Final datasheet

EasyPACK™ 2B module with CoolMOS™ CFD7A Automotive MOSFET and PressFIT / NTC

Features


Typical appearance

- Electrical features
  - V_{DSS} = 650 V
  - I_{DN} = 35 A / I_{DRM} = 70 A
  - Low switching losses
  - Low inductive design
  - Integrated snubber
- Mechanical features
  - PressFIT contact technology
  - Integrated NTC temperature sensor
  - Rugged mounting due to integrated mounting clamps

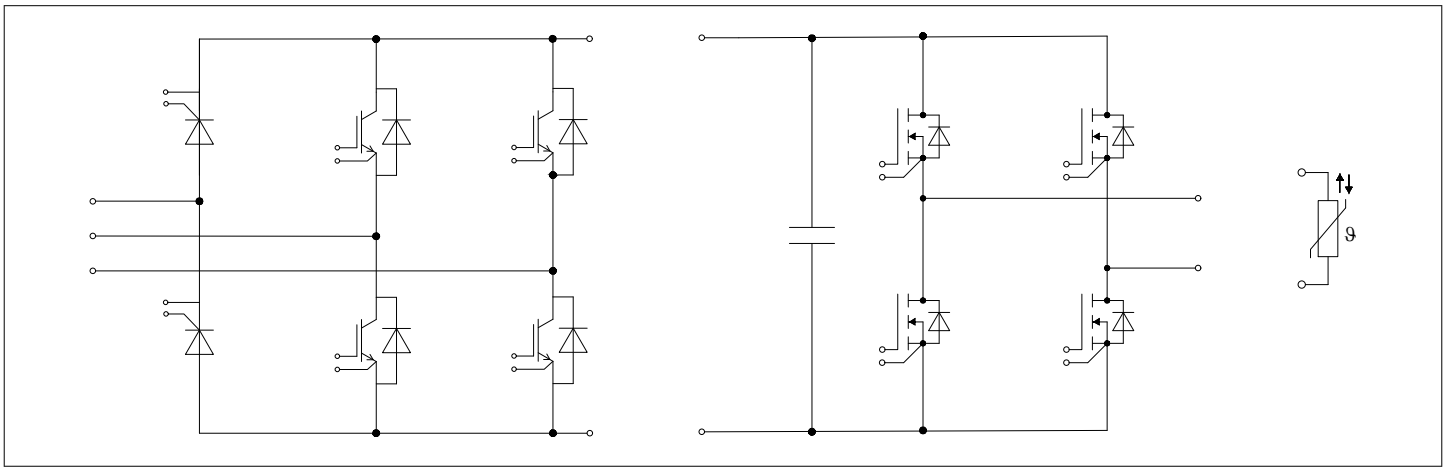
Potential applications

- Automotive auxillary applications
- DC charger for EV
- High-frequency switching application

Product validation

- Qualified according to AQG 324, release no.: 02.1/2019

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	2.4	mm
Clearance	d_{Clear}	terminal to heatsink	10.0	mm
Clearance	d_{Clear}	terminal to terminal	2.4	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[1)]	L_{sCE}			24		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_H = 25 °C, per switch		3.8		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting force per clamp	*F*		40		80	N
Weight	*G*			39		g

1) Value is given for the IGBT part of the module

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

2 MOSFET

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	V_{DSS}		T_{vj} = 25 °C	650	V
			T_{vj} = -40 °C	605	
Implemented drain current	I_{DN}			35	A
Continuous DC drain current	I_{DDC}	T_{vj} = 150 °C, V_{GS} = 10 V	T_H = 65 °C	30	A
Repetitive peak drain current	I_{DRM}	verified by design, t_p limited by T_{vjmax}		70	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}	$f_{repetition} \leq 100$ kHz, $t_{pulse} \leq 2$ ns	±30	V
Gate-source voltage, max. static voltage	V_{GS}		±20	V
dv/dt ruggedness	dv/dt	$V_{DS} = 400$ V	120	V/ns

Table 4 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source on-resistance	$R_{DS(on)}$	$I_D = 35$ A	$V_{GS} = 10$ V, $T_{vj} = 25$ °C		30	39.4	mΩ
			$V_{GS} = 10$ V, $T_{vj} = 125$ °C		53		
			$V_{GS} = 10$ V, $T_{vj} = 150$ °C		61		
Gate threshold voltage	$V_{GS(th)}$	$I_D = 1.74$ mA, $V_{DS} = V_{GS}$, $T_{vj} = 25$ °C		3.55	4	4.45	V
Total gate charge	Q_G	$V_{DD} = 400$ V, $V_{GS} = 10$ V			0.141		µC
Internal gate resistor	R_{Gint}	$T_{vj} = 25$ °C			3.8		Ω
Input capacitance	C_{ISS}	$f = 100$ kHz, $V_{DS} = 400$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C		6.95		nF
Output capacitance	C_{OSS}	$f = 100$ kHz, $V_{DS} = 400$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C		0.092		nF
Reverse transfer capacitance	C_{rss}	$f = 100$ kHz, $V_{DS} = 400$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C		0.021		nF
C_{OSS} stored energy	E_{OSS}	$V_{DS} = 400$ V, $V_{GS} = 10$ V, $T_{vj} = 25$ °C			17.9		µJ
Drain-source leakage current	I_{DSS}	$V_{DS} = 650$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C			10	µA
Gate-source leakage current	I_{GSS}	$V_{DS} = 0$ V, $T_{vj} = 25$ °C	$V_{GS} = 20$ V			100	nA
Turn-on delay time (inductive load)	$t_{d\,on}$	$I_D = 35$ A, $R_{Gon} = 11$ Ω, $V_{DD} = 400$ V, $V_{GS} = 0/10$ V	$T_{vj} = 25$ °C		120		ns
			$T_{vj} = 125$ °C		117		
			$T_{vj} = 150$ °C		115		
Rise time (inductive load)	t_r	$I_D = 35$ A, $R_{Gon} = 11$ Ω, $V_{DD} = 400$ V, $V_{GS} = 0/10$ V	$T_{vj} = 25$ °C		12.6		ns
			$T_{vj} = 125$ °C		14.1		
			$T_{vj} = 150$ °C		15		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off delay time (inductive load)	$t_{d\,off}$	I_D = 35 A, R_{Goff} = 0 Ω, V_{DD} = 400 V, V_{GS} = 0/10 V	T_{vj} = 25 °C		103		ns
			T_{vj} = 125 °C		110		
			T_{vj} = 150 °C		113		
Fall time (inductive load)	t_f	I_D = 35 A, R_{Goff} = 0 Ω, V_{DD} = 400 V, V_{GS} = 0/10 V	T_{vj} = 25 °C		4.4		ns
			T_{vj} = 125 °C		4.8		
			T_{vj} = 150 °C		5.1		
Thermal resistance, junction to heat sink	R_{thJH}	per MOSFET, λ_{grease} = 1 W/(m·K)			1.06		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

3 Body diode (MOSFET)

Table 5 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
DC body diode forward current	I_{SD}	T_{vj} = 175 °C, V_{GS} = 0 V	T_H = 65 °C	35	A
dv/dt ruggedness	dv/dt	V_{DS} = 400 V, I_{SD} = 35 A	T_{vj} = 25 °C	70	V/ns
di/dt ruggedness	di/dt	V_{DS} = 400 V, I_{SD} = 35 A	T_{vj} = 25 °C	1300	A/µs

Table 6 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_{SD}	I_{SD} = 35 A, V_{GS} = 0 V	T_{vj} = 25 °C		1.05	1.35	V
			T_{vj} = 125 °C		0.92		
			T_{vj} = 150 °C		0.88		

4 IGBT, Inverter

Table 7 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	30	A

(table continues...)

Table 7 (continued) Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak collector current	I_{CRM}	t_p limited by $T_{vj\,op}$	80	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 = 40 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.47	1.97	V
			T_{vj} = 125 °C		1.58		
			T_{vj} = 150 °C		1.61		
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 = 100 kHz, T_{vj} = 25 °C, V_{CE} = 25 V, V_{GE} = 0 V			2.75		nF
Reverse transfer capacitance	C_{res}	f = 100 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			16	µA
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 = 40 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 5.1 Ω	T_{vj} = 25 °C		0.029		µs
			T_{vj} = 125 °C		0.028		
			T_{vj} = 150 °C		0.028		
Rise time (inductive load)	t_r	I_C = 40 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 5.1 Ω	T_{vj} = 25 °C		0.012		µs
			T_{vj} = 125 °C		0.013		
			T_{vj} = 150 °C		0.014		
Turn-off delay time (inductive load)	t_{doff}	I_C = 40 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Goff} = 15 Ω	T_{vj} = 25 °C		0.200		µs
			T_{vj} = 125 °C		0.225		
			T_{vj} = 150 °C		0.234		
Fall time (inductive load)	t_f	I_C = 40 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Goff} = 15 Ω	T_{vj} = 25 °C		0.029		µs
			T_{vj} = 125 °C		0.030		
			T_{vj} = 150 °C		0.031		
Turn-on energy loss per pulse	E_{on}	I_C = 40 A, V_{CC} = 400 V, L_σ = 10 nH, V_{GE} = 0/15 V, R_{Gon} = 5.1 Ω, di/dt = 2450 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.83		mJ
			T_{vj} = 125 °C		1.09		
			T_{vj} = 150 °C		1.16		

(table continues...)

Table 8 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off energy loss per pulse	E_{off}	I_C = 40 A, V_{CC} = 400 V, L_σ = 10 nH, V_{GE} = 0/15 V, R_{Goff} = 15 Ω, dv/dt = 10600 V/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.33		mJ
			T_{vj} = 125 °C		0.4		
			T_{vj} = 150 °C		0.43		
Thermal resistance, junction to heat sink	R_{thJH}	per IGBT, λ_{grease} = 1 W/(m·K)			1.72		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
Continuous DC forward current	I_F			40	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		80	A
I^2t - value	I^2t	t_P = 10 ms, V_R = 0 V	T_{vj} = 125 °C	133	A^2s
			T_{vj} = 150 °C	91	

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		1.50	2.05	V
			T_{vj} = 125 °C		1.48		
			T_{vj} = 150 °C		1.47		
Peak reverse recovery current	I_{RM}	V_{CC} = 400 V, I_F = 40 A, V_{GE} = 0 V, -di$_F$/dt = 2450 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		39.7		A
			T_{vj} = 125 °C		55.5		
			T_{vj} = 150 °C		61		
Recovered charge	Q_r	V_{CC} = 400 V, I_F = 40 A, V_{GE} = 0 V, -di$_F$/dt = 2450 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		1.53		µC
			T_{vj} = 125 °C		2.59		
			T_{vj} = 150 °C		2.99		

(table continues...)

Table 10 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Reverse recovery energy	E_{rec}	V_{CC} = 400 V, I_F = 40 A, V_{GE} = 0 V, -di$_F$/dt = 2450 A/µs (T_{vj} = 150 °C)	T_{vj} = 25 °C		0.33		mJ
			T_{vj} = 125 °C		0.67		
			T_{vj} = 150 °C		0.79		
Thermal resistance, junction to heat sink	R_{thJH}	per diode, λ_{grease} = 1 W/(m·K)			1.99		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		150	°C

6 Thyristor, Rectifier

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
Repetitive peak off-state voltage	V_{DRM}		T_{vj} = 25 °C	1200	V
Maximum RMS current at rectifier output	I_{RMSmax}	T_H = 65 °C		60	A
Maximum RMS forward current per chip	I_{FRMSM}	T_H = 65 °C		60	A
Surge forward current	I_{FSM}	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	413	A
			T_{vj} = 150 °C	316	
I^2t - value	I^2t	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	853	A^2s
			T_{vj} = 150 °C	499	

Table 12 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_T	I_T = 65 A	T_{vj} = 25 °C			1.39	V
Gate trigger current	I_{gt}	V_D = 6 V	T_{vj} = -40 °C			80	mA
			T_{vj} = 25 °C			50	
Gate trigger voltage	V_{gt}	V_D = 6 V	T_{vj} = -40 °C			1.6	V
			T_{vj} = 25 °C			1.5	
Gate non-trigger current	I_{gd}	V_D/V_{DRM}=0.67	T_{vj} = 150 °C			3.0	mA
Gate non-trigger voltage	V_{gd}	V_D/V_{DRM}=0.67	T_{vj} = 25 °C			0.2	V
Holding current	I_H	V_D = 6 V	T_{vj} = 25 °C			120	mA

(table continues...)

Table 12 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Reverse current	I_r		T_{vj} = 25 °C, V_R = 1200 V			0.5	mA
Thermal resistance, junction to heat sink	R_{thJH}	per Thyristor			1.05		K/W
Temperature under switching conditions	$T_{vj\ op}$			-40		125	°C
Temperature under overload switching conditions	$T_{vj\ over}$	Overload, cumulative max. 100 h				140	°C

7 Capacitor

Table 13 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated DC voltage	V_{DC}	T = 25 °C		1000		V
Capacitance value	C_{nom}	T = 25 °C		66		nF
Temperature range	T_{cap}		-40		125	°C

8 NTC-Thermistor

Table 14 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	T_{NTC} = 25 °C	9.7	10	10.3	kΩ
Power dissipation	P_{25}	T_{NTC} = 25 °C			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2\text{-}1/(298{,}15\ K))]$		3447		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2\text{-}1/(298{,}15\ K))]$		3487		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2\text{-}1/(298{,}15\ K))]$		3510		K

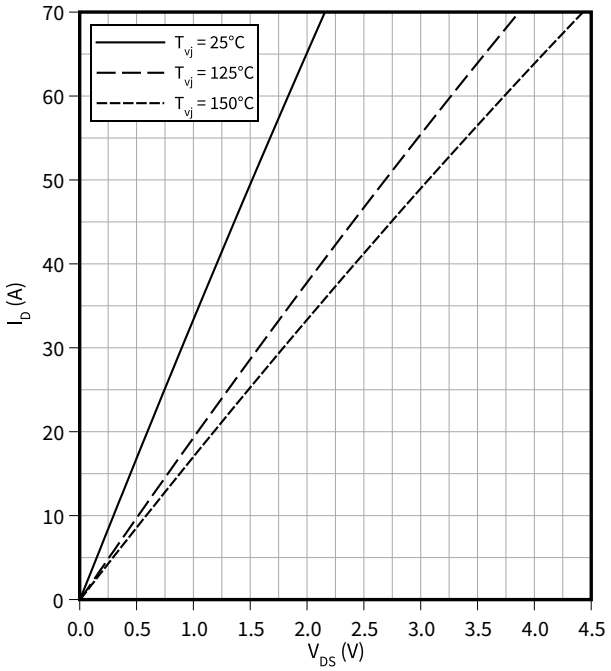
Note: For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4

9 Characteristics diagrams

Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

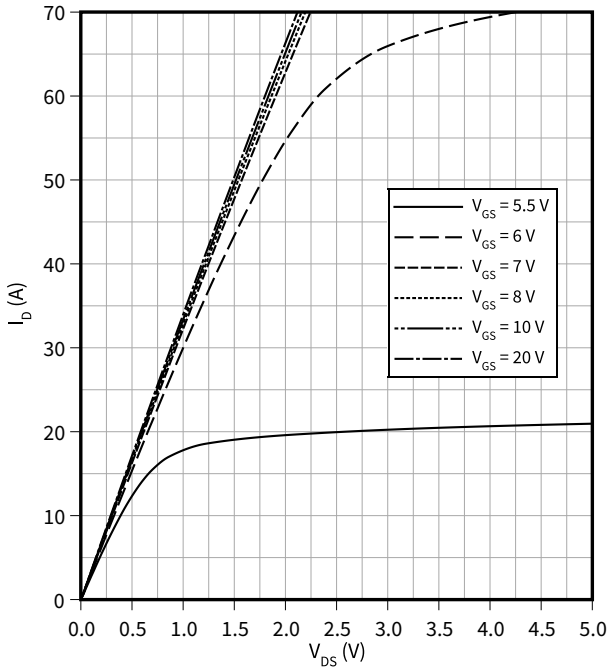
$V_{GS} = 10$ V



Output characteristic field (typical), MOSFET

$I_D = f(V_{DS})$

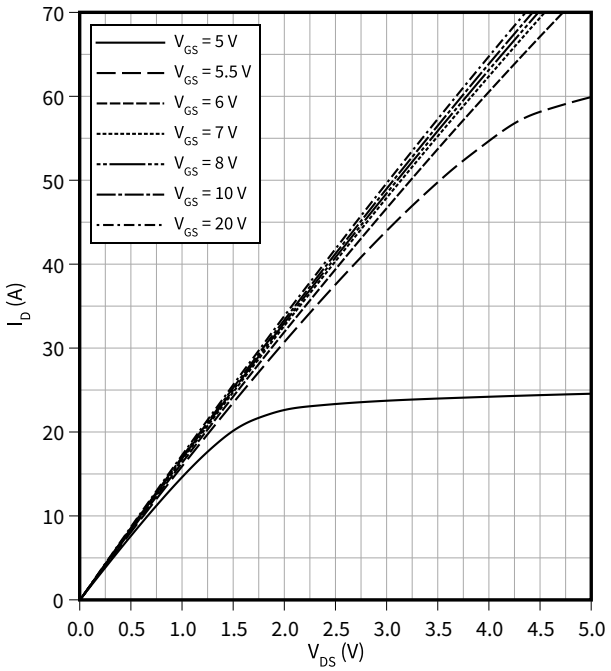
$T_{vj} = 25$ °C



Output characteristic field (typical), MOSFET

$I_D = f(V_{DS})$

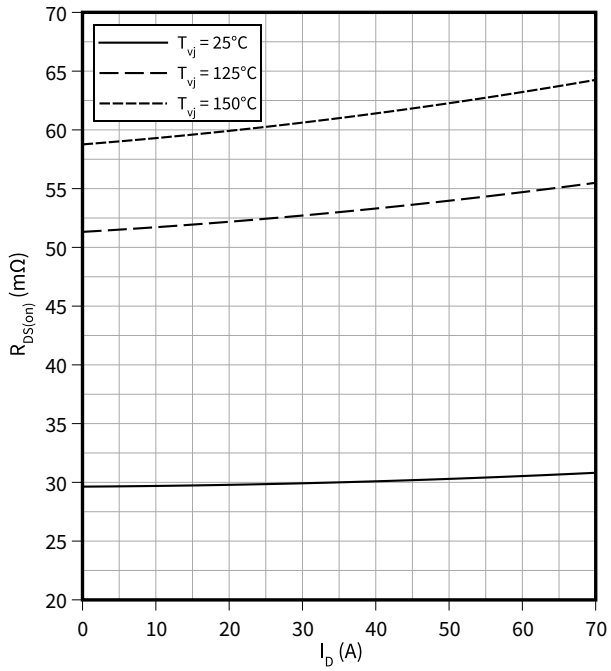
$T_{vj} = 150$ °C



Drain source on-resistance (typical), MOSFET

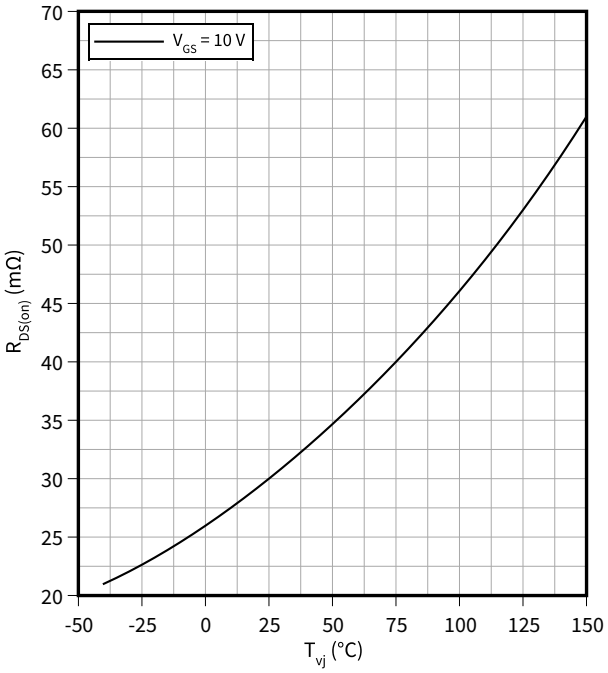
$R_{DS(on)} = f(I_D)$

$V_{GS} = 10$ V



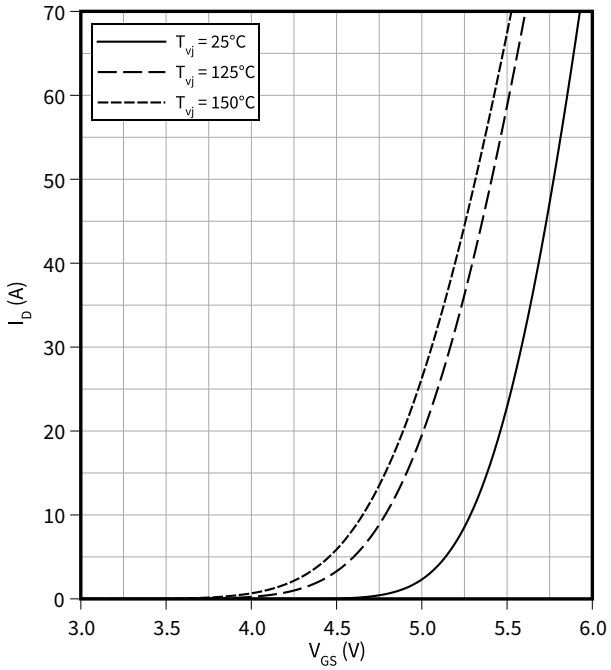
Drain source on-resistance (typical), MOSFET

$R_{DS(on)} = f(T_{vj})$
$I_D = 35$ A



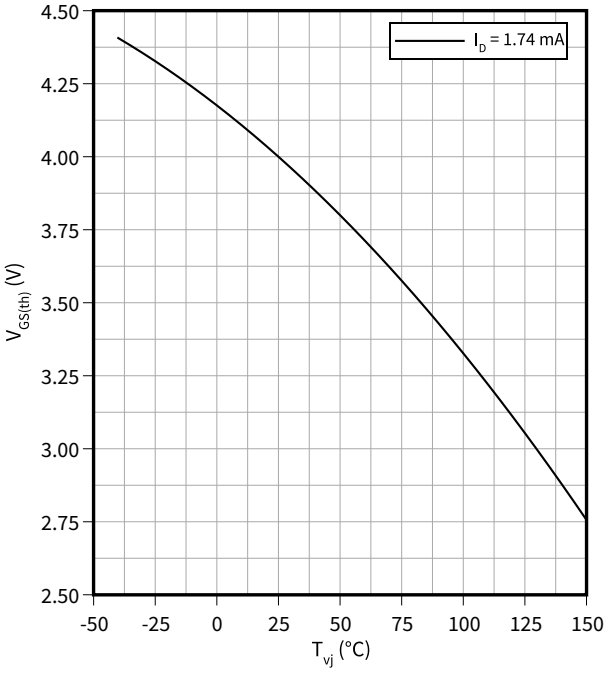
Transfer characteristic (typical), MOSFET

$I_D = f(V_{GS})$
$V_{DS} = 20$ V



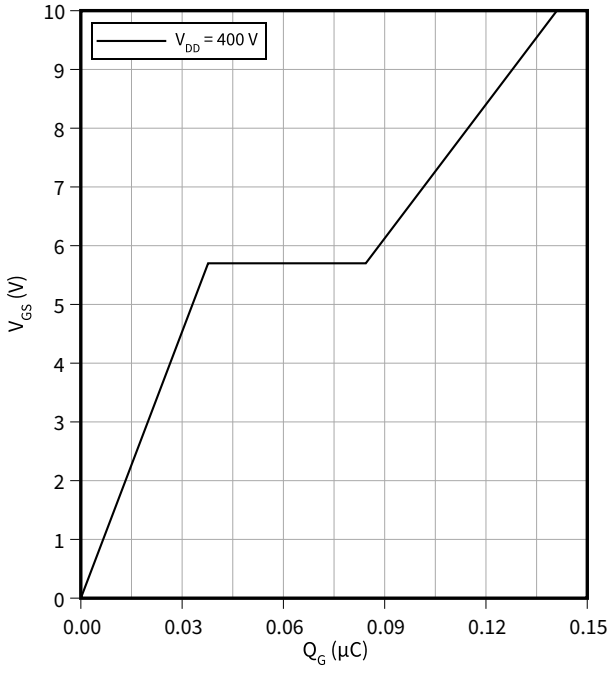
Gate-source threshold voltage (typical), MOSFET

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



Gate charge characteristic (typical), MOSFET

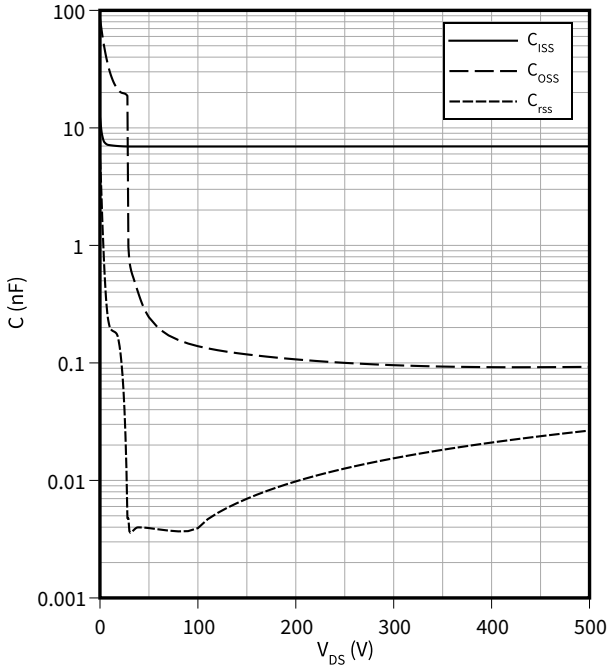
$V_{GS} = f(Q_G)$
$I_D = 35$ A, $T_{vj} = 25$ °C



Capacity characteristic (typical), MOSFET

$C = f(V_{DS})$

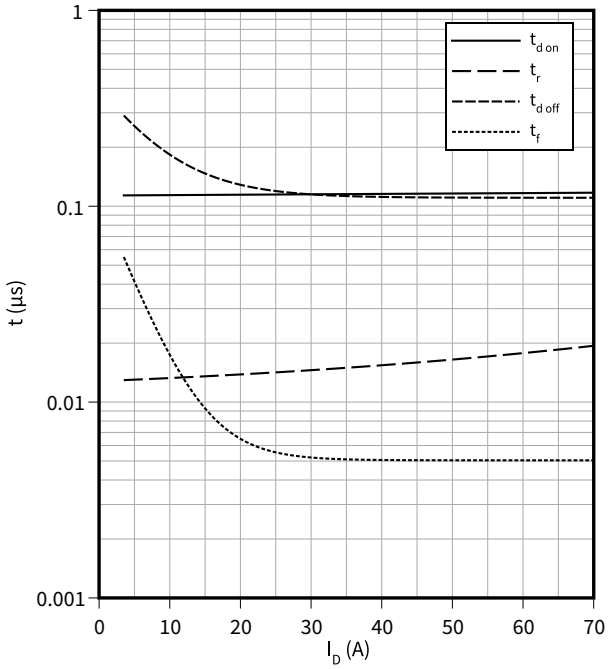
$f = 100\ kHz$, $T_{vj} = 25\ °C$, $V_{GS} = 0\ V$



Switching times (typical), MOSFET

$t = f(I_D)$

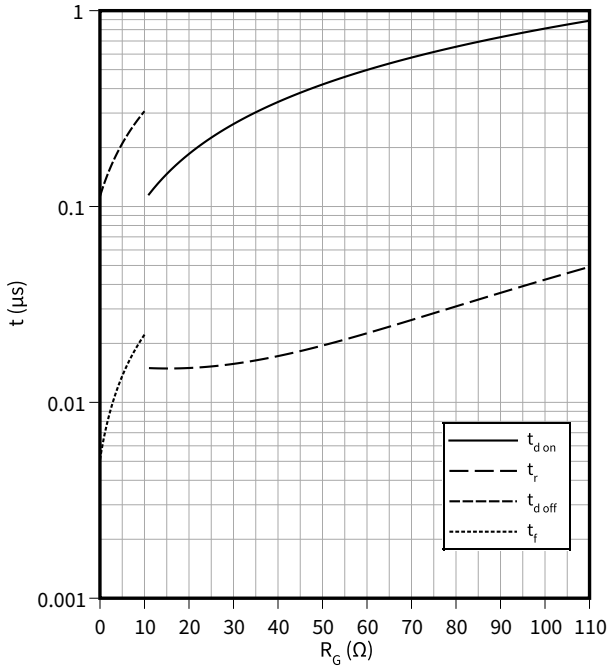
$R_{Goff} = 0\ \Omega$, $R_{Gon} = 11\ \Omega$, $V_{DD} = 400\ V$, $T_{vj} = 150\ °C$, $V_{GS} = 0/10\ V$



Switching times (typical), MOSFET

$t = f(R_G)$

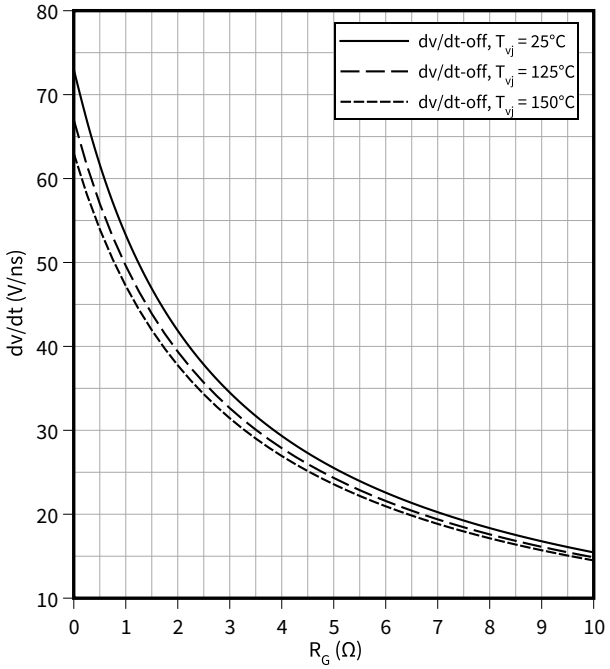
$V_{DD} = 400\ V$, $I_D = 35\ A$, $T_{vj} = 150\ °C$, $V_{GS} = 0/10\ V$



Voltage slope (typical), MOSFET

$dv/dt = f(R_G)$

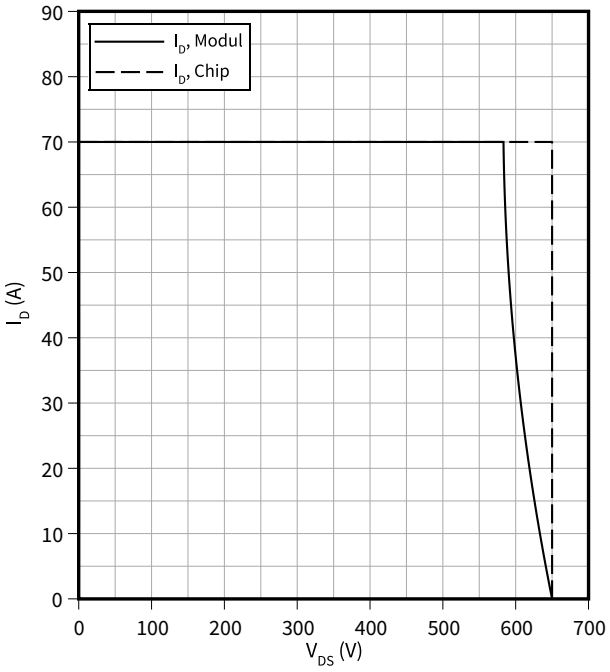
$V_{DD} = 400\ V$, $V_{GS} = 0/10\ V$, $I_D = 35\ A$



Reverse bias safe operating area (RBSOA), MOSFET

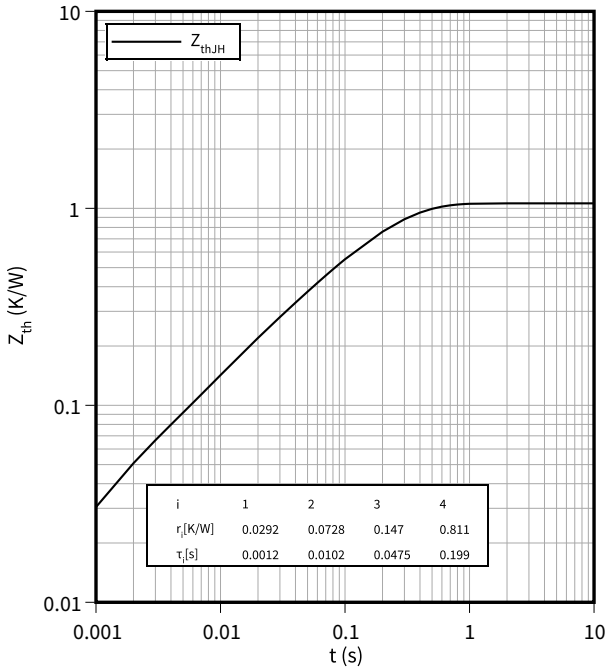
$I_D = f(V_{DS})$

$R_{Goff} = 0\ \Omega$, $T_{vj} = 150\ °C$, $V_{GS} = 0/10\ V$



Transient thermal impedance, MOSFET

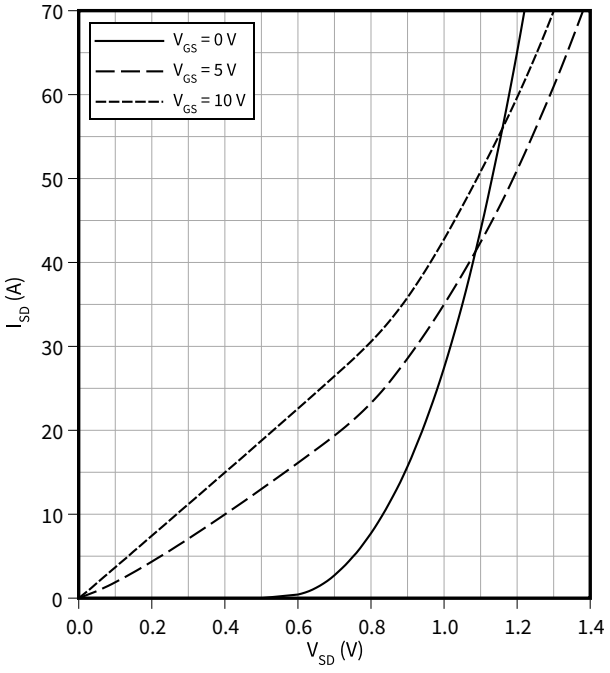
$Z_{th} = f(t)$



Forward characteristic body diode (typical), MOSFET

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

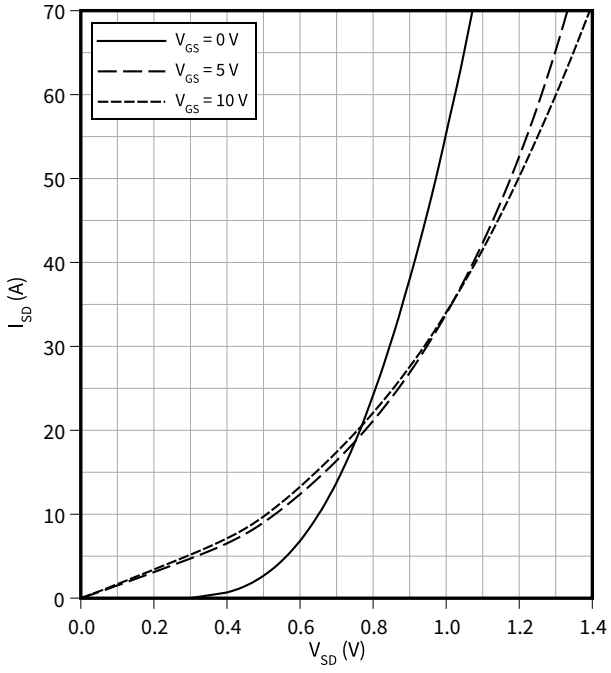
$T_{vj} = 25\ °C$



Forward characteristic body diode (typical), MOSFET

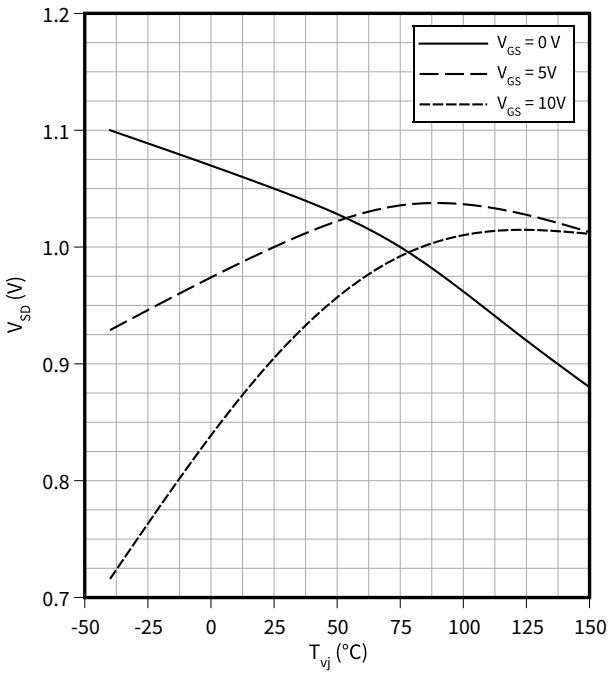
$I_{SD} = f(V_{SD})$

$T_{vj} = 150\ °C$



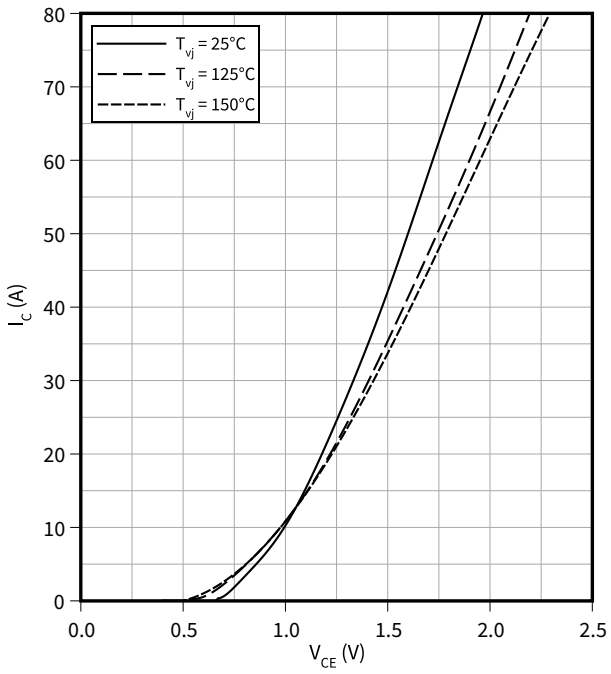
Forward voltage of body diode (typical), MOSFET

$V_{SD} = f(T_{vj})$
$I_{SD} = 35$ A



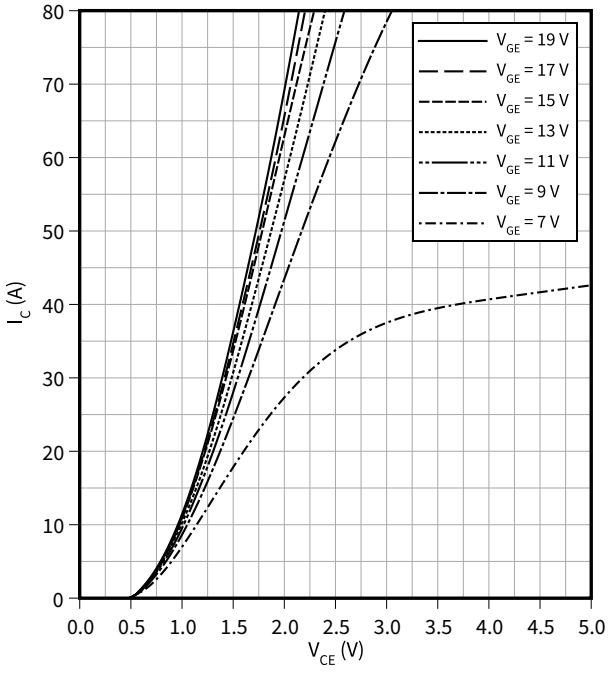
Output characteristic (typical), IGBT, Inverter

$I_C = f(V_{CE})$
$V_{GE} = 15$ V



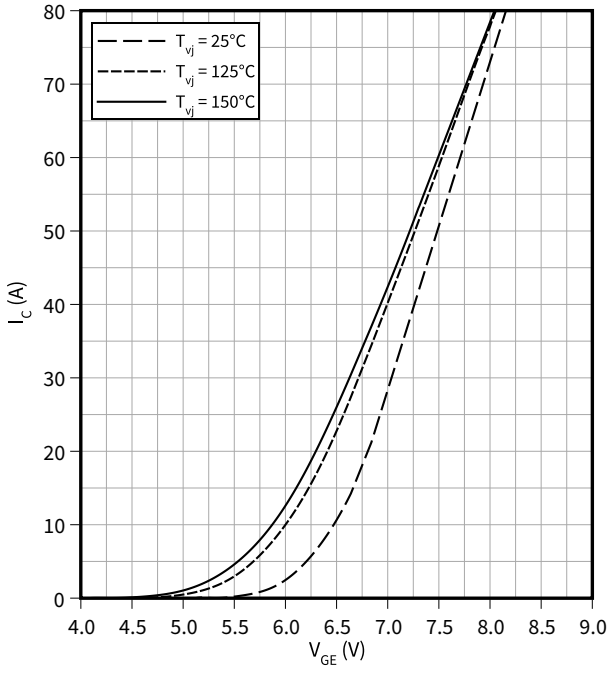
Output characteristic field (typical), IGBT, Inverter

$I_C = f(V_{CE})$
$T_{vj} = 150$ °C



Transfer characteristic (typical), IGBT, Inverter

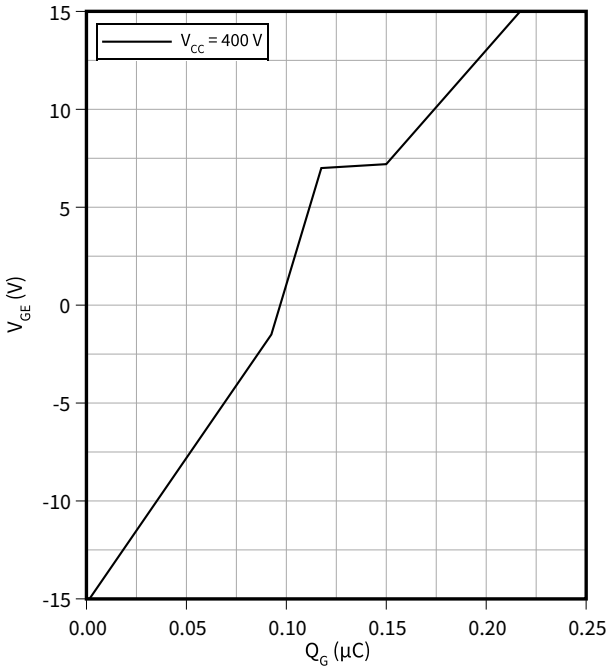
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



Gate charge characteristic (typical), IGBT, Inverter

$V_{GE} = f(Q_G)$

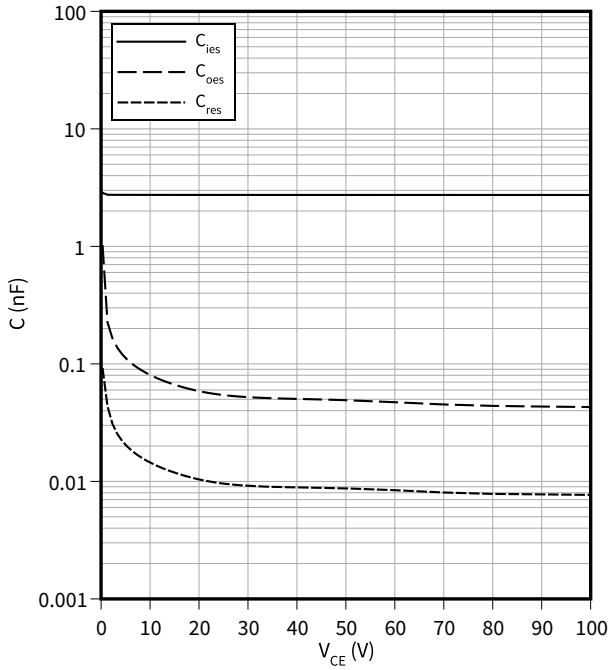
$I_C = 40$ A, $T_{vj} = 25$ °C



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

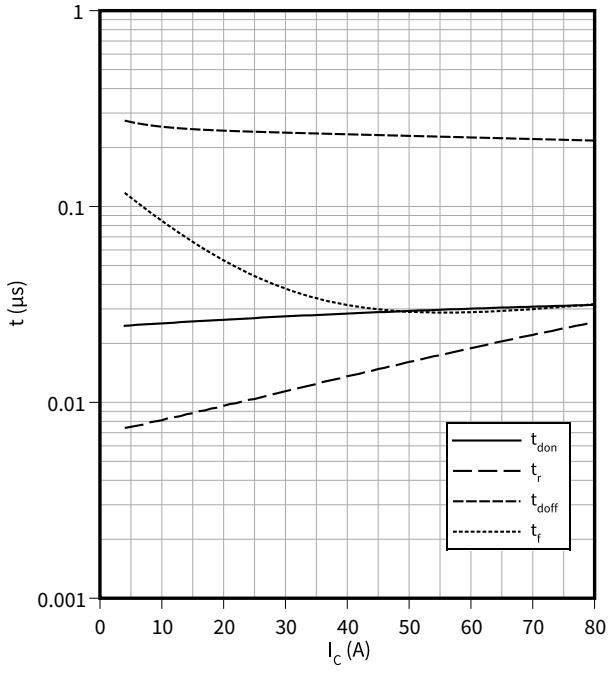
$f = 100$ kHz, $V_{GE} = 0$ V, $T_{vj} = 25$ °C



Switching times (typical), IGBT, Inverter

$t = f(I_C)$

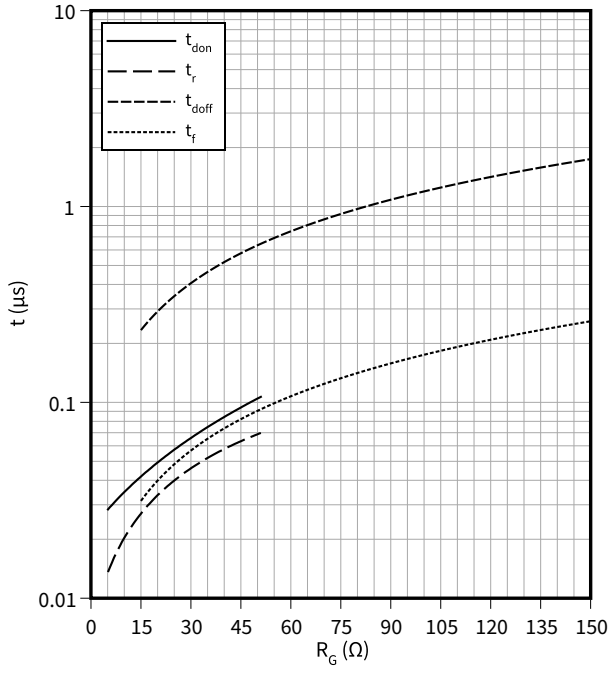
$R_{Goff} = 15\ \Omega$, $R_{Gon} = 5.1\ \Omega$, $V_{GE} = 0/15$ V, $V_{CC} = 400$ V, $T_{vj} = 150$ °C



Switching times (typical), IGBT, Inverter

$t = f(R_G)$

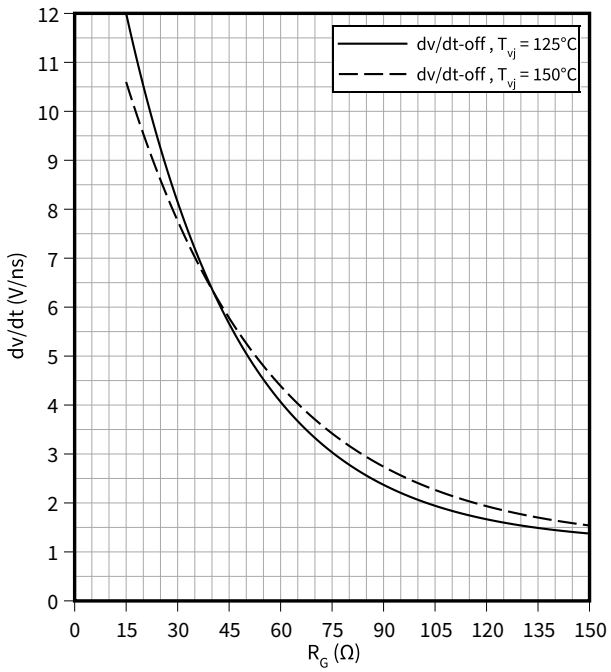
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $T_{vj} = 150$ °C



Voltage slope (typical), IGBT, Inverter

dv/dt = f(R_G)

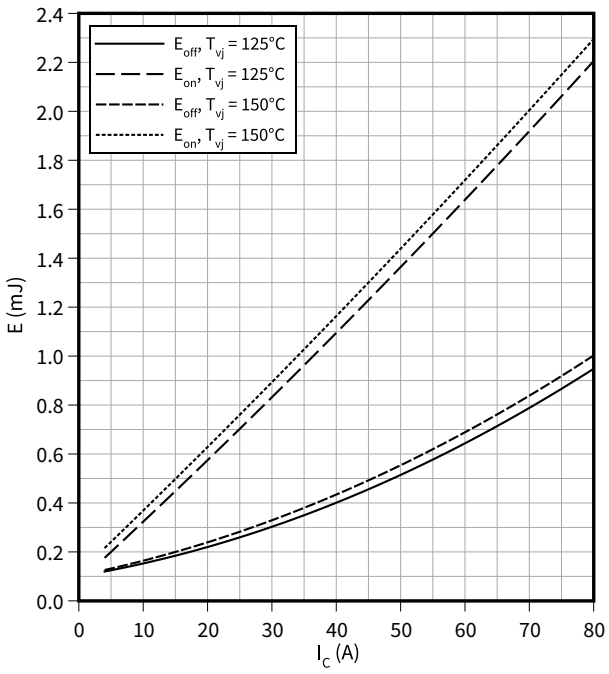
I_C = 40 A, V_{CC} = 400 V, V_{GE} = 0/15 V



Switching losses (typical), IGBT, Inverter

E = f(I_C)

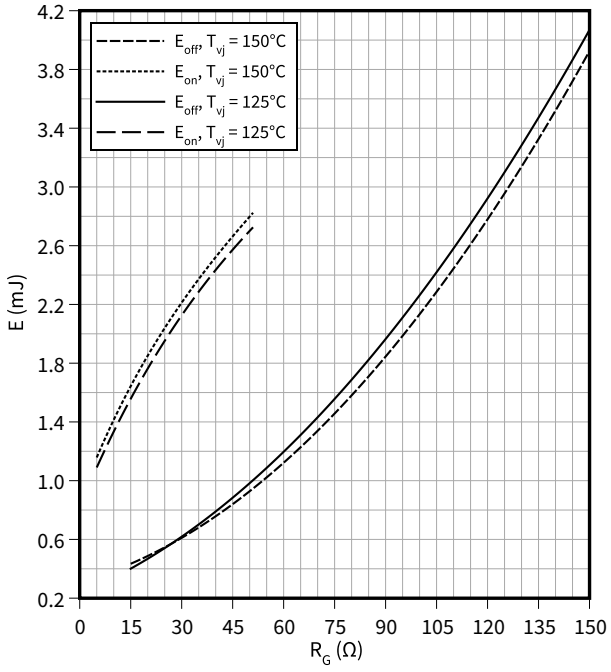
R_{Goff} = 15 Ω, R_{Gon} = 5.1 Ω, V_{GE} = 0/15 V, V_{CC} = 400 V



Switching losses (typical), IGBT, Inverter

E = f(R_G)

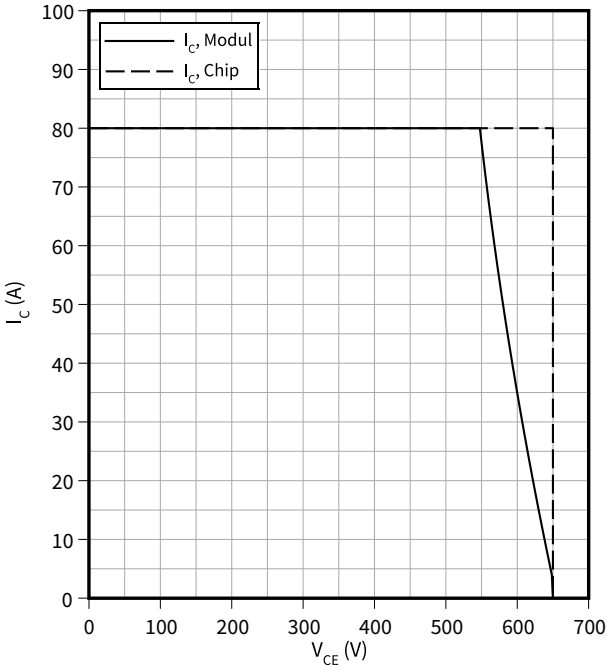
V_{GE} = 0/15 V, I_C = 40 A, V_{CC} = 400 V



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

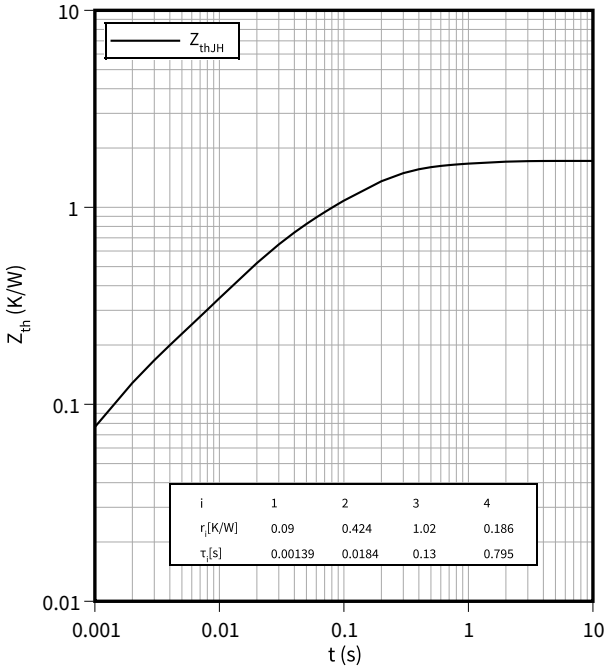
I_C = f(V_{CE})

R_{Goff} = 15 Ω, V_{GE} = 0/15 V, T_{vj} = 150 °C



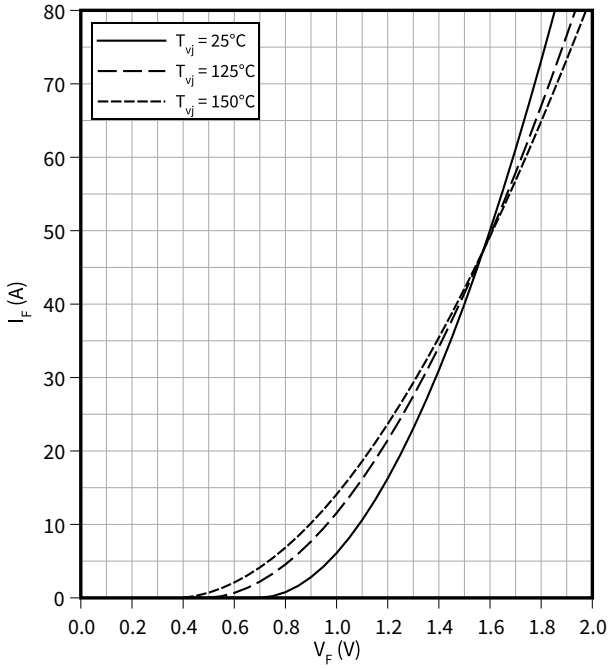
Transient thermal impedance, IGBT, Inverter

$Z_{th} = f(t)$



Forward characteristic (typical), Diode, Inverter

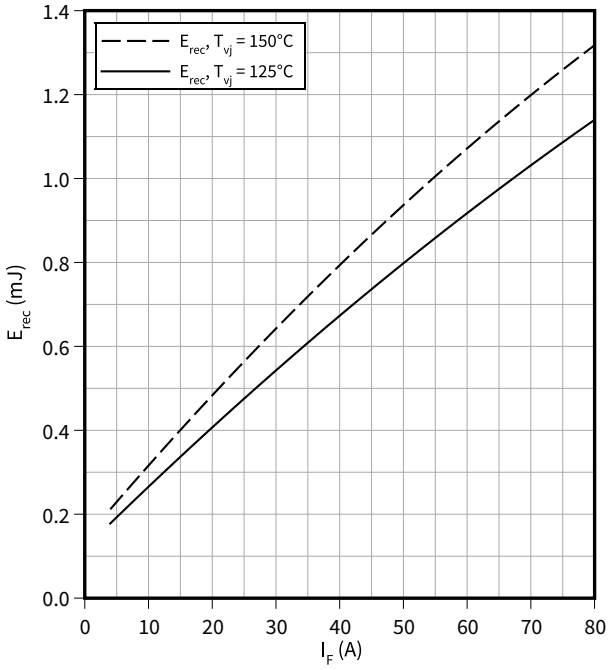
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

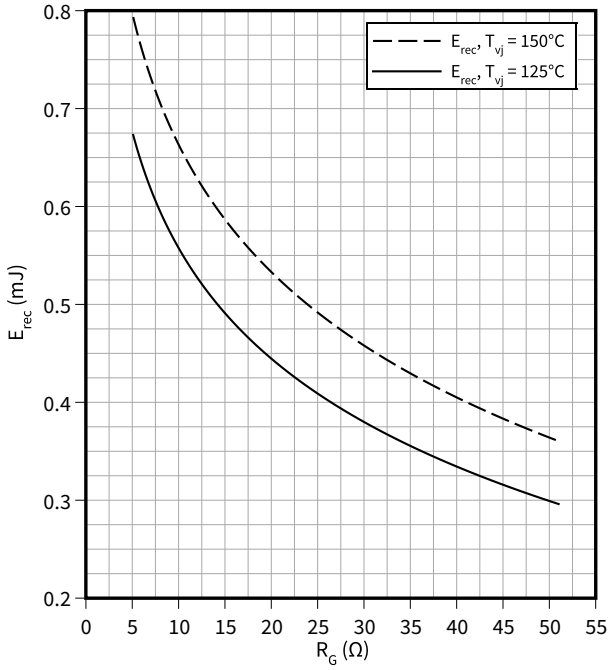
$R_G = 5.1\ \Omega$, $V_{CC} = 400\ V$



Switching losses (typical), Diode, Inverter

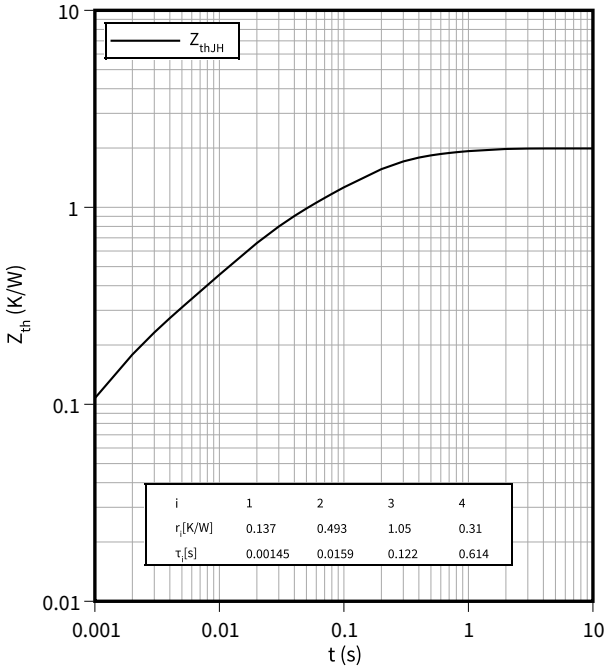
$E_{rec} = f(R_G)$

$I_F = 40\ A$, $V_{CC} = 400\ V$



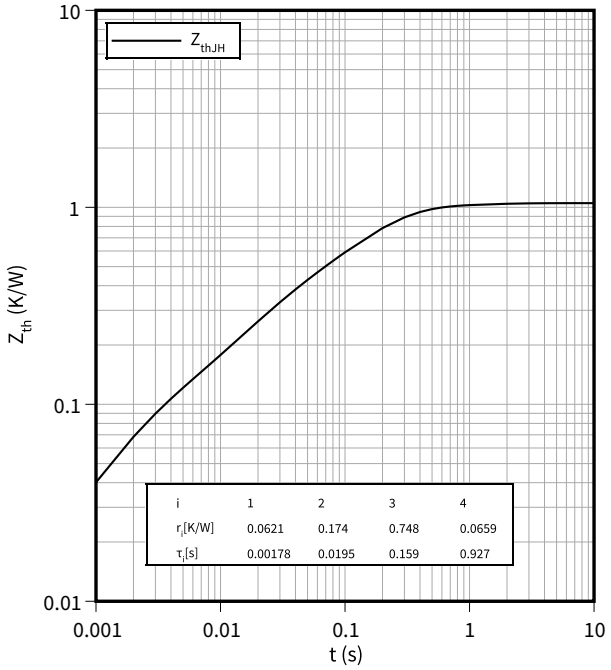
Transient thermal impedance, Diode, Inverter

$Z_{th} = f(t)$



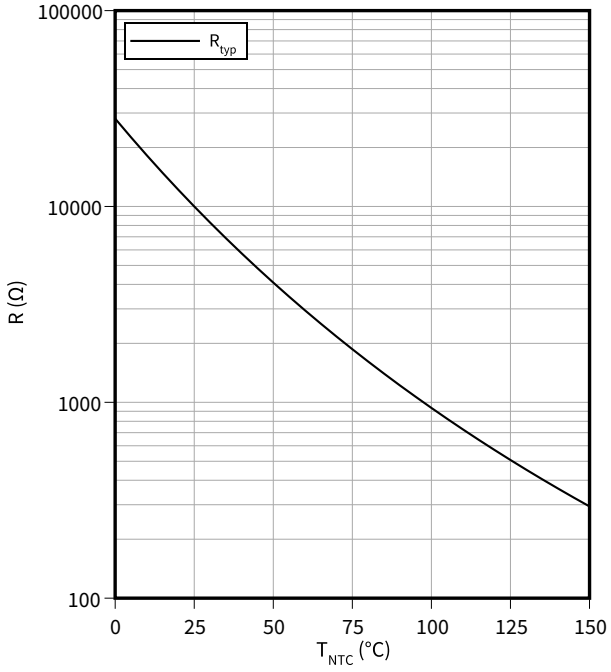
Transient thermal impedance, Thyristor, Rectifier

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



10 Circuit diagram

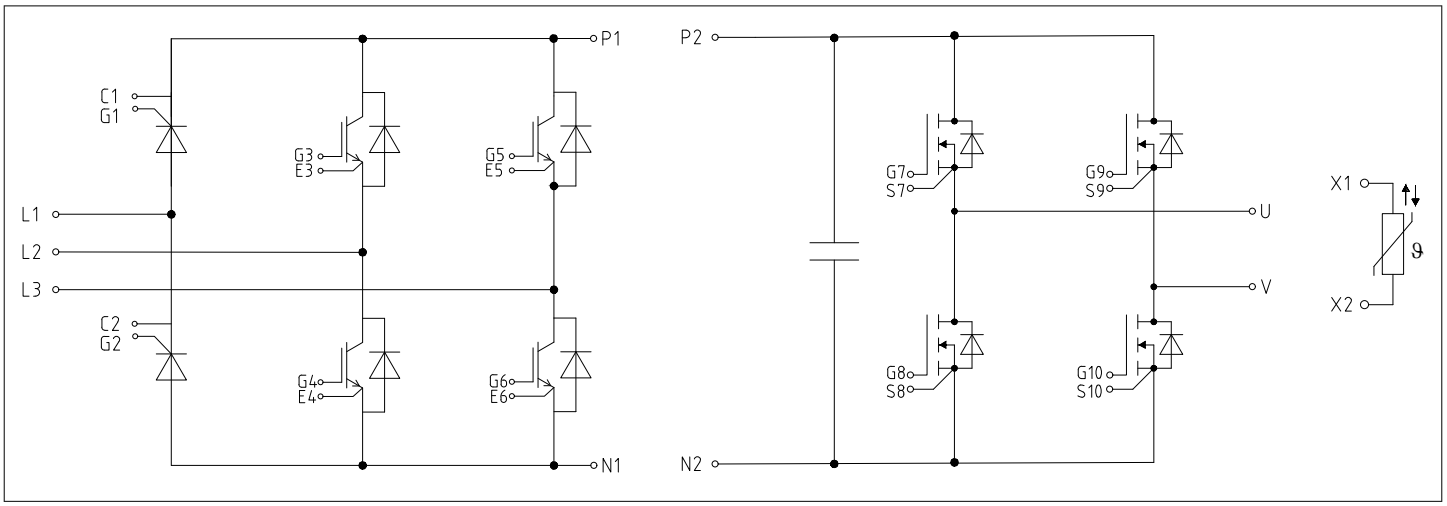


Figure 1

11 Package outlines

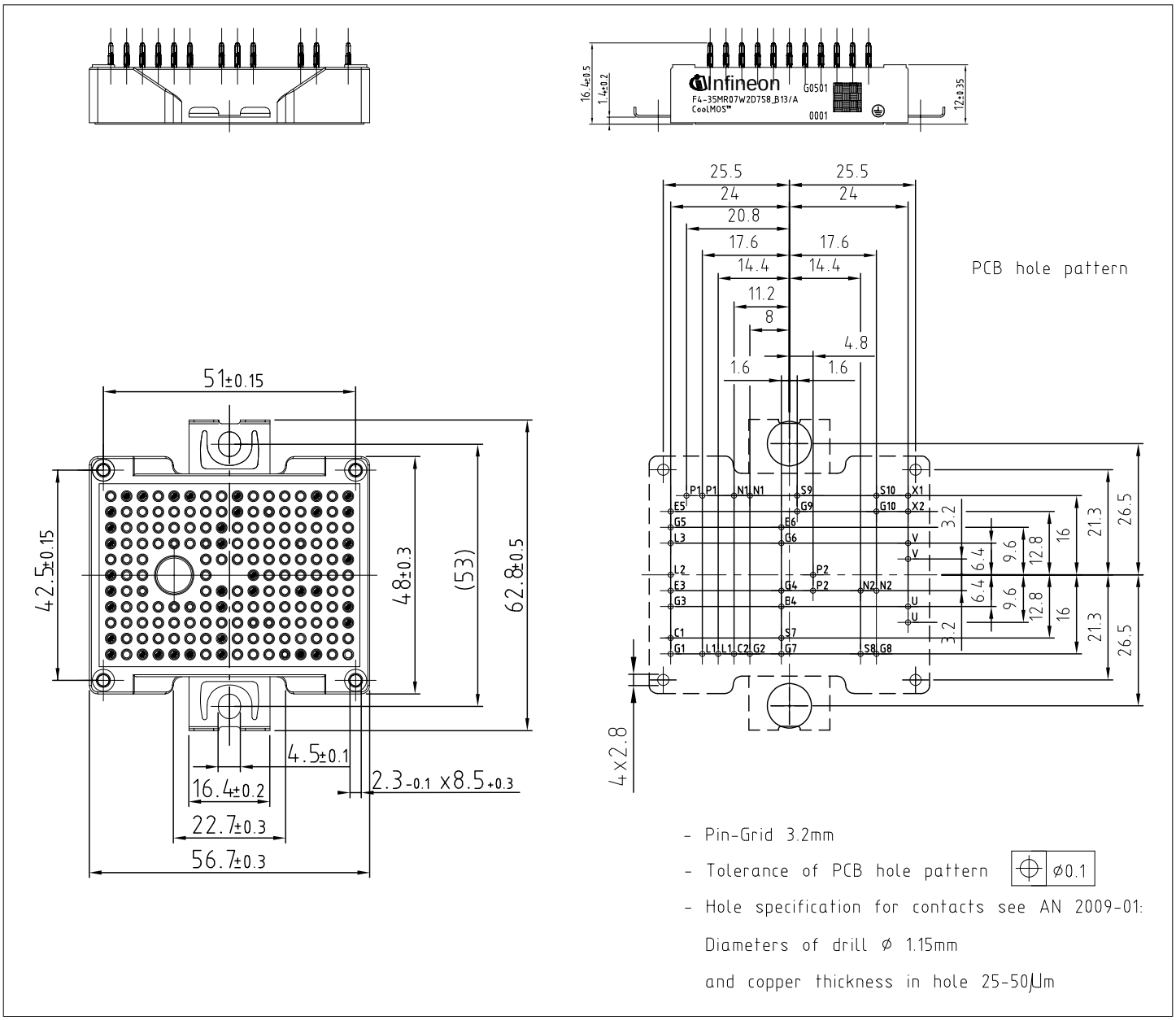


Figure 2

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
0.10	2022-03-16	Target datasheet
0.20	2022-06-20	Preliminary datasheet
1.00	2022-06-21	Final datasheet
1.10	2023-08-22	10424AERRA

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Document reference
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