EasyPACK™ 2B module with Trench/Fieldstop IGBT H3 and rapid diode and PressFIT / NTC

Features

- Electrical features
  - V_{CES} = 650 V
  - $I_{C\ nom}$ = 100 A / I_{CRM} = 200 A
  - Increased blocking voltage capability up to 650 V
  - Low inductive design
  - Low switching losses
  - Low $V_{CE,sat}$
- Mechanical features
  - Al_2O_3 substrate with low thermal resistance
  - Compact design
  - PressFIT contact technology
  - Rugged mounting due to integrated mounting clamps

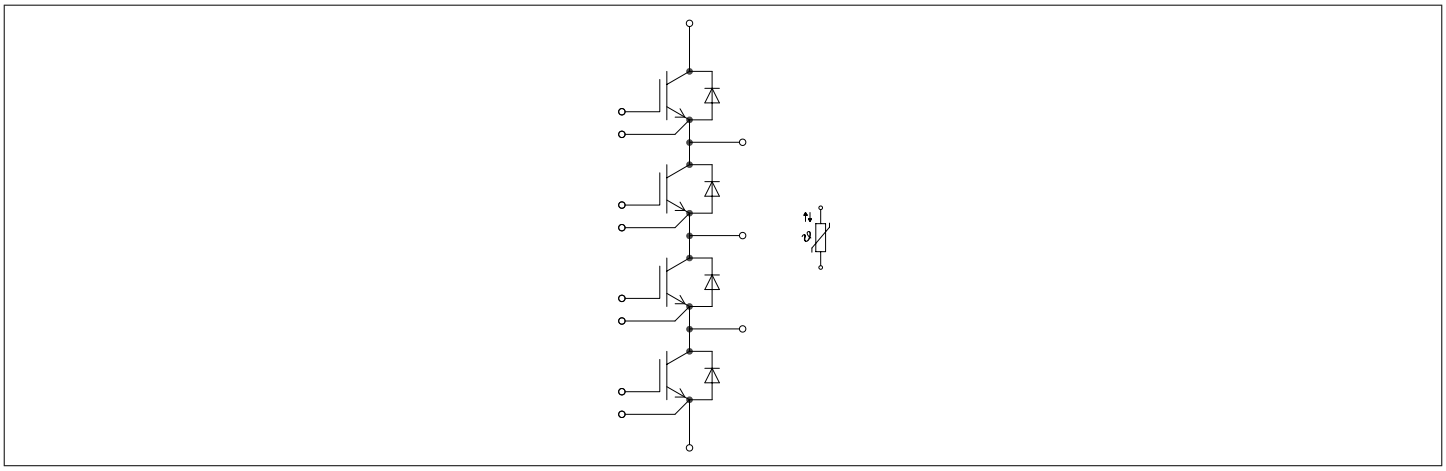
Potential applications

- Three-level applications
- Motor drives
- Solar 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	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}			41		nH
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 25A rms per connector pin.

2 IGBT, T1 / T4

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	40	A
Repetitive peak collector current	I_{CRM}	t_P = 1 ms		100	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		1.68	2.00	V
			T_{vj} = 125 °C		1.86		
			T_{vj} = 150 °C		1.89		
Gate threshold voltage	V_{GEth}	I_C = 0.8 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.05	5.75	6.45	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 400 V			0.5		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} = 650 V, V_{GE} = 0 V			2.95		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 650 V, V_{GE} = 0 V			0.096		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.021	mA
Gate-emitter leakage current	I_{GES}	V_{CE} = 650 V, V_{GE} = 0 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} = 2.2 Ω	T_{vj} = 25 °C		0.014		µs
			T_{vj} = 125 °C		0.015		
			T_{vj} = 150 °C		0.015		
Rise time (inductive load)	t_r	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Gon} = 2.2 Ω	T_{vj} = 25 °C		0.008		µs
			T_{vj} = 125 °C		0.010		
			T_{vj} = 150 °C		0.011		
Turn-off delay time (inductive load)	t_{doff}	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 2.2 Ω	T_{vj} = 25 °C		0.124		µs
			T_{vj} = 125 °C		0.147		
			T_{vj} = 150 °C		0.150		
Fall time (inductive load)	t_f	I_C = 50 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 2.2 Ω	T_{vj} = 25 °C		0.038		µs
			T_{vj} = 125 °C		0.073		
			T_{vj} = 150 °C		0.084		
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} = 2.2 Ω, di/dt = 4100 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.244		mJ
			T_{vj} = 125 °C		0.406		
			T_{vj} = 150 °C		0.451		
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} = 2.2 Ω, dv/dt = 5100 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.593		mJ
			T_{vj} = 125 °C		0.94		
			T_{vj} = 150 °C		1.06		
Thermal resistance, junction to heat sink	R_{thJH}	per IGBT			1.19		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

3 Diode, D1 / D4

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			75	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		150	A
I^2t - value	I^2t	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	680	A^2s
			T_{vj} = 150 °C	660	

Table 6 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 75 A	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}	I_F = 75 A, V_R = 300 V, V_{GE} = -15 V, -di$_F$/dt = 3400 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		63		A
			T_{vj} = 125 °C		75		
			T_{vj} = 150 °C		79.1		
Recovered charge	Q_r	I_F = 75 A, V_R = 300 V, V_{GE} = -15 V, -di$_F$/dt = 3400 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		2		µC
			T_{vj} = 125 °C		3.8		
			T_{vj} = 150 °C		4.5		
Reverse recovery energy	E_{rec}	I_F = 75 A, V_R = 300 V, V_{GE} = -15 V, -di$_F$/dt = 3400 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.433		mJ
			T_{vj} = 125 °C		0.813		
			T_{vj} = 150 °C		0.959		
Thermal resistance, junction to heat sink	R_{thJH}	per diode			1.16		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

4 IGBT, T2 / T3

Table 7 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CES}		T_{vj} = 25 °C	650	V

(table continues...)

Table 7 (continued) Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Implemented collector current	I_{CN}			100	A
Continuous 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 8 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE\,sat}$	I_C = 100 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.46	1.90	V
			T_{vj} = 125 °C		1.61		
			T_{vj} = 150 °C		1.68		
Gate threshold voltage	V_{GEth}	I_C = 1.6 mA, V_{CE} = V_{GE}, T_{vj} = 25 °C		5.05	5.75	6.45	V
Gate charge	Q_G	V_{GE} = ±15 V, V_{CE} = 400 V			1.1		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} = 650 V, V_{GE} = 0 V			6.2		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 650 V, V_{GE} = 0 V			0.19		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.016	mA
Gate-emitter leakage current	I_{GES}	V_{CE} = 650 V, V_{GE} = 0 V, T_{vj} = 25 °C				100	nA
Turn-on delay time (inductive load)	t_{don}	I_C = 100 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Gon} = 2.2 Ω	T_{vj} = 25 °C		0.072		µs
			T_{vj} = 125 °C		0.082		
			T_{vj} = 150 °C		0.083		
Rise time (inductive load)	t_r	I_C = 100 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Gon} = 2.2 Ω	T_{vj} = 25 °C		0.024		µs
			T_{vj} = 125 °C		0.027		
			T_{vj} = 150 °C		0.027		
Turn-off delay time (inductive load)	t_{doff}	I_C = 100 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 2.2 Ω	T_{vj} = 25 °C		0.185		µs
			T_{vj} = 125 °C		0.215		
			T_{vj} = 150 °C		0.220		
Fall time (inductive load)	t_f	I_C = 100 A, V_{CE} = 300 V, V_{GE} = ±15 V, R_{Goff} = 2.2 Ω	T_{vj} = 25 °C		0.027		µs
			T_{vj} = 125 °C		0.063		
			T_{vj} = 150 °C		0.084		

(table continues...)

Table 8 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-on energy loss per pulse	E_{on}	I_C = 100 A, V_{CE} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Gon} = 2.2 Ω, di/dt = 3600 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.981		mJ
			T_{vj} = 125 °C		1.42		
			T_{vj} = 150 °C		1.53		
Turn-off energy loss per pulse	E_{off}	I_C = 100 A, V_{CE} = 300 V, L_σ = 35 nH, V_{GE} = ±15 V, R_{Goff} = 2.2 Ω, dv/dt = 5300 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.37		mJ
			T_{vj} = 125 °C		2.06		
			T_{vj} = 150 °C		2.3		
Thermal resistance, junction to heat sink	R_{thJH}	per IGBT			0.830		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

5 Diode, D2 / D3

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
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	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	390	A^2s
			T_{vj} = 150 °C	370	

Table 10 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 50 A	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}	I_F = 50 A, V_R = 300 V, V_{GE} = -15 V, -di_F/dt = 4100 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		59.9		A
			T_{vj} = 125 °C		72.3		
			T_{vj} = 150 °C		76.6		

(table continues...)

Table 10 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Recovered charge	Q_r	I_F = 50 A, V_R = 300 V, V_{GE} = -15 V, -di$_F$/dt = 4100 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.49		µC
			T_{vj} = 125 °C		2.75		
			T_{vj} = 150 °C		3.18		
Reverse recovery energy	E_{rec}	I_F = 50 A, V_R = 300 V, V_{GE} = -15 V, -di$_F$/dt = 4100 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.332		mJ
			T_{vj} = 125 °C		0.638		
			T_{vj} = 150 °C		0.734		
Thermal resistance, junction to heat sink	R_{thJH}	per diode			1.64		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	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2\text{-}1/(298{,}15\ K))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2\text{-}1/(298{,}15\ K))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2\text{-}1/(298{,}15\ K))]$		3433		K

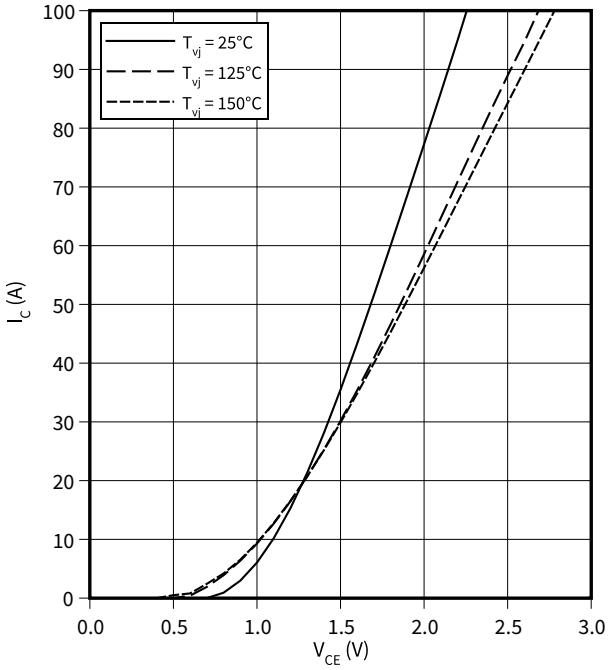
Note: Specification according to the valid application note.

7 Characteristics diagrams

Output characteristic (typical), IGBT, T1 / T4

$I_C = f(V_{CE})$

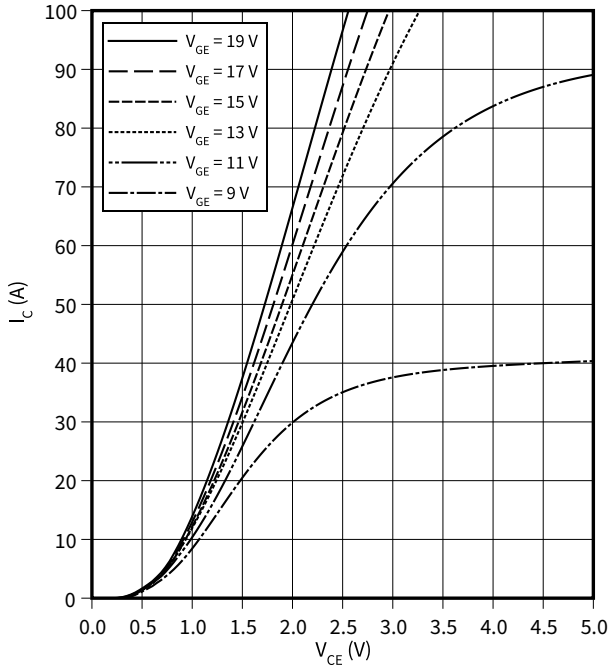
V_{GE} = 15 V



Output characteristic field (typical), IGBT, T1 / T4

$I_C = f(V_{CE})$

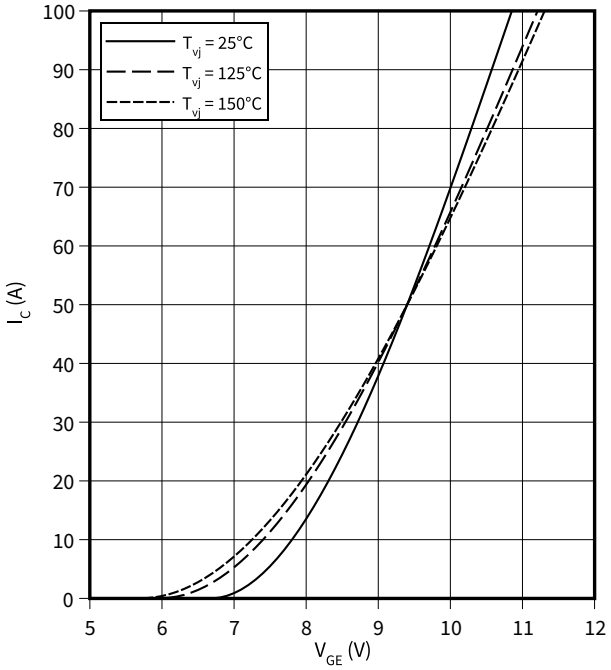
T_{vj} = 150 °C



Transfer characteristic (typical), IGBT, T1 / T4

$I_C = f(V_{GE})$

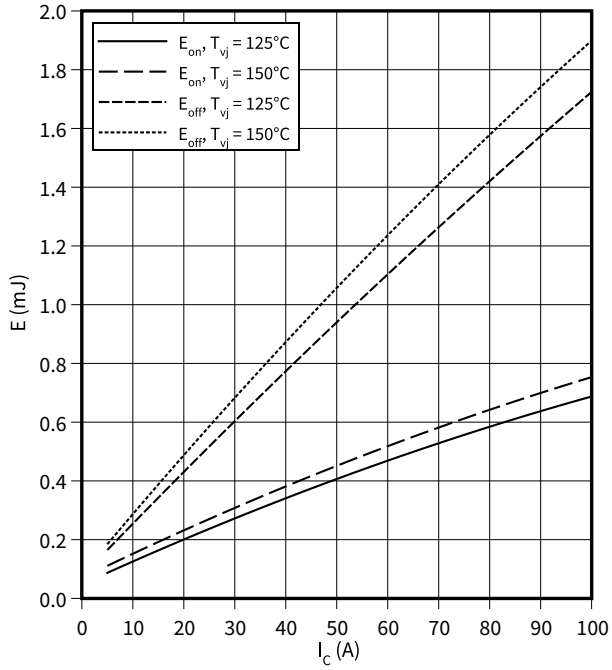
V_{CE} = 20 V



Switching losses (typical), IGBT, T1 / T4

$E = f(I_C)$

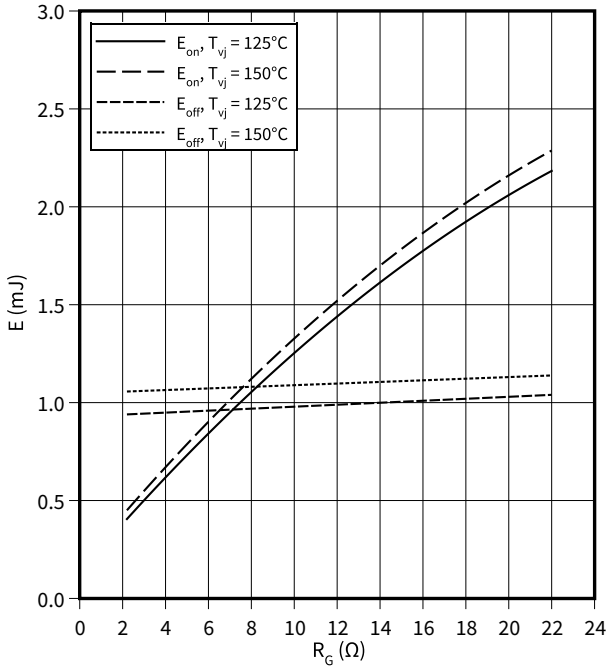
R_{Goff} = 2.2 Ω, R_{Gon} = 2.2 Ω, V_{CE} = 300 V, V_{GE} = +/- 15 V



Switching losses (typical), IGBT, T1 / T4

$E = f(R_G)$

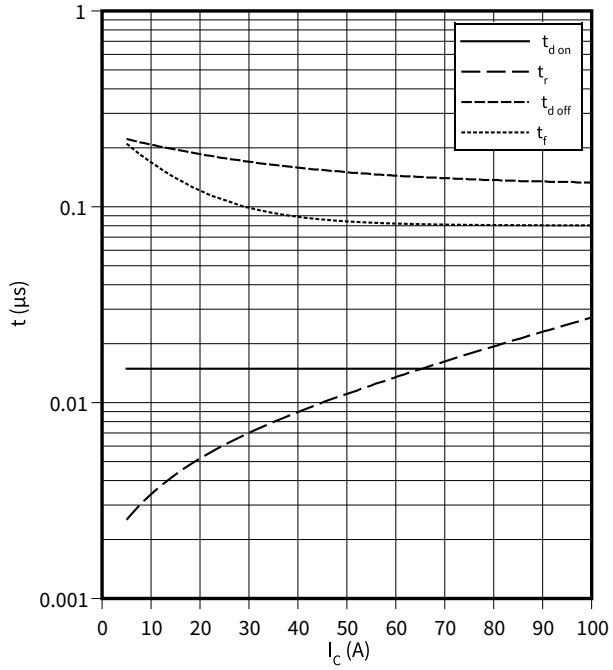
I_C = 50 A, V_{CE} = 300 V, V_{GE} = +/- 15 V



Switching times (typical), IGBT, T1 / T4

$t = f(I_C)$

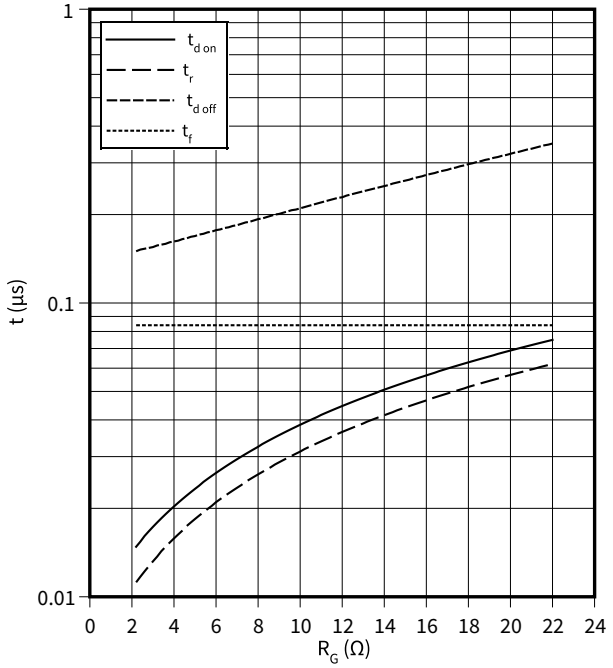
R_{Goff} = 2.2 Ω, R_{Gon} = 2.2 Ω, V_{CE} = 300 V, V_{GE} = +/- 15 V, T_{vj} = 150 °C



Switching times (typical), IGBT, T1 / T4

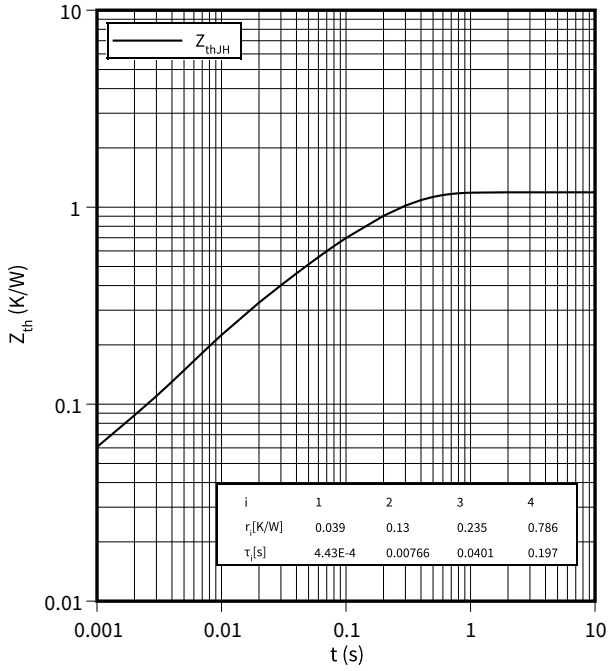
$t = f(R_G)$

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



Transient thermal impedance, IGBT, T1 / T4

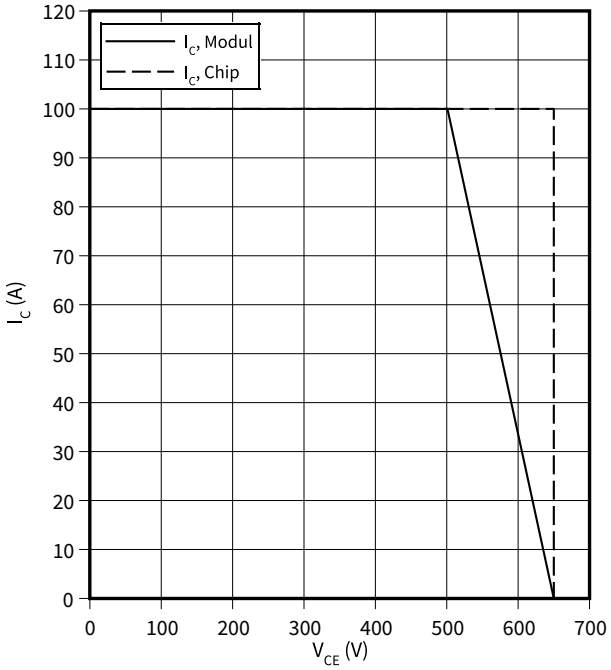
$Z_{th} = f(t)$



Reverse bias safe operating area (RBSOA), IGBT, T1 / T4

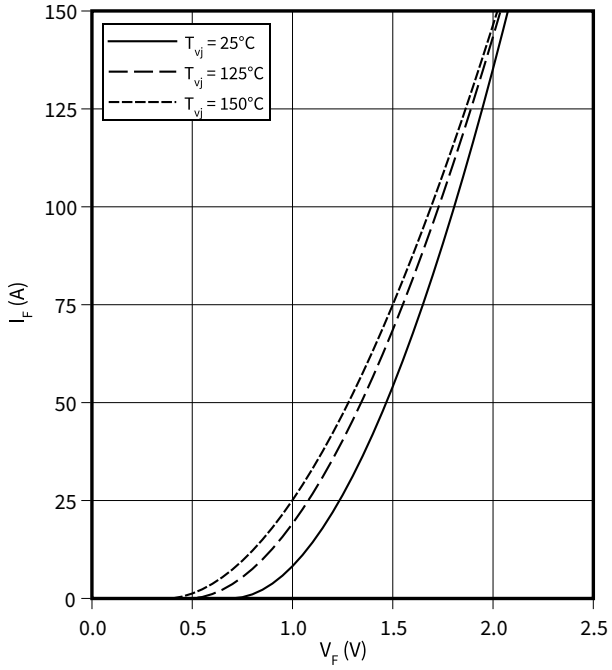
$I_C = f(V_{CE})$

$R_{Goff} = 2.2\ \Omega$, $V_{GE} = \pm 15$ V, $T_{vj} = 150$ °C



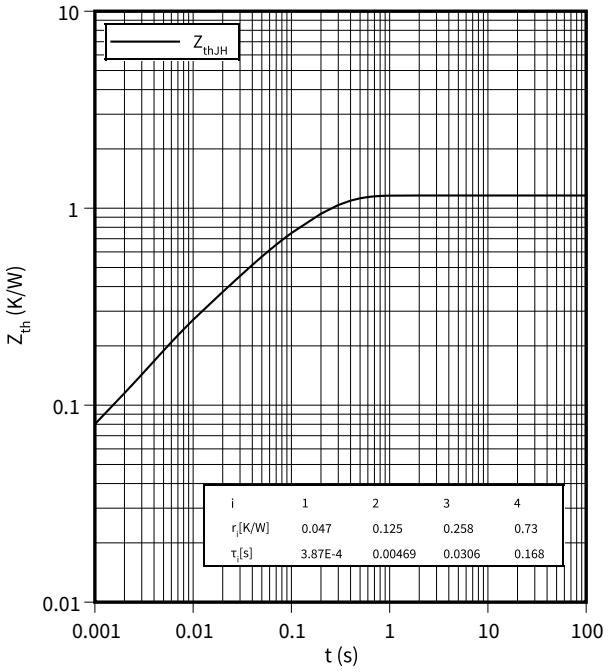
Forward characteristic (typical), Diode, D1 / D4

$I_F = f(V_F)$



Transient thermal impedance, Diode, D1 / D4

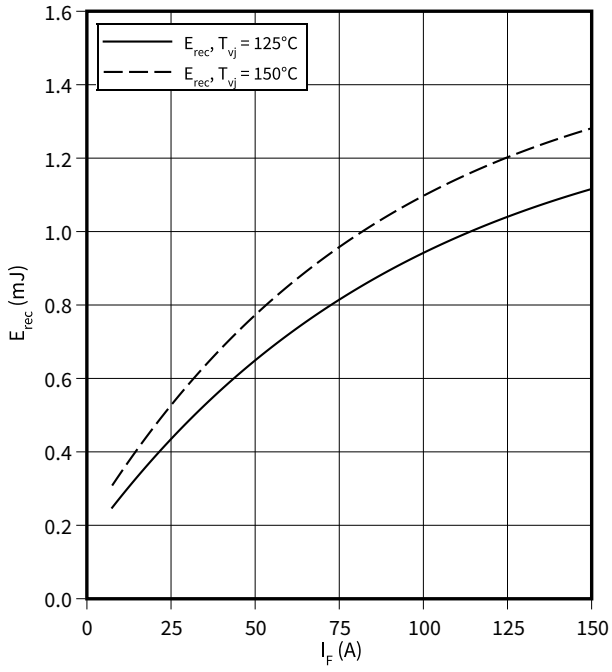
$Z_{th} = f(t)$



Switching losses (typical), Diode, D1 / D4

$E_{rec} = f(I_F)$

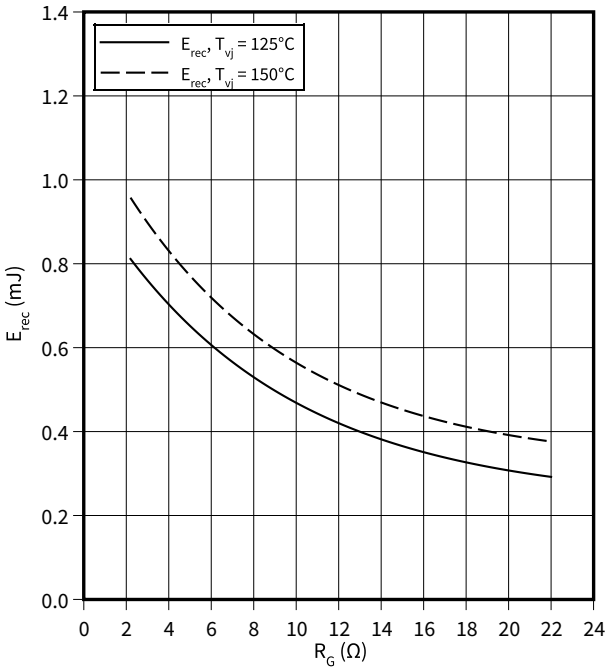
$R_{Gon} = 2.2\ \Omega$, $V_{CE} = 300$ V



Switching losses (typical), Diode, D1 / D4

$E_{rec} = f(R_G)$

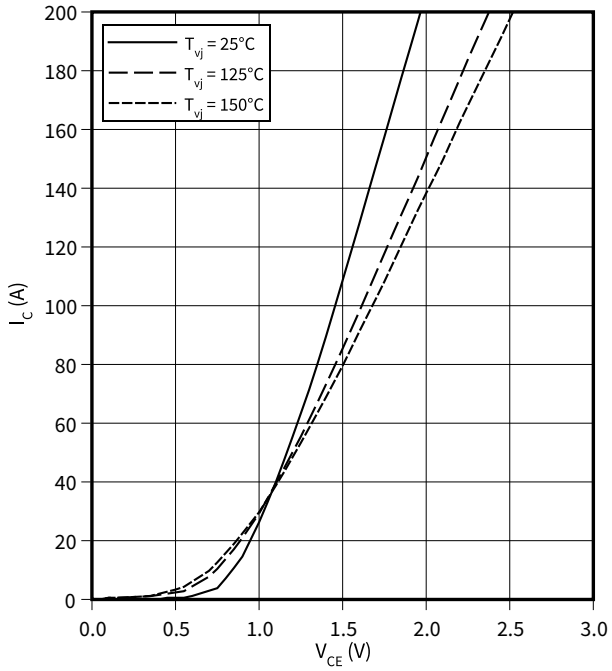
$V_{CE} = 300\ V$, $I_F = 75\ A$



Output characteristic (typical), IGBT, T2 / T3

$I_C = f(V_{CE})$

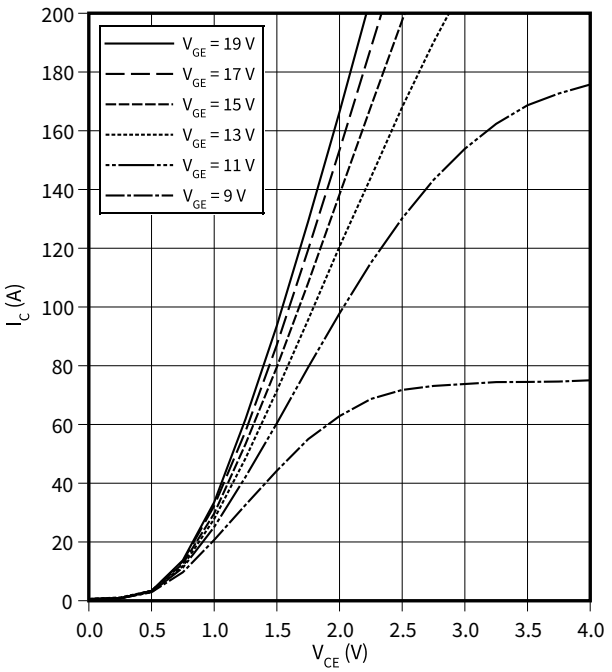
$V_{GE} = 15\ V$



Output characteristic field (typical), IGBT, T2 / T3

$I_C = f(V_{CE})$

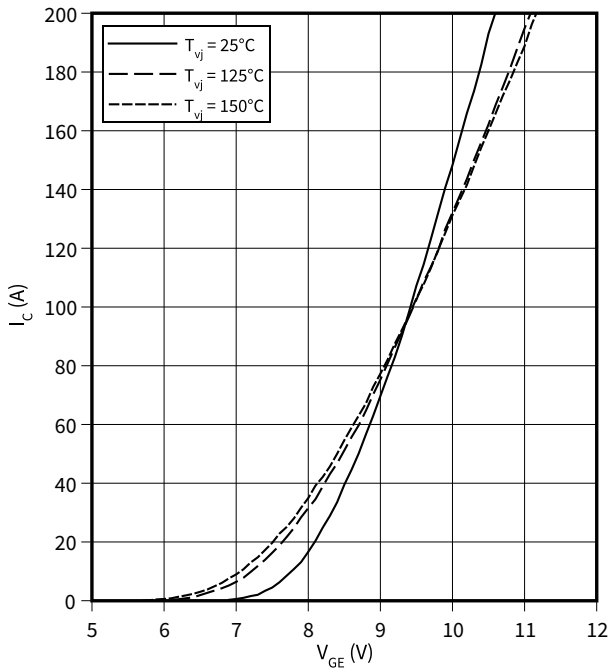
$T_{vj} = 150\ °C$



Transfer characteristic (typical), IGBT, T2 / T3

$I_C = f(V_{GE})$

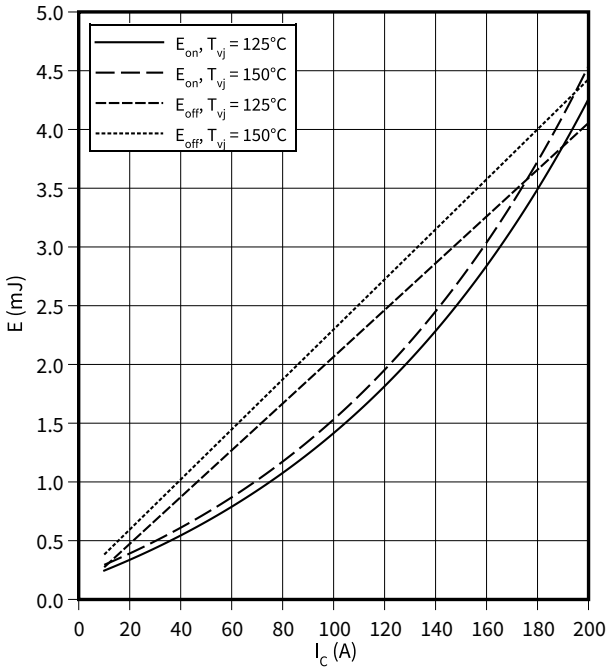
$V_{CE} = 20\ V$



Switching losses (typical), IGBT, T2 / T3

$E = f(I_C)$

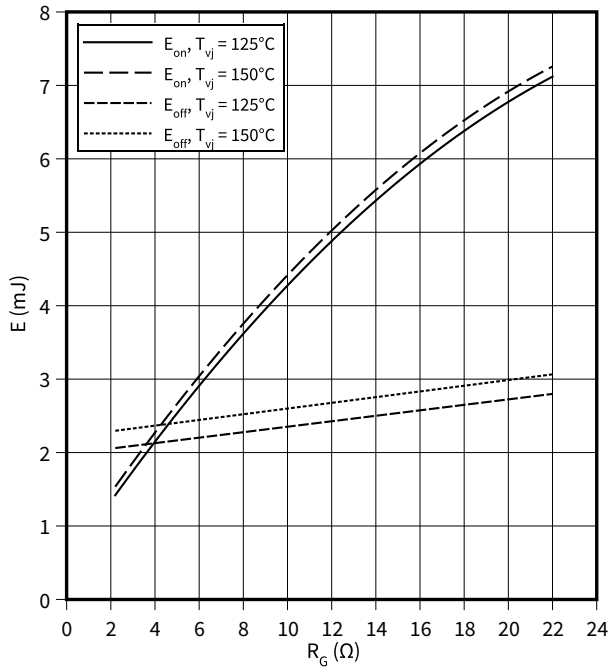
$R_{Goff} = 2.2\ \Omega$, $R_{Gon} = 2.2\ \Omega$, $V_{CE} = 300\ V$, $V_{GE} = +/- 15\ V$



Switching losses (typical), IGBT, T2 / T3

$E = f(R_G)$

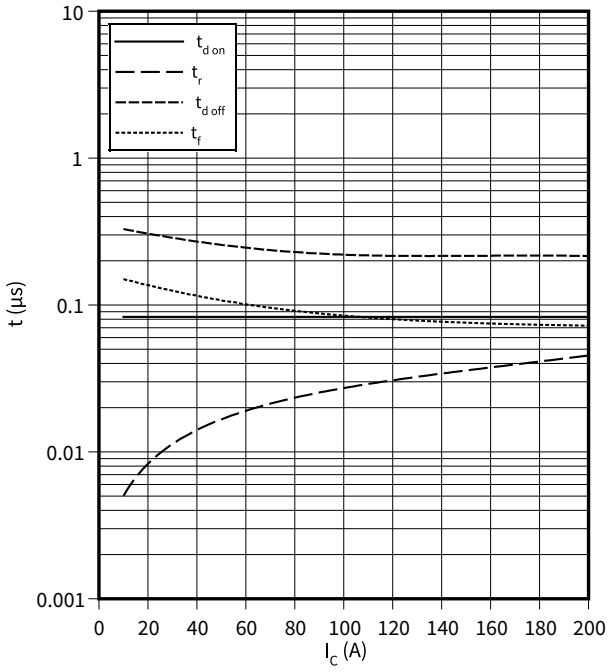
$I_C = 100\ A$, $V_{CE} = 300\ V$, $V_{GE} = +/- 15\ V$



Switching times (typical), IGBT, T2 / T3

$t = f(I_C)$

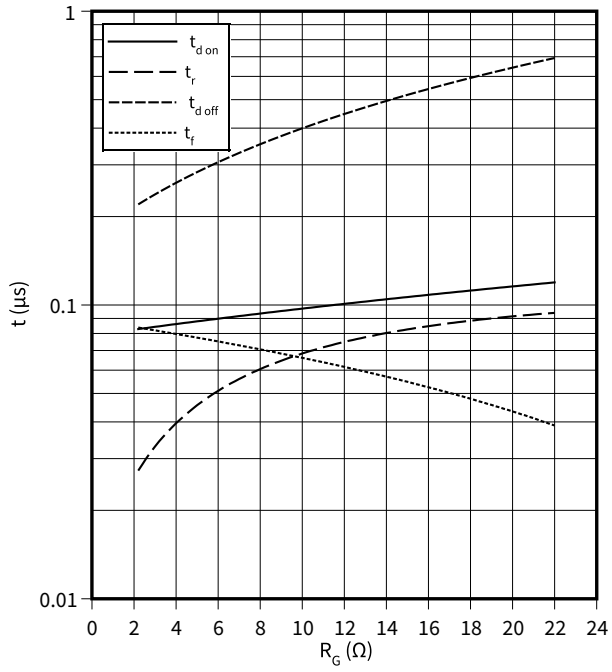
$R_{Goff} = 2.2\ \Omega$, $R_{Gon} = 2.2\ \Omega$, $V_{CE} = 300\ V$, $V_{GE} = +/- 15\ V$, $T_{vj} = 150\ °C$



Switching times (typical), IGBT, T2 / T3

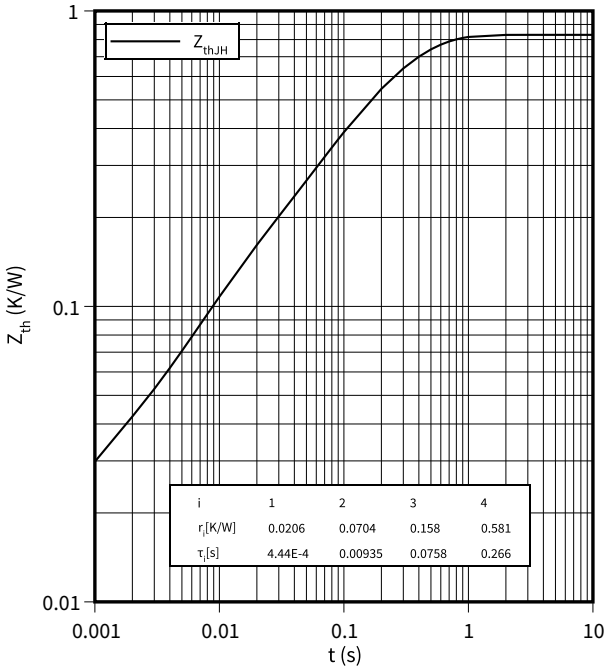
$t = f(R_G)$

$I_C = 100\ A$, $V_{CE} = 300\ V$, $V_{GE} = +/- 15\ V$, $T_{vj} = 150\ °C$



Transient thermal impedance, IGBT, T2 / T3

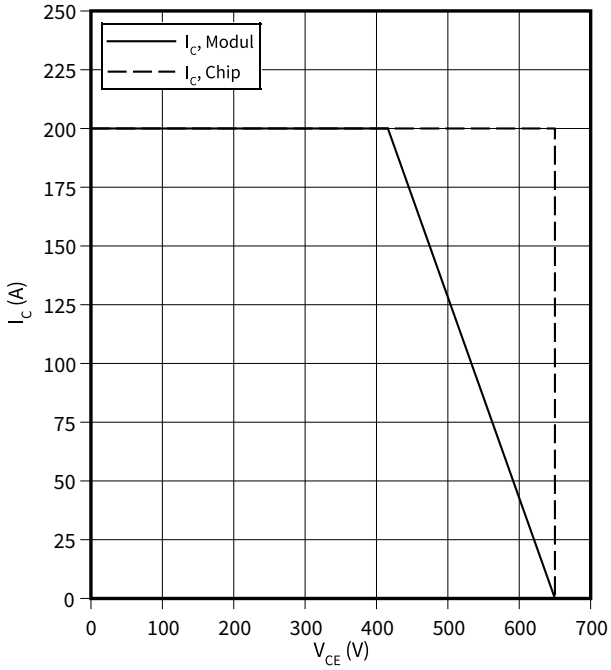
$Z_{th} = f(t)$



Reverse bias safe operating area (RBSOA), IGBT, T2 / T3

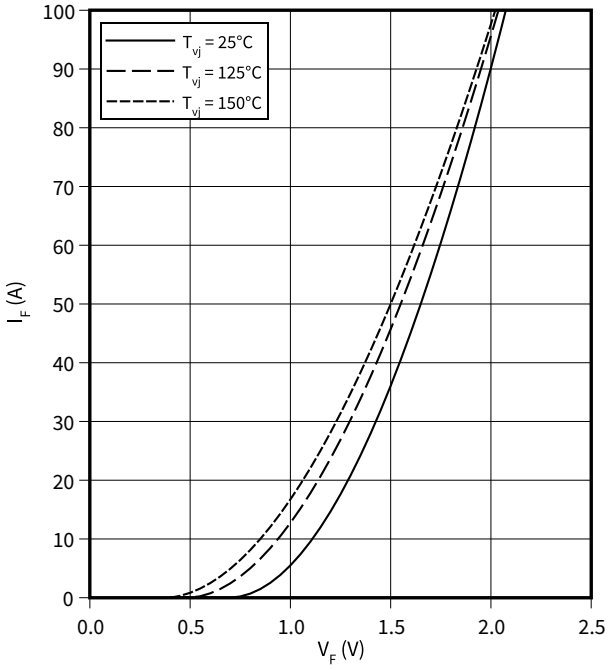
$I_C = f(V_{CE})$

$R_{Goff} = 2.2\ \Omega$, $V_{GE} = \pm 15$ V, $T_{vj} = 150$ °C



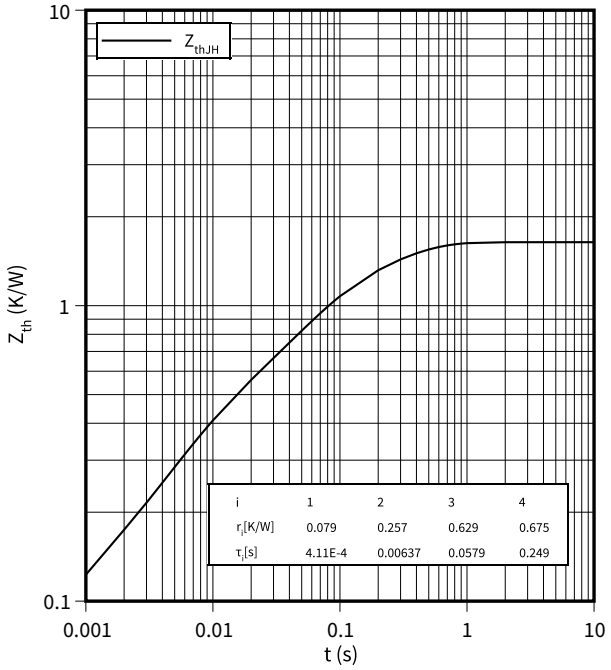
Forward characteristic (typical), Diode, D2 / D3

$I_F = f(V_F)$



Transient thermal impedance, Diode, D2 / D3

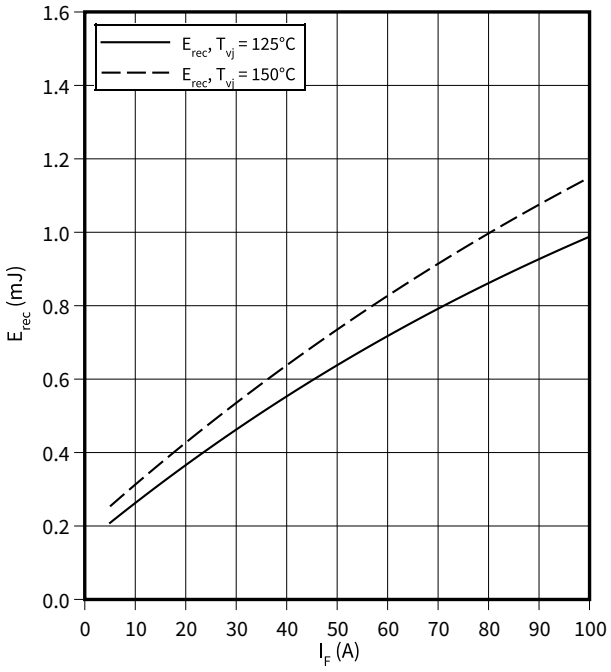
$Z_{th} = f(t)$



Switching losses (typical), Diode, D2 / D3

$E_{rec} = f(I_F)$

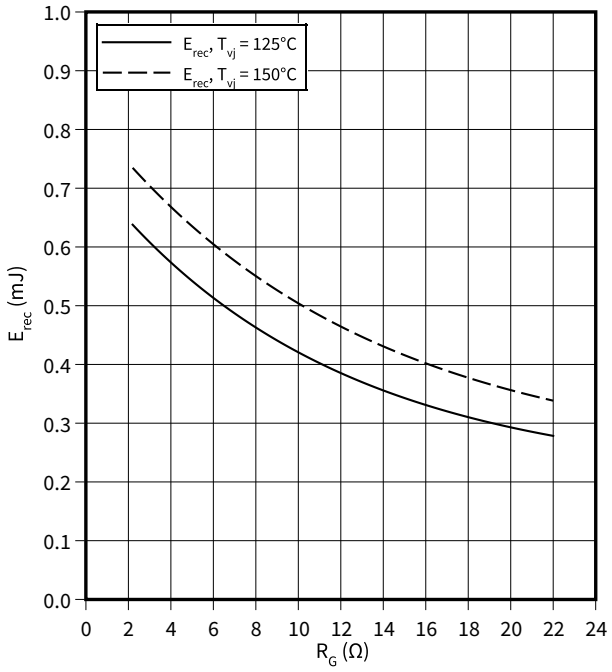
$R_{Gon} = 2.2\ \Omega$, $V_{CE} = 300\ V$



Switching losses (typical), Diode, D2 / D3

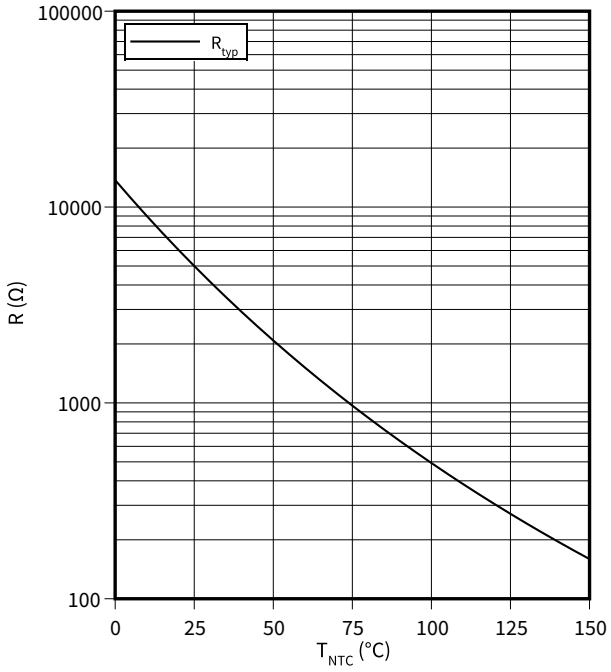
$E_{rec} = f(R_G)$

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



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



8 Circuit diagram

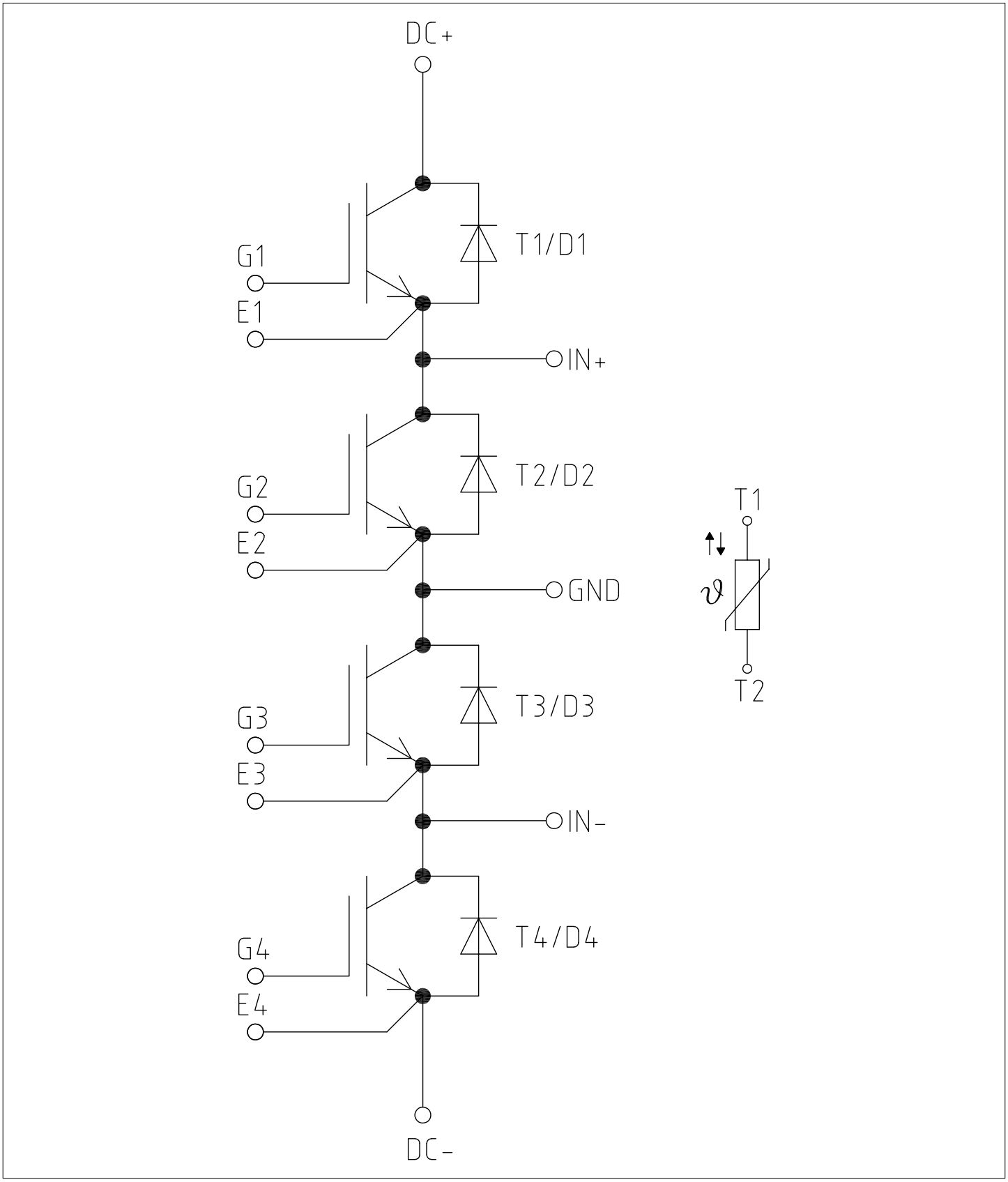


Figure 1

9 Package outlines

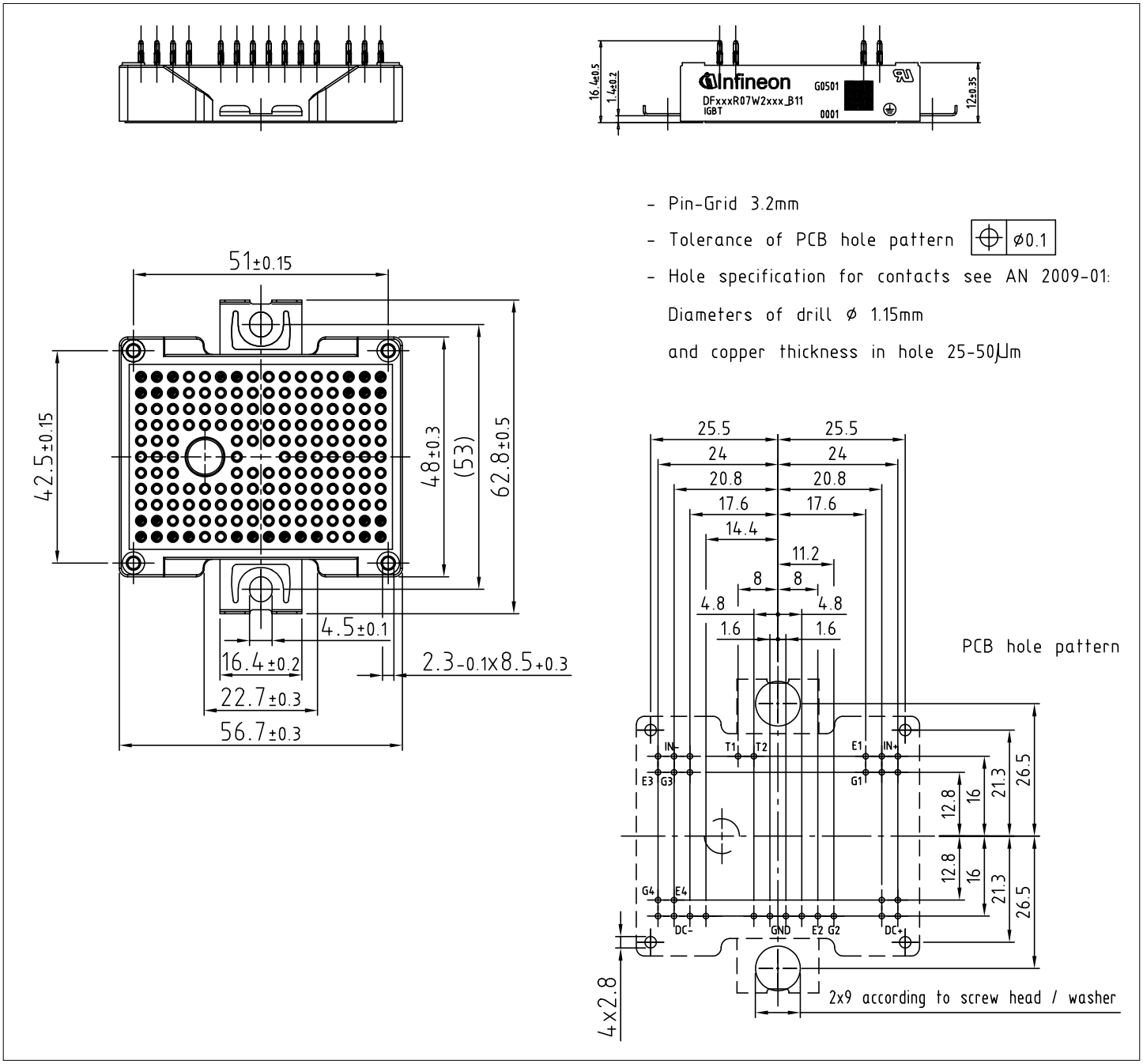


Figure 2

10 Module label code

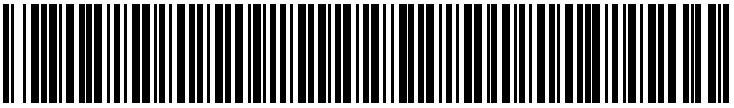
Module label code			
Code format	Data Matrix		Barcode Code128
Encoding	ASCII text		Code Set A
Symbol size	16x16		23 digits
Standard	IEC24720 and IEC16022		IEC8859-1
Code content	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production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

Figure 3

Revision history

Document revision	Date of release	Description of changes
0.10	2021-06-30	Target datasheet
1.00	2021-11-15	Final datasheet

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