EasyPACK™ module with CoolSiC™ Trench MOSFET and PressFIT / NTC / TIM

Features

- Electrical features
  - V_{DSS} = 1200 V
  - I_{DN} = 100 A / I_{DRM} = 200 A
  - High current density
  - Low switching losses
- Mechanical features
  - Rugged mounting due to integrated mounting clamps
  - Integrated NTC temperature sensor
  - PressFIT contact technology
  - Pre-applied thermal interface material

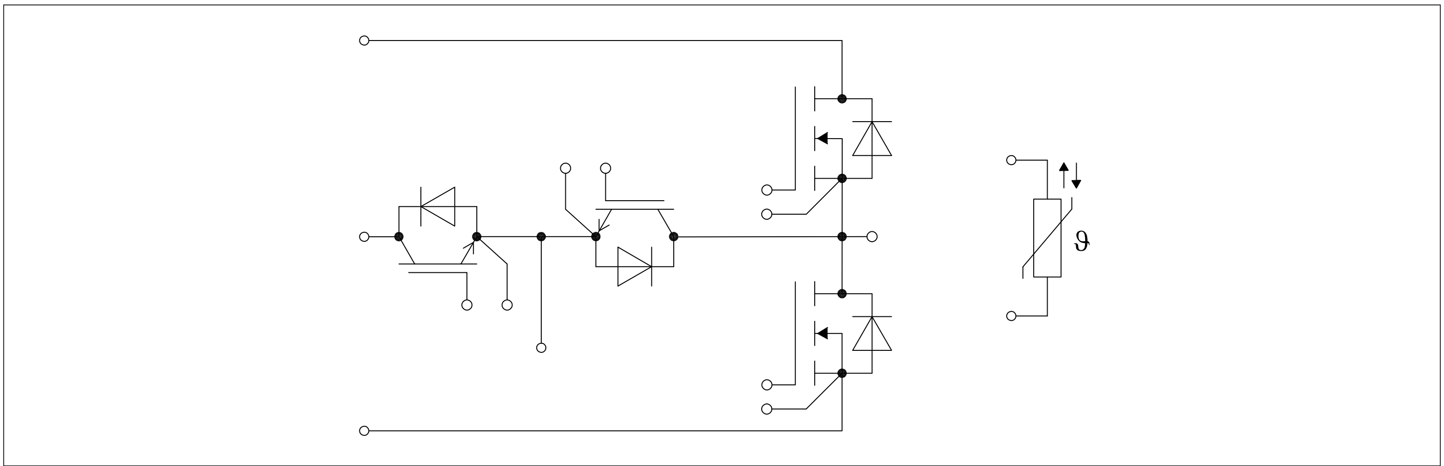
Potential applications

- Solar applications
- Three-level applications
- DC charger for EV

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 = 60 s	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}			12		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_H=25°C, per switch		0.4		mΩ
Storage temperature	T_{stg}		-40		125	°C
Maximum baseplate operation temperature	T_{BPmax}				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.*
Storage and shipment of modules with TIM => see AN2012-07.

2 MOSFET

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	V_{DSS}		T_{vj} = 25 °C	1200	V
Implemented drain current	I_{DN}			100	A
Continuous DC drain current	I_{DDC}	T_{vj} = 175 °C, V_{GS} = 18 V	T_H = 65 °C	85	A
Repetitive peak drain current	I_{DRM}	verified by design, t_p limited by T_{vjmax}		200	A

(table continues...)

Table 3 (continued) Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Gate-source voltage, max. transient voltage	V_{GS}	D<0.01	-10/23	V
Gate-source voltage, max. static voltage	V_{GS}		-7/20	V

Table 4 Recommended values

Parameter	Symbol	Note or test condition	Values	Unit
On-state gate voltage	$V_{GS(on)}$		15...18	V
Off-state gate voltage	$V_{GS(off)}$		-5...0	V

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source on-resistance	$R_{DS(on)}$	I_D = 100 A	V_{GS} = 18 V, T_{vj} = 25 °C		8.1	12	mΩ
			V_{GS} = 18 V, T_{vj} = 125 °C		13.1		
			V_{GS} = 18 V, T_{vj} = 175 °C		17.4		
			V_{GS} = 15 V, T_{vj} = 25 °C		9.7		
Gate threshold voltage	$V_{GS(th)}$	I_D = 40 mA, V_{DS} = V_{GS}, T_{vj} = 25 °C, (tested after 1ms pulse at V_{GS} = +20 V)		3.45	4.3	5.15	V
Total gate charge	Q_G	V_{DS} = 800 V, V_{GS} = -3/18 V			0.297		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			2.1		Ω
Input capacitance	C_{ISS}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		8.8		nF
Output capacitance	C_{OSS}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		0.42		nF
Reverse transfer capacitance	C_{rss}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		0.028		nF
C_{OSS} stored energy	E_{OSS}	V_{DS} = 800 V, V_{GS} = -3/18 V, T_{vj} = 25 °C			172		µJ
Drain-source leakage current	I_{DSS}	V_{DS} = 1200 V, V_{GS} = -3 V	T_{vj} = 25 °C		0.06	380	µA
Gate-source leakage current	I_{GSS}	V_{DS} = 0 V, T_{vj} = 25 °C	V_{GS} = 20 V			400	nA

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-on delay time (inductive load)	$t_{d\ on}$	I_D = 100 A, R_{Gon} = 15 Ω, V_{DS} = 400 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		83		ns
			T_{vj} = 125 °C		73		
			T_{vj} = 175 °C		70		
Rise time (inductive load)	t_r	I_D = 100 A, R_{Gon} = 15 Ω, V_{DS} = 400 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		106		ns
			T_{vj} = 125 °C		111		
			T_{vj} = 175 °C		116		
Turn-off delay time (inductive load)	$t_{d\ off}$	I_D = 100 A, R_{Goff} = 3.3 Ω, V_{DS} = 400 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		74		ns
			T_{vj} = 125 °C		80		
			T_{vj} = 175 °C		84		
Fall time (inductive load)	t_f	I_D = 100 A, R_{Goff} = 3.3 Ω, V_{DS} = 400 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		17		ns
			T_{vj} = 125 °C		16		
			T_{vj} = 175 °C		16		
Turn-on energy loss per pulse	E_{on}	I_D = 100 A, V_{DS} = 400 V, L_σ = 27 nH, V_{GS} = -3/18 V, R_{Gon} = 15 Ω, di/dt = 2 kA/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		3.28		mJ
			T_{vj} = 125 °C		3.97		
			T_{vj} = 175 °C		4.33		
Turn-off energy loss per pulse	E_{off}	I_D = 100 A, V_{DS} = 400 V, L_σ = 27 nH, V_{GS} = -3/18 V, R_{Goff} = 3.3 Ω, dv/dt = 20.1 kV/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		0.32		mJ
			T_{vj} = 125 °C		0.38		
			T_{vj} = 175 °C		0.42		
Thermal resistance, junction to heat sink	R_{thJH}	per MOSFET, Valid with IFX pre-applied Thermal Interface Material				0.581	K/W
Temperature under switching conditions	$T_{vj\ op}$			-40		175	°C

Note: *The selection of positive and negative gate-source voltages impacts the long-term behavior of the MOSFET and body diode. The design guidelines described in Application Note AN 2018-09 must be considered to ensure sound operation of the device over the planned lifetime.*

Tvj op > 150°C is allowed for operation at overload conditions for MOSFET and body diode. For detailed specifications, please refer to AN 2021-13.

3 Body diode

Table 6 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
DC body diode forward current	I_{SD}	T_{vj} = 175 °C, V_{GS} = -3 V	T_H = 65 °C	32	A

Table 7 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_{SD}	I_{SD} = 100 A, V_{GS} = -3 V	T_{vj} = 25 °C		4.2	5.35	V
			T_{vj} = 125 °C		3.9		
			T_{vj} = 175 °C		3.8		

4 IGBT, 3-Level

Table 8 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}			200	A
Continuous DC collector current	I_{CDC}	$T_{vj\,max}$ = 175 °C	T_H = 65 °C	90	A
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\,op}$		200	A
Gate-emitter peak voltage	V_{GES}			±20	V

Table 9 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	0.74	1.17	1.59	V
			T_{vj} = 125 °C		1.20		
			T_{vj} = 150 °C		1.21		
Gate threshold voltage	V_{GEth}	I_C = 2 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			0.84		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			14.3		nF
Reverse transfer capacitance	C_{res}	f = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			0.05		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			1	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 = 100 A, V_{CE} = 400 V, V_{GE} = ±15 V, R_{Gon} = 2.7 Ω	T_{vj} = 25 °C		0.014		µs
			T_{vj} = 125 °C		0.015		
			T_{vj} = 150 °C		0.015		

(table continues...)

Table 9 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Rise time (inductive load)	t_r	I_C = 100 A, V_{CE} = 400 V, V_{GE} = ±15 V, R_{Gon} = 2.7 Ω	T_{vj} = 25 °C		0.009		µs
			T_{vj} = 125 °C		0.010		
			T_{vj} = 150 °C		0.011		
Turn-off delay time (inductive load)	t_{doff}	I_C = 100 A, V_{CE} = 400 V, V_{GE} = ±15 V, R_{Goff} = 39 Ω	T_{vj} = 25 °C		0.650		µs
			T_{vj} = 125 °C		0.680		
			T_{vj} = 150 °C		0.700		
Fall time (inductive load)	t_f	I_C = 100 A, V_{CE} = 400 V, V_{GE} = ±15 V, R_{Goff} = 39 Ω	T_{vj} = 25 °C		0.023		µs
			T_{vj} = 125 °C		0.045		
			T_{vj} = 150 °C		0.055		
Turn-on energy loss per pulse	E_{on}	I_C = 100 A, V_{CE} = 400 V, L_σ = 27 nH, V_{GE} = ±15 V, R_{Gon} = 2.7 Ω, di/dt = 7600 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.264		mJ
			T_{vj} = 125 °C		0.394		
			T_{vj} = 150 °C		0.438		
Turn-off energy loss per pulse	E_{off}	I_C = 100 A, V_{CE} = 400 V, L_σ = 27 nH, V_{GE} = ±15 V, R_{Goff} = 39 Ω, dv/dt = 4800 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.7		mJ
			T_{vj} = 125 °C		2.05		
			T_{vj} = 150 °C		2.31		
Thermal resistance, junction to heat sink	R_{thJH}	per IGBT, Valid with IFX pre-applied Thermal Interface Material				0.723	K/W
Temperature under switching conditions	$T_{vj\ op}$			-40		150	°C

5 Diode, 3-Level

Table 10 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}			150	A
Continuous DC forward current	I_F			100	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		200	A
I^2t - value	I^2t	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	1270	A^2s
			T_{vj} = 150 °C	1480	

Table 11 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 100 A, V_{GE} = 0 V	T_{vj} = 25 °C	0.74	1.35	1.86	V
			T_{vj} = 125 °C		1.29		
			T_{vj} = 150 °C		1.25		
Peak reverse recovery current	I_{RM}	I_F = 100 A, V_R = 400 V, V_{GE} = -15 V, -di$_F$/dt = 2000 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		64.2		A
			T_{vj} = 125 °C		99.8		
			T_{vj} = 150 °C		114		
Recovered charge	Q_r	I_F = 100 A, V_R = 400 V, V_{GE} = -15 V, -di$_F$/dt = 2000 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		3.99		µC
			T_{vj} = 125 °C		7.07		
			T_{vj} = 150 °C		9.8		
Reverse recovery energy	E_{rec}	I_F = 100 A, V_R = 400 V, V_{GE} = -15 V, -di$_F$/dt = 2000 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.45		mJ
			T_{vj} = 125 °C		1		
			T_{vj} = 150 °C		1.35		
Thermal resistance, junction to heat sink	R_{thJH}	per diode, Valid with IFX pre-applied Thermal Interface Material				0.802	K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

6 NTC-Thermistor

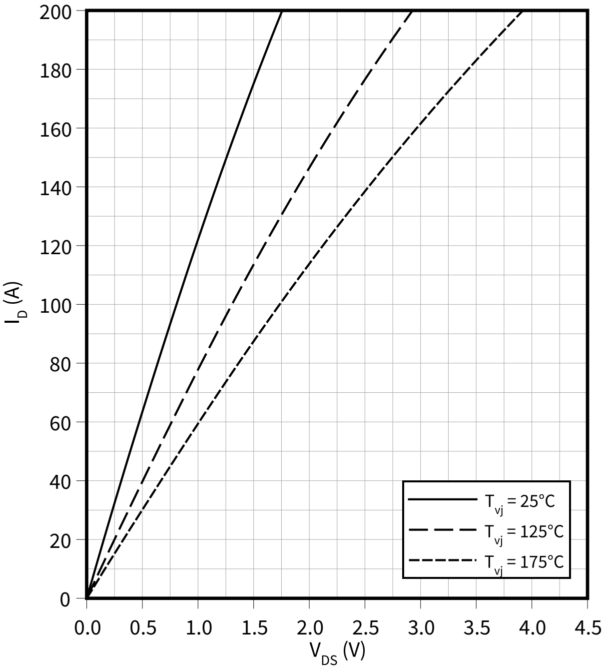
Table 12 Characteristic values

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

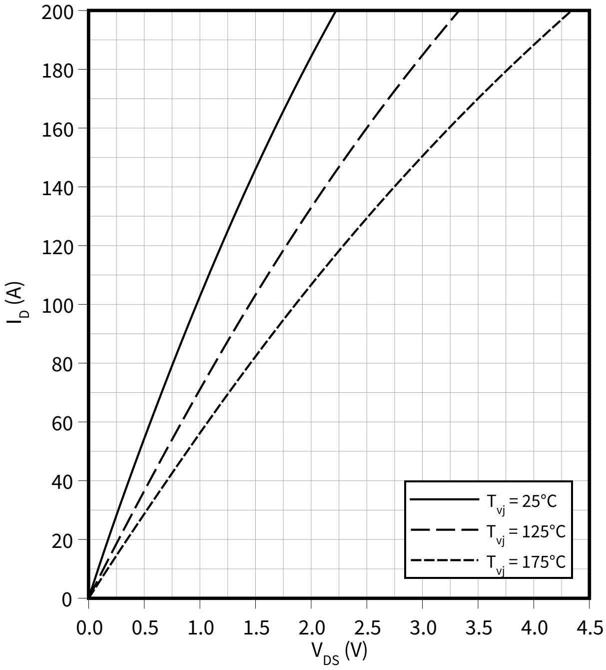
Note: Specification according to the valid application note.

7 Characteristics diagrams

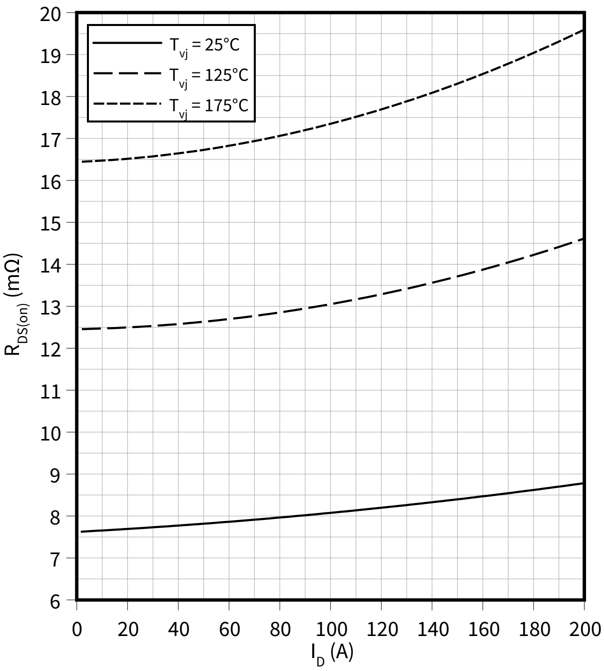
output characteristic (typical), MOSFET
$I_D = f(V_{DS})$
$V_{GS} = 18$ V



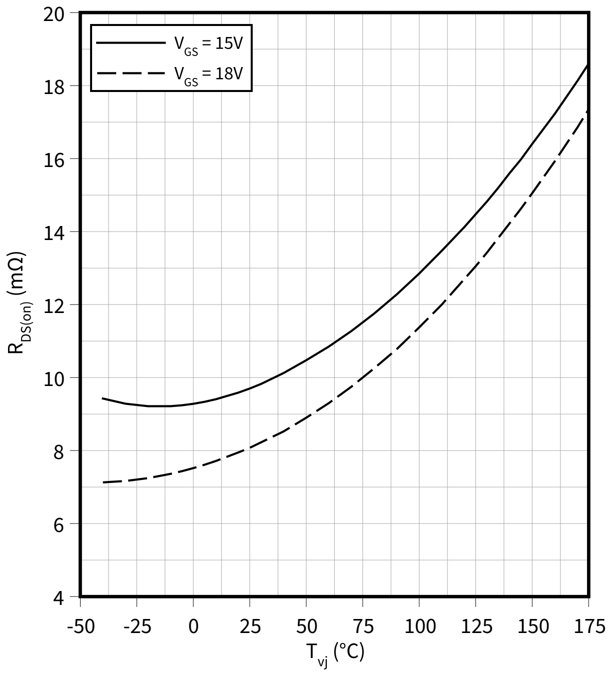
output characteristic (typical), MOSFET
$I_D = f(V_{DS})$
$V_{GS} = 15$ V



Drain source on-resistance (typical), MOSFET
$R_{DS(on)} = f(I_D)$
$V_{GS} = 18$ V



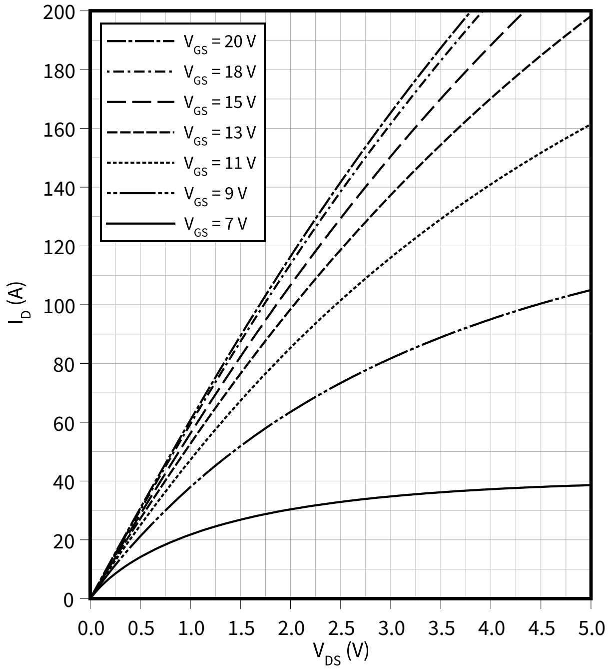
Drain source on-resistance (typical), MOSFET
$R_{DS(on)} = f(T_{vj})$
$I_D = 100$ A



Output characteristic field (typical), MOSFET

$I_D = f(V_{DS})$

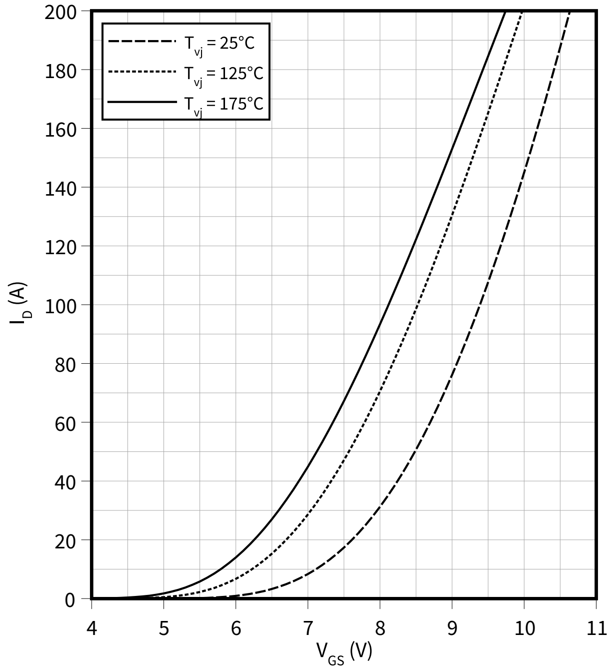
$T_{vj} = 175\ °C$



Transfer characteristic (typical), MOSFET

$I_D = f(V_{GS})$

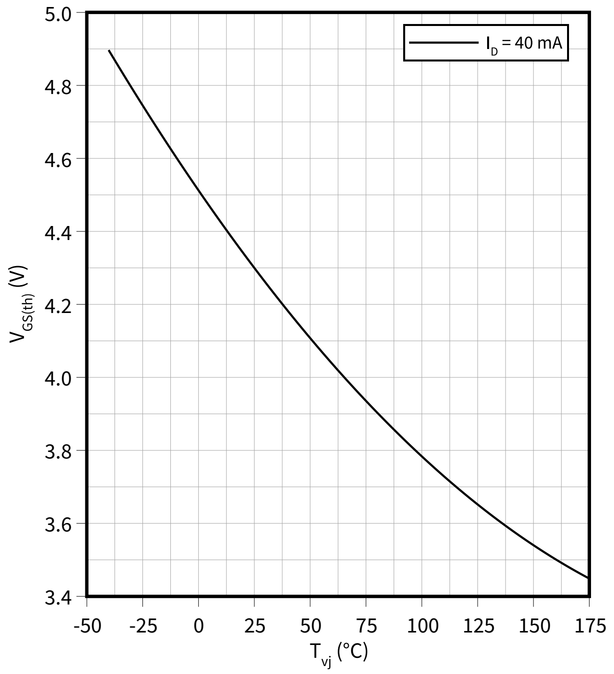
$V_{DS} = 20\ V$



Gate-source threshold voltage (typical), MOSFET

$V_{GS(th)} = f(T_{vj})$

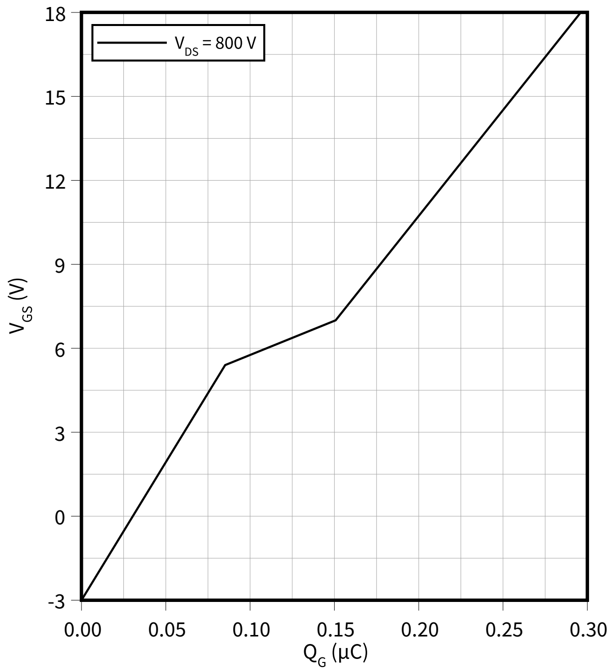
$V_{GS} = V_{DS}$



Gate charge characteristic (typical), MOSFET

$V_{GS} = f(Q_G)$

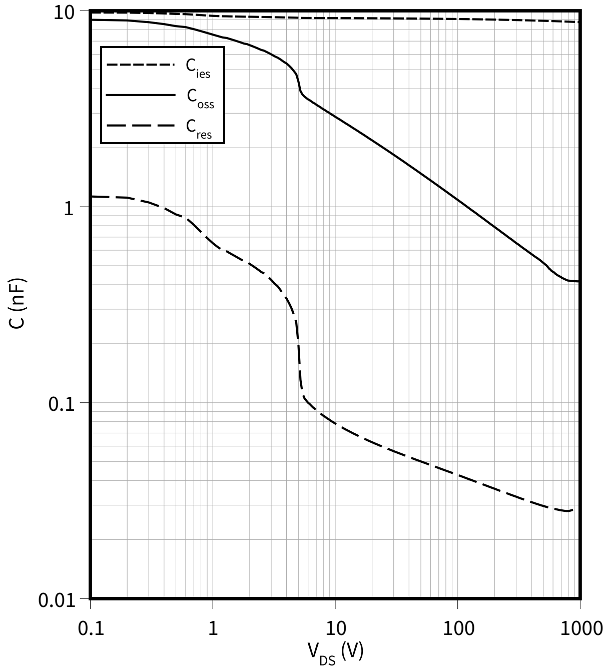
$I_D = 100\ A,\ T_{vj} = 25\ °C$



Capacity characteristic (typical), MOSFET

$C = f(V_{DS})$

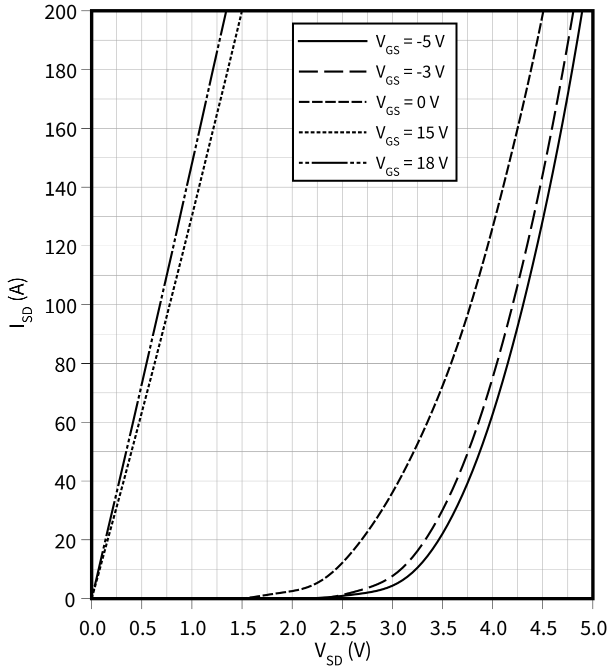
$f = 100\ \text{kHz}, T_{vj} = 25\ °C, V_{GS} = 0\ V$



Forward characteristic body diode (typical), MOSFET

$I_{SD} = f(V_{SD})$

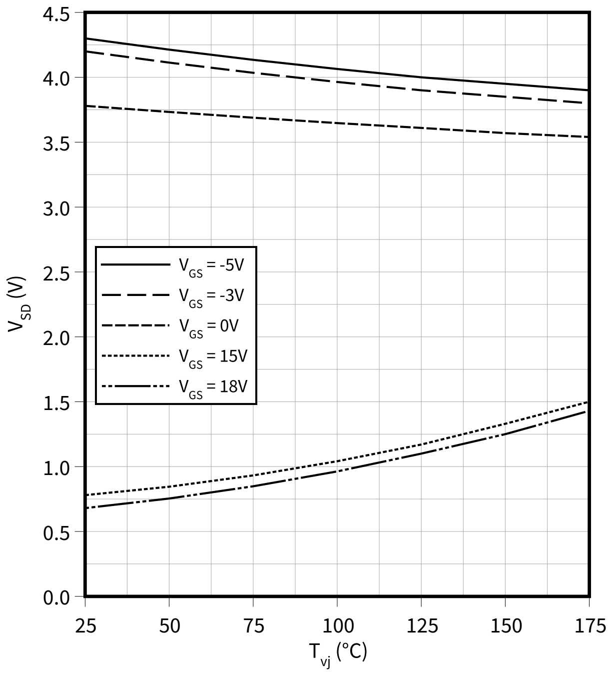
$T_{vj} = 25\ °C$



Forward voltage of body diode (typical), MOSFET

$V_{SD} = f(T_{vj})$

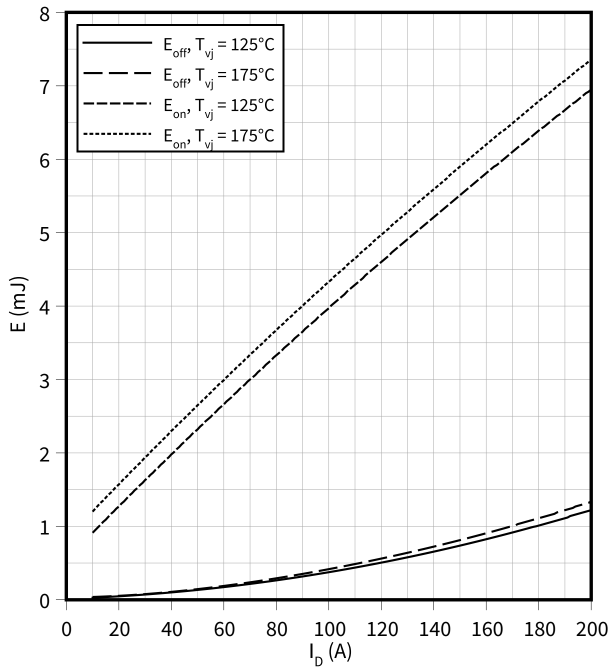
$I_{SD} = 100\ A$



Switching losses (typical), MOSFET

$E = f(I_D)$

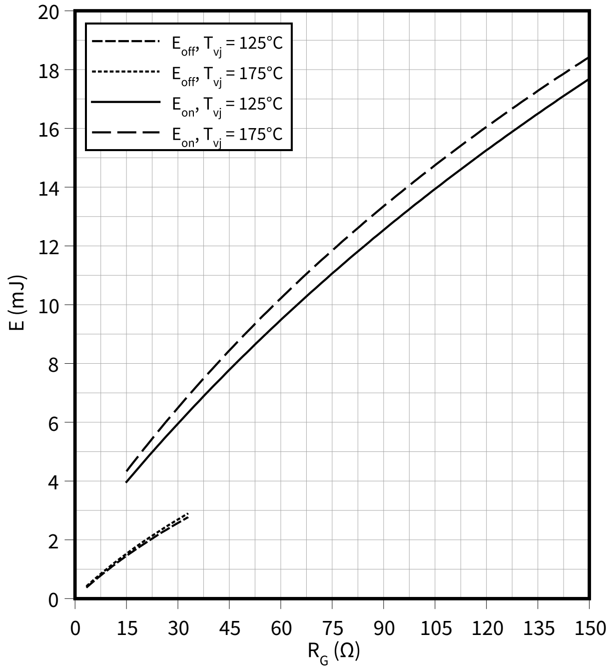
$R_{Goff} = 3.3\ \Omega, R_{Gon} = 15\ \Omega, V_{DS} = 400\ V, V_{GS} = -3/18\ V$



Switching losses (typical), MOSFET

$E = f(R_G)$

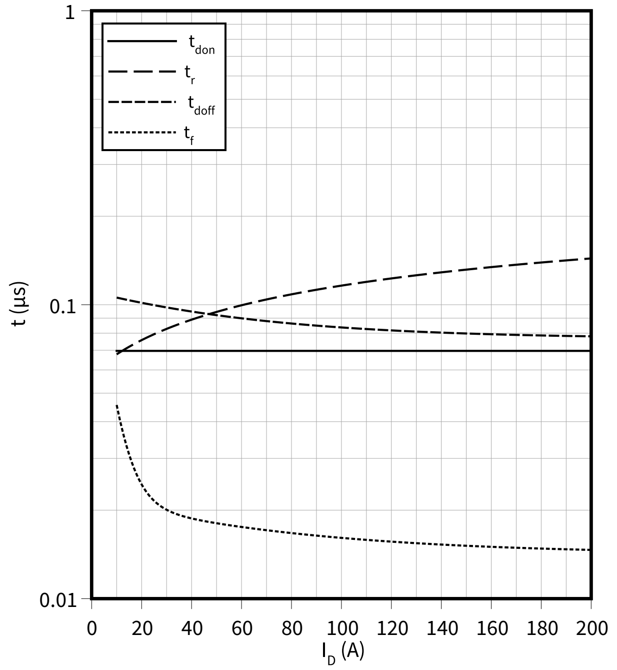
V_{DS} = 400 V, I_D = 100 A, V_{GS} = -3/18 V



Switching times (typical), MOSFET

$t = f(I_D)$

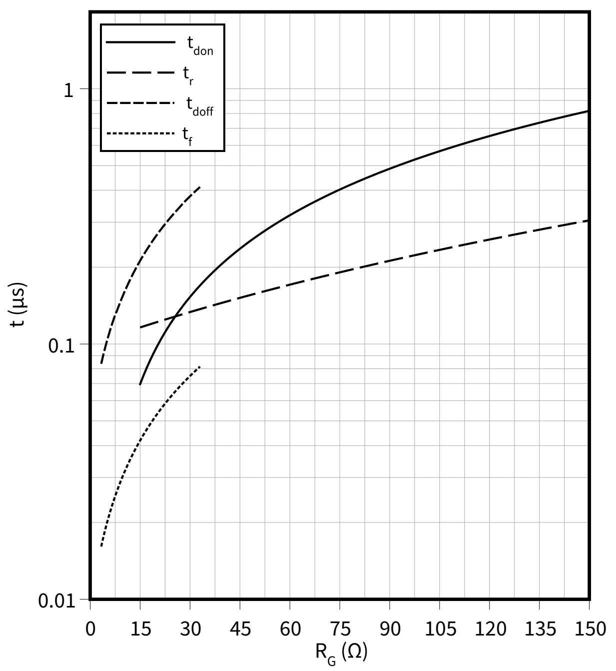
R_{Goff} = 3.3 Ω, R_{Gon} = 15 Ω, V_{DS} = 400 V, T_{vj} = 175 °C, V_{GS} = -3/18 V



Switching times (typical), MOSFET

$t = f(R_G)$

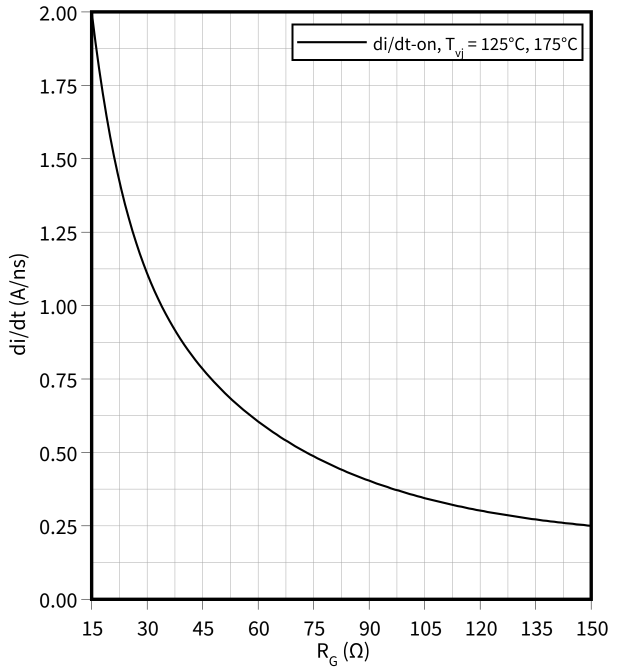
V_{DS} = 400 V, I_D = 100 A, T_{vj} = 175 °C, V_{GS} = -3/18 V



Current slope (typical), MOSFET

$di/dt = f(R_G)$

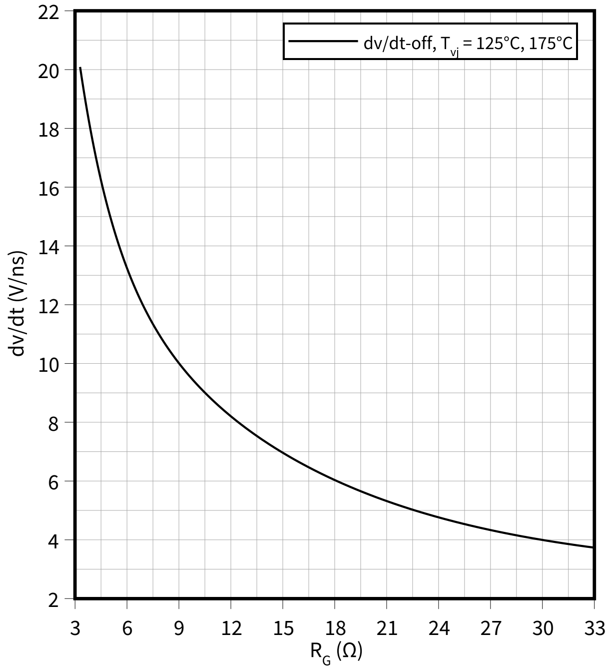
V_{DS} = 400 V, I_D = 100 A, V_{GS} = -3/18 V



Voltage slope (typical), MOSFET

$dv/dt = f(R_G)$

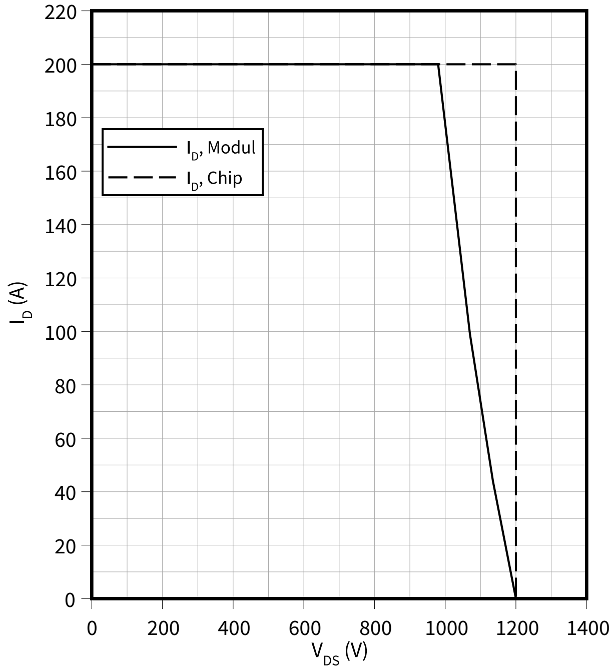
V_{DS} = 400 V, I_D = 100 A, V_{GS} = -3/18 V



Reverse bias safe operating area (RBSOA), MOSFET

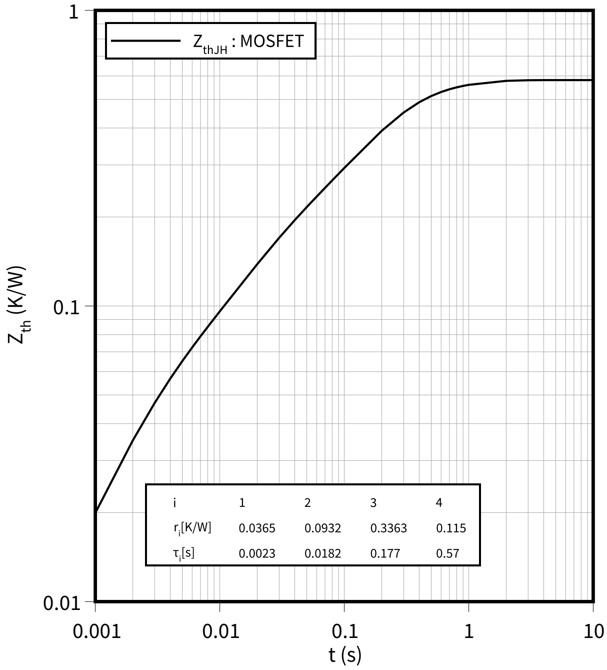
$I_D = f(V_{DS})$

R_{Goff} = 3.3 Ω, T_{vj} = 175 °C, V_{GS} = -3/18 V



Transient thermal impedance, MOSFET

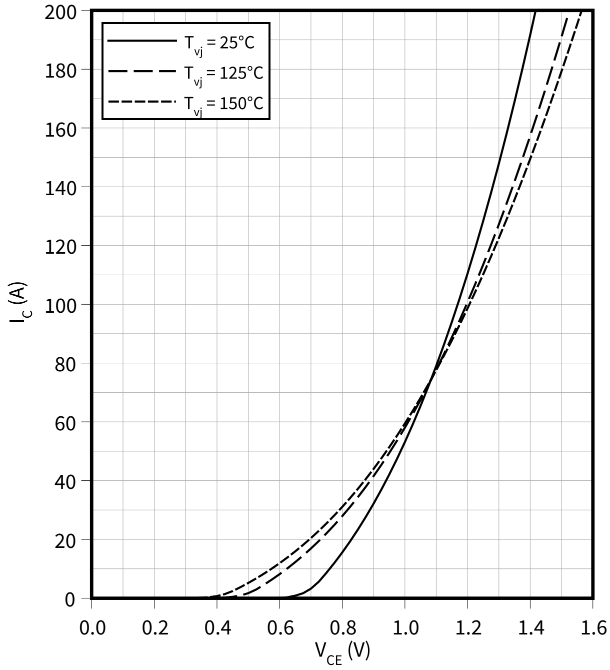
$Z_{th} = f(t)$



Output characteristic (typical), IGBT, 3-Level

$I_C = f(V_{CE})$

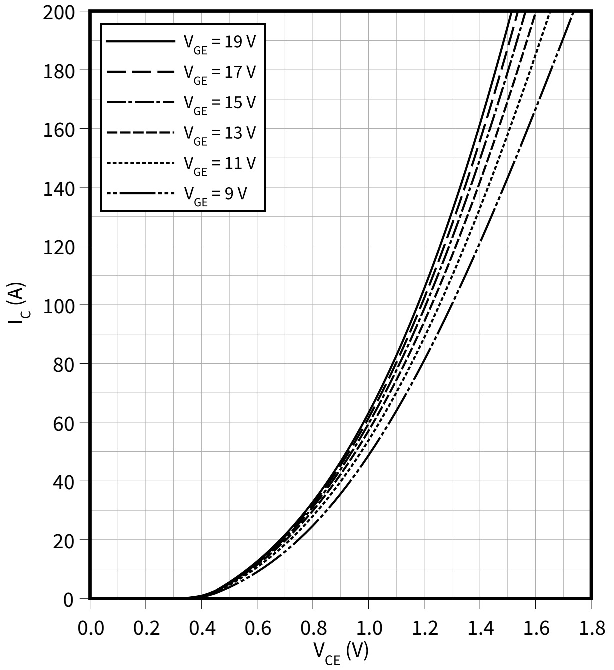
V_{GE} = 15 V



Output characteristic field (typical), IGBT, 3-Level

$I_C = f(V_{CE})$

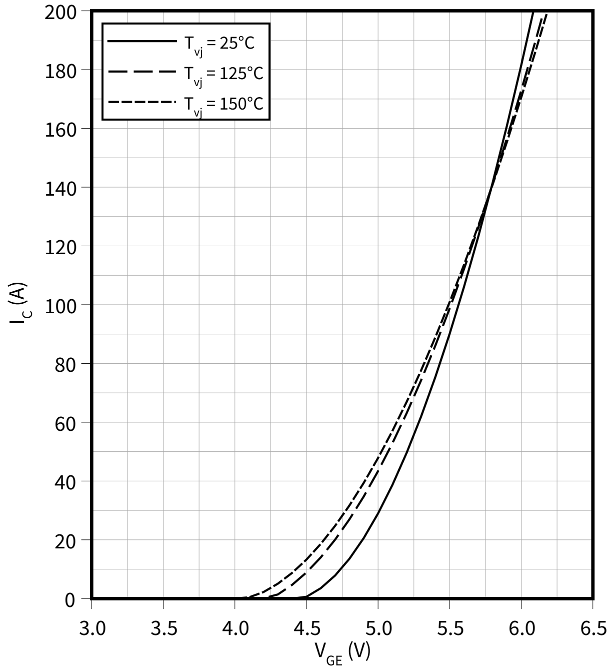
$T_{vj} = 150\ °C$



Transfer characteristic (typical), IGBT, 3-Level

$I_C = f(V_{GE})$

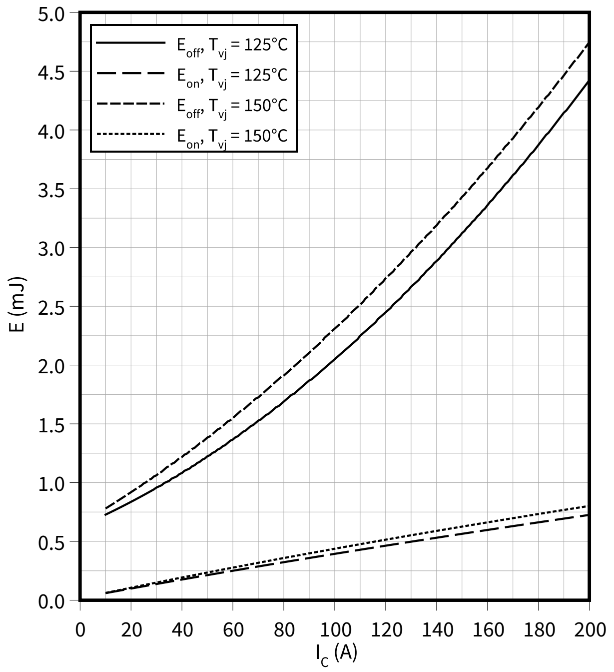
$V_{CE} = 20\ V$



Switching losses (typical), IGBT, 3-Level

$E = f(I_C)$

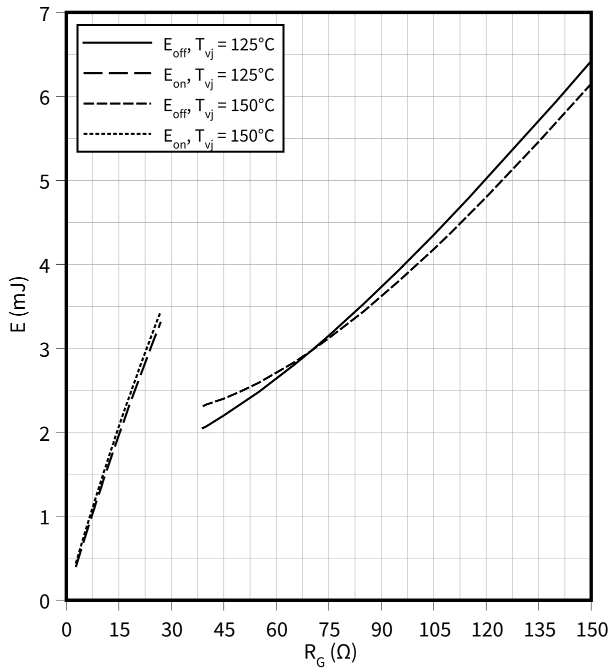
$R_{Goff} = 39\ \Omega$, $R_{Gon} = 2.7\ \Omega$, $V_{CE} = 400\ V$, $V_{GE} = -15\ /\ +15\ V$



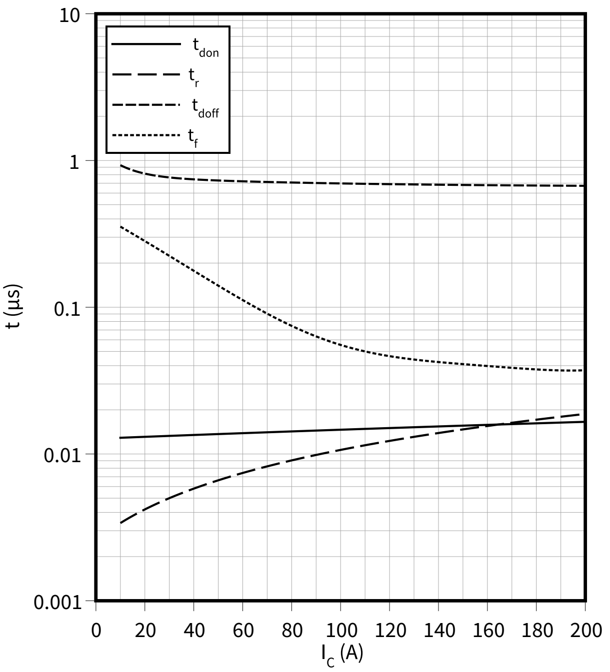
Switching losses (typical), IGBT, 3-Level

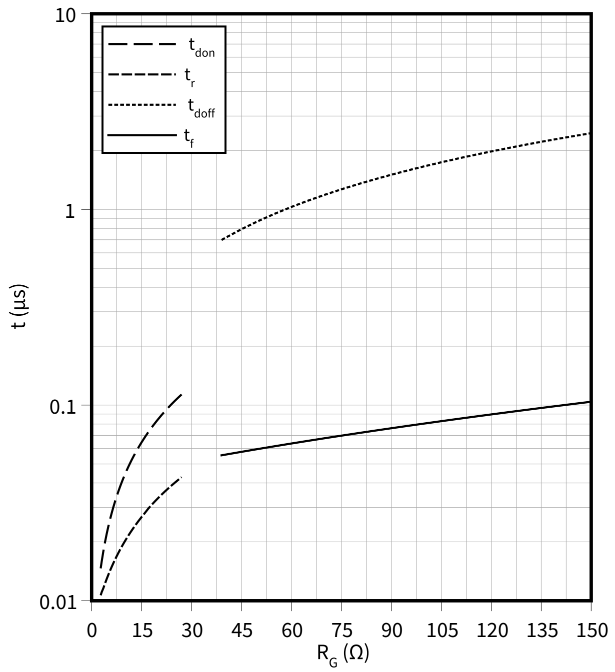
$E = f(R_G)$

$I_C = 100\ A$, $V_{CE} = 400\ V$, $V_{GE} = -15\ /\ +15\ V$

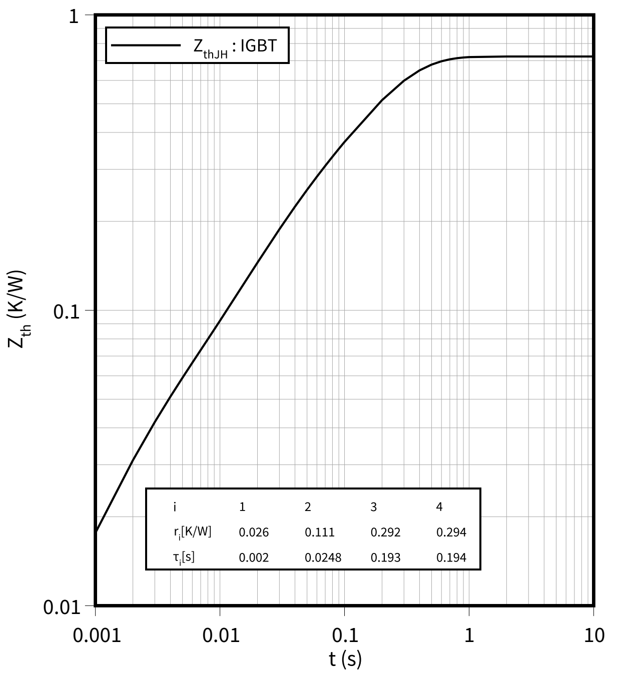


Switching times (typical), IGBT, 3-Level $t = f(I_C)$ R_{Goff} = 39 Ω, R_{Gon} = 2.7 Ω, R_{Gon} = 2.7 Ω, V_{CE} = 400 V, V_{GE} = ± 15 V, T_{vj} = 150 °C	**Switching times (typical), IGBT, 3-Level** $t = f(R_G)$ I_C = 100 A, V_{CE} = 400 V, V_{GE} = -15 / +15 V, T_{vj} = 150 °C

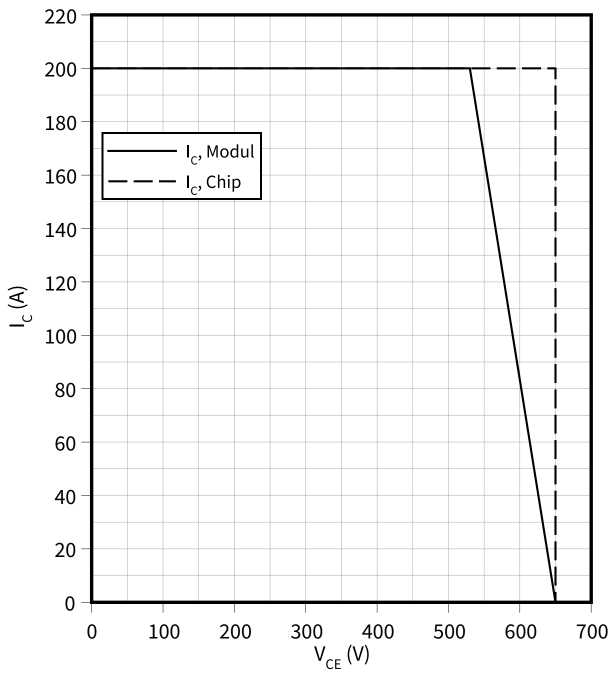




Transient thermal impedance, IGBT, 3-Level $Z_{th} = f(t)$	**Reverse bias safe operating area (RBSOA), IGBT, 3-Level** $I_C = f(V_{CE})$ T_{vj} = 150 °C, R_{Goff} = 39 Ω, V_{GE} = ±15 V



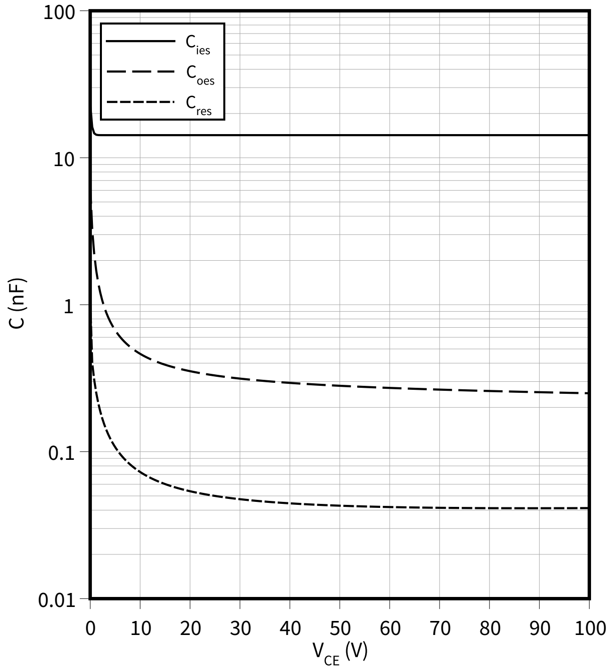
i	1	2	3	4
r_i[K/W]	0.026	0.111	0.292	0.294
$τ_i$[s]	0.002	0.0248	0.193	0.194



Capacity characteristic (typical), IGBT, 3-Level

$C = f(V_{CE})$

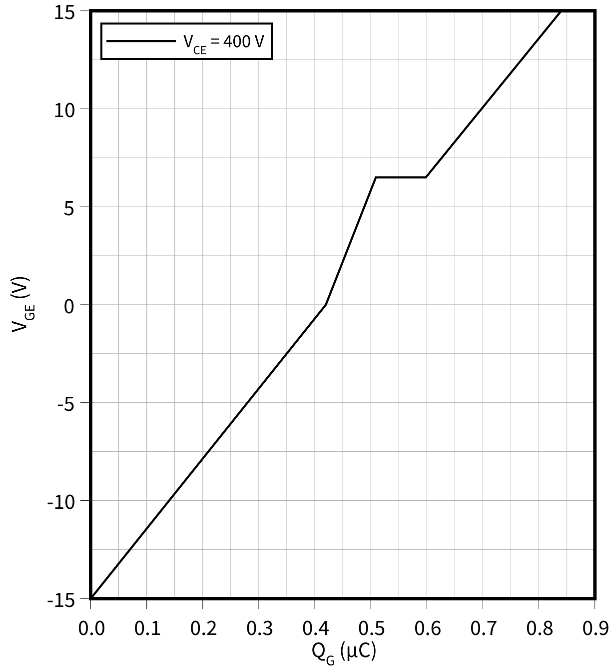
$f = 100\ kHz$, $V_{GE} = 0\ V$, $T_{vj} = 25\ °C$



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

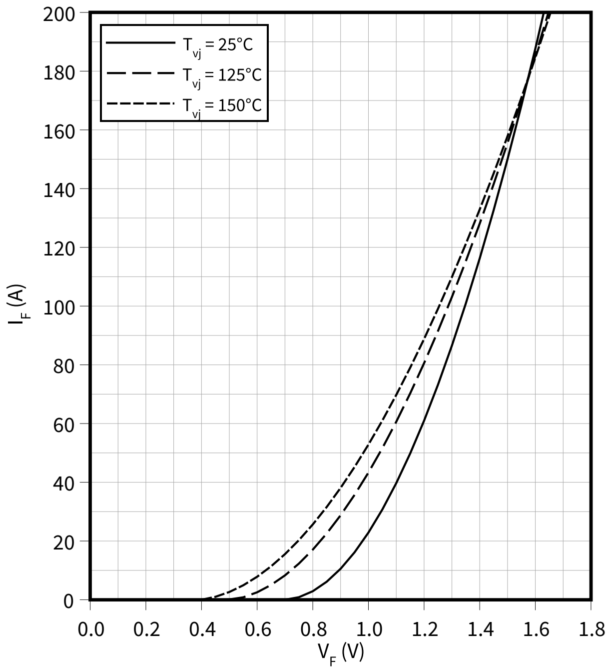
$V_{GE} = f(Q_G)$

$I_C = 100\ A$, $T_{vj} = 25\ °C$



Forward characteristic (typical), Diode, 3-Level

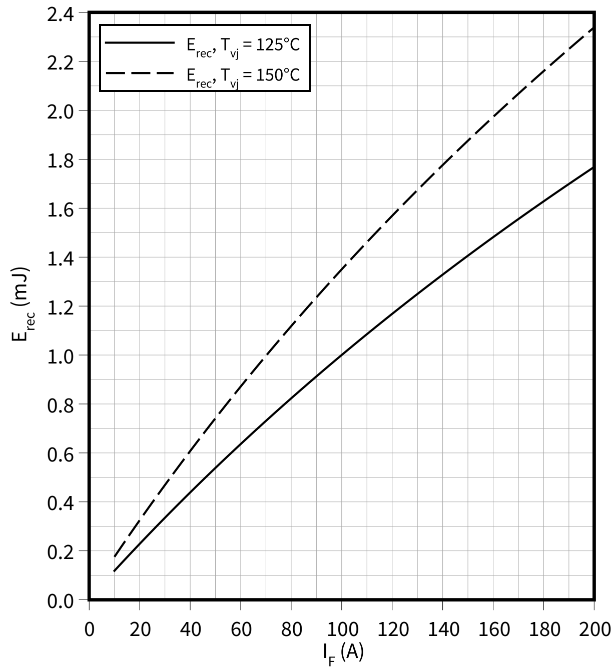
$I_F = f(V_F)$



Switching losses (typical), Diode, 3-Level

$E_{rec} = f(I_F)$

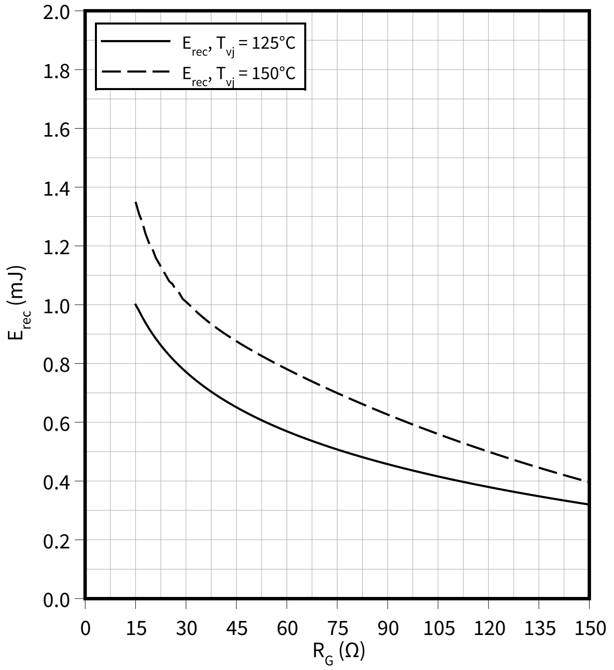
$R_G = 15\ \Omega$, $V_R = 400\ V$



Switching losses (typical), Diode, 3-Level

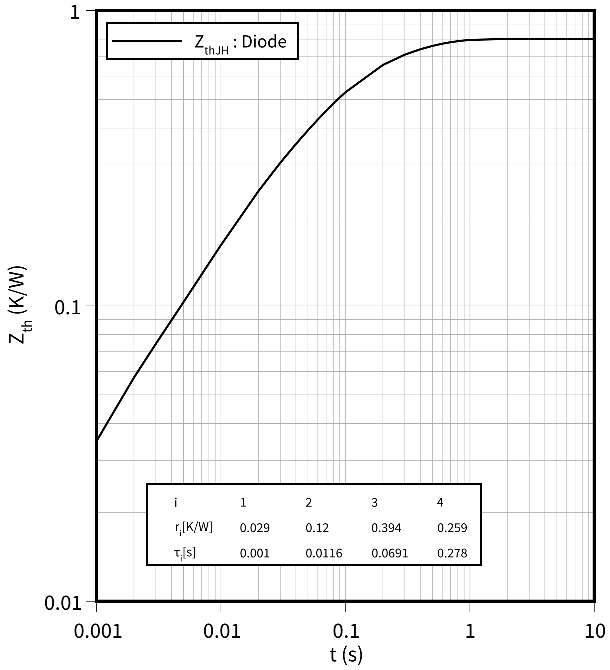
$E_{rec} = f(R_G)$

$I_F = 100\ A$, $V_R = 400\ V$



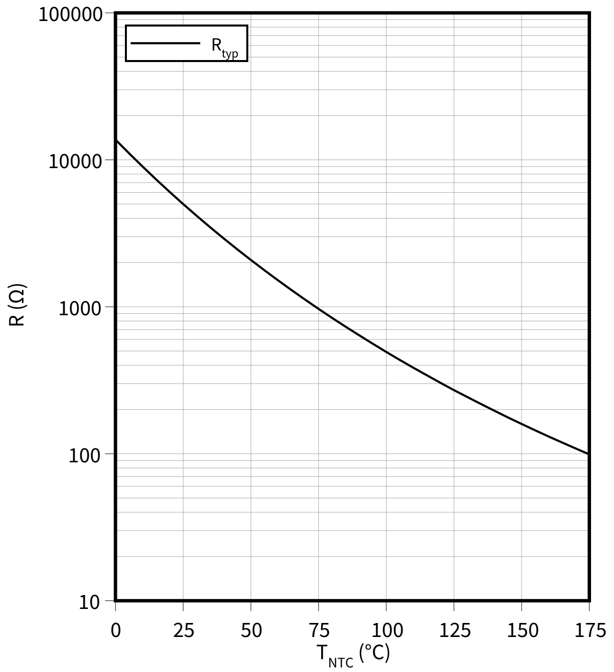
Transient thermal impedance, Diode, 3-Level

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



8 Circuit diagram

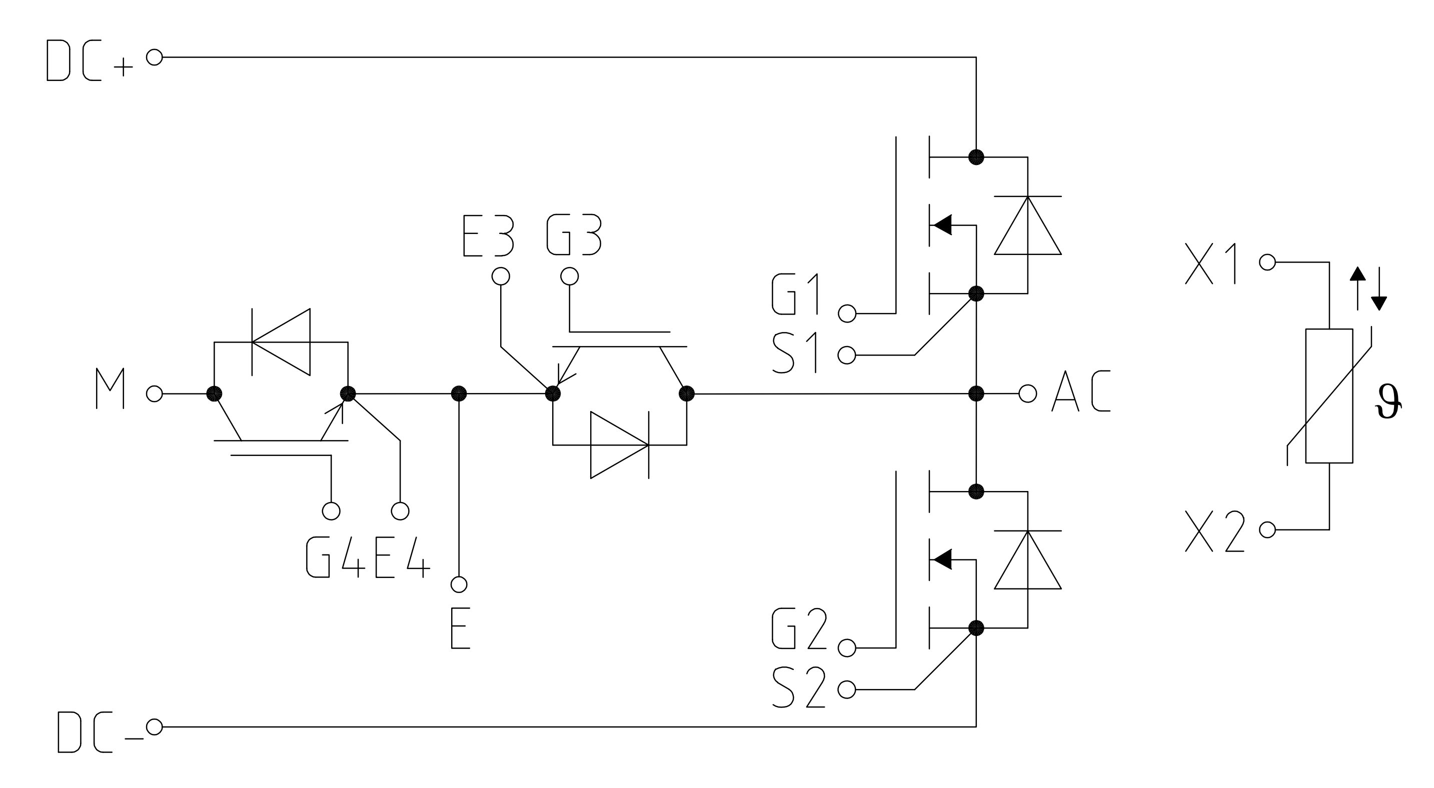


Figure 1

9 Package outlines

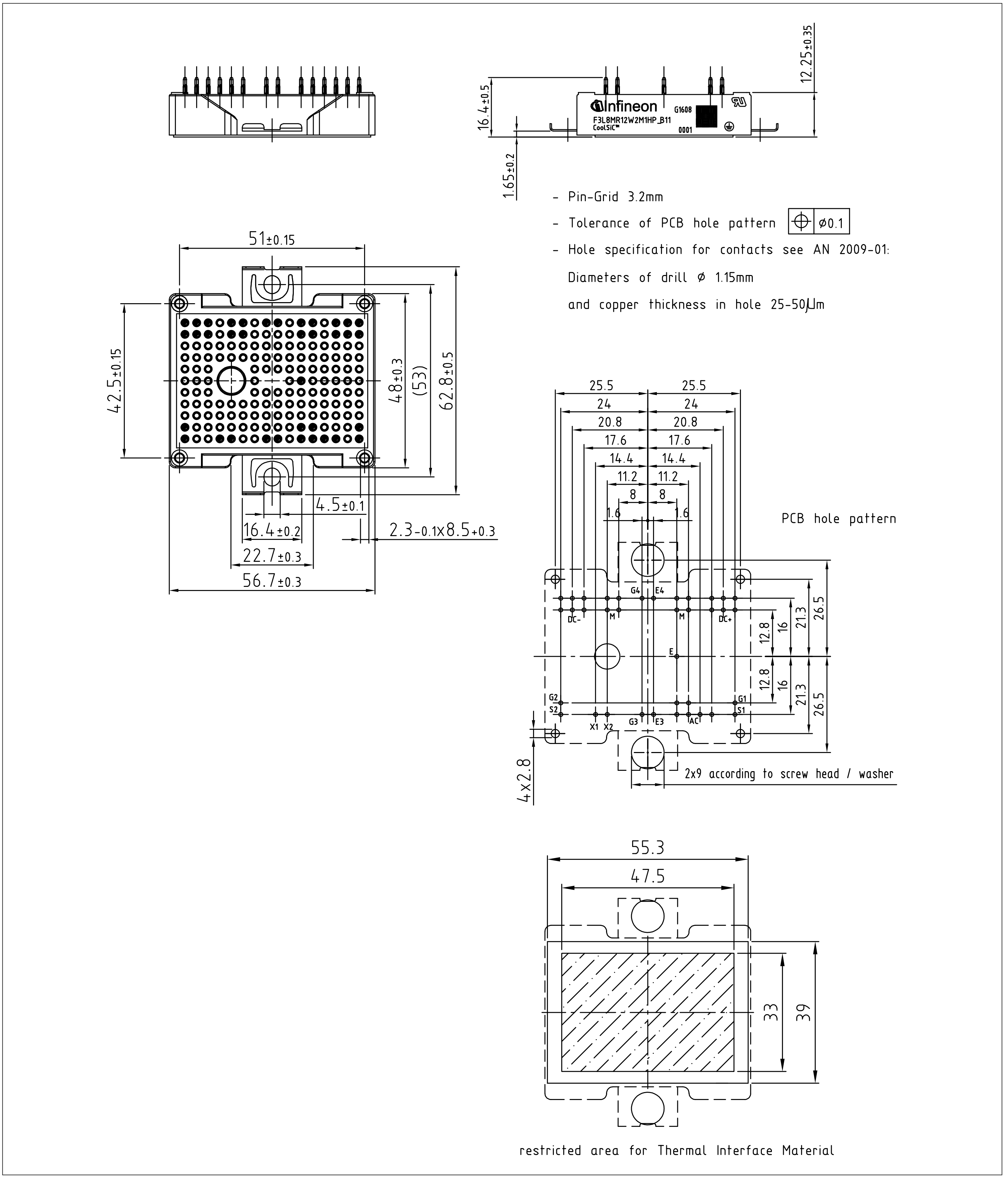


Figure 2

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*	*Digit*	*Example*
	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 3

Revision history

Document revision	Date of release	Description of changes
0.10	2021-04-07	
1.00	2022-03-09	Final datasheet
1.10	2022-03-10	Final datasheet

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