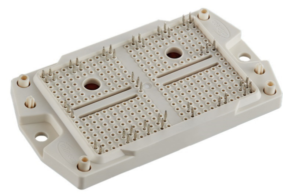
EasyPACK™ module with TRENCHSTOP™ 5 and Emitter Controlled 3 diode and PressFIT / NTC



Features

- Electrical features
  - V_{CES} = 650 V
  - $I_{C\ nom}$ = 100 A / I_{CRM} = 200 A
  - Low switching losses
- Mechanical features
  - Al_2O_3 substrate with low thermal resistance
  - Integrated NTC temperature sensor
  - PressFIT contact technology

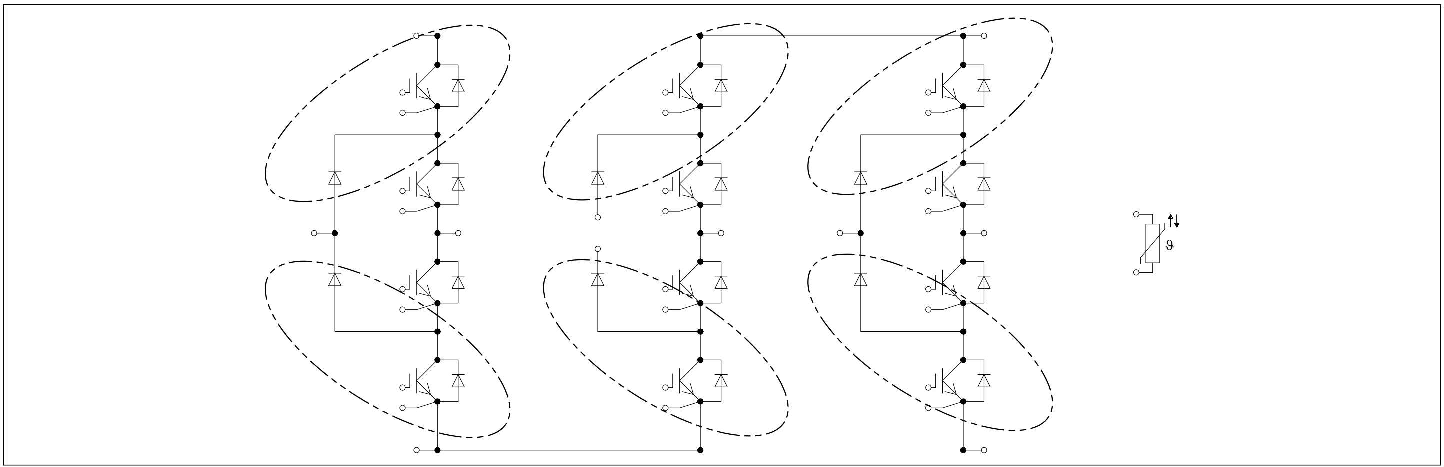
Potential applications

- Solar applications
- 3-level-applications

Product validation

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

Description



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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, f = 50 Hz, t = 1 min	3.0	kV
Internal Isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	d_{Creep}	terminal to heatsink	9.6	mm
Creepage distance	d_{Creep}	terminal to terminal	6.8	mm
Clearance	d_{Clear}	terminal to heatsink	9.4	mm
Clearance	d_{Clear}	terminal to terminal	5.5	mm
Comparative tracking index	*CTI*		> 400	
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}				28		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_H=25°C, per switch			1.6		mΩ
Storage temperature	T_{stg}			-40		125	°C
Mounting torque for modul mounting	*M*	- Mounting according to valid application note	M5, Screw	1.3		1.5	Nm
Weight	*G*				78		g

Note: The current under continuous operation is limited to 25 A rms per connector pin.

2 IGBT,3-Level

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}			100	A
Continous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_H = 65 °C	70	A
Repetitive peak collector current	I_{CRM}	t_P = 1 ms		200	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 = 50 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.17	1.38	V
			T_{vj} = 125 °C		1.20		
			T_{vj} = 150 °C		1.21		
Gate threshold voltage	V_{GEth}	I_C = 1 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		3.25	4	4.75	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 400 V			0.42		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			7.1		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			0.025		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.007	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_{CE} = 300 V, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω	T_{vj} = 25 °C		0.026		µs
			T_{vj} = 125 °C		0.028		
			T_{vj} = 150 °C		0.028		
Rise time (inductive load)	t_r	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω	T_{vj} = 25 °C		0.011		µs
			T_{vj} = 125 °C		0.012		
			T_{vj} = 150 °C		0.012		
Turn-off delay time (inductive load)	t_{doff}	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω	T_{vj} = 25 °C		0.140		µs
			T_{vj} = 125 °C		0.170		
			T_{vj} = 150 °C		0.180		
Fall time (inductive load)	t_f	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω	T_{vj} = 25 °C		0.020		µs
			T_{vj} = 125 °C		0.050		
			T_{vj} = 150 °C		0.050		
Turn-on energy loss per pulse	E_{on}	I_C = 50 A, V_{CE} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω, di/dt = 2900 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.45		mJ
			T_{vj} = 125 °C		0.66		
			T_{vj} = 150 °C		0.72		
Turn-off energy loss per pulse	E_{off}	I_C = 50 A, V_{CE} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω, dv/dt = 4500 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.65		mJ
			T_{vj} = 125 °C		0.92		
			T_{vj} = 150 °C		1.02		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 360 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 0 µs, T_{vj} = 150 °C		800		A
Thermal resistance, junction to heatsink	R_{thJH}	per IGBT			0.886		K/W

Table 4 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Temperature under switching conditions	$T_{vj\,op}$		-40		150	°C

3 IGBT, Inverter

Table 5 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}			75	A
Continous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_H = 65 °C	75	A
Repetitive peak collector current	I_{CRM}	t_P = 1 ms		150	A
Gate-emitter peak voltage	V_{GES}			±20	V

Table 6 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		0.99	1.43	V
			T_{vj} = 125 °C		0.94		
			T_{vj} = 150 °C		0.91		
Gate threshold voltage	V_{GEth}	I_C = 1 mA, V_{CE} = 20 V, T_{vj} = 25 °C		4.25	5	5.75	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 400 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			11.8		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			0.042		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.007	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_{CE} = 300 V, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω	T_{vj} = 25 °C		0.053		µs
			T_{vj} = 125 °C		0.049		
			T_{vj} = 150 °C		0.048		

Table 6 **Characteristic values (continued)**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Rise time (inductive load)	t_r	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω	T_{vj} = 25 °C		0.017		µs
			T_{vj} = 125 °C		0.018		
			T_{vj} = 150 °C		0.019		
Turn-off delay time (inductive load)	t_{doff}	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω	T_{vj} = 25 °C		0.330		µs
			T_{vj} = 125 °C		0.370		
			T_{vj} = 150 °C		0.380		
Fall time (inductive load)	t_f	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω	T_{vj} = 25 °C		0.130		µs
			T_{vj} = 125 °C		0.210		
			T_{vj} = 150 °C		0.240		
Turn-on energy loss per pulse	E_{on}	I_C = 50 A, V_{CE} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Gon} = 8.2 Ω, di/dt = 2400 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.29		mJ
			T_{vj} = 125 °C		0.34		
			T_{vj} = 150 °C		0.36		
Turn-off energy loss per pulse	E_{off}	I_C = 50 A, V_{CE} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Goff} = 8.2 Ω, dv/dt = 1600 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		2.48		mJ
			T_{vj} = 125 °C		3.45		
			T_{vj} = 150 °C		3.69		
SC data	I_{SC}	V_{GE} ≤ 15 V, V_{CC} = 360 V, V_{CEmax}=V_{CES}-L_{sCE}*di/dt	t_P ≤ 0 µs, T_{vj} ≤ 150 °C		900		A
Thermal resistance, junction to heatsink	R_{thJH}	per IGBT			0.902		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

4 Diode, 3-Level

Table 7 **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}			75	A
Continous DC forward current	I_F			40	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		150	A

Table 7 **Maximum rated values (continued)**

Parameter	Symbol	Note or test condition		Values	Unit
I^2t - value	I^2t	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	370	A^2s
			T_{vj} = 150 °C	360	

Table 8 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 40 A, V_{GE} = 0 V	T_{vj} = 25 °C		1.30	1.64	V
			T_{vj} = 125 °C		1.20		
			T_{vj} = 150 °C		1.15		
Peak reverse recovery current	I_{RM}	I_F = 40 A, V_R = 300 V, V_{GE} = -15 V, -di_F/dt = 2900 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		47		A
			T_{vj} = 125 °C		60		
			T_{vj} = 150 °C		66		
Recovered charge	Q_r	I_F = 40 A, V_R = 300 V, V_{GE} = -15 V, -di_F/dt = 2900 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		2.13		µC
			T_{vj} = 125 °C		4.18		
			T_{vj} = 150 °C		4.9		
Reverse recovery energy	E_{rec}	I_F = 40 A, V_R = 300 V, V_{GE} = -15 V, -di_F/dt = 2900 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.55		mJ
			T_{vj} = 125 °C		1.04		
			T_{vj} = 150 °C		1.23		
Thermal resistance, junction to heatsink	R_{thJH}	per diode			1.21		K/W
Temperature under switching conditions	$T_{vj\ op}$			-40		150	°C

5 Diode, Inverter

Table 9 **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}			75	A
Continous DC forward current	I_F			40	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		150	A

Table 9 **Maximum rated values (continued)**

Parameter	Symbol	Note or test condition		Values	Unit
I^2t - value	I^2t	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	370	A^2s
			T_{vj} = 150 °C	360	

Table 10 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 40 A, V_{GE} = 0 V	T_{vj} = 25 °C		1.30	1.64	V
			T_{vj} = 125 °C		1.20		
			T_{vj} = 150 °C		1.15		
Peak reverse recovery current	I_{RM}	I_F = 40 A, V_R = 300 V, V_{GE} = -15 V, -di_F/dt = 2400 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		42		A
			T_{vj} = 125 °C		55		
			T_{vj} = 150 °C		59		
Recovered charge	Q_r	I_F = 40 A, V_R = 300 V, V_{GE} = -15 V, -di_F/dt = 2400 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.73		µC
			T_{vj} = 125 °C		4.11		
			T_{vj} = 150 °C		4.47		
Reverse recovery energy	E_{rec}	I_F = 40 A, V_R = 300 V, V_{GE} = -15 V, -di_F/dt = 2400 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.21		mJ
			T_{vj} = 125 °C		1.03		
			T_{vj} = 150 °C		1.18		
Thermal resistance, junction to heatsink	R_{thJH}	per diode			1.04		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

6 NTC-Thermistor

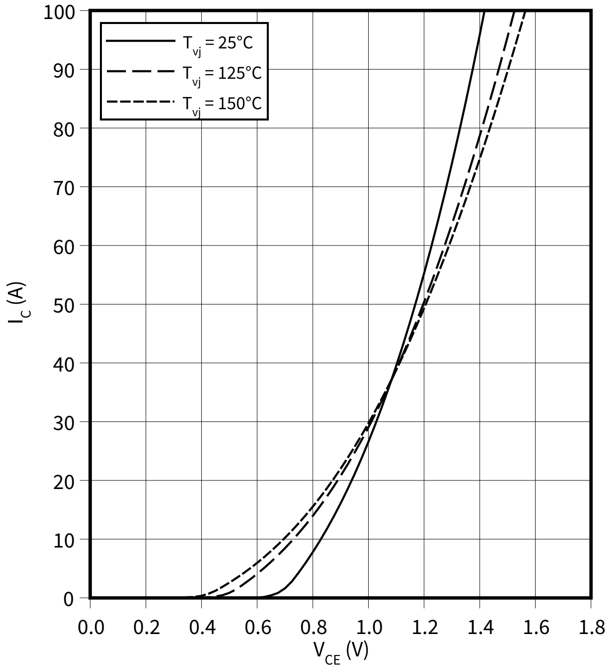
Table 11 **Characteristic values**

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

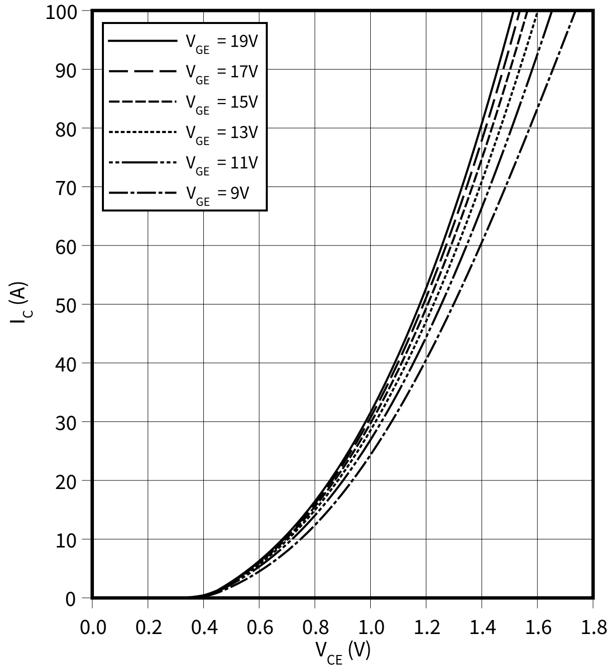
Note: Specification according to the valid application note.

7 Characteristics diagrams

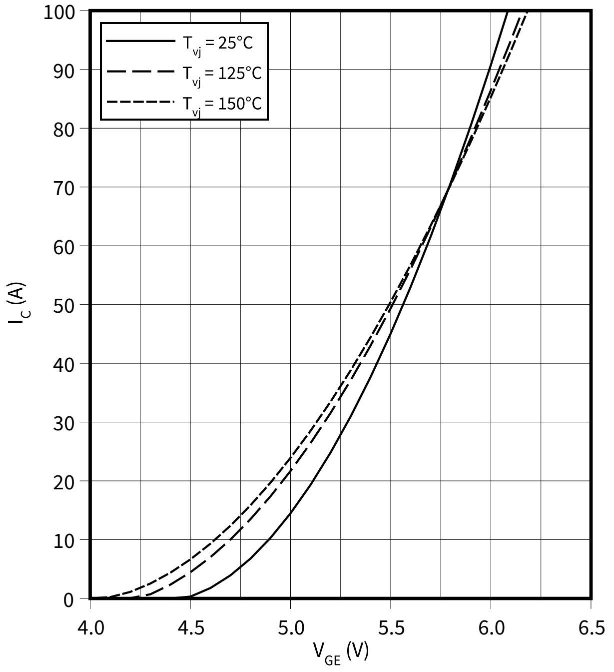
output characteristic (typical), IGBT,3-Level
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



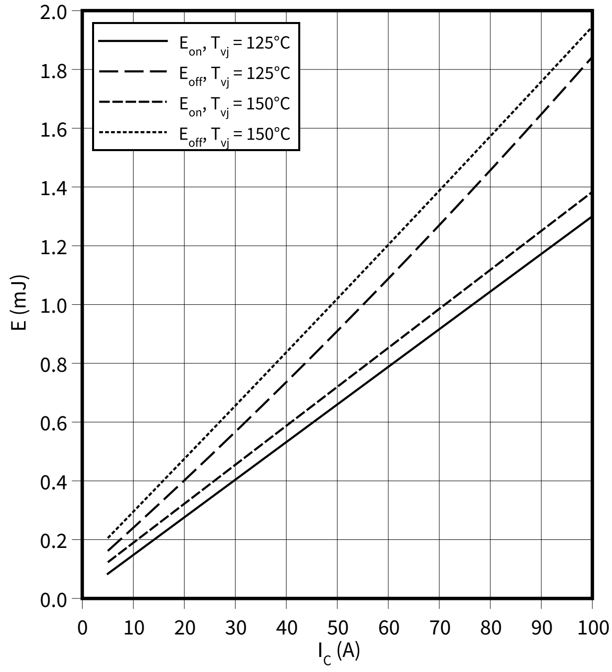
output characteristic (typical), IGBT,3-Level
$I_C = f(V_{CE})$
$T_{vj} = 150$ °C



transfer characteristic (typical), IGBT,3-Level
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



switching losses (typical), IGBT,3-Level
$E = f(I_C)$
$R_{Goff} = 8.2\ \Omega$, $R_{Gon} = 8.2\ \Omega$, $V_{CE} = 300$ V, $V_{GE} = \pm 15$ V

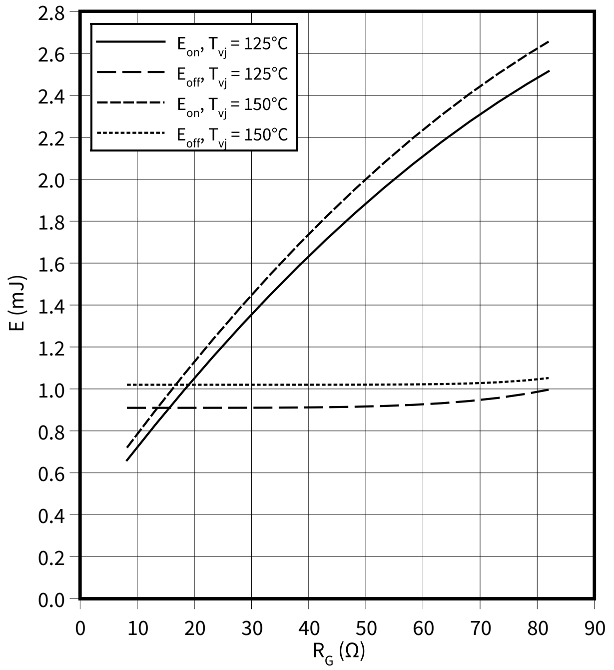


7 Characteristics diagrams

switching losses (typical), IGBT,3-Level

$E = f(R_G)$

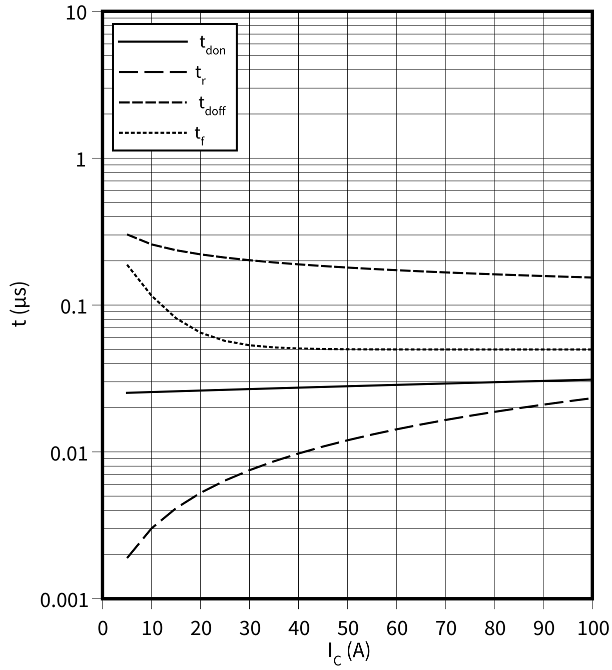
I_C = 50 A, V_{CE} = 300 V, V_{GE} = ± 15 V



switching times (typical), IGBT,3-Level

$t = f(I_C)$

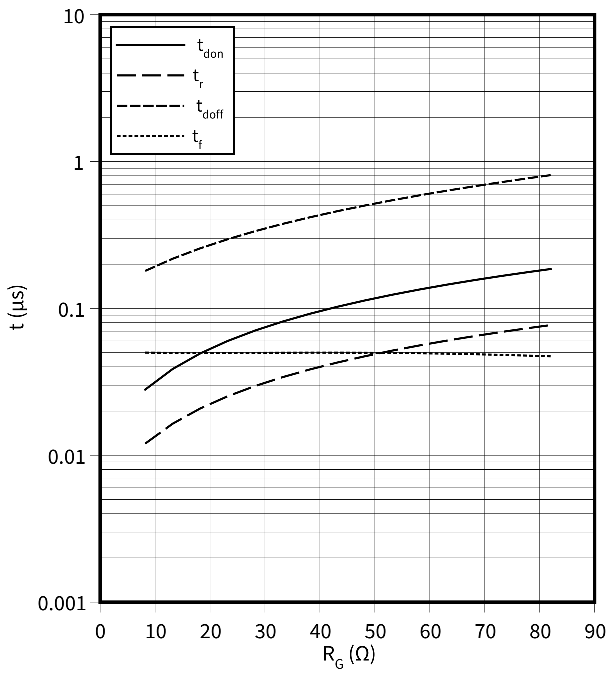
R_{Goff} = 8.2 Ω, R_{Gon} = 8.2 Ω, V_{CE} = 300 V, V_{GE} = ± 15 V, T_{vj} = 150 °C



switching times (typical), IGBT,3-Level

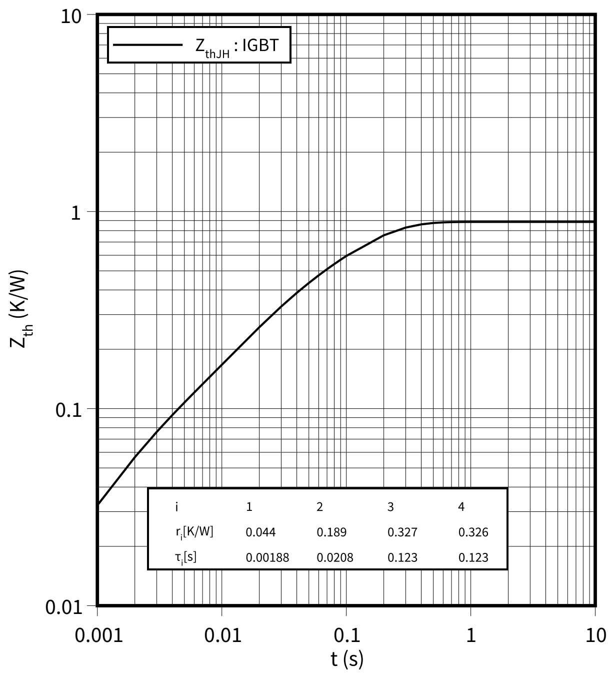
$t = f(R_G)$

I_C = 50 A, V_{CE} = 300 V, V_{GE} = ± 15 V, T_{vj} = 150 °C



transient thermal impedance , IGBT,3-Level

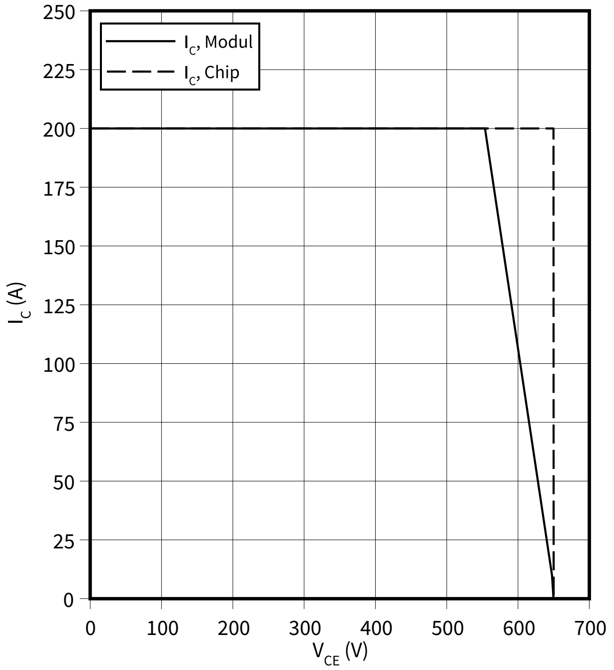
$Z_{th} = f(t)$



reverse bias safe operating area (RBSOA), IGBT,3-Level

$I_C = f(V_{CE})$

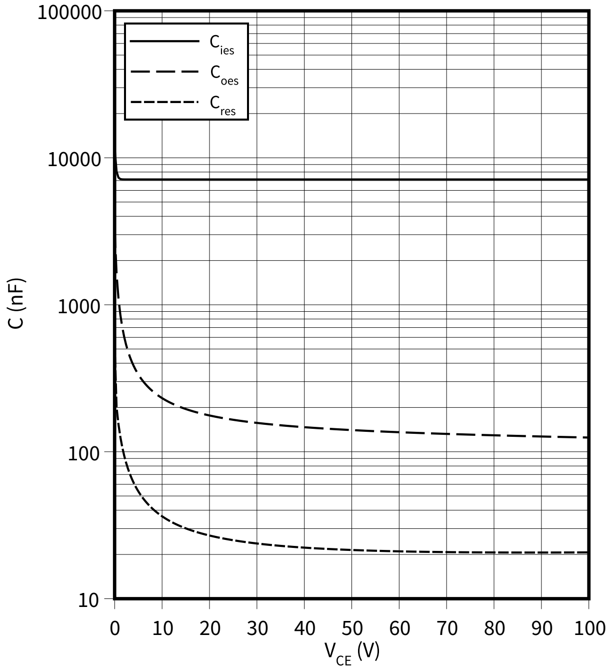
$R_{Goff} = 8.2\ \Omega$, $V_{GE} = \pm15$ V, $T_{vj} = 150$ °C



capacity characteristic (typical), IGBT,3-Level

$C = f(V_{CE})$

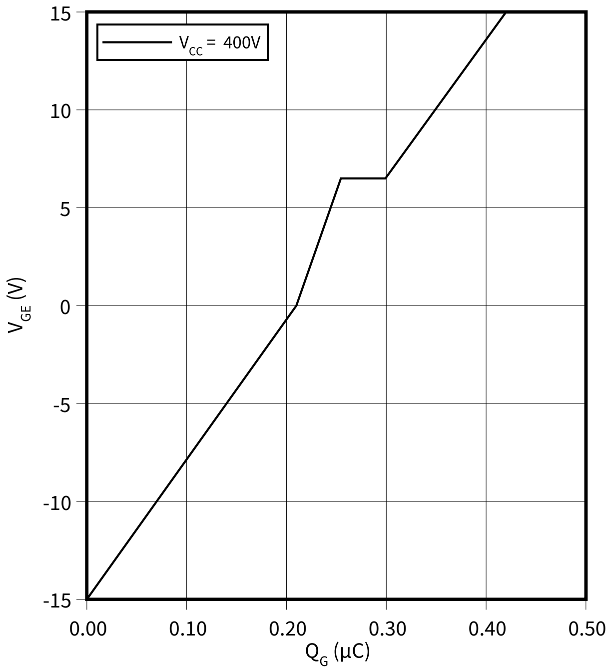
f = 100 kHz, $V_{GE} = 0$ V, $T_{vj} = 25$ °C



gate charge characteristic (typical), IGBT,3-Level

$V_{GE} = f(Q_G)$

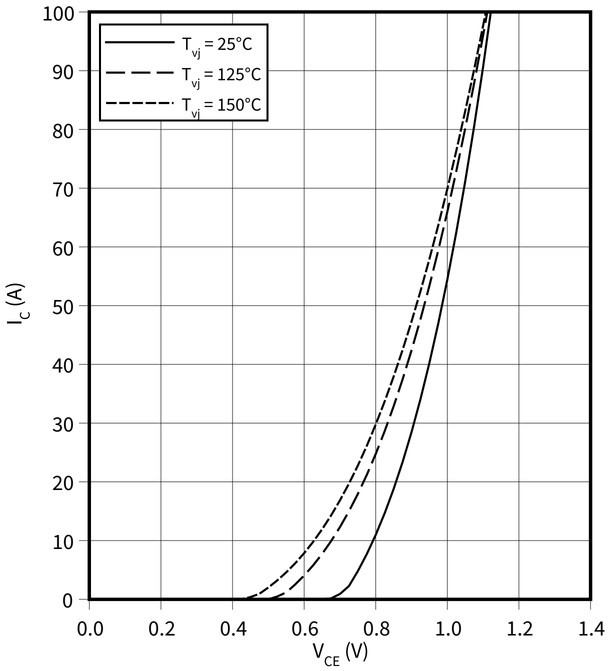
$I_C = 50$ A, $T_{vj} = 25$ °C



output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

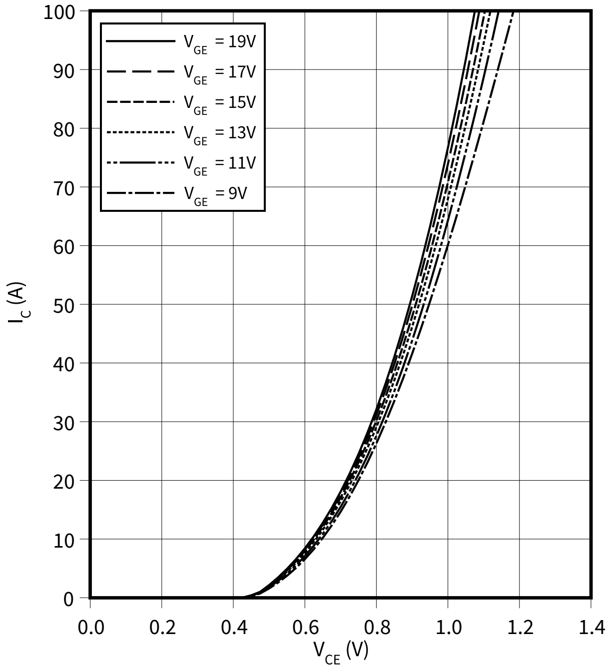
$V_{GE} = 15$ V



output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$

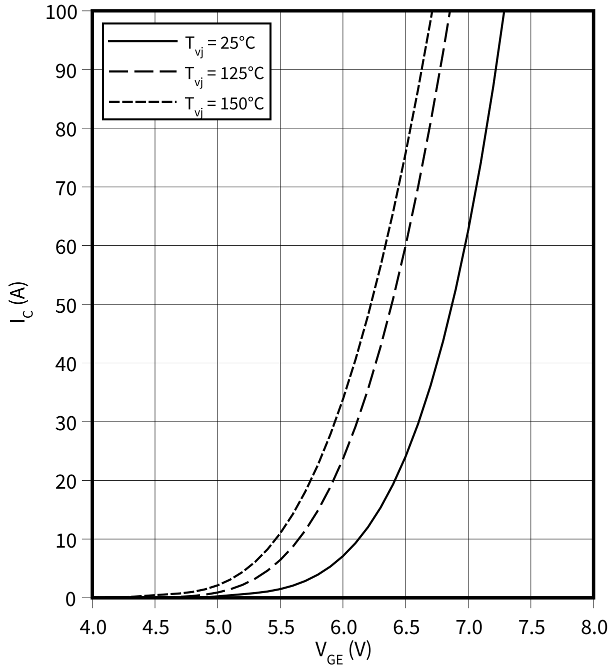
$T_{vj} = 150$ °C



transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

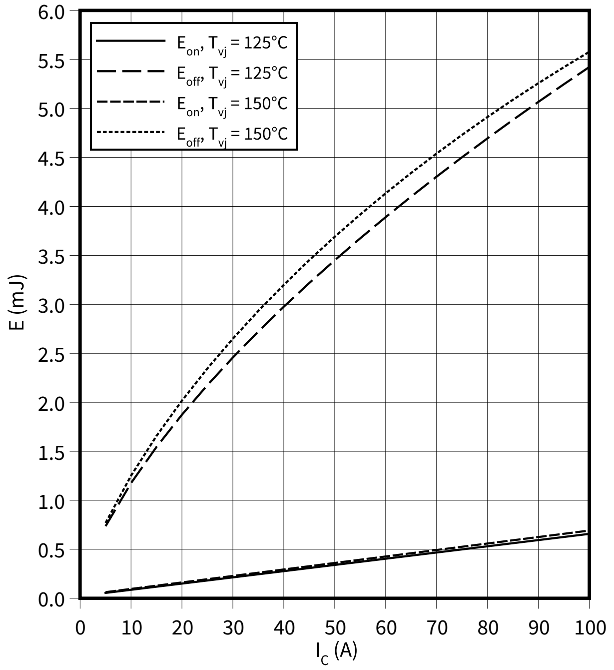
$V_{CE} = 20$ V



switching losses (typical), IGBT, Inverter

$E = f(I_C)$

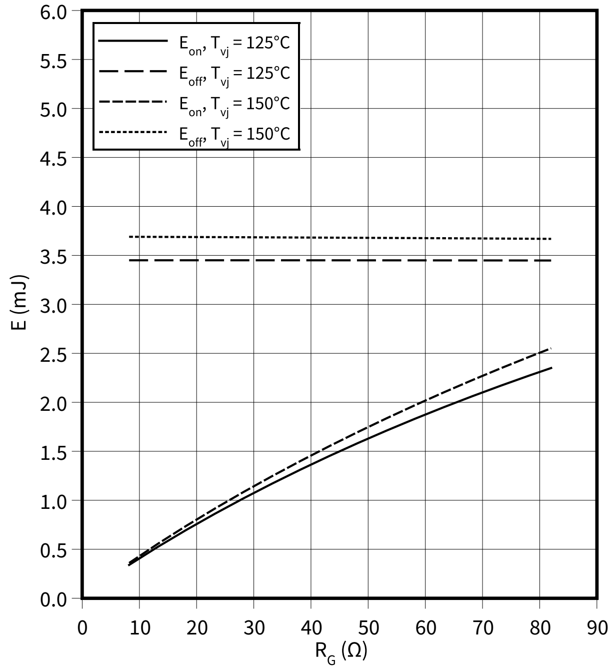
$R_{Goff} = 8.2\ \Omega$, $R_{Gon} = 8.2\ \Omega$, $V_{CE} = 300$ V, $V_{GE} = \pm 15$ V



switching losses (typical), IGBT, Inverter

$E = f(R_G)$

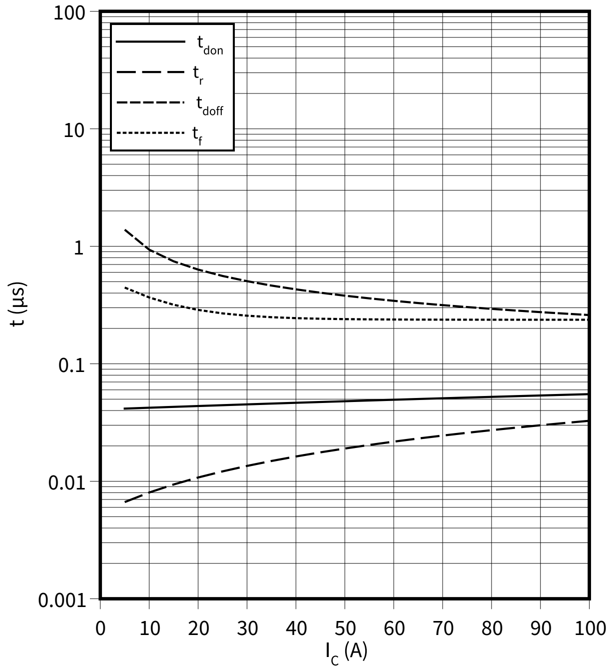
$I_C = 50$ A, $V_{CE} = 300$ V, $V_{GE} = \pm 15$ V



switching times (typical), IGBT, Inverter

t = f(I_C)

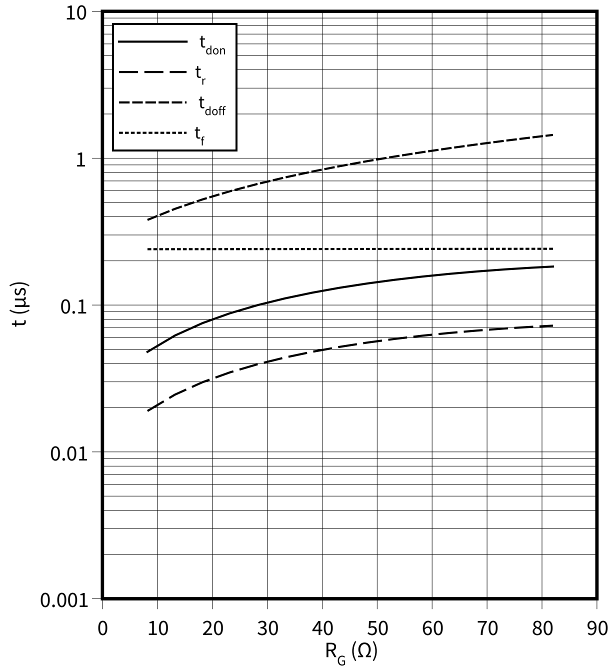
R_{Goff} = 8.2 Ω, R_{Gon} = 8.2 Ω, V_{CE} = 300 V, V_{GE} = ± 15 V, T_{vj} = 150 °C



switching times (typical), IGBT, Inverter

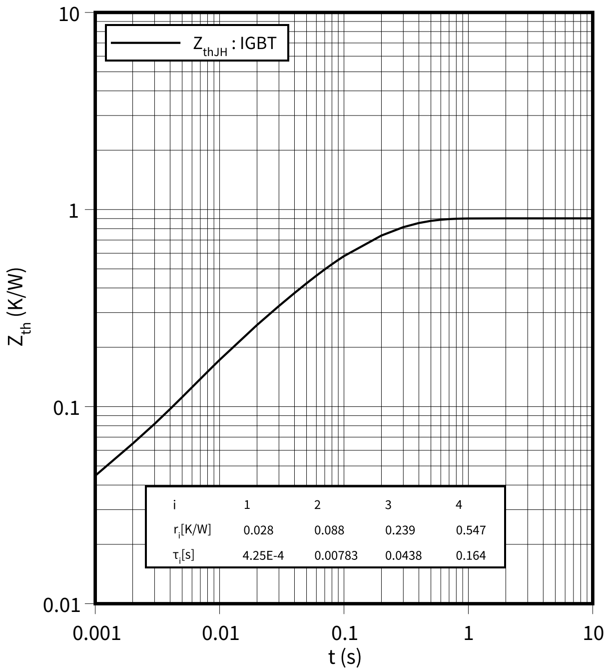
t = f(R_G)

I_C = 50 A, V_{CE} = 300 V, V_{GE} = ± 15 V, T_{vj} = 150 °C



transient thermal impedance , IGBT, Inverter

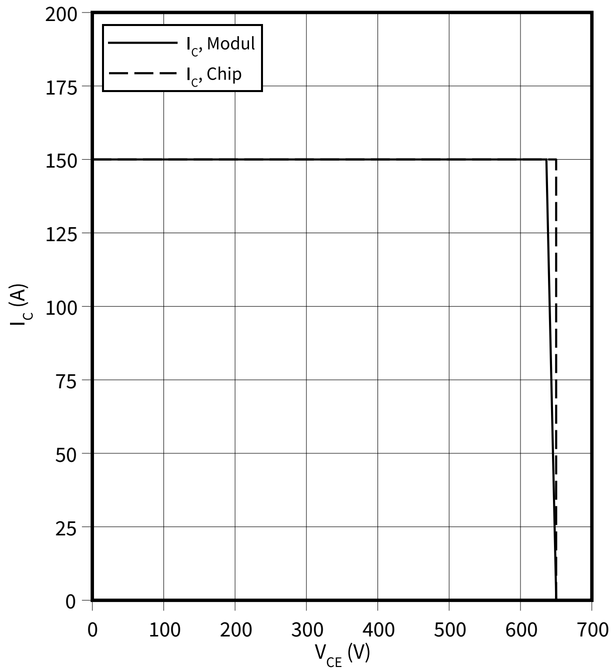
Z_{th} = f(t)



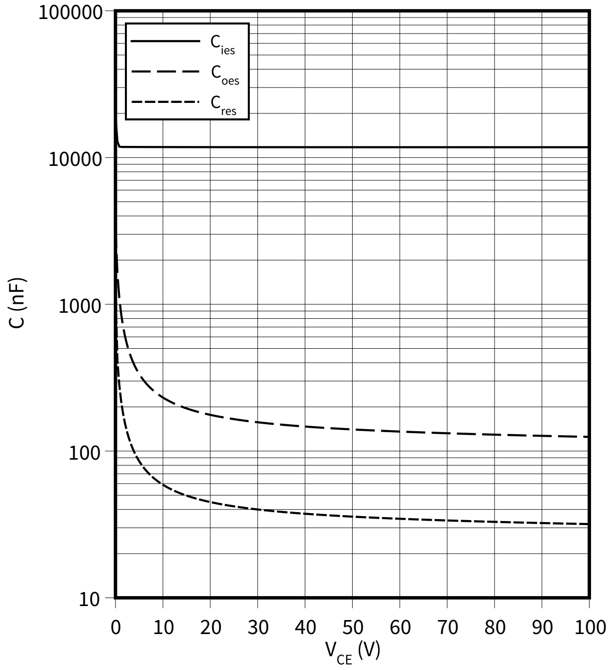
reverse bias safe operating area (RBSOA), IGBT, Inverter

I_C = f(V_{CE})

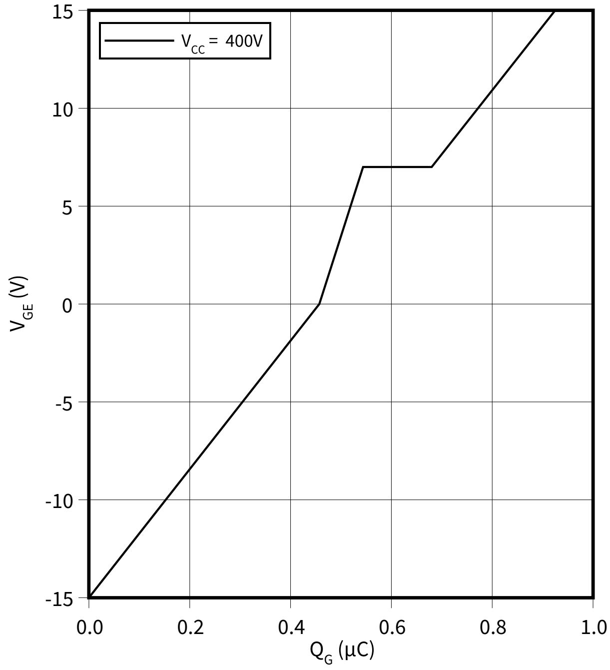
R_{Goff} = 8.2 Ω, V_{GE} = ±15 V, T_{vj} = 150 °C



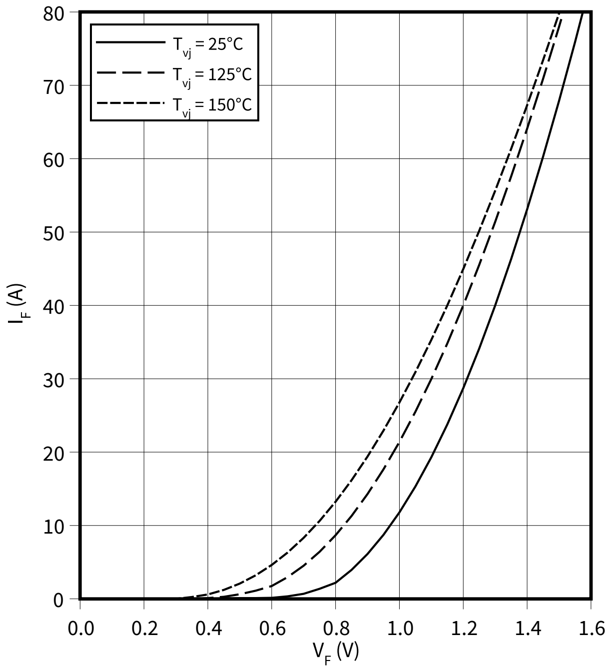
capacity characteristic (typical), IGBT, Inverter
$C = f(V_{CE})$
$f = 100\ kHz$, $V_{GE} = 0\ V$, $T_{vj} = 25\ °C$



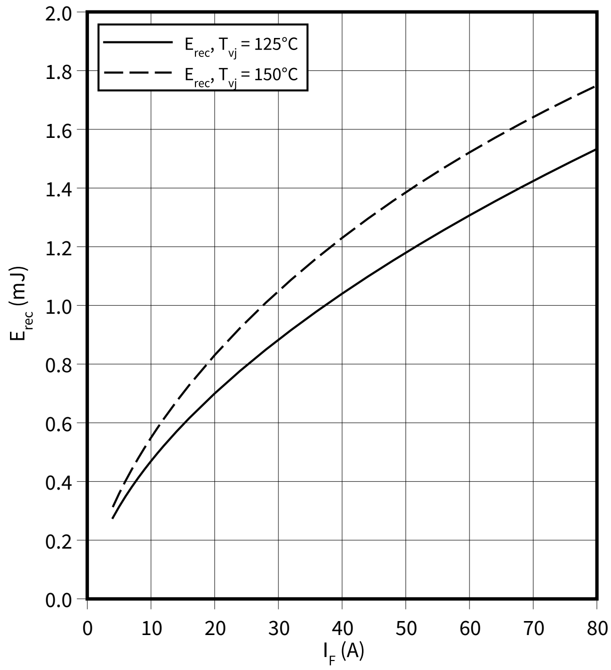
gate charge characteristic (typical), IGBT, Inverter
$V_{GE} = f(Q_G)$
$I_C = 50\ A$, $T_{vj} = 25\ °C$



forward characteristic of (typical), Diode, 3-Level
$I_F = f(V_F)$



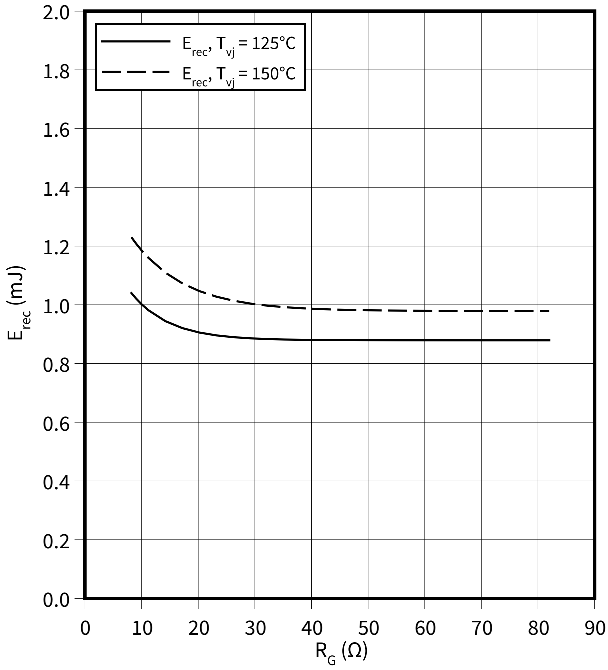
switching losses (typical), Diode, 3-Level
$E_{rec} = f(I_F)$
$R_{Gon} = 8.2\ \Omega$, $V_{CE} = 300\ V$



switching losses (typical), Diode, 3-Level

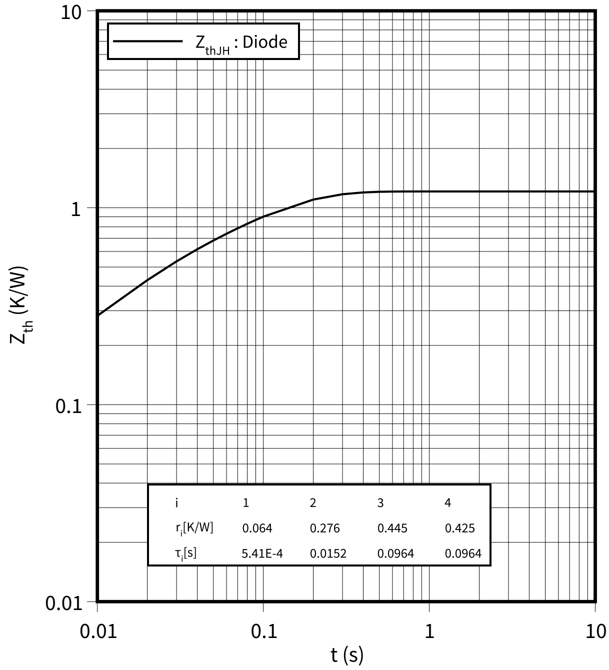
$E_{rec} = f(R_G)$

$V_{CE} = 300$ V, $I_F = 40$ A



transient thermal impedance , Diode, 3-Level

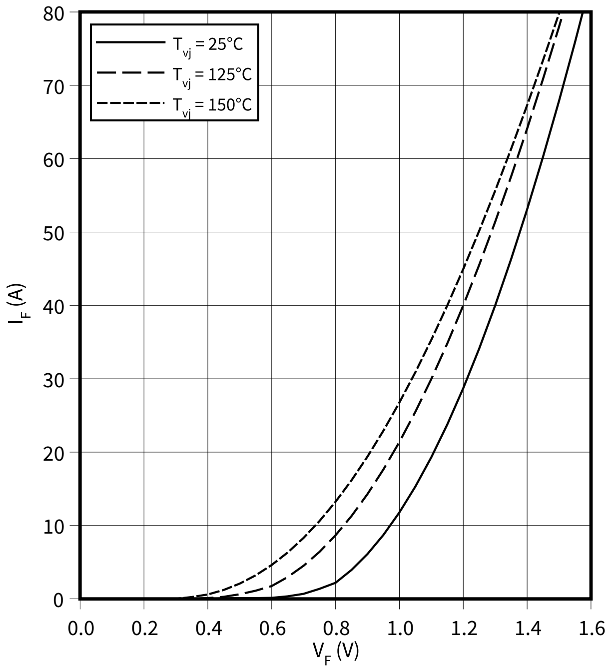
$Z_{th} = f(t)$



i	1	2	3	4
r_i[K/W]	0.064	0.276	0.445	0.425
$τ_i$[s]	5.41E-4	0.0152	0.0964	0.0964

forward characteristic of (typical), Diode, Inverter

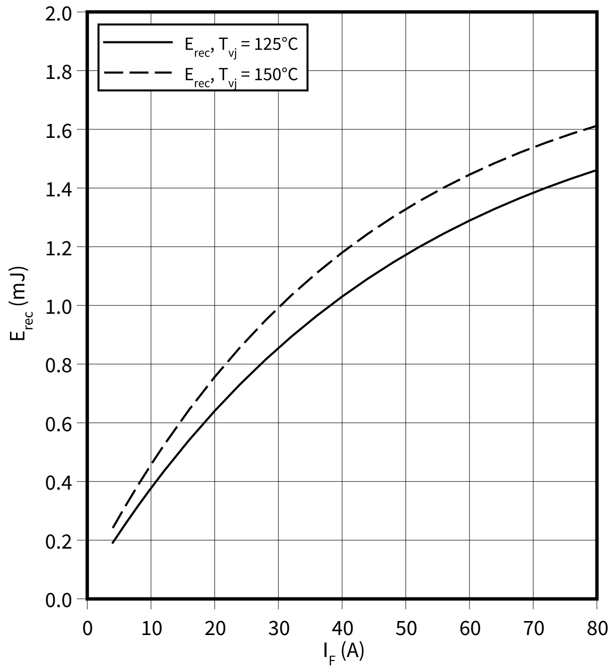
$I_F = f(V_F)$



switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

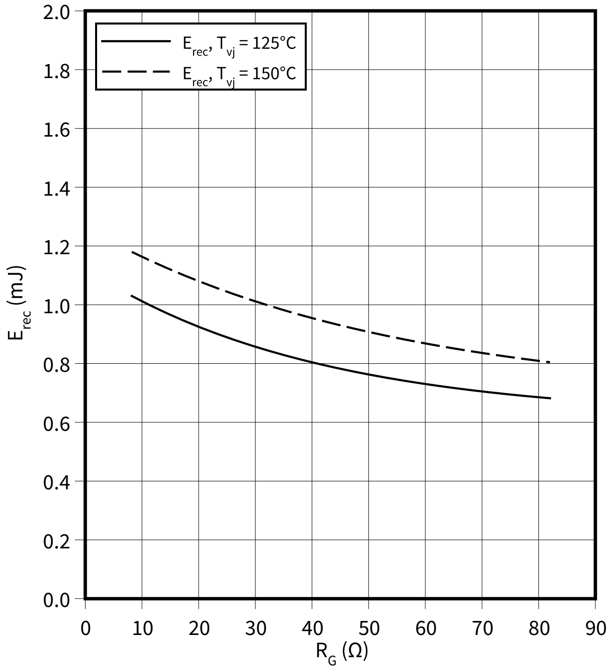
$R_{Gon} = 8.2$ Ω, $V_{CE} = 300$ V



switching losses (typical), Diode, Inverter

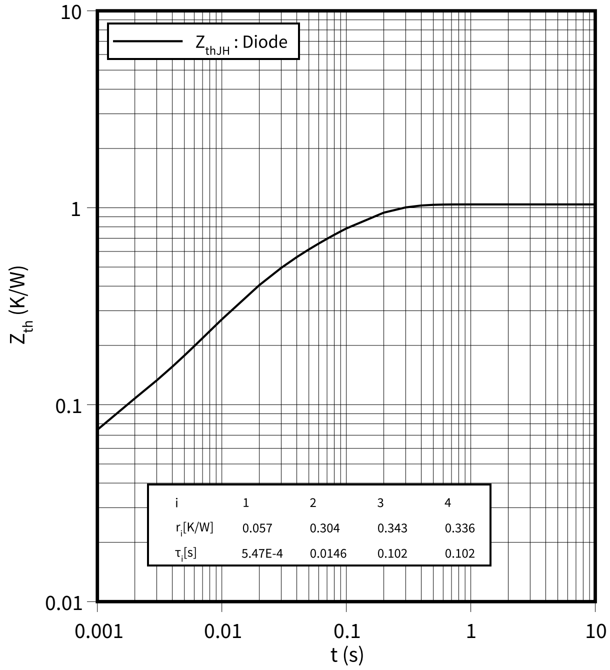
$E_{rec} = f(R_G)$

$V_{CE} = 300$ V, $I_F = 40$ A



transient thermal impedance , Diode, Inverter

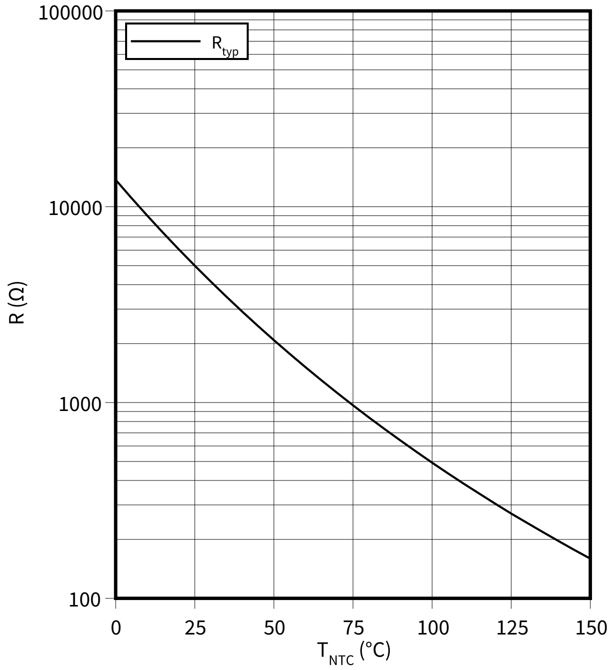
$Z_{th} = f(t)$



i	1	2	3	4
r_i[K/W]	0.057	0.304	0.343	0.336
τ_i[s]	5.47E-4	0.0146	0.102	0.102

temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



8 Circuit diagram

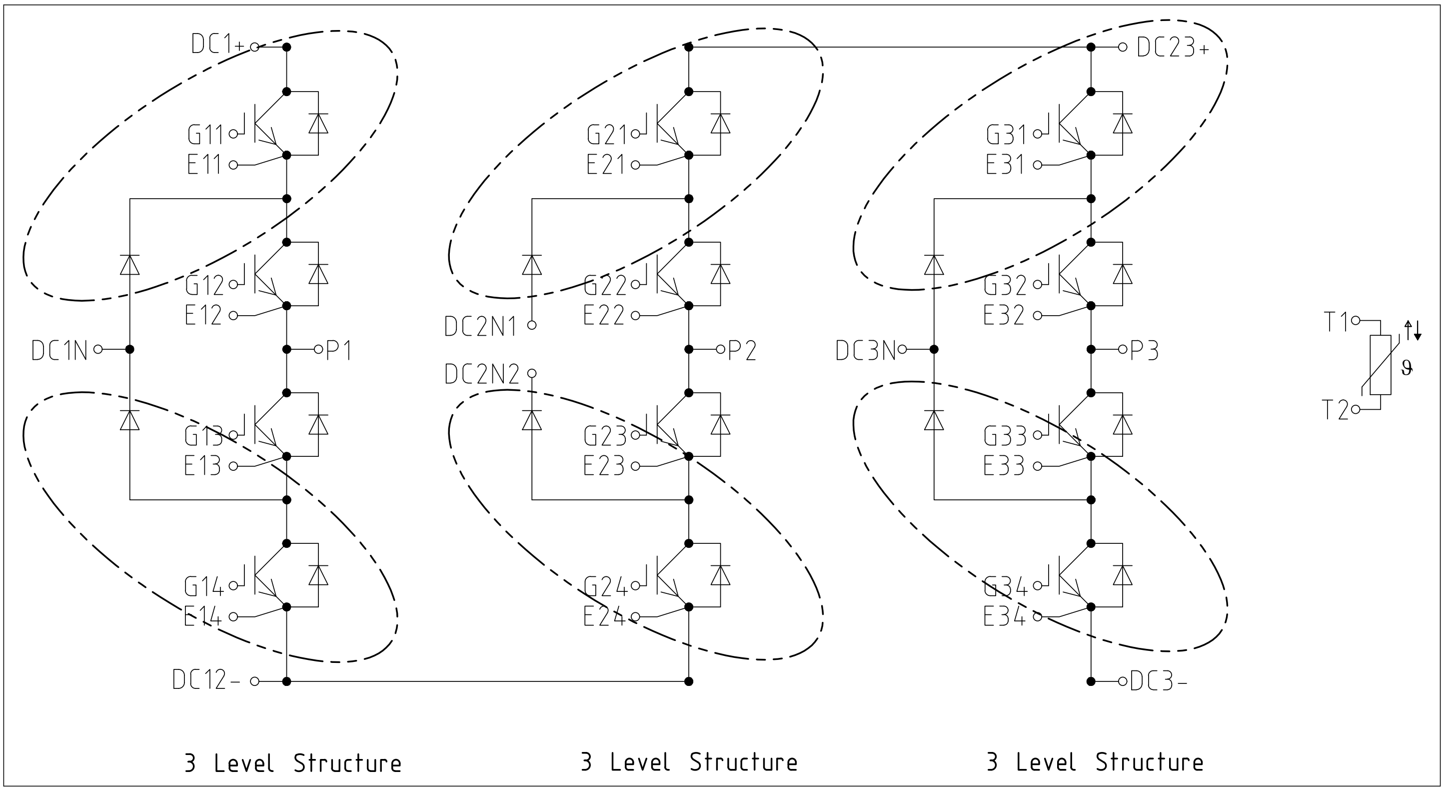


Figure 2

9 Package outlines

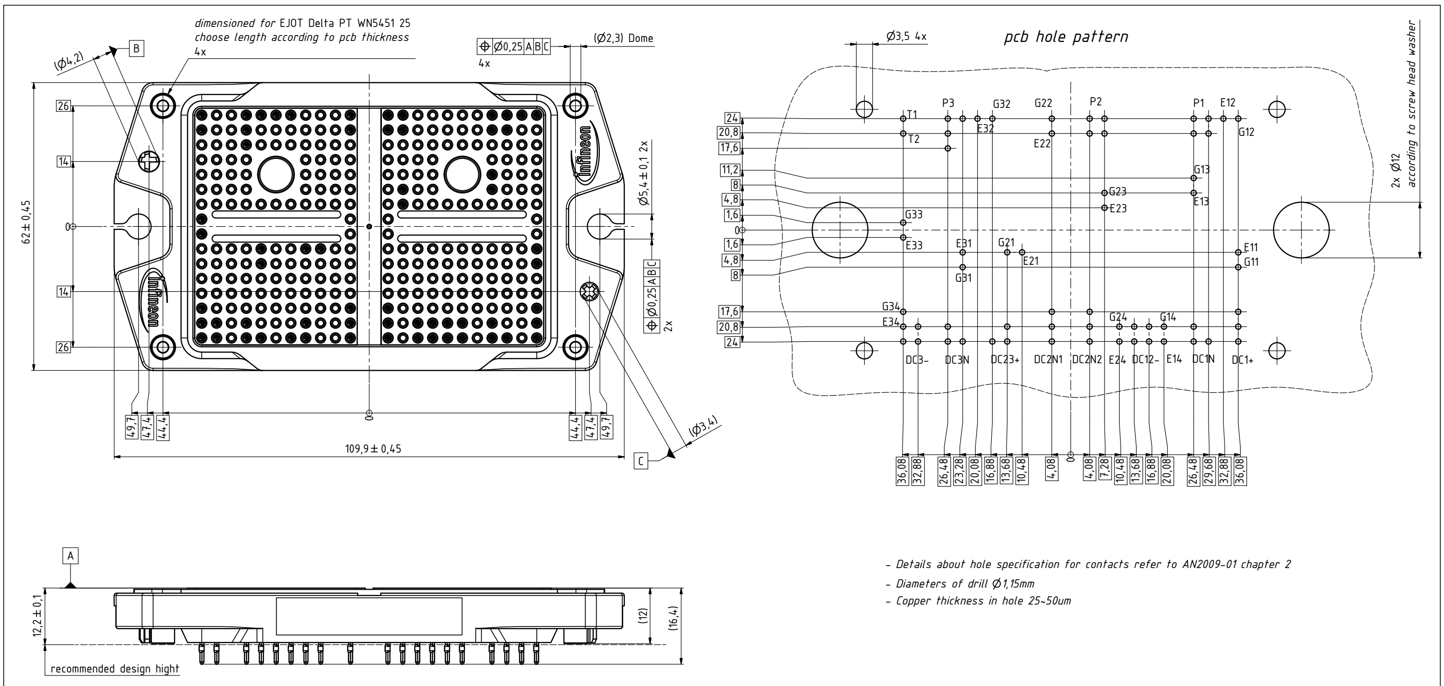


Figure 3

10 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 4

Revision history

Document revision	Date of release	Description of changes
V1.0	2020-04-03	
1.00	2021-04-22	Final

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Edition 2021-04-22

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference
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