C		1.11		
			T_{vj} = 150 °C		1.28		
Thermal resistance, junction to heat sink	R_{thJH}	per diode			1.45		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

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_H = 80 °C		50	A
Maximum RMS current at rectifier output	I_{RMSM}	T_H = 80 °C		50	A
Surge forward current	I_{FSM}	t_P = 10 ms	T_{vj} = 25 °C	665	A
			T_{vj} = 150 °C	526	
I^2t - value	I^2t	t_P = 10 ms	T_{vj} = 25 °C	2210	A^2s
			T_{vj} = 150 °C	1380	

Table 8 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 50 A	T_{vj} = 150 °C		0.93		V
Reverse current	I_r	T_{vj} = 150 °C, V_R = 1600 V			1.1		mA
Thermal resistance, junction to heat sink	R_{thJH}	per diode			1.03		K/W
Temperature under switching conditions	$T_{vj,\,op}$			-40		150	°C

5 IGBT, Boost

Table 9 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CES}		T_{vj} = 25 °C	650	V
Implemented collector current	I_{CN}			50	A
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_H = 65 °C	35	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		1.60	2.20	V
			T_{vj} = 125 °C		1.75		
			T_{vj} = 150 °C		1.79		
Gate threshold voltage	V_{GEth}	I_C = 0.5 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		3.85	4.60	5.35	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CC} = 400 V			0.217		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0		Ω
Input capacitance	C_{ies}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			2.75		nF
Reverse transfer capacitance	C_{res}	f = 1000 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			0.01		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.014	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 = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Gon} = 18 Ω	T_{vj} = 25 °C		0.054		µs
			T_{vj} = 125 °C		0.051		
			T_{vj} = 150 °C		0.050		
Rise time (inductive load)	t_r	I_C = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Gon} = 18 Ω	T_{vj} = 25 °C		0.064		µs
			T_{vj} = 125 °C		0.064		
			T_{vj} = 150 °C		0.065		
Turn-off delay time (inductive load)	t_{doff}	I_C = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Goff} = 18 Ω	T_{vj} = 25 °C		0.130		µs
			T_{vj} = 125 °C		0.140		
			T_{vj} = 150 °C		0.150		

(table continues...)

Table 10 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Fall time (inductive load)	t_f	I_C = 50 A, V_{CC} = 300 V, V_{GE} = ±15 V, R_{Goff} = 18 Ω	T_{vj} = 25 °C		0.016		µs
			T_{vj} = 125 °C		0.027		
			T_{vj} = 150 °C		0.029		
Turn-on energy loss per pulse	E_{on}	I_C = 50 A, V_{CC} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Gon} = 18 Ω, di/dt = 650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.52		mJ
			T_{vj} = 125 °C		1.79		
			T_{vj} = 150 °C		1.84		
Turn-off energy loss per pulse	E_{off}	I_C = 50 A, V_{CC} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Goff} = 18 Ω, dv/dt = 1100 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.41		mJ
			T_{vj} = 125 °C		0.54		
			T_{vj} = 150 °C		0.57		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 400 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 0 µs, T_{vj}=150 °C		250		A
Thermal resistance, junction to heat sink	R_{thJH}	per IGBT			1.42		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

6 Diode, Boost

Table 11 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}		T_{vj} = 25 °C	650	V
Implemented forward current	I_{FN}			50	A
Continuous DC forward current	I_F			50	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		100	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	225	A^2s
			T_{vj} = 150 °C	215	

Table 12 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 50 A, V_{GE} = 0 V	T_{vj} = 25 °C		1.65	2.15	V
			T_{vj} = 125 °C		1.55		
			T_{vj} = 150 °C		1.50		
Peak reverse recovery current	I_{RM}	V_{CC} = 300 V, I_F = 50 A, V_{GE} = 15 V, -di$_F$/dt = 650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		14.9		A
			T_{vj} = 125 °C		24.5		
			T_{vj} = 150 °C		26.5		
Recovered charge	Q_r	V_{CC} = 300 V, I_F = 50 A, V_{GE} = 15 V, -di$_F$/dt = 650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.1		µC
			T_{vj} = 125 °C		2.2		
			T_{vj} = 150 °C		2.6		
Reverse recovery energy	E_{rec}	V_{CC} = 300 V, I_F = 50 A, V_{GE} = 15 V, -di$_F$/dt = 650 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.18		mJ
			T_{vj} = 125 °C		0.38		
			T_{vj} = 150 °C		0.46		
Thermal resistance, junction to heat sink	R_{thJH}	per diode			1.61		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

7 Diode, Reverse

Table 13 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}		T_{vj} = 25 °C	650	V
Continuous DC forward current	I_F			10	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		20	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	12.5	A^2s
			T_{vj} = 150 °C	9.5	

Table 14 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 10 A, V_{GE} = 0 V	T_{vj} = 25 °C		1.60	2.00	V
			T_{vj} = 125 °C		1.55		
			T_{vj} = 150 °C		1.52		
Thermal resistance, junction to heat sink	R_{thJH}	per diode			2.72		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

8 NTC-Thermistor

Table 15 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

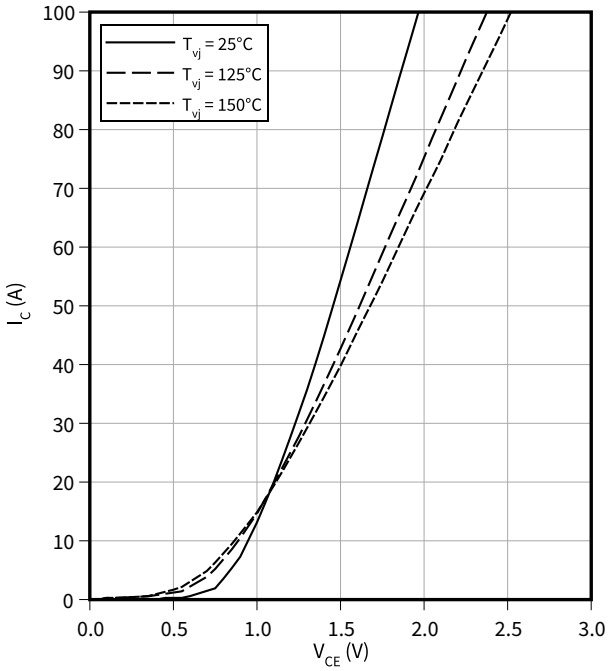
Note: Specification according to the valid application note.

9 Characteristics diagrams

Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

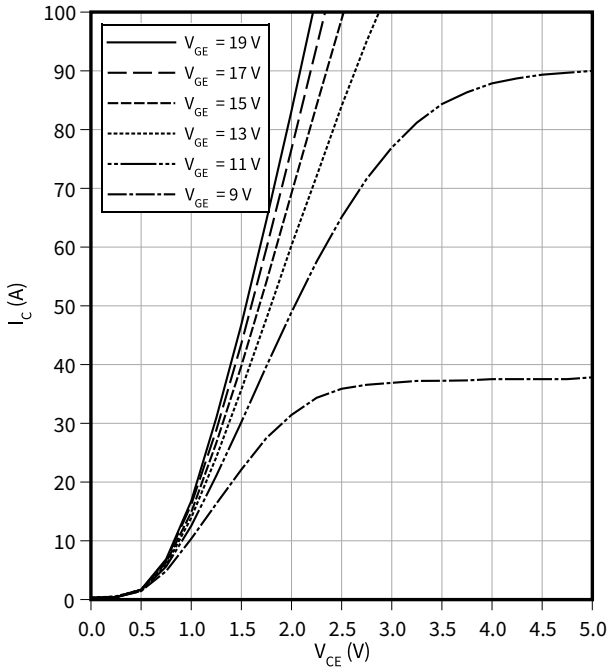
V_{GE} = 15 V



Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$

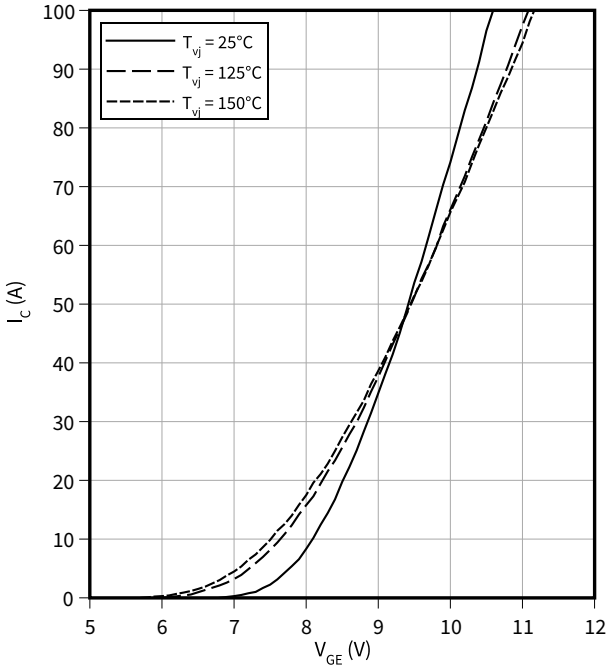
T_{vj} = 150 °C



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

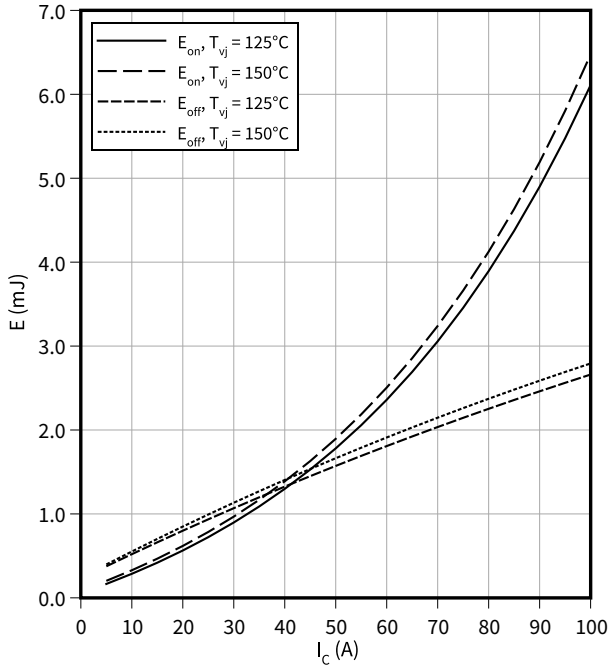
V_{CE} = 20 V



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

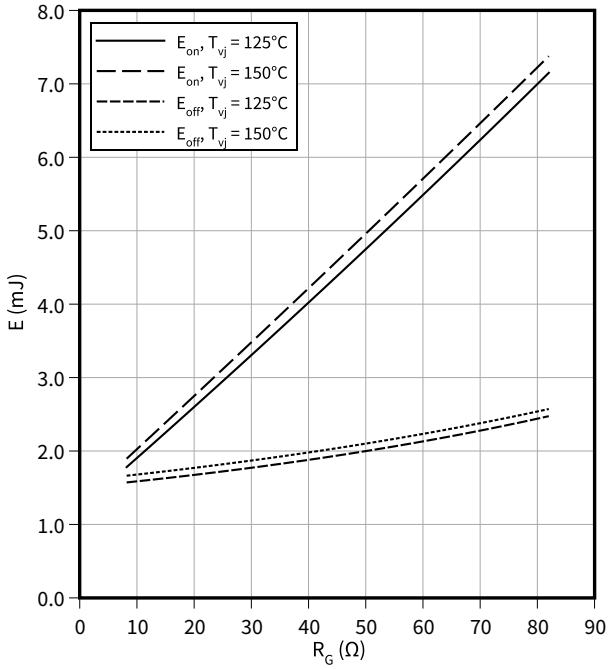
R_{Goff} = 8.2 Ω, R_{Gon} = 8.2 Ω, V_{CC} = 300 V, V_{GE} = ± 15 V



Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

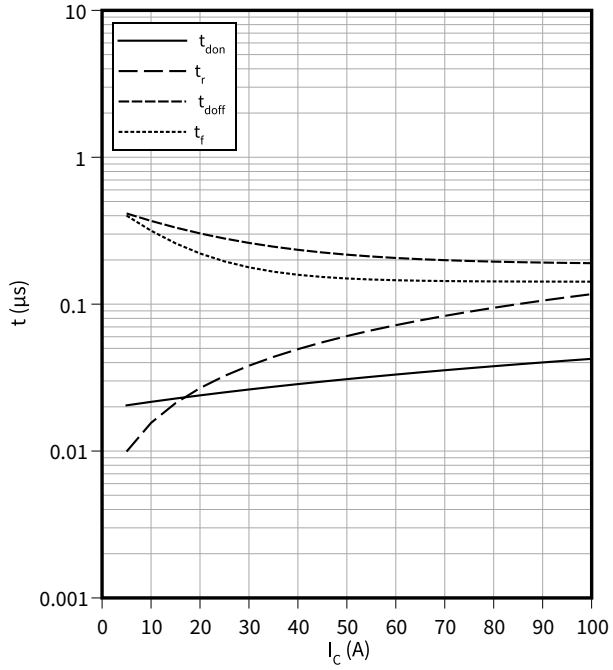
$V_{GE} = \pm 15$ V, $I_C = 50$ A, $V_{CC} = 300$ V



Switching times (typical), IGBT, Inverter

$t = f(I_C)$

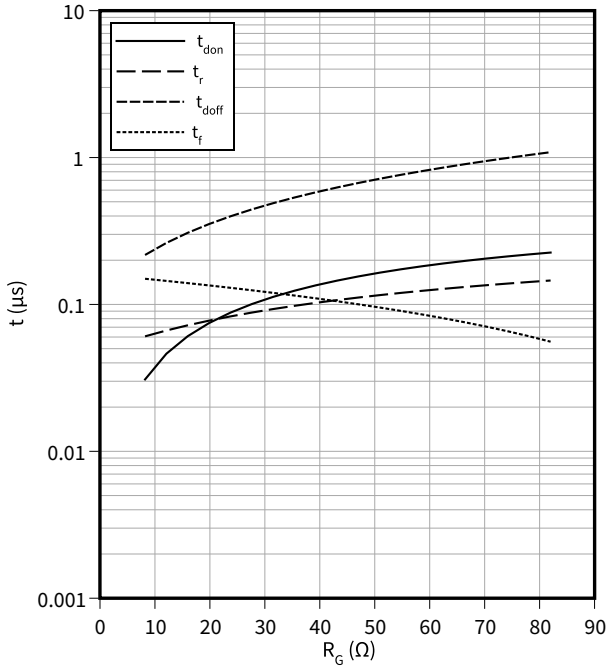
$R_{Goff} = 8.2\ \Omega$, $R_{Gon} = 8.2\ \Omega$, $V_{CC} = 300$ V, $V_{GE} = \pm 15$ V, $T_{vj} = 150$ °C



Switching times (typical), IGBT, Inverter

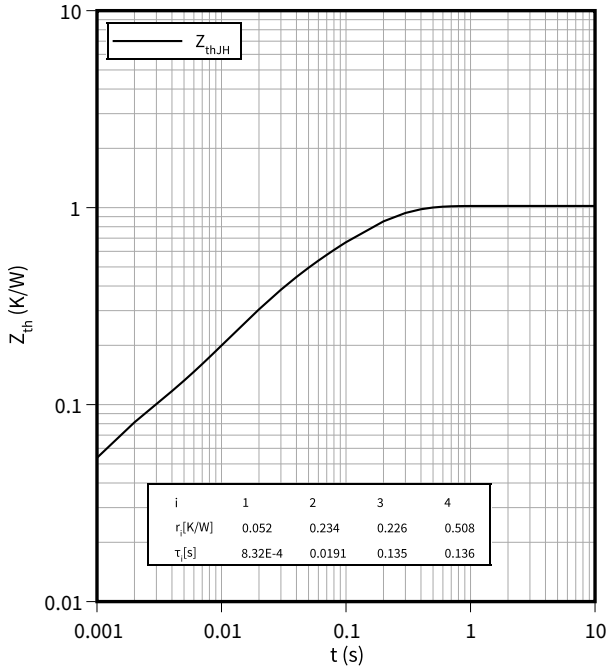
$t = f(R_G)$

$I_C = 50$ A, $V_{CC} = 300$ V, $V_{GE} = \pm 15$ V, $T_{vj} = 150$ °C



Transient thermal impedance , IGBT, Inverter

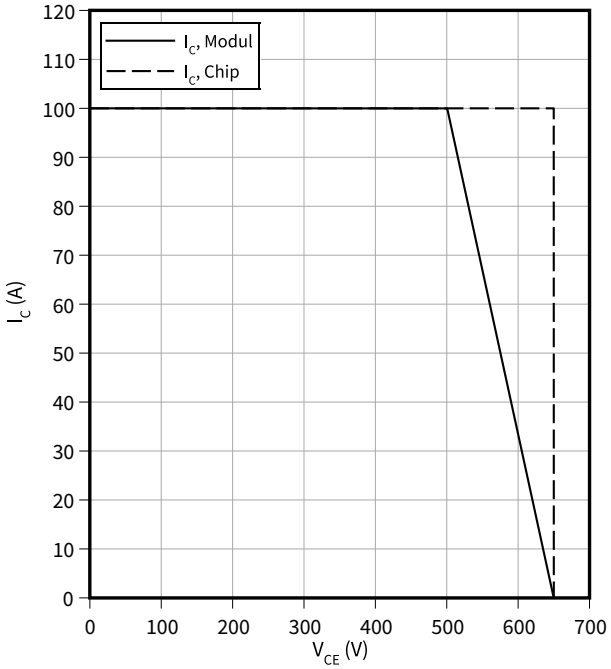
$Z_{th} = f(t)$



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

$I_C = f(V_{CE})$

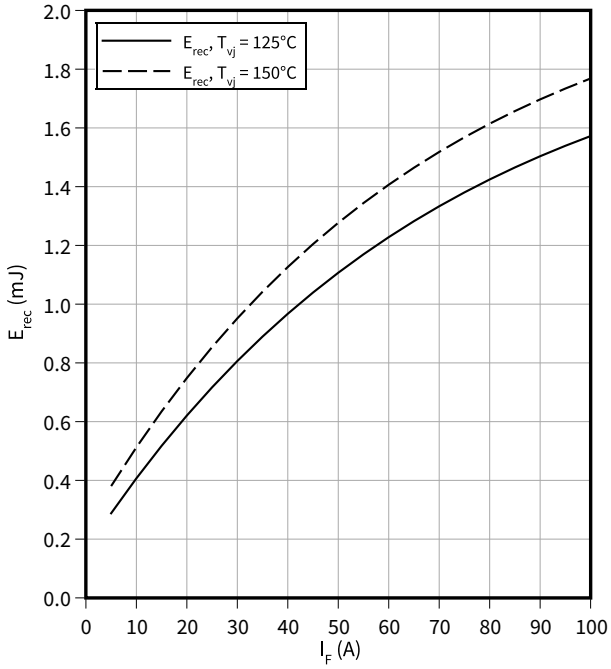
R_{Goff} = 8.2 Ω, V_{GE} = ±15 V, T_{vj} = 150 °C



Switching losses (typical), Diode, Inverter

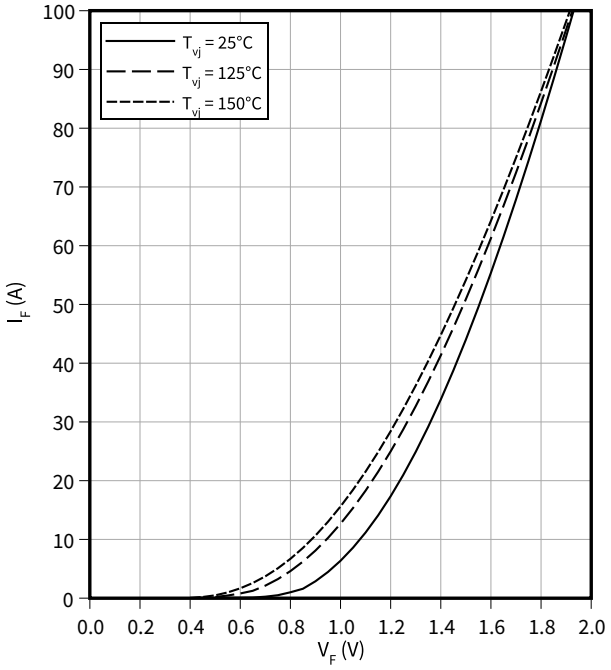
$E_{rec} = f(I_F)$

$R_{Gon} = R_{Gon}(IGBT)$, V_{CC} = 300 V



Forward characteristic (typical), Diode, Inverter

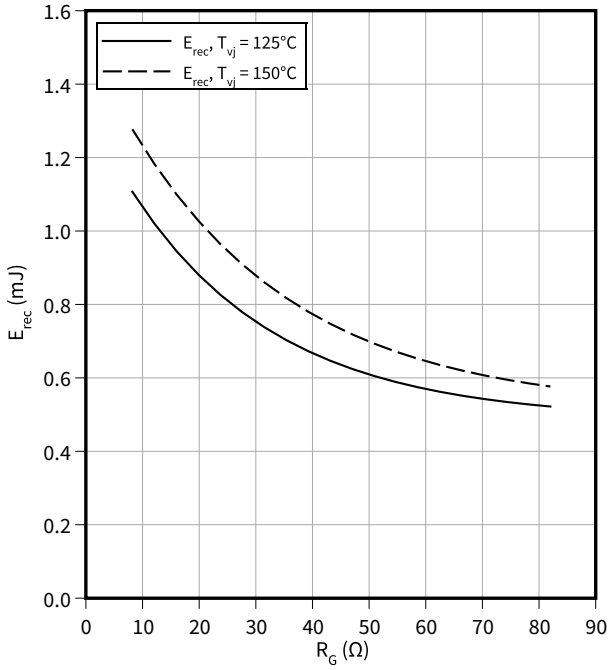
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

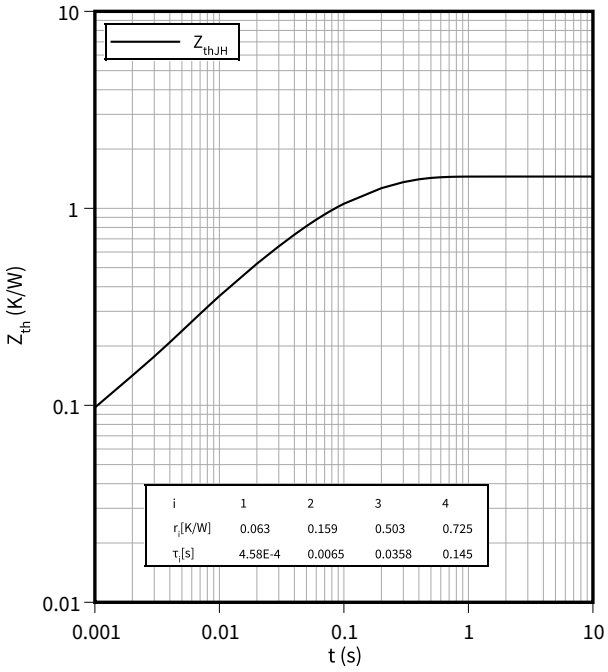
$E_{rec} = f(R_G)$

I_F = 50 A, V_{CC} = 300 V



Transient thermal impedance, Diode, Inverter

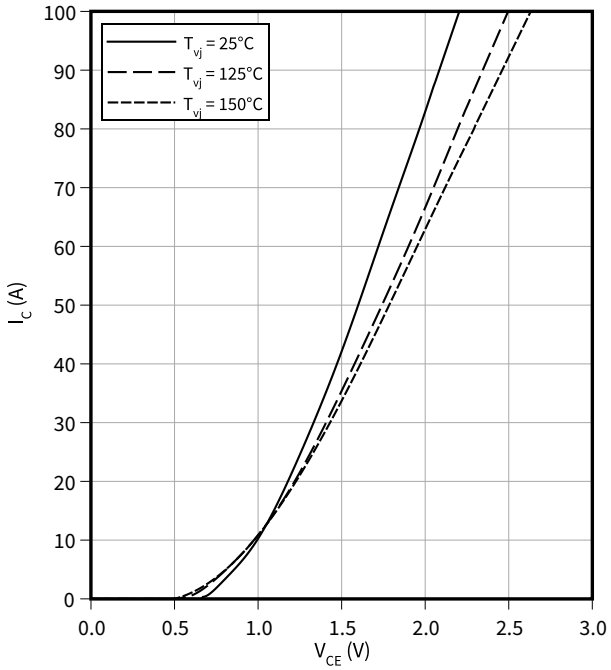
$Z_{th} = f(t)$



Output characteristic (typical), IGBT, Boost

$I_C = f(V_{CE})$

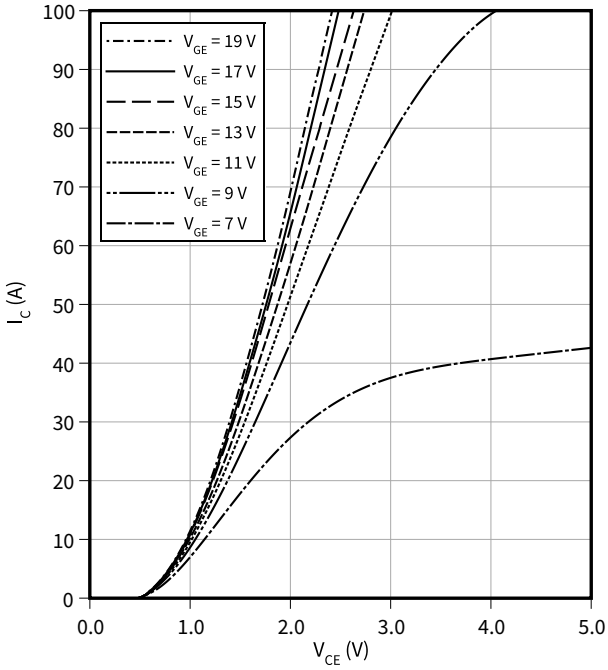
$V_{GE} = 15$ V



Output characteristic field (typical), IGBT, Boost

$I_C = f(V_{CE})$

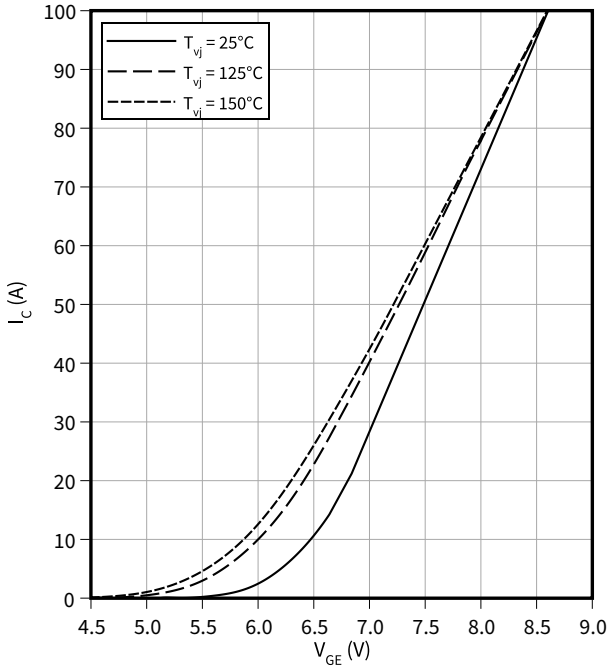
$T_{vj} = 150$ °C



Transfer characteristic (typical), IGBT, Boost

$I_C = f(V_{GE})$

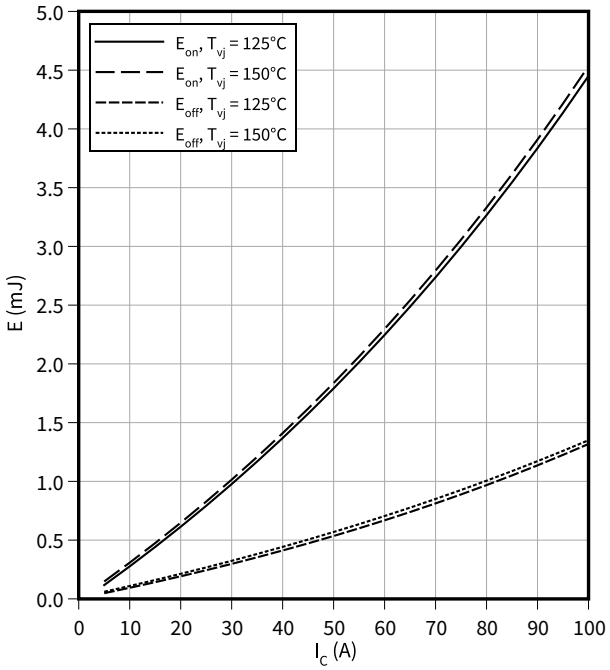
$V_{CE} = 20$ V



Switching losses (typical), IGBT, Boost

$E = f(I_C)$

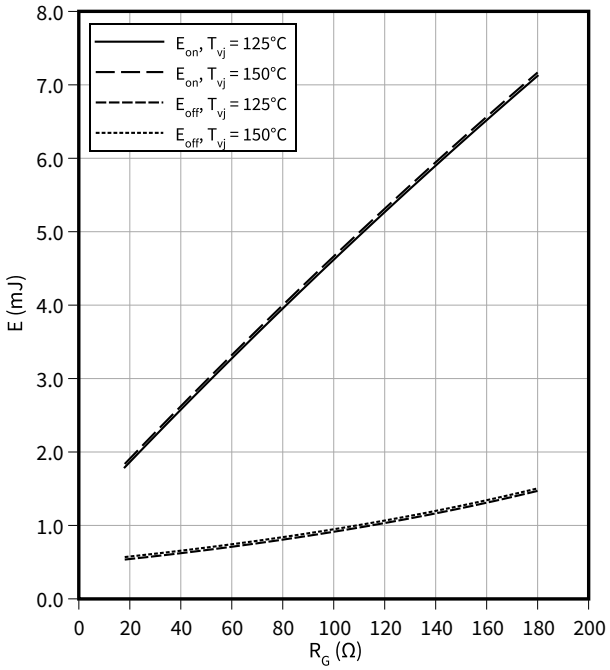
$R_{Goff} = 18\ \Omega$, $R_{Gon} = 18\ \Omega$, $V_{CC} = 300$ V, $V_{GE} = \pm 15$ V



Switching losses (typical), IGBT, Boost

$E = f(R_G)$

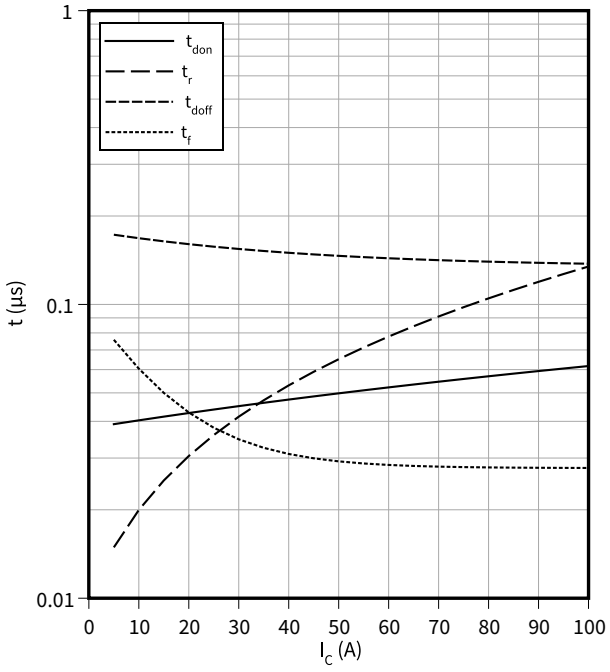
$V_{GE} = \pm 15$ V, $V_{CC} = 300$ V, $I_C = 50$ A



Switching times (typical), IGBT, Boost

$t = f(I_C)$

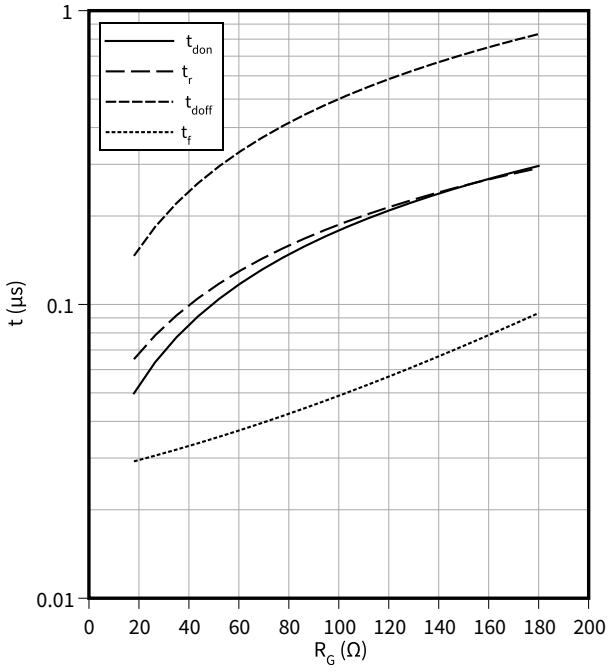
$R_{Goff} = 18\ \Omega$, $R_{Gon} = 18\ \Omega$, $V_{CC} = 300$ V, $V_{GE} = \pm 15$ V, $T_{vj} = 150$ °C



Switching times (typical), IGBT, Boost

$t = f(R_G)$

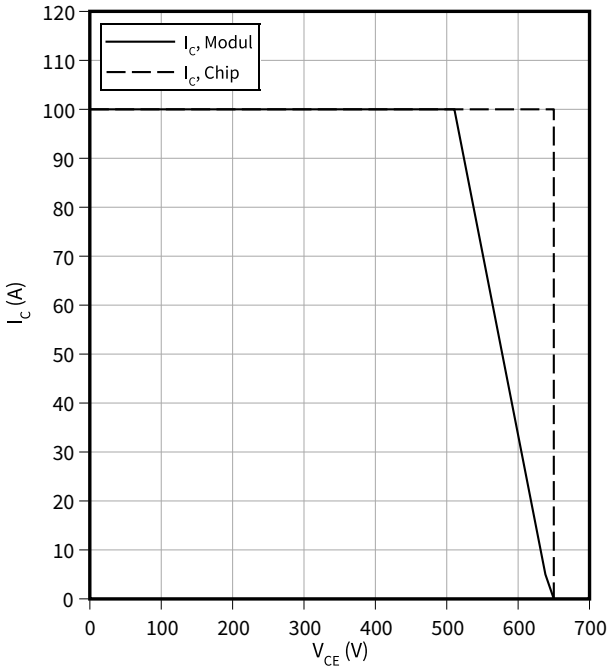
$I_C = 50$ A, $V_{CC} = 300$ V, $V_{GE} = \pm 15$ V, $T_{vj} = 150$ °C



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

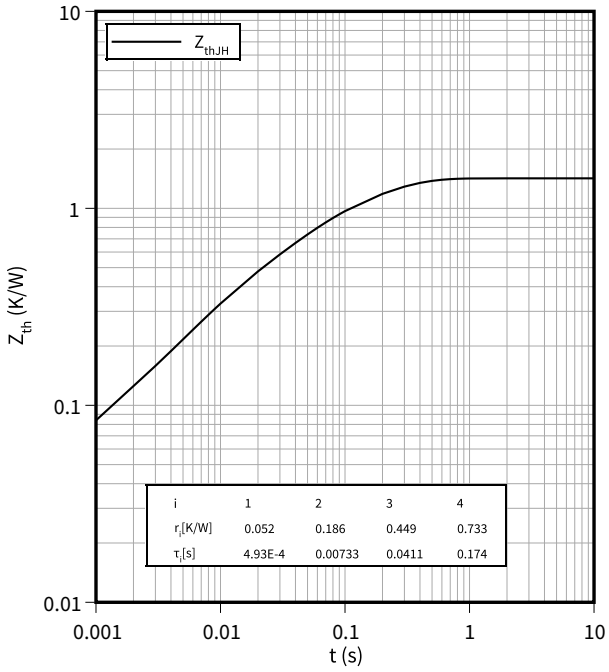
$I_C = f(V_{CE})$

$T_{vj} = 150\ °C$, $R_{Goff} = 18\ \Omega$, $V_{GE} = \pm 15\ V$



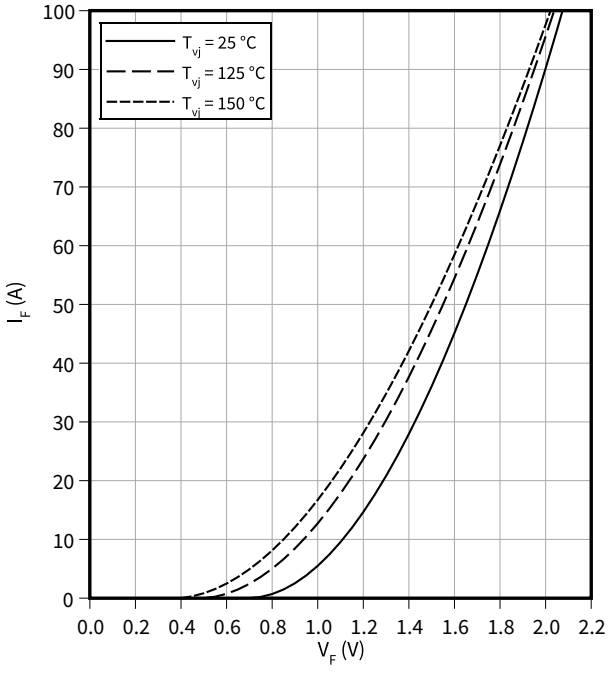
Transient thermal impedance , IGBT, Boost

$Z_{th} = f(t)$



Forward characteristic (typical), Diode, Boost

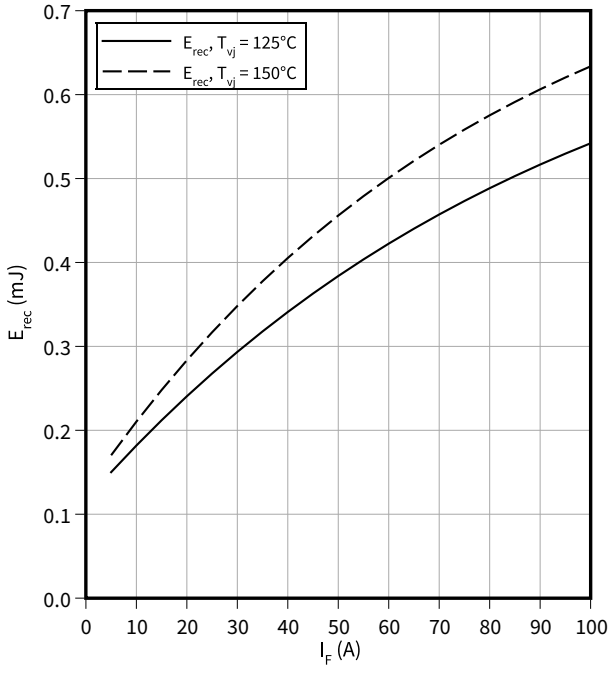
$I_F = f(V_F)$



Switching losses (typical), Diode, Boost

$E_{rec} = f(I_F)$

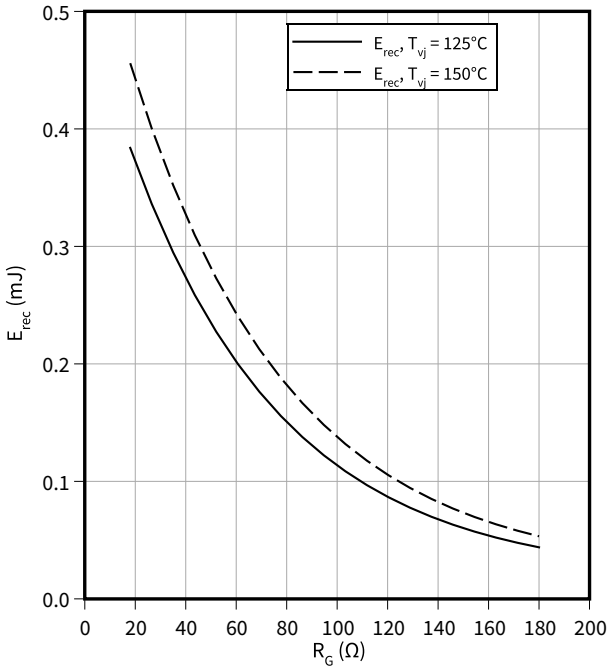
$R_{Gon} = R_{Gon}(IGBT)$, $V_{CC} = 300\ V$



Switching losses (typical), Diode, Boost

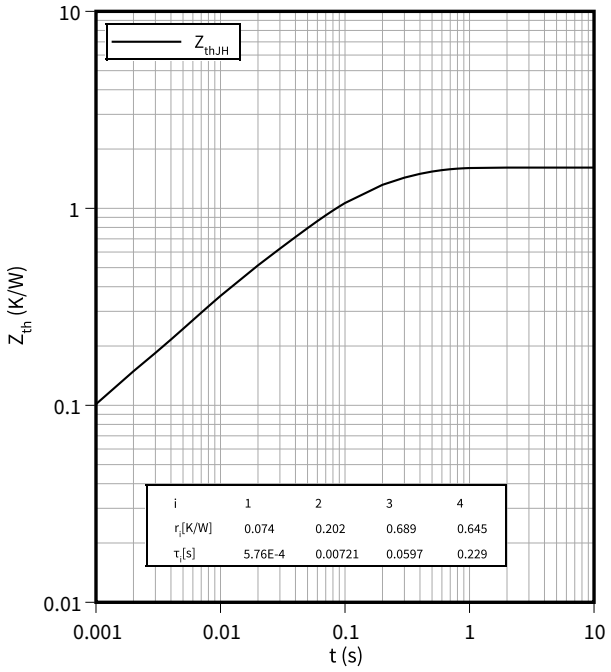
$E_{rec} = f(R_G)$

$I_F = 50\ A, V_{CC} = 300\ V$



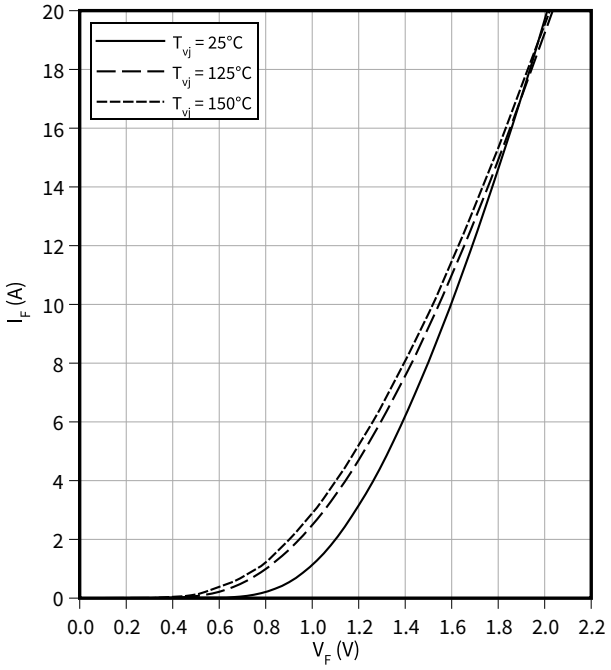
Transient thermal impedance, Diode, Boost

$Z_{th} = f(t)$



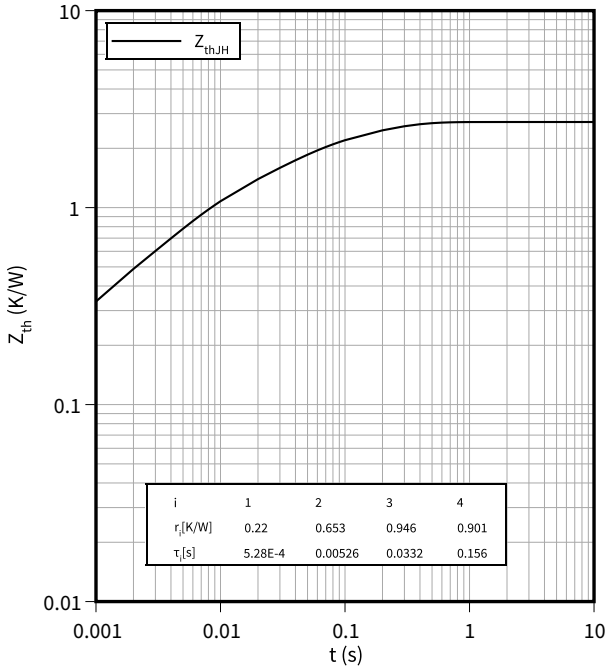
Forward characteristic (typical), Diode, Reverse

$I_F = f(V_F)$



Transient thermal impedance, Diode, Reverse

$Z_{th} = f(t)$



10 Circuit diagram

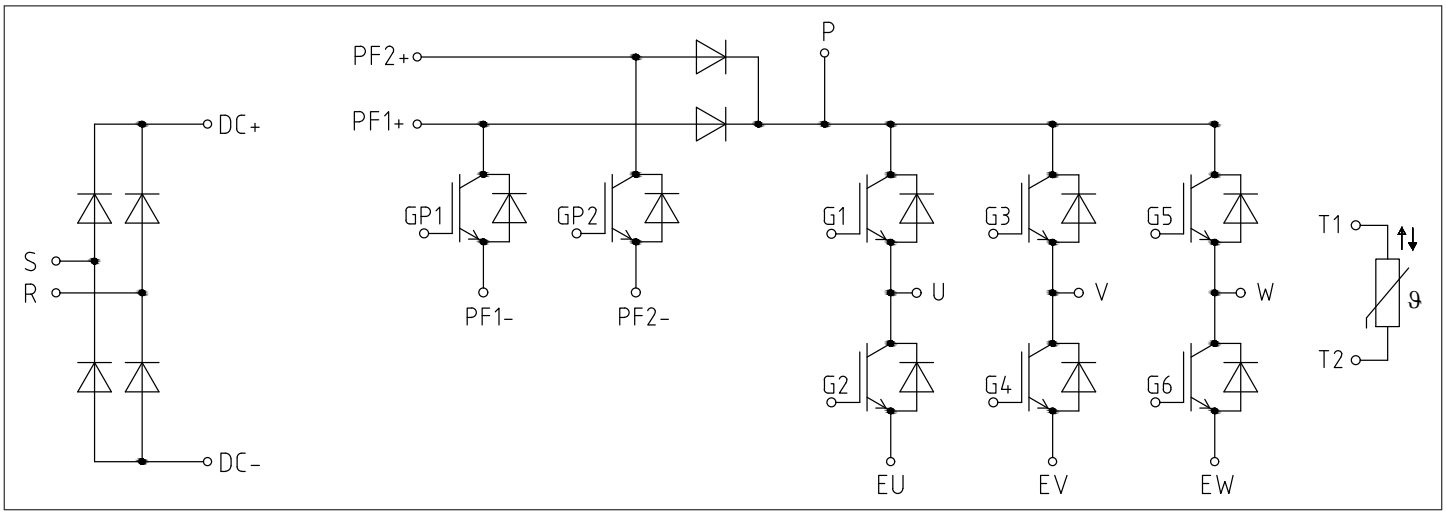


Figure 1

11 Package outlines

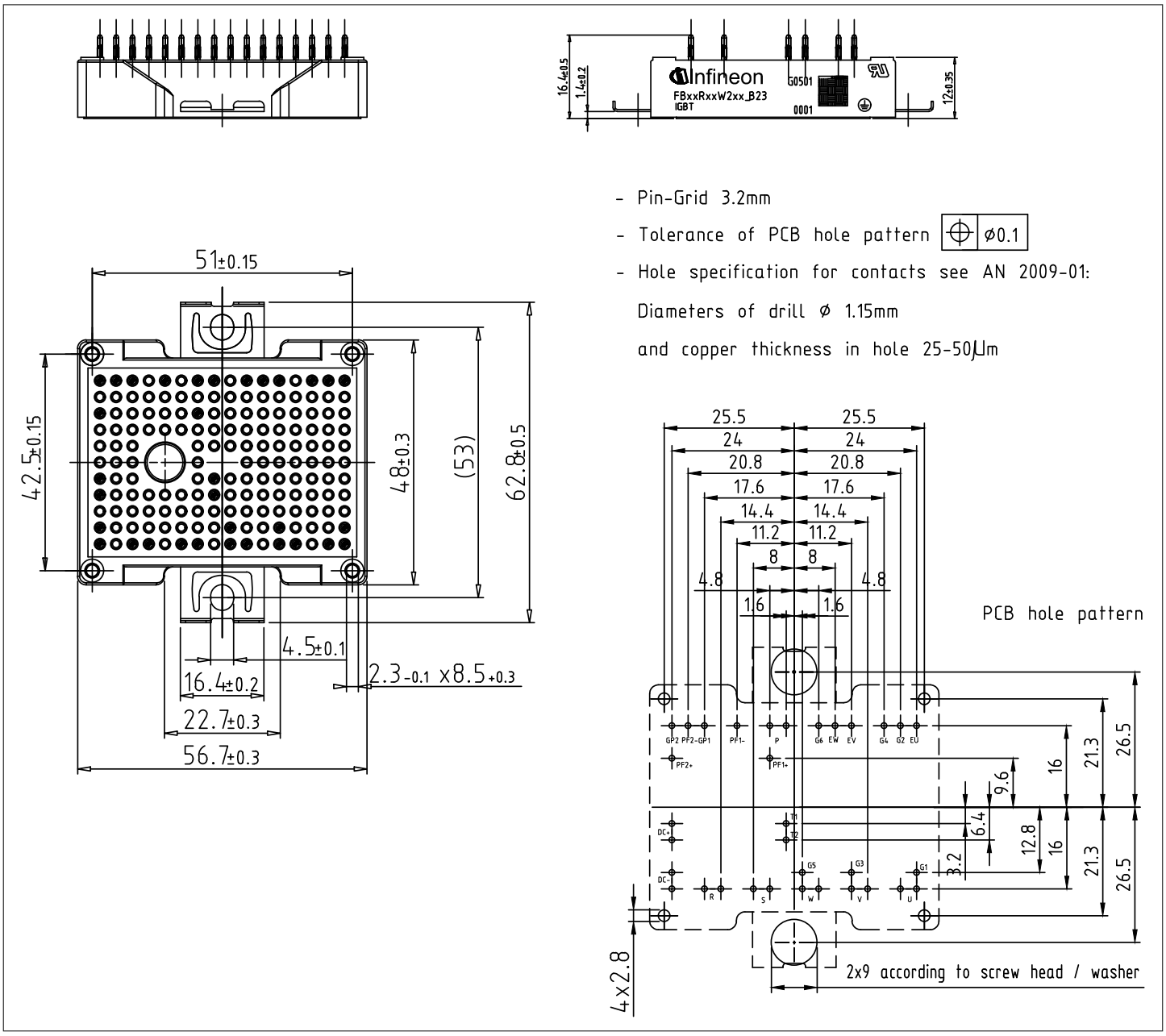


Figure 2

12 Module label code

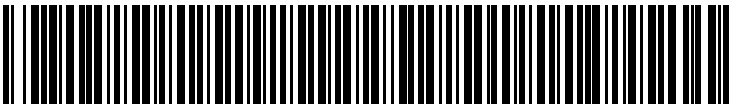
Module label code			
Code format	Data Matrix		Barcode Code128
Encoding	ASCII text		Code Set A
Symbol size	16x16		23 digits
Standard	IEC24720 and IEC16022		IEC8859-1
Code content	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production week)	*Digit* 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	*Example* 71549 142846 55054991 15 30
Example	 7154914284655054991530		 7154914284655054991530

Figure 3

Revision history

Document revision	Date of release	Description of changes
V1.0	2019-06-24	Target datasheet
V1.1	2020-03-20	Target datasheet
n/a	2020-09-01	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.00	2021-03-25	
1.01	2022-09-16	Correction according ERRATA 10282ERRA

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Edition 2022-09-16

Published by

Infineon Technologies AG

81726 Munich, Germany

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IFX-AAY200-004

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