THE DATASHEET OF

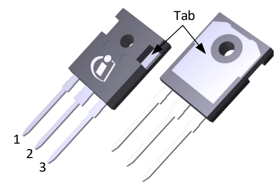
IMW65R039M1HXKSA1

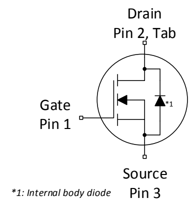
MOSFET

650 V CoolSiC™ M1 SiC Trench Power Device

The 650 V CoolSiC™ is built over the solid silicon carbide technology developed in Infineon in more than 20 years. Leveraging the wide bandgap SiC material characteristics, the 650V CoolSiC™ MOSFET offers a unique combination of performance, reliability and ease of use. Suitable for high temperature and harsh operations, it enables the simplified and cost effective deployment of the highest system efficiency.

PG-TO 247-3





Features

- Optimized switching behavior at higher currents
- Commutation robust fast body diode with low Q_{rr}
- Superior gate oxide reliability
- $T_{j,max}$=175°C and excellent thermal behavior
- Lower $R_{DS(on)}$ and pulse current dependency on temperature
- Increased avalanche capability
- Compatible with standard drivers (recommended driving voltage: 18V)

Benefits

- Unique combination of high performance, high reliability and ease of use
- Ease of use and integration
- Suitable for topologies with continuous hard commutation
- Higher robustness and system reliability
- Efficiency improvement
- Reduced system size leading to higher power density

Potential applications

- SMPS
- UPS (uninterruptable power supplies)
- Solar PV inverters
- EV charging infrastructure
- Energy storage and battery formation
- Class D amplifiers

Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS} @ T_J = 25 °C	650	V
$R_{DS(on),typ}$	39	mΩ
$R_{DS(on),max}$	50	mΩ
$Q_{G,typ}$	41	nC
$I_{D,pulse}$	123	A
Q_{oss} @ 400 V	97	nC
E_{oss} @ 400 V	14.6	µJ

Type / Ordering Code	Package	Marking	Related Links
IMW65R039M1H	PG-TO247-3	65R039M1	see Appendix A

Table of Contents

1 Maximum ratings

at T_J = 25 °C, unless otherwise specified

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current[1]	I_D	- -	- -	46 35	A	T_C = 25 °C T_C = 100 °C
Pulsed drain current[2]	$I_{D,pulse}$	-	-	123	A	T_C = 25 °C
Avalanche energy, single pulse	E_{AS}	-	-	213	mJ	I_D = 8.0 A, V_{DD} = 50 V, L = 6.7 mH; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	1.06	mJ	I_D = 8.0 A, V_{DD} = 50 V; see table 10
Avalanche current, single pulse	I_{AS}	-	-	8.0	A	-
MOSFET *dv/dt* ruggedness	*dv/dt*	-	-	200	V/ns	V_{DS} = 0...400 V
Gate source voltage (static)	V_{GS}	-2	-	20	V	static
Gate source voltage (recommended driving voltage)	V_{GS}	0	-	18	V	-
Gate source voltage (dynamic)	V_{GS}	-5	-	23	V	$t_{pulse,negative}$ <= 15 ns $t_{pulse,positive}$ <= 1% duty cycle/f_{sw}
Power dissipation	P_{tot}	-	-	176	W	T_C = 25 °C
Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature	T_J	-55	-	175	°C	-
Mounting torque	-	-	-	60	Ncm	M3 and M3.5 screws
Continuous diode forward current[1]	I_S	-	-	46	A	T_C = 25 °C
Diode pulse current[2]	$I_{S,pulse}$	-	-	123	A	T_C = 25 °C
Insulation withstand voltage	V_{ISO}	-	-	n.a.	V	V_{rms}, T_C = 25 °C, t = 1 min

[1] Limited by $T_{J,max}$
[2] Pulse width t_p limited by $T_{J,max}$

2 Thermal characteristics

Table 3 Thermal characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.85	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	62	°C/W	leaded
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	-	-	°C/W	n.a.
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6mm (0.063 in.) from case for 10s

3 Electrical characteristics

at T_J = 25 °C, unless otherwise specified

Table 4 Static characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	650	-	-	V	V_{GS} = 0 V, I_D = 0.75 mA
Gate threshold voltage[1]	$V_{(GS)th}$	3.5	4.5	5.7	V	V_{DS} = V_{GS}, I_D = 7.5 mA
Zero gate voltage drain current	I_{DSS}	- -	1 3	150 -	µA	V_{DS} = 650 V, V_{GS} = 0 V, T_J = 25 °C V_{DS} = 650 V, V_{GS} = 0 V, T_J = 175 °C
Gate-source leakage current	I_{GSS}	-	-	100	nA	V_{GS} = 20 V, V_{DS} = 0 V
Drain-source on-state resistance	$R_{DS(on)}$	- -	0.039 0.055	0.05 -	Ω	V_{GS} = 18 V, I_D = 25.0 A, T_J = 25 °C V_{GS} = 18 V, I_D = 25.0 A, T_J =175 °C
Gate resistance	R_G	-	5.0	-	Ω	f = 1 MHz, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	1393	-	pF	V_{GS} = 0 V, V_{DS} = 400 V, f = 250 kHz
Reverse capacitance	C_{rss}	-	15	-	pF	V_{GS} = 0 V, V_{DS} = 400 V, f = 250 kHz
Output capacitance[2]	C_{oss}	-	160	208	pF	V_{GS} = 0 V, V_{DS} = 400 V, f = 250 kHz
Output charge[2]	Q_{oss}	-	97	126	nC	calculation based on C_{oss}
Effective output capacitance, energy related[3]	$C_{o(er)}$	-	182	-	pF	V_{GS} = 0 V, V_{DS} = 0...400 V
Effective output capacitance, time related[4]	$C_{o(tr)}$	-	241	-	pF	I_D = constant, V_{GS} = 0 V, V_{DS} = 0...400 V
Turn-on delay time	$t_{d(on)}$	-	11.5	-	ns	V_{DD} = 400 V, V_{GS} = 18 V, I_D = 25.0 A, R_G = 1.8 Ω; see table 9
Rise time	t_r	-	22.0	-	ns	V_{DD} = 400 V, V_{GS} = 18 V, I_D = 25.0 A, R_G = 1.8 Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	19.0	-	ns	V_{DD} = 400 V, V_{GS} = 18 V, I_D = 25.0 A, R_G = 1.8 Ω; see table 9
Fall time	t_f	-	7.0	-	ns	V_{DD} = 400 V, V_{GS} = 18 V, I_D = 25.0 A, R_G = 1.8 Ω; see table 9

1) Tested after 1 ms pulse at V_{GS} = +20 V
2) Maximum specification is defined by calculated six sigma upper confidence bound
3) $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400 V
4) $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 400 V

Table 6 Gate charge characteristics

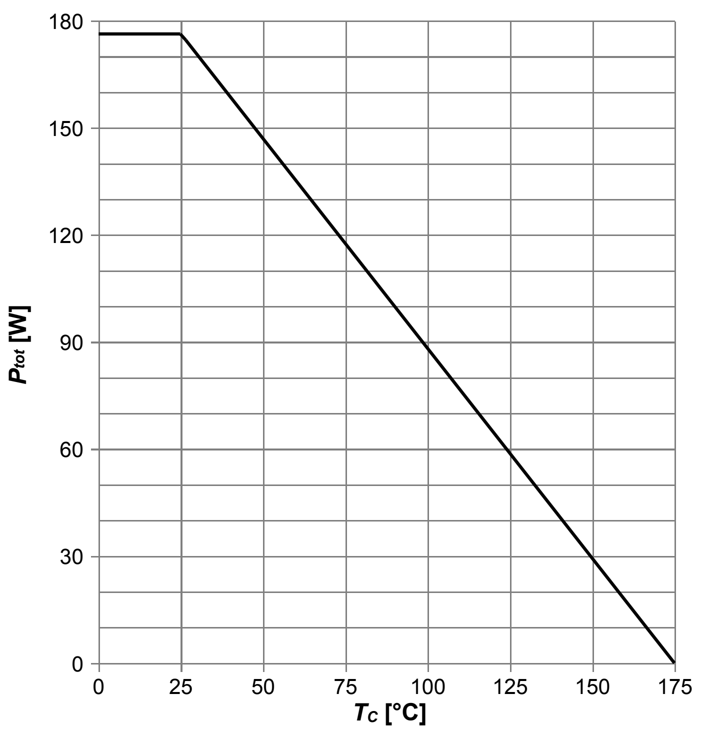
Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	11	-	nC	V_{DD} = 400 V, I_D = 25.0 A, V_{GS} = 0 to 18 V
Gate to drain charge	Q_{gd}	-	9	-	nC	V_{DD} = 400 V, I_D = 25.0 A, V_{GS} = 0 to 18 V
Gate charge total	Q_g	-	41	-	nC	V_{DD} = 400 V, I_D = 25.0 A, V_{GS} = 0 to 18 V

Table 7 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	4.0	-	V	V_{GS} = 0 V, I_F = 25.0 A, T_J = 25 °C
Reverse recovery time	t_{rr}	-	30	-	ns	V_R = 400 V, I_F = 25.0 A, di_F/dt = 1000 A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	160	-	nC	V_R = 400 V, I_F = 25.0 A, di_F/dt = 1000 A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	10.5	-	A	V_R = 400 V, I_F = 25.0 A, di_F/dt = 1000 A/µs; see table 8

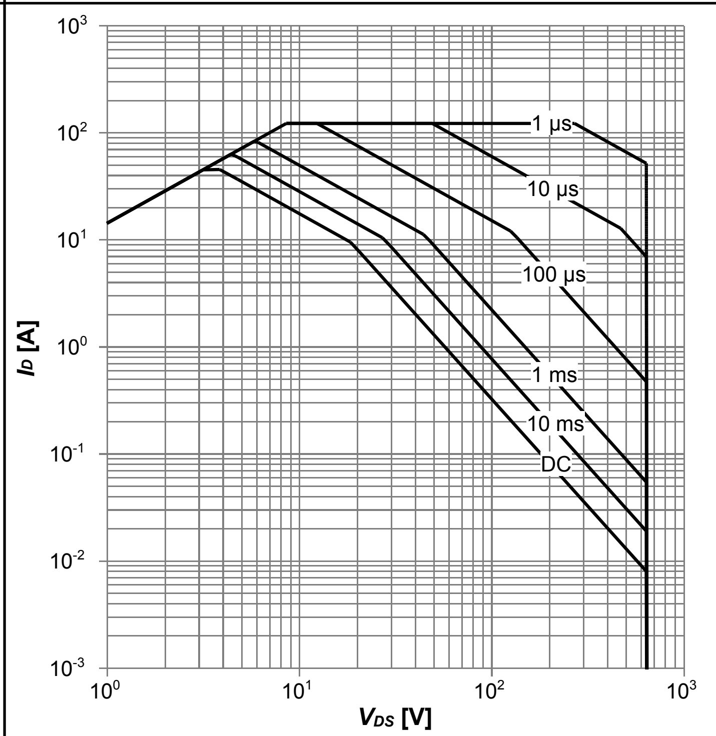
4 Electrical characteristics diagrams

Diagram 1: Power dissipation



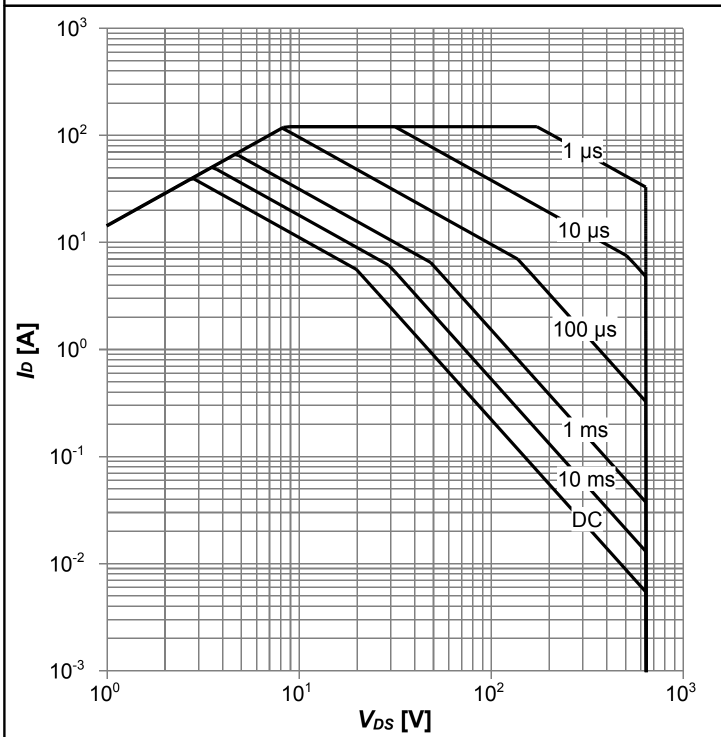
$P_{tot}=f(T_C)$

Diagram 2: Safe operating area



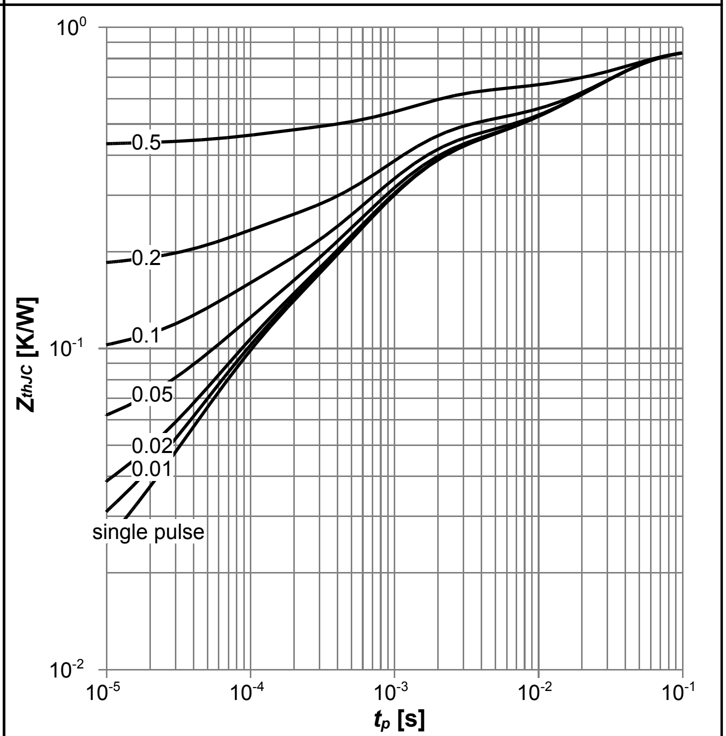
$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$; parameter: t_p

Diagram 3: Safe operating area



$I_D=f(V_{DS})$; $T_C=80$ °C; $D=0$; parameter: t_p

Diagram 4: Max. transient thermal impedance



$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

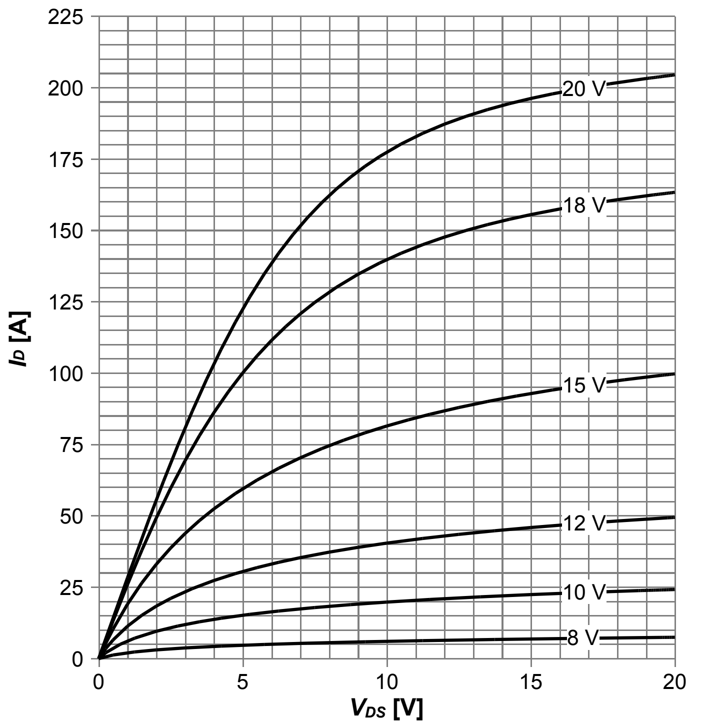
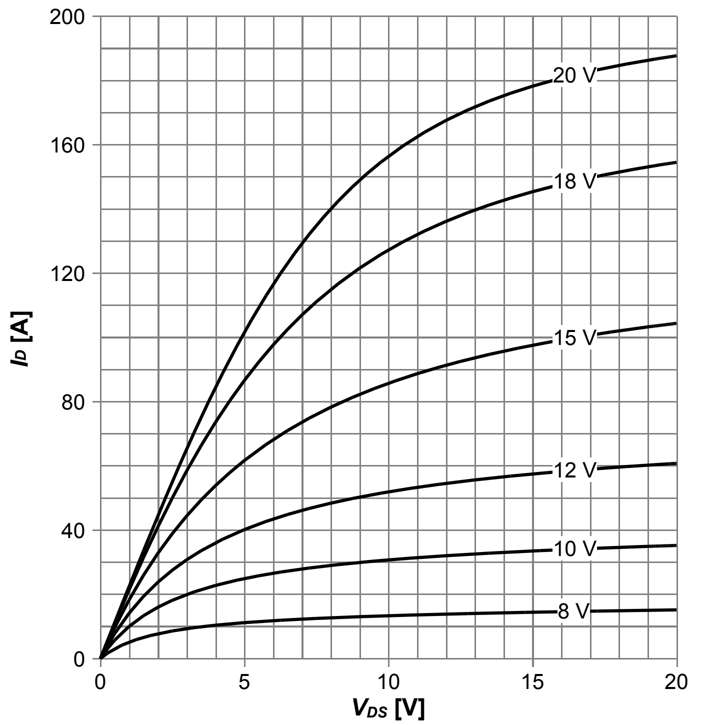
Diagram 5: Typ. output characteristics	**Diagram 6: Typ. output characteristics**
	
$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: V_{GS}	$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: V_{GS}

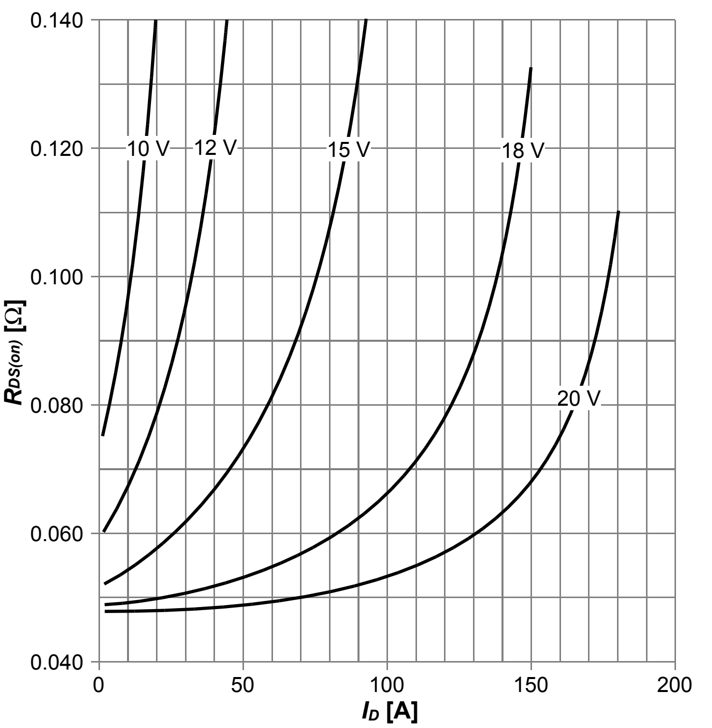
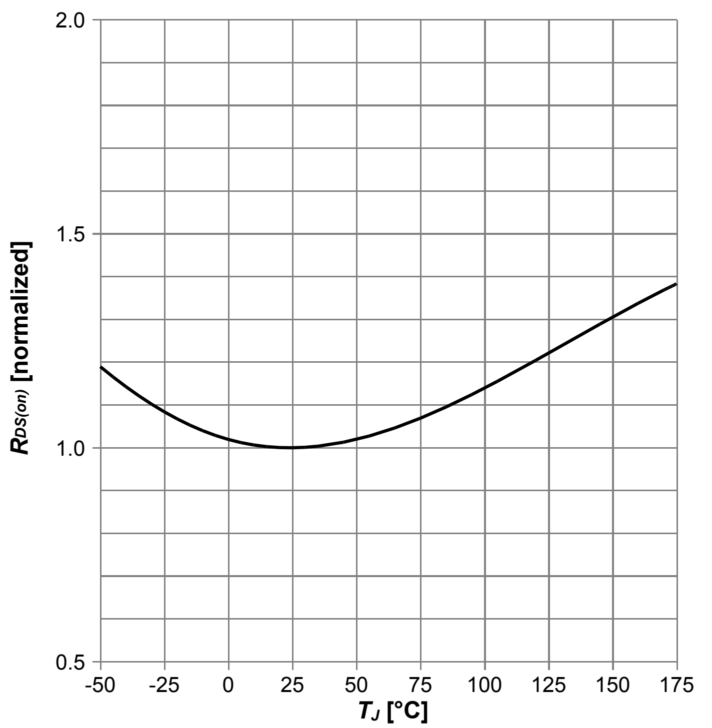
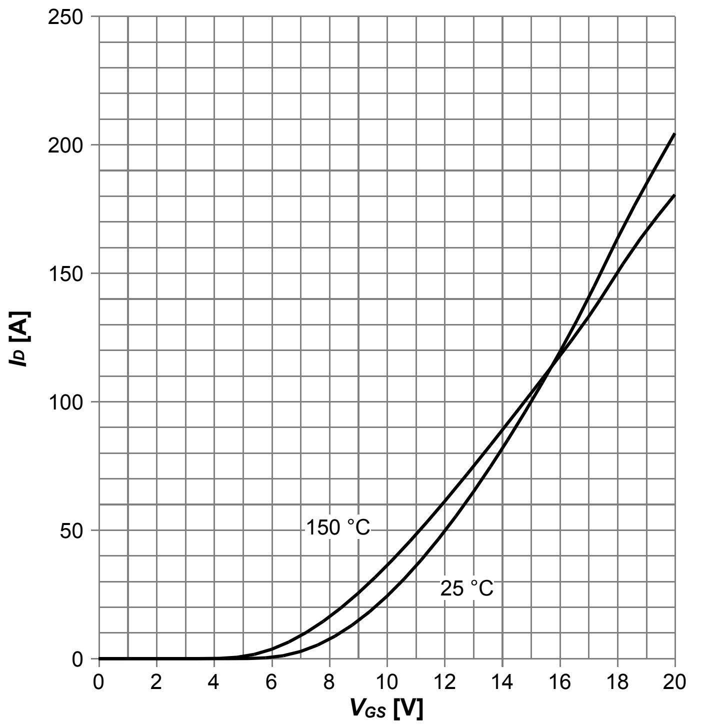
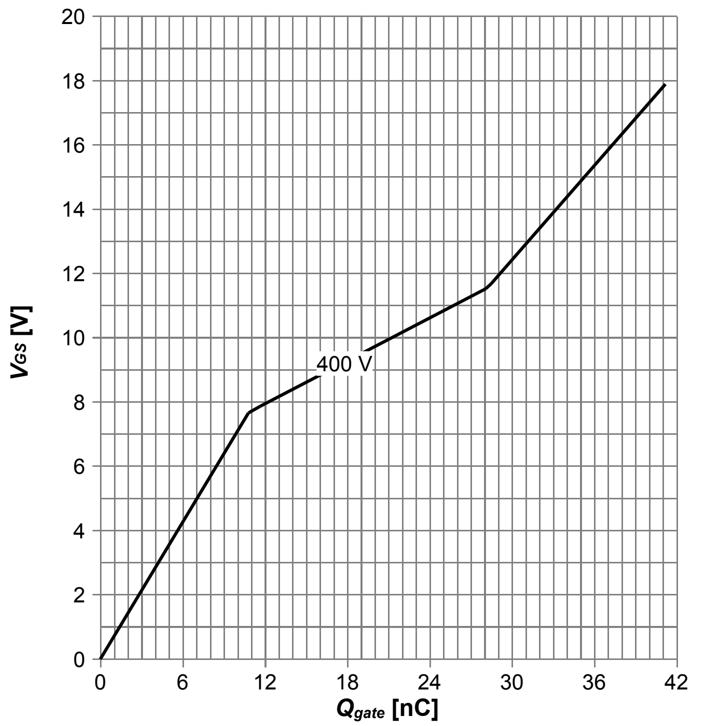
Diagram 7: Typ. drain-source on-state resistance	**Diagram 8: Drain-source on-state resistance**
	
$R_{DS(on)}=f(I_D)$; $T_j=150$ °C; parameter: V_{GS}	$R_{DS(on)}=f(T_j)$; $I_D=25.0$ A; $V_{GS}=18$ V

Diagram 9: Typ. transfer characteristics



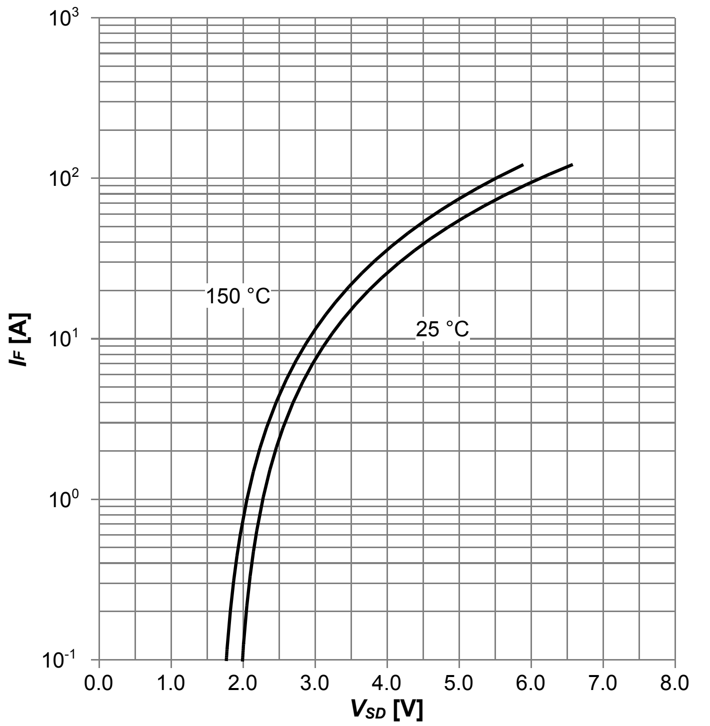
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge



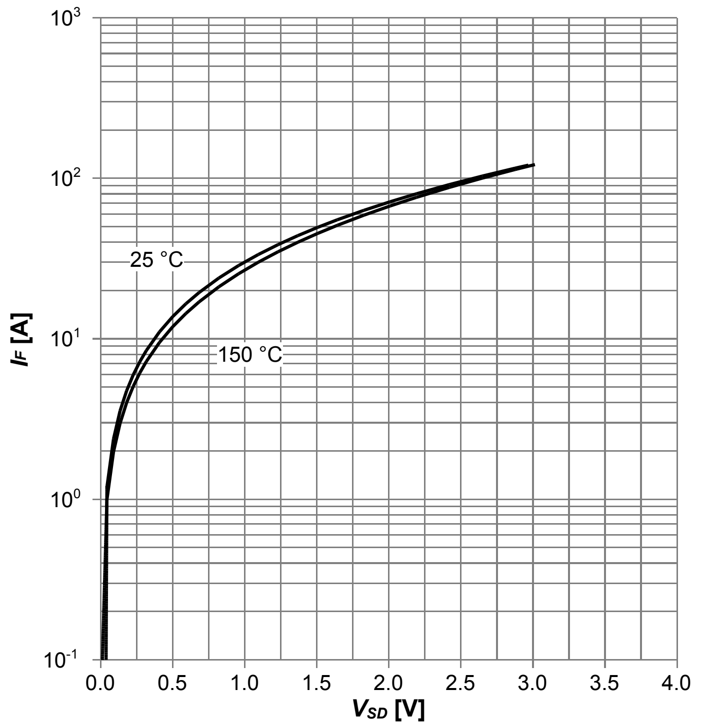
V_{GS}=f(Q_{gate}); I_D=25.0 A pulsed; parameter: V_{DD}

Diagram 11: Typ. forward characteristics of reverse diode



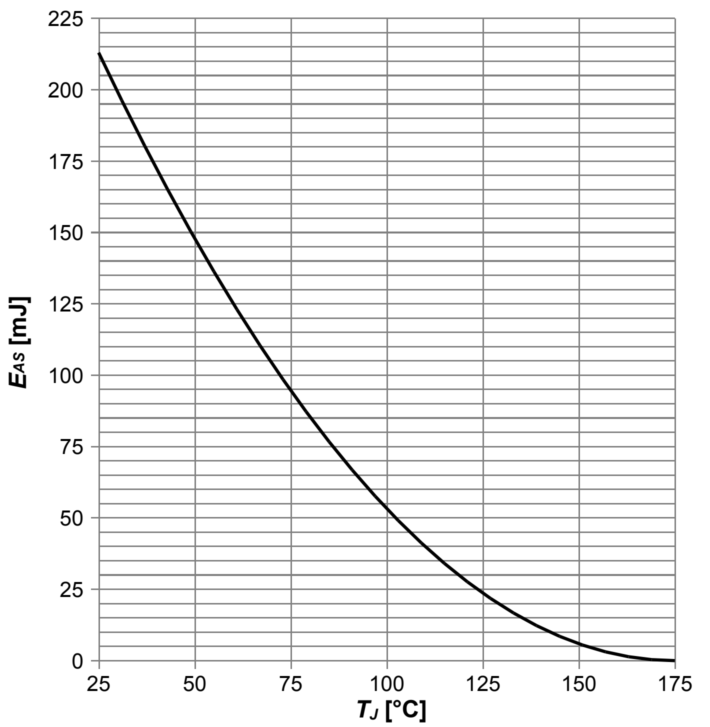
I_F=f(V_{SD}); parameter: T_j

Diagram 12: Typ. channel reverse characteristics



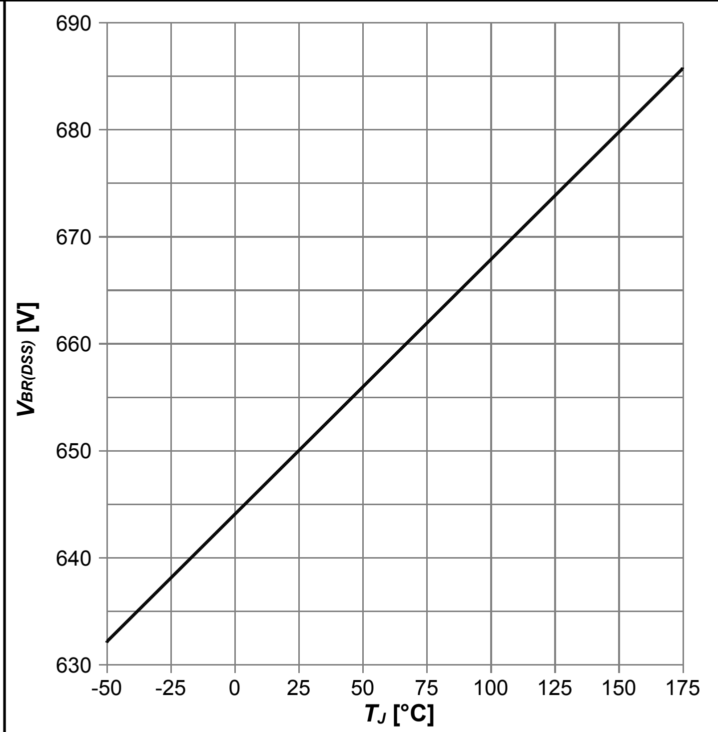
I_F=f(V_{SD}); V_{GS}=18 V; parameter: T_j

Diagram 13: Avalanche energy



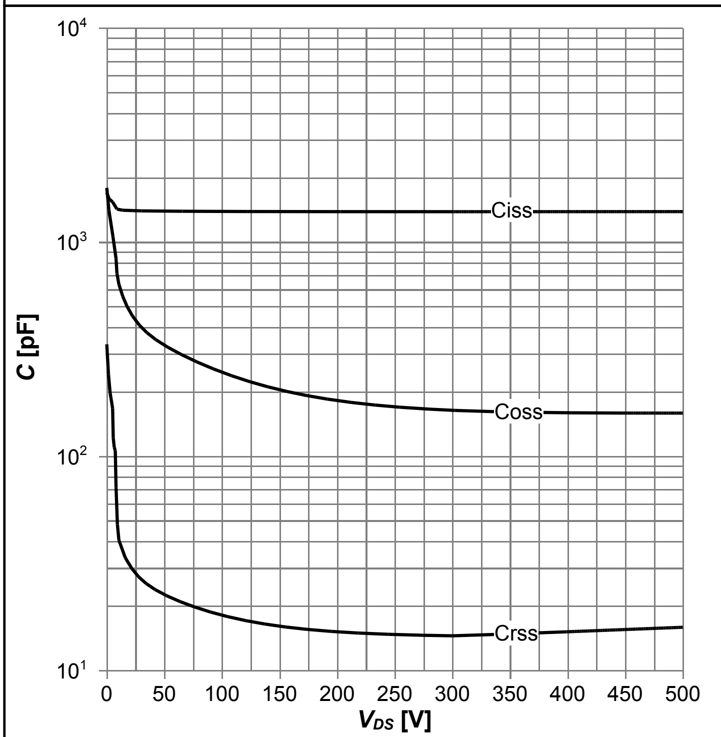
E_{AS}=f(T_j); I_D=8.0 A; V_{DD}=50 V

Diagram 14: Drain-source breakdown voltage



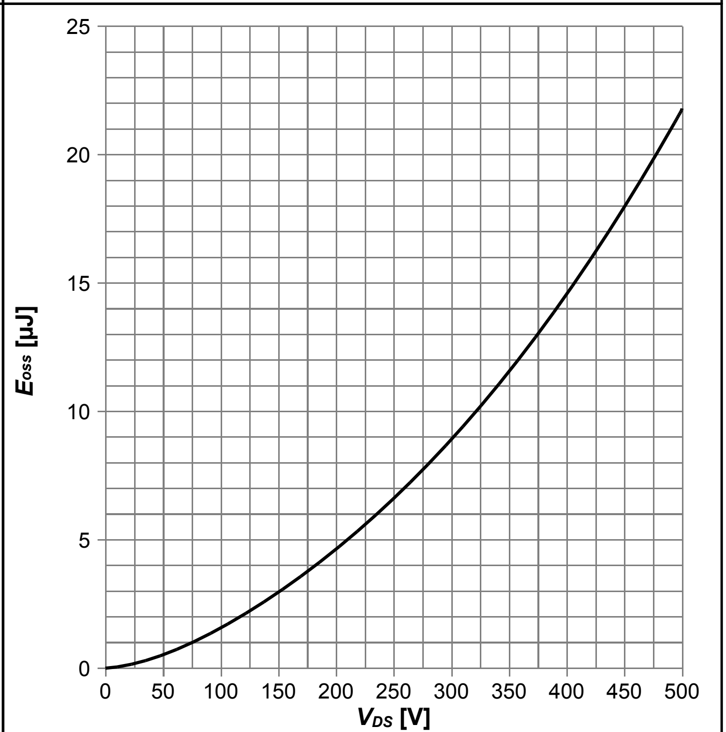
$V_{BR(DSS)}$=f(T_j); I_D=0.75 mA

Diagram 15: Typ. capacitances



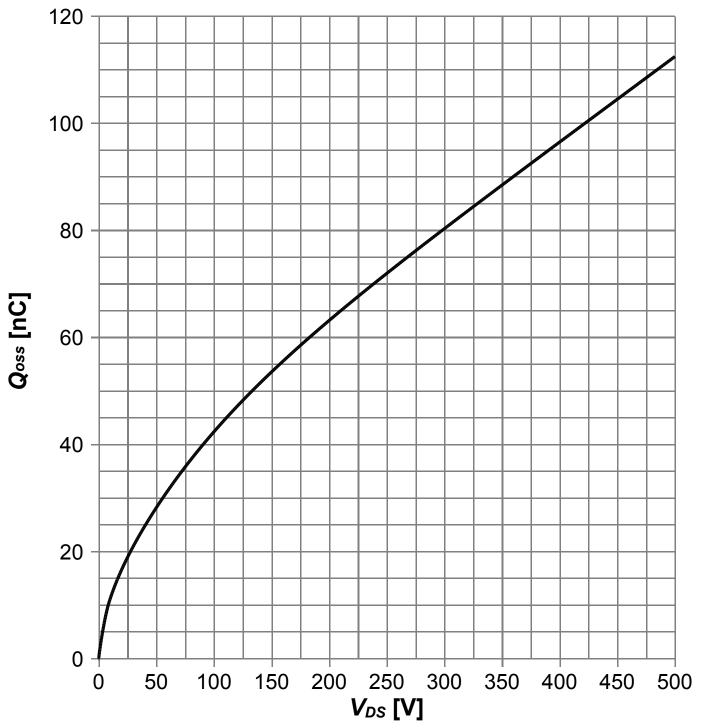
C=f(V_{DS}); V_{GS}=0 V; f=250 kHz

Diagram 16: Typ. Coss stored energy



E_{oss}=f(V_{DS})

Diagram 17: Typ. Qoss output charge

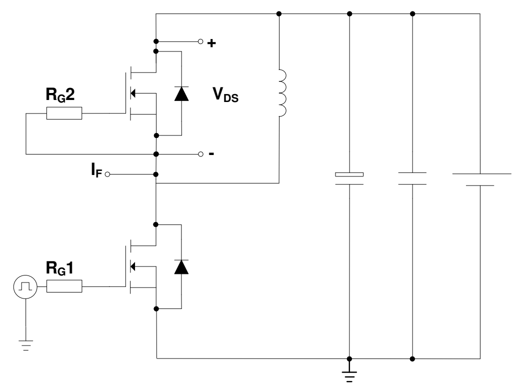


Q_{oss}=f(V_{DS})

5 Test Circuits

Table 8 Diode characteristics (SiC)

Test circuit for diode characteristics	Diode recovery waveform



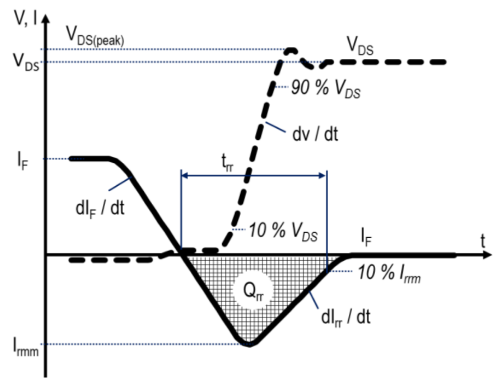
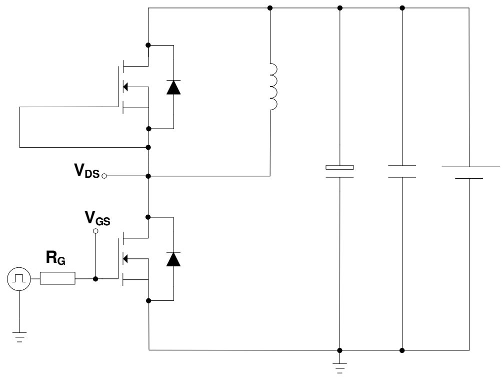


Table 9 Switching times (SiC)

Switching times test circuit for inductive load	Switching times waveform



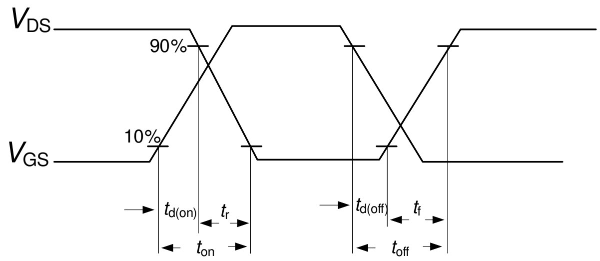
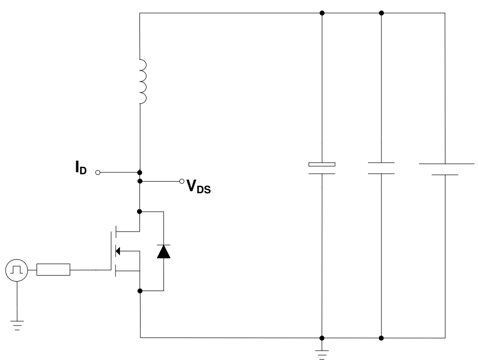
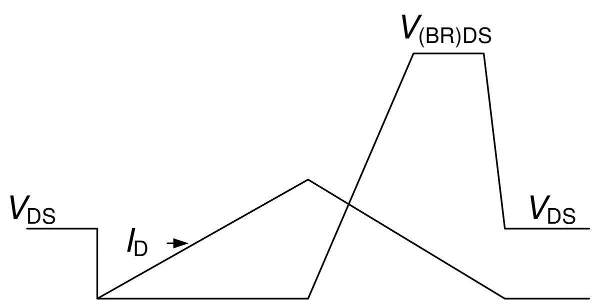


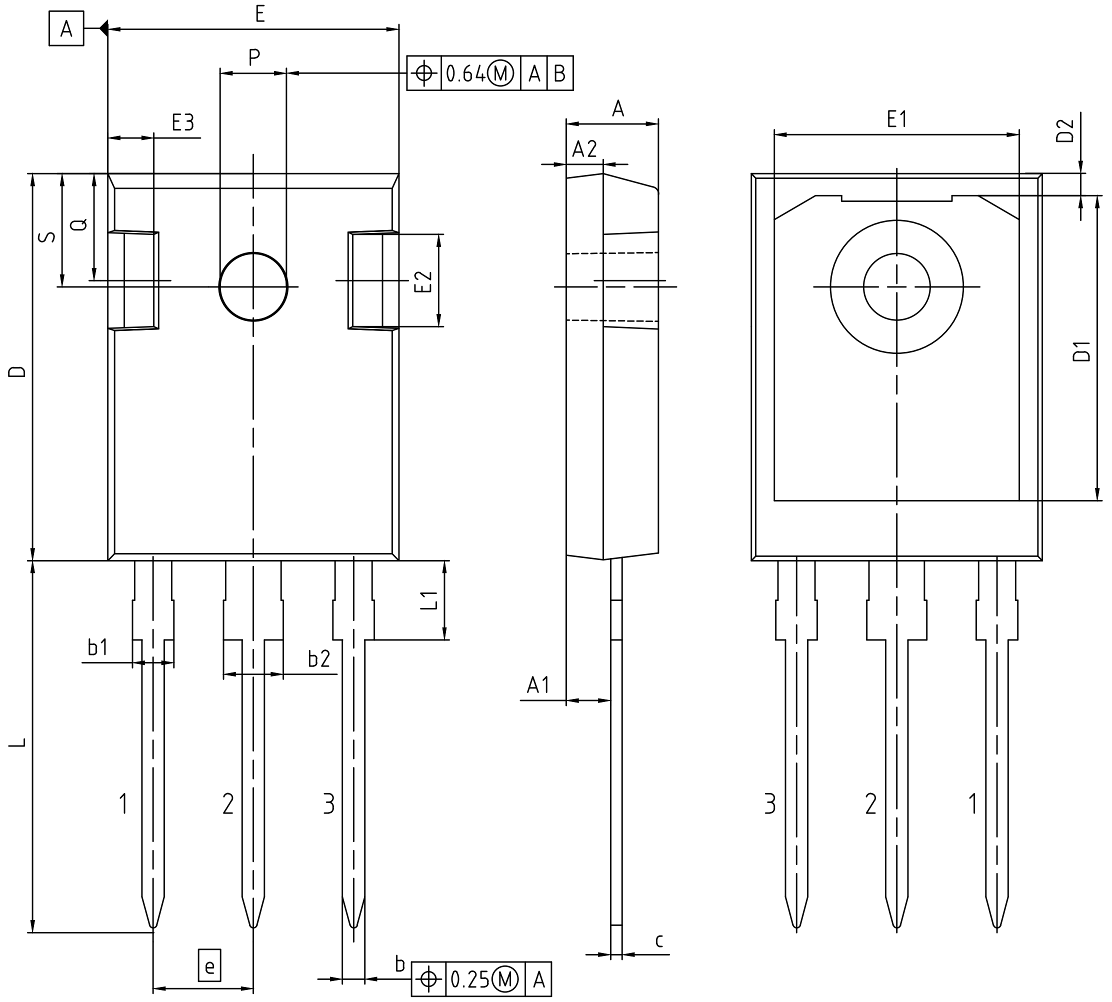
Table 10 Unclamped inductive load (SiC)

Unclamped inductive load test circuit	Unclamped inductive waveform





6 Package Outlines



DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.70	5.30
A1	2.20	2.60
A2	1.50	2.50
b	1.00	1.40
b1	1.60	2.41
b2	2.57	3.43
c	0.38	0.89
D	20.70	21.50
D1	13.08	17.65
D2	0.51	1.35
E	15.50	16.30
E1	12.38	14.15
E2	3.40	5.10
E3	1.00	2.60
e	5.44	
L	19.80	20.40
L1	3.85	4.50
P	3.50	3.70
Q	5.35	6.25
S	6.04	6.30

DOCUMENT NO.
Z8B00003327

REVISION
06

SCALE 3:1
0 1 2 3 4 5mm

EUROPEAN PROJECTION

ISSUE DATE
25.07.2018

Figure 1 Outline PG-TO247-3, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

- **IFX CoolSiC M1 Webpage:** www.infineon.com
- **IFX CoolSiC M1 application note:** www.infineon.com
- **IFX CoolSiC M1 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

Revision History

IMW65R039M1H		
Revision: 2021-03-17, Rev. 2.0		
Previous Revision		
Revision	Date	Subjects (major changes since last revision)
2.0	2021-03-17	Release of final version

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Infineon Technologies AG
81726 München, Germany