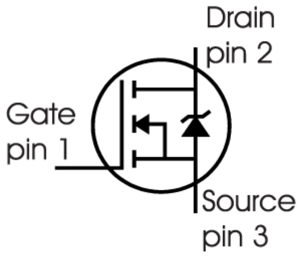
AIMW120R045M1

CoolSiC™ 1200V SiC Trench MOSFET

Silicon Carbide MOSFET



Features

- Revolutionary semiconductor material - Silicon Carbide
- Very low switching losses
- Threshold-free on state characteristic
- IGBT-compatible driving voltage (15V for turn-on)
- 0V turn-off gate voltage
- Benchmark gate threshold voltage, $V_{GS(th)}$=4.5V
- Fully controllable dv/dt
- Commutation robust body diode, ready for synchronous rectification
- Temperature independent turn-off switching losses

Benefits

- Efficiency improvement
- Enabling higher frequency
- Increased power density
- Cooling effort reduction
- Reduction of system complexity and cost

Potential Applications

- On-board Charger/PFC
- Booster/DC-DC Converter
- Auxilliary Inverter

Product Validation

Qualified for Automotive Applications. Product Validation according to AEC-Q100/101”

Table 1 Key Performance and Package Parameters

Type	V_{DS}	I_D (T_C=25°C, $R_{th(j-c,max)}$)	$R_{DS(on),typ}$ (T_{vj}=25°C, I_D=20A, V_{GS}=15V)	T_{vjmax}	Marking	SP Number	Package
AIMW120R045M1	1200V	52A	45mΩ	175°C	A120M1045	SP002472666	PG-TO247-3-41

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1 Maximum ratings

Table 2 Maximum ratings[1]

Parameter	Symbol	Value	Unit
Drain-source voltage, $T_{vj} \geq 25°C$	V_{DSS}	1200	V
DC drain current for $R_{th(j-c,max)}$, limited by T_{vjmax}, V_{GS}=15V T_C = 25°C T_C = 100°C	I_D	 52 36	A
Pulsed drain current, t_p limited by T_{vjmax}, V_{GS} = 15V	$I_{D,pulse}$[1]	130	A
DC body diode forward current for $R_{th(j-c,max)}$, limited by T_{vjmax}, V_{GS}=0V T_C = 25°C T_C = 100°C	I_{SD}	 52 28	A
Pulsed body diode current, t_p limited by T_{vjmax}	$I_{SD,pulse}$[1]	68	A
Gate-source voltage[2] Max transient voltage, < 1% duty cycle Recommended turn-on gate voltage Recommended turn-off gate voltage	 V_{GSS} $V_{GSS,on}$ $V_{GSS,off}$	 -7… 20 15 0	V
Power dissipation, limited by T_{vjmax} T_C = 25°C T_C=100°C	P_{tot}	 228 114	W
Virtual junction temperature	T_{vj}	-40…175	°C
Storage temperature	T_{stg}	-55…150	°C
Soldering temperature, wavesoldering only allowed at leads, 1.6mm (0.063 in.) from case for 10 s	T_{sold}	260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

[1] Not subject to production test. Parameter verified by design/characterization.
[2] Important note: The selection of positive and negative gate-source voltages impacts the long-term behavior of the device. The design guidelines described in Application Note AN2018-09 must be considered to ensure sound operation of the device over the planned lifetime.

2 Thermal resistances

Table 3 Thermal resistances[1]

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET/body diode thermal resistance, junction – case	$R_{th(j-c)}$		-	0.51	0.66	K/W
Thermal resistance, junction – ambient	$R_{th(j-a)}$	leaded	-	-	62	K/W

[1] Not subject to production test. Parameter verified by design/characterization.

3 Electrical Characteristics

3.1 Static characteristics

Table 4 Static characteristics (at T_{vj}=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Drain-source on-state resistance[2]	$R_{DS(on)}$	V_{GS}=15V, I_D=20A, T_{vj} = 25°C T_{vj} = 100°C T_{vj} = 175°C	- - -	45 55 75	59 - -	mΩ
Body Diode forward voltage	V_{SD}	V_{GS}= 0V, I_{SD}=20A T_{vj} = 25°C T_{vj} =100°C T_{vj} =175°C	- - -	4.1 4.0 3.9	5.2 - -	V
Gate-source threshold voltage[2]	$V_{GS(th)}$	(tested after 1 ms pulse at V_{GS}=+20 V) I_D = 10mA, V_{DS} = V_{GS} T_{vj} = 25°C T_{vj} =175°C	3.5 -	4.5 3.6	5.7 -	V
Zero gate voltage drain current	I_{DSS}	V_{GS} = 0V, V_{DS} = 1200V T_{vj}=25°C T_{vj}=175°C	- -	2 50	200 -	µA
Gate-source leakage current	I_{GSS}	V_{GS} = 20V, V_{DS} = 0V	-	-	120	nA
		V_{GS} = -10V, V_{DS} = 0V	-	-	-120	nA
Transconductance	g_{fs}	V_{DS} = 20V, I_D = 20A	-	11.1	-	S
Internal gate resistance	$R_{G,int}$	f = 1MHz, V_{AC} = 25mV	-	4.5	-	Ω

[2] Important note: The selection of positive and negative gate-source voltages impacts the long-term behavior of the device. The design guidelines described in Application Note AN2018-09 must be considered to ensure sound operation of the device over the planned lifetime.

3.2 Dynamic characteristics

Table 5 Dynamic characteristics (at T_{vj}=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Input capacitance	C_{iss}	V_{DS} = 800V, V_{GS} = 0V, f=1MHz, V_{AC} = 25mV	-	2130	-	pF
Output capacitance	C_{oss}			107		
Reverse capacitance	C_{rss}			11		
C_{oss} stored energy	E_{oss}			44		µJ
Total gate charge	Q_G	V_{DD} = 800V, I_D = 20A, V_{GS} = 0/15V, turn-on pulse	-	57	-	nC
Gate to source charge	$Q_{GS,pl}$			19		
Gate to drain charge	Q_{GD}			13		
Short-circuit withstand time[3]	t_{SC}	V_{DD} = 800V, L_σ = 80nH, $R_{G,ext}$ = 9Ohm, T_{vj} = 175°C $V_{GS,on}$ = 15V	-	3	-	µs

[3] Verified by design for single short circuit event at $V_{GS,on}$ = 15V.

3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load [4]

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET Characteristics, T_{vj}=25°C						
Turn-on delay time	$t_{d(on)}$	V_{DD}=800V, I_D=20A, V_{GS}=0V/15V, $R_{G,ext}$=2Ω, $L_σ$=40nH, diode: body diode at V_{GS}=0V see Fig. E	-	9	-	ns
Rise time	t_r		-	32	-	ns
Turn-off delay time	$t_{d(off)}$		-	17	-	ns
Fall time	t_f		-	13	-	ns
Turn-on energy	E_{on}		-	450	-	µJ
Turn-off energy	E_{off}		-	70	-	µJ
Total switching energy	E_{tot}		-	520	-	µJ
Body Diode Characteristics, T_{vj}=25°C						
Diode reverse recovery charge	Q_{rr}	V_{DD} = 800V, I_{SD}=20A, V_{GS} at diode=0V, di_f/dt=1000A/µs, Q_{rr} includes also Q_C, see Fig. C	-	0.15	-	µC
Diode peak reverse recovery current	I_{rrm}		-	8	-	A

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
MOSFET Characteristics, T_{vj}=175°C						
Turn-on delay time	$t_{d(on)}$	V_{DD}=800V, I_D=20A, V_{GS}=0V/15V, $R_{G,ext}$=2Ω, $L_σ$=40nH, diode: body diode at V_{GS}=0V, see Fig. E	-	9	-	ns
Rise time	t_r		-	32	-	ns
Turn-off delay time	$t_{d(off)}$		-	20	-	ns
Fall time	t_f		-	14	-	ns
Turn-on energy	E_{on}		-	490	-	µJ
Turn-off energy	E_{off}		-	75	-	µJ
Total switching energy	E_{tot}		-	565	-	µJ
Body Diode Characteristics, T_{vj}=175°C						
Diode reverse recovery charge	Q_{rr}	V_{DD} = 800V, I_{SD}=20A, V_{GS} at diode=0V, di_f/dt=1000A/µs, Q_{rr} includes also Q_C, see Fig. C	-	0.25	-	µC
Diode peak reverse recovery current	I_{rrm}		-	10	-	A

[4] The chip technology was characterized up to 200 kV/µs. The measured dv/dt was limited by measurement test setup and package.

4 Electrical characteristic diagrams

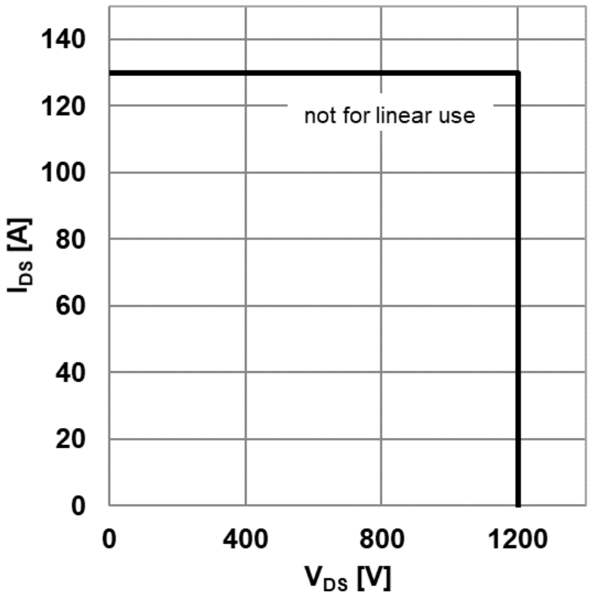


Figure 1 Reverse bias safe operating area (RBSOA) (V_{gs} = 0/15V, T_c = 25°C, T_j < 175°C)

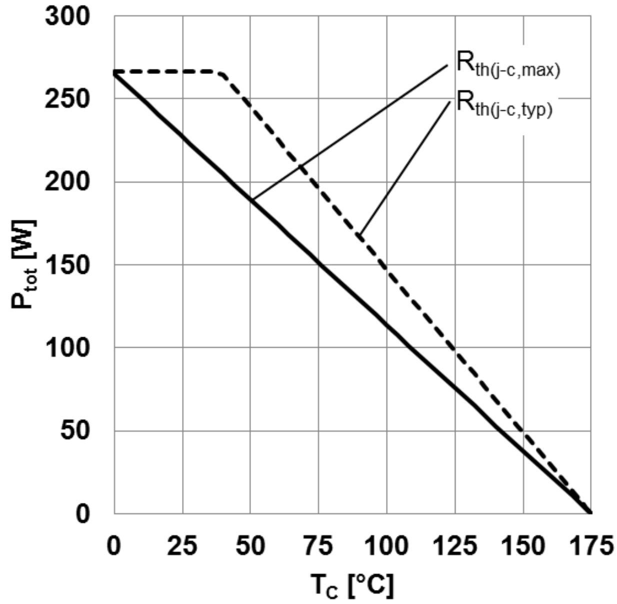


Figure 2 Power dissipation as a function of case temperature limited by bond wire (P_{tot}=f(T_C))

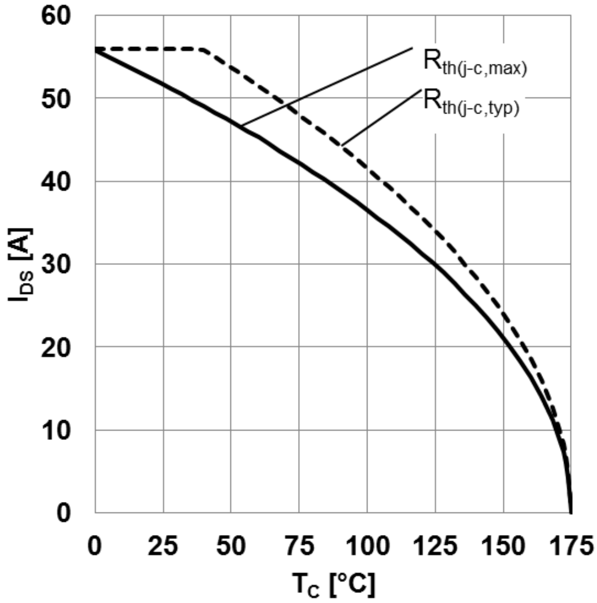


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire (I_{DS}=f(T_C))

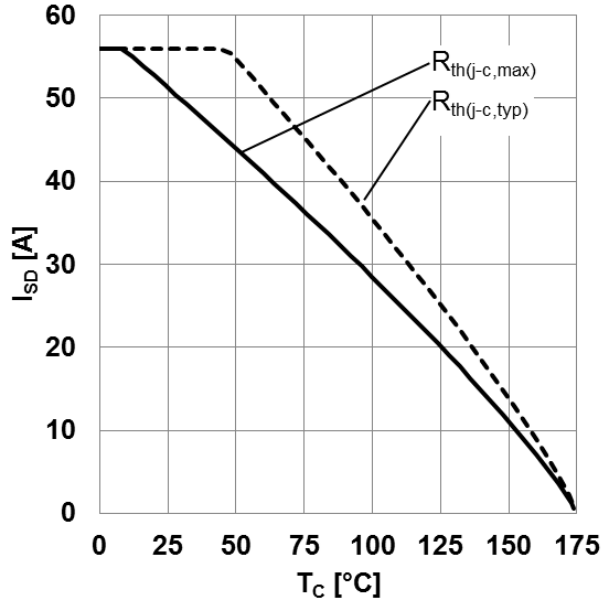


Figure 4 Maximum source to drain current as a function of case temperature limited by bond wire (I_{SD}=f(T_C), V_{GS}=0V)

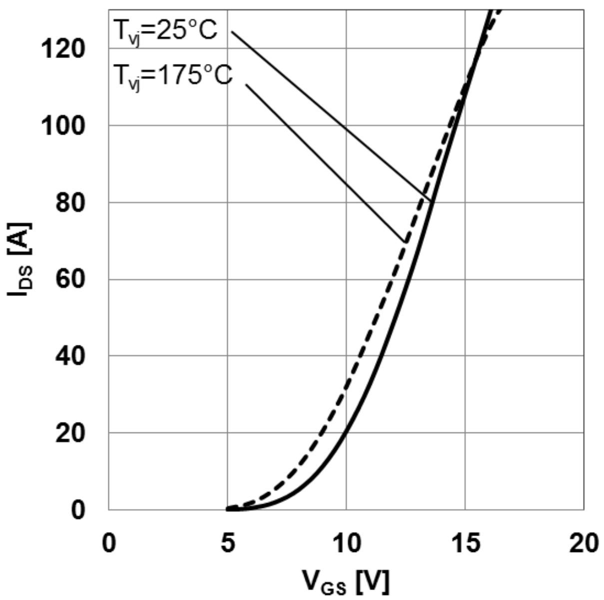


Figure 5 Typical transfer characteristic (I_{DS}=f(V_{GS}), V_{DS}=20V, t_P = 20 µs)

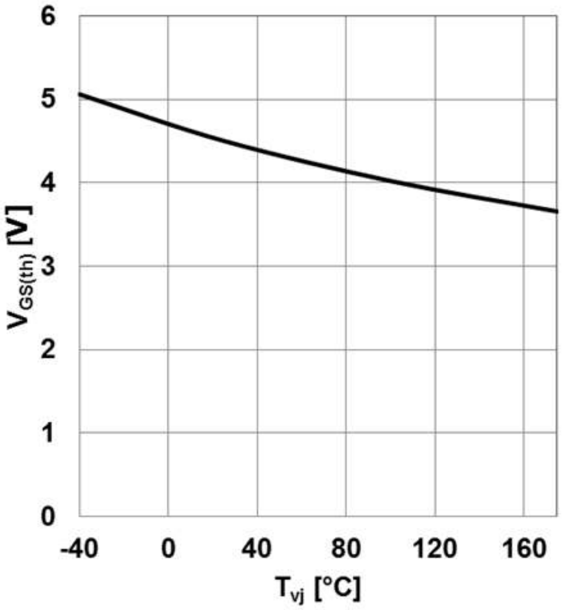


Figure 6 Typical gate-source threshold voltage as a function of junction temperature ($V_{GS(th)}$=f(T_{vj}), I_{DS}=10mA, V_{GS}=V_{DS})

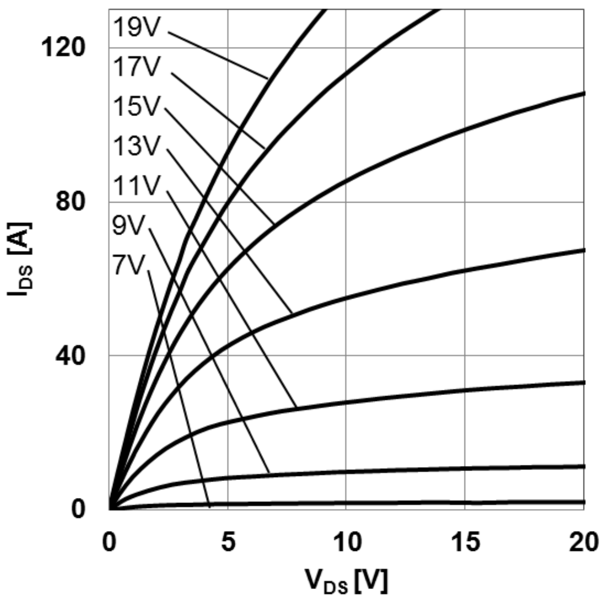


Figure 7 Typical output characteristic, V_{GS} as parameter (I_{DS}=f(V_{DS}), T_{vj}=25°C, t_P = 20 µs)

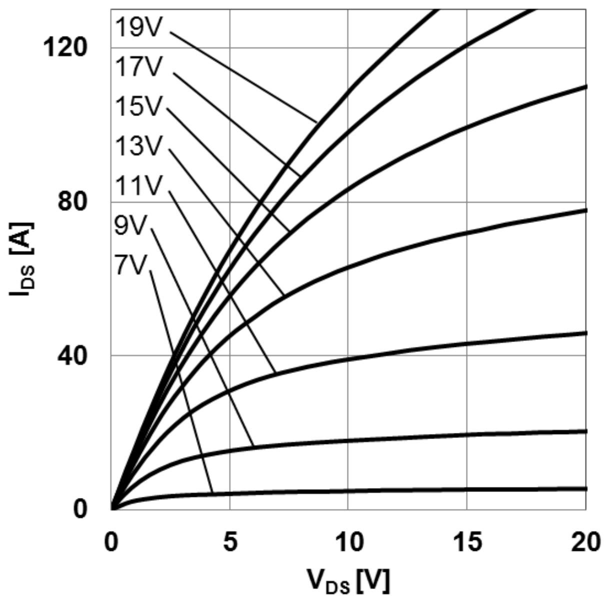


Figure 8 Typical output characteristic, V_{GS} as parameter (I_{DS}=f(V_{DS}), T_{vj}=175°C, t_P = 20 µs)

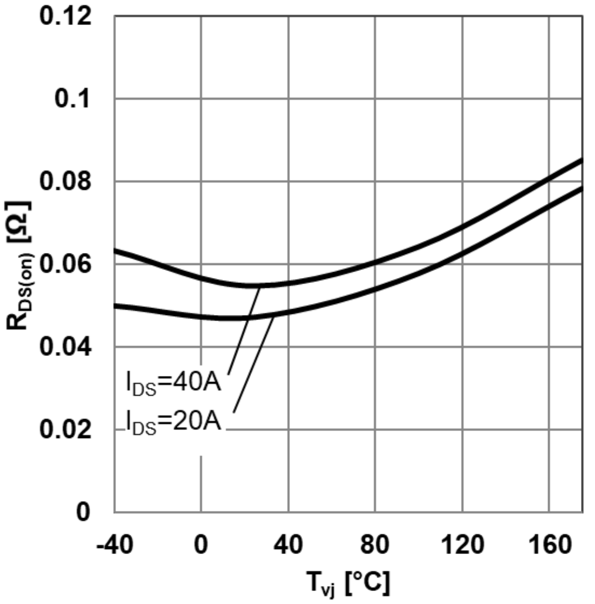


Figure 9 Typical on-resistance as a function of junction temperature ($R_{DS(on)}=f(T_{vj})$, $V_{GS}=15V$)

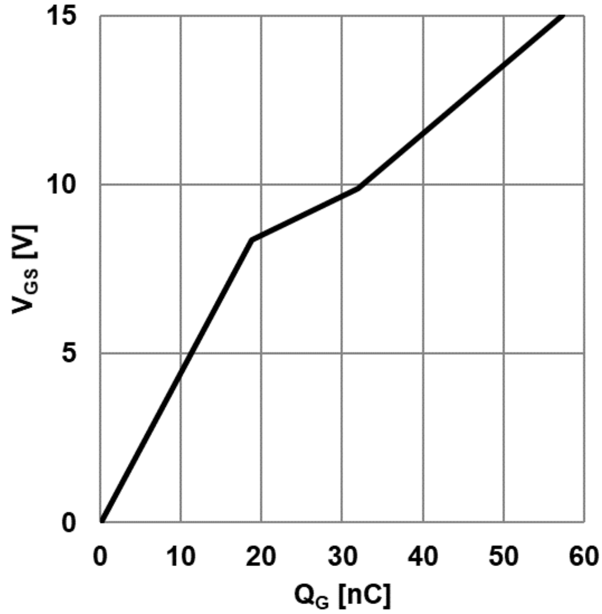


Figure 10 Typical gate charge ($V_{GS}=f(Q_G)$, $I_{DS}=20A$, $V_{DS}=800V$, turn-on pulse)

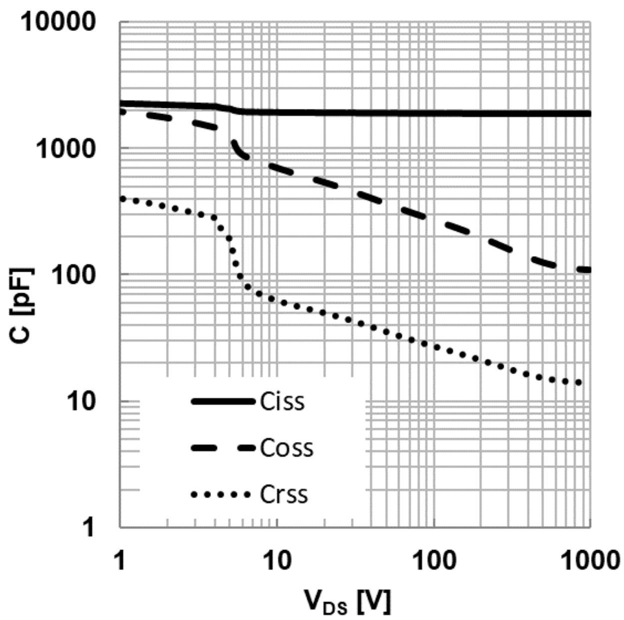


Figure 11 Typical capacitance as a function of drain-source voltage ($C=f(V_{DS})$, $V_{GS}=0V$, f=1MHz)

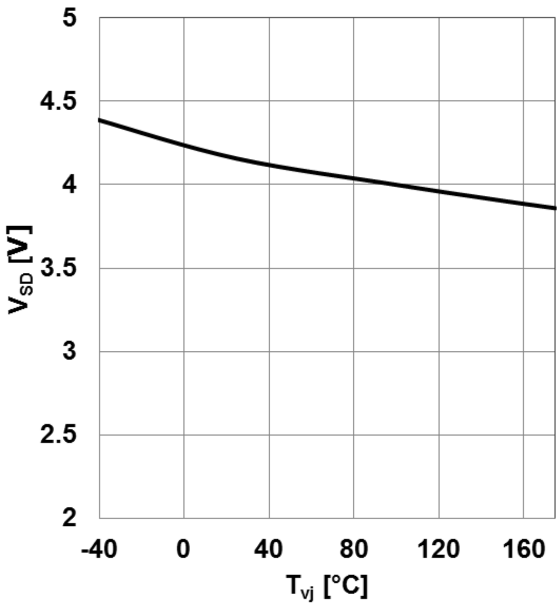


Figure 12 Typical body diode forward voltage as function of junction temperature ($V_{SD}=f(T_{vj})$, $V_{GS}=0V$, $I_{SD}=20A$)

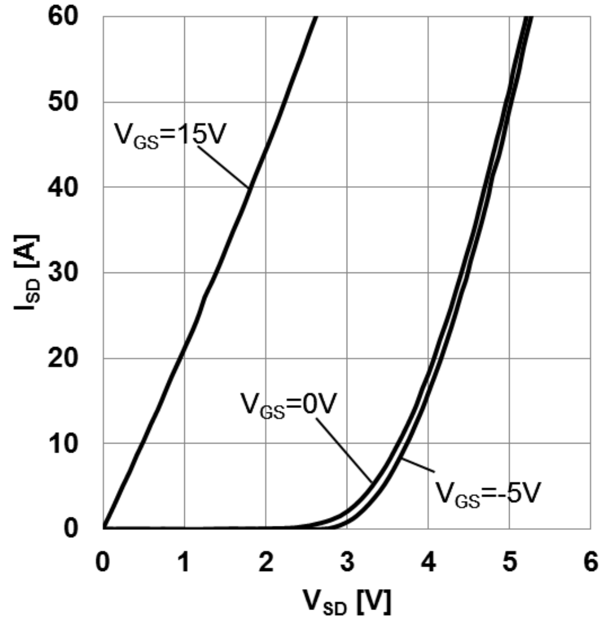


Figure 13 Typical body diode forward current as function of forward voltage, V_{GS} as parameter (I_{SD}=f(V_{SD}), T_{vj}=25°C, t_P=20 µs)

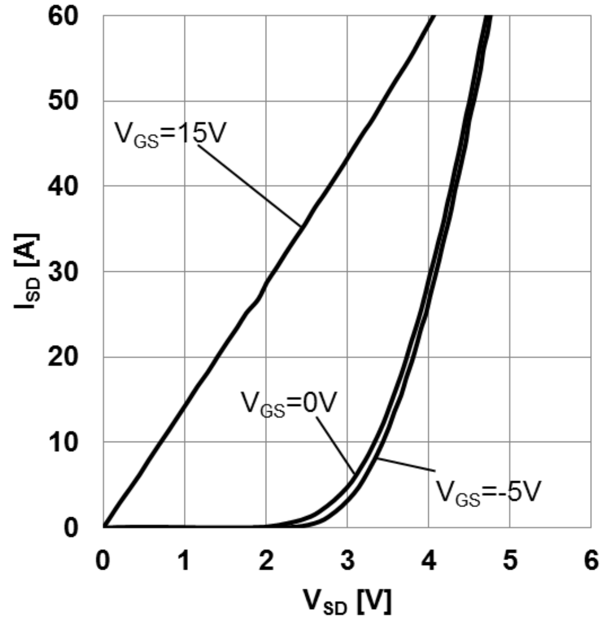


Figure 14 Typical body diode forward current as function of forward voltage, V_{GS} as parameter (I_{SD}=f(V_{SD}), T_{vj}=175°C, t_P=20 µs)

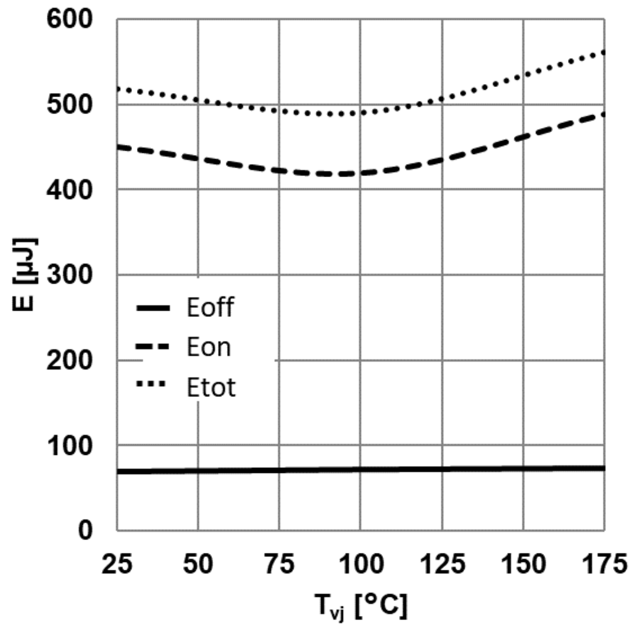


Figure 15 Typical switching energy losses as a function of junction temperature (E=f(T_{vj}), V_{DD}=800V, V_{GS}=0V/15V, $R_{G,ext}$=2Ω, I_D=20A, ind. load, test circuit in Fig. E, diode: body diode)

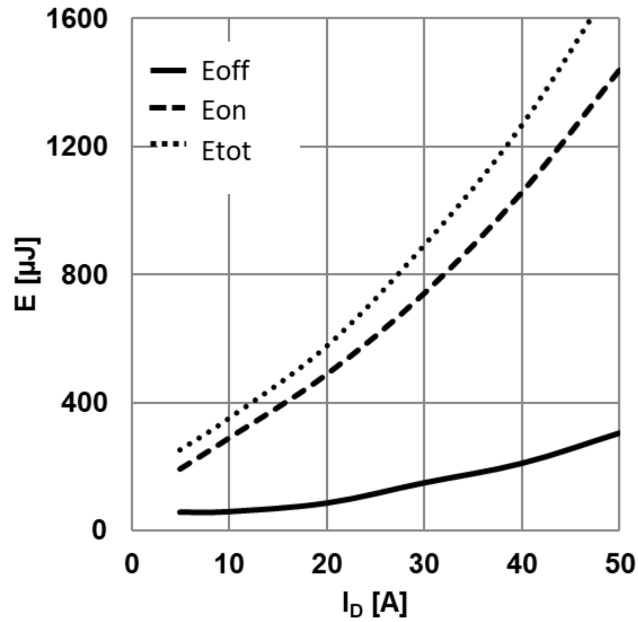


Figure 16 Typical switching energy losses as a function of drain-source current (E = f(I_{DS}), V_{DD} = 800V, V_{GS} = 0V/15V, $R_{G,ext}$ = 2Ω, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode)

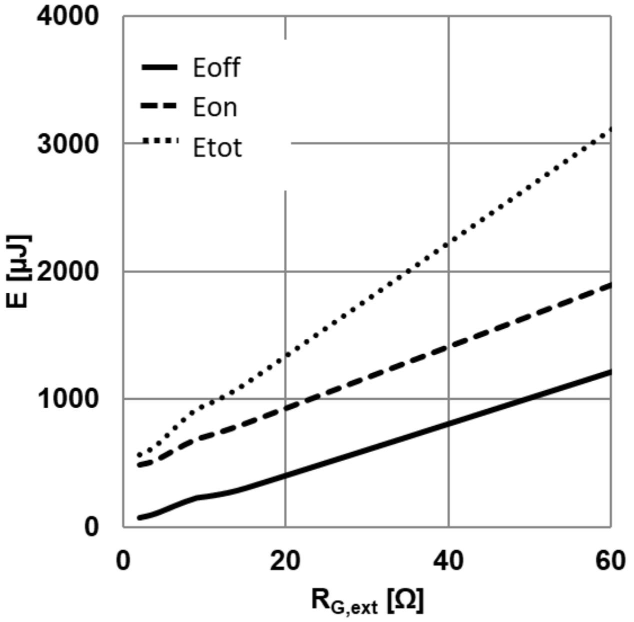


Figure 17 Typical switching energy losses as a function of gate resistance ($E=f(R_{G,ext})$, V_{DD}=800V, V_{GS}=0V/15V, I_D=20A, T_{vj}=175°C, ind. load, test circuit in Fig. E, diode: body diode)

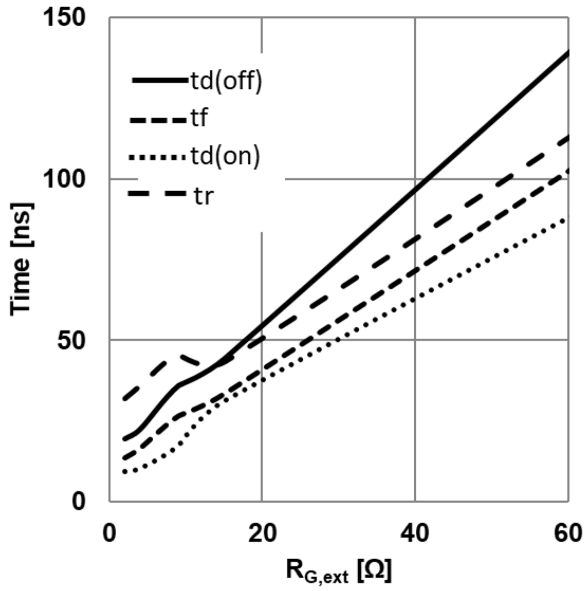


Figure 18 Typical switching times as a function of gate resistor ($t=f(R_{G,ext})$, V_{DD}=800V, V_{GS}=0V/15V, I_D=20A, T_{vj}=175°C, ind. load, test circuit in Fig. E, diode: body diode)

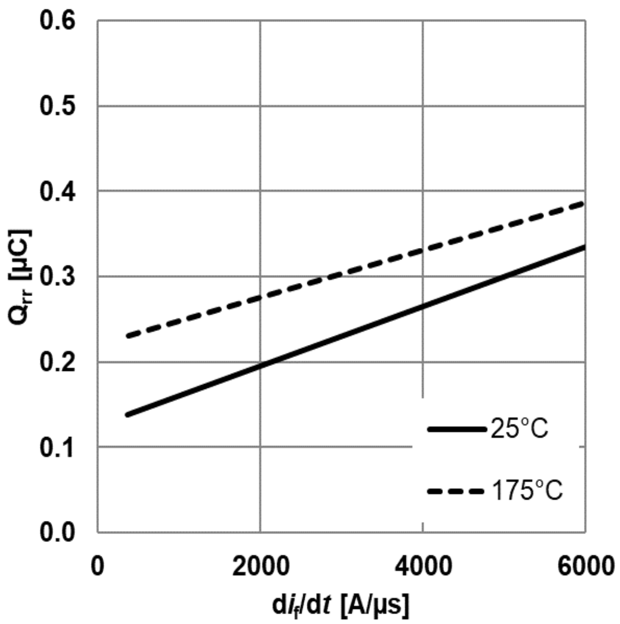


Figure 19 Typical reverse recovery charge as a function of diode current slope ($Q_{rr}=f(di_f/dt)$, V_{DD}=800V, I_D=20A, ind. load, test circuit in Fig.E)

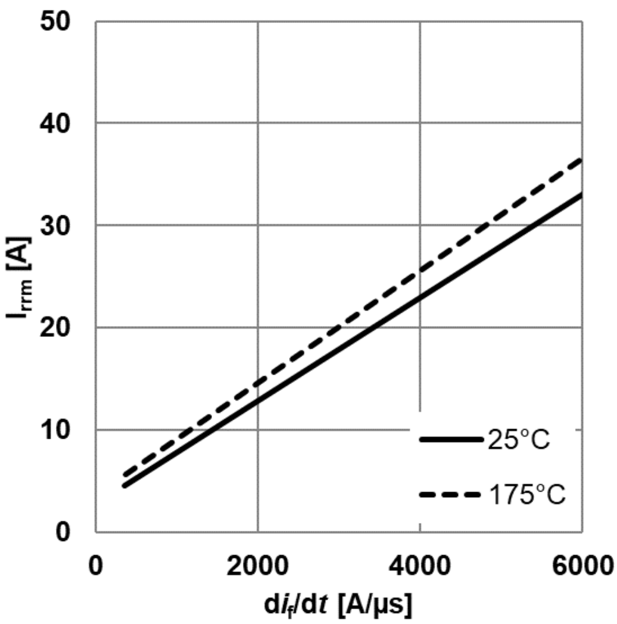
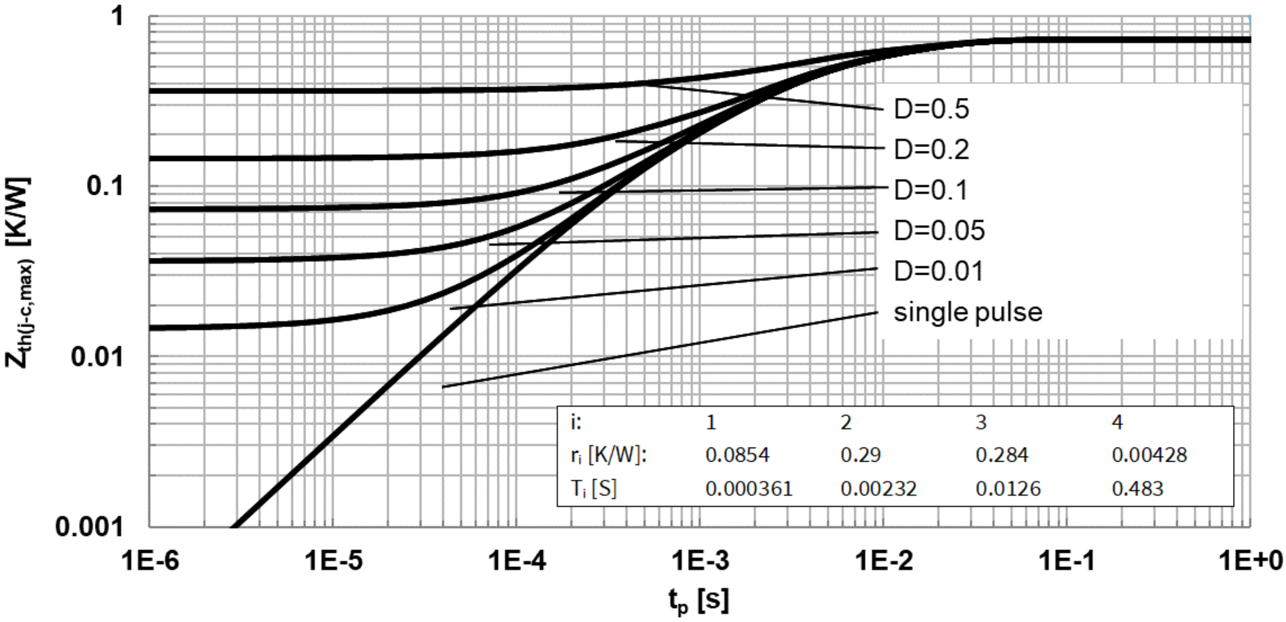


Figure 20 Typical reverse recovery current as a function of diode current slope ($I_{rrm}=f(di_f/dt)$, V_{DD}=800V, I_D=20A, ind. load, test circuit in Fig.E)

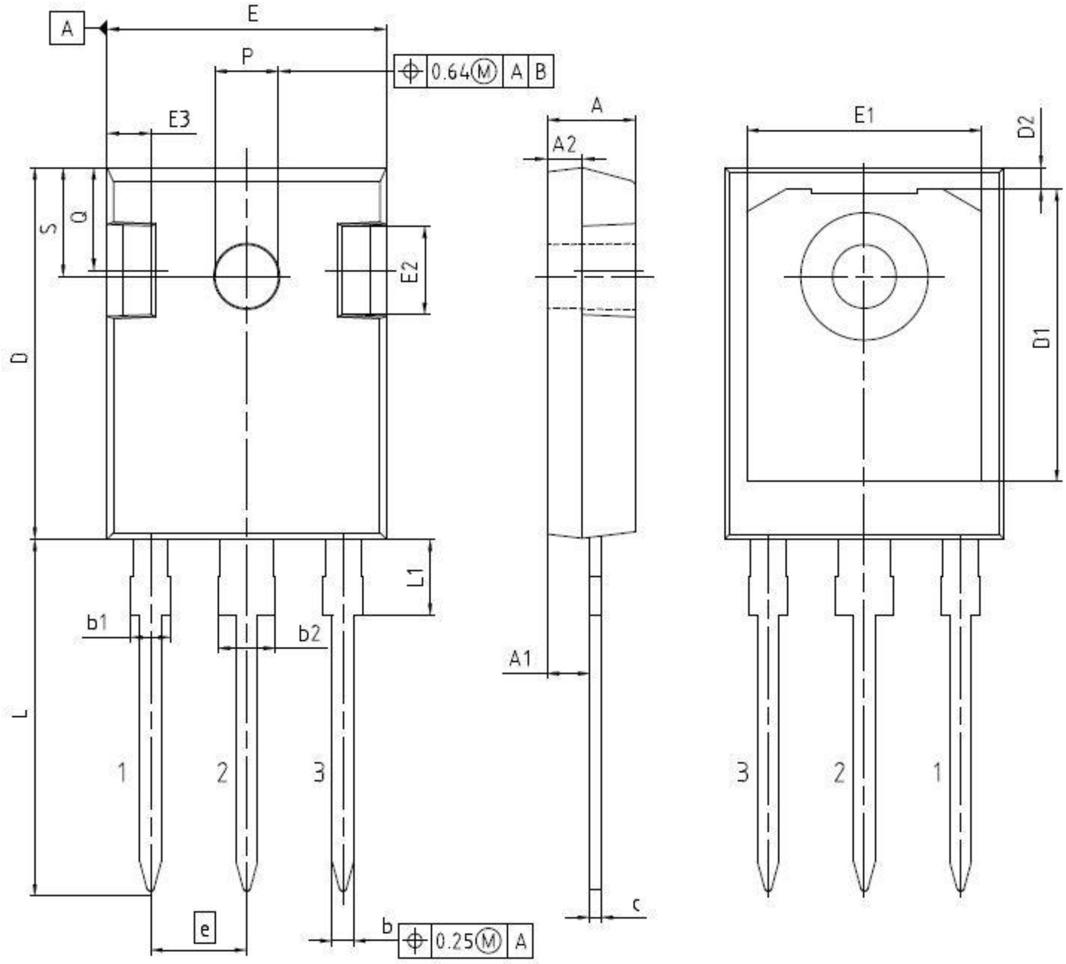


i:	1	2	3	4
r_i [K/W]:	0.0854	0.29	0.284	0.00428
T_i [S]	0.000361	0.00232	0.0126	0.483

Figure 21 Max. transient thermal resistance (MOSFET/diode)
($Z_{th(j-c,max)} = f(t_P)$, parameter $D = t_p/T$, thermal equivalent circuit in Fig. D)

5 Package drawing

PG-TO247-3-41



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.
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SCALE 3:1
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EUROPEAN PROJECTION

ISSUE DATE
25.07.2018

Figure 22 Package drawing

6 Test conditions

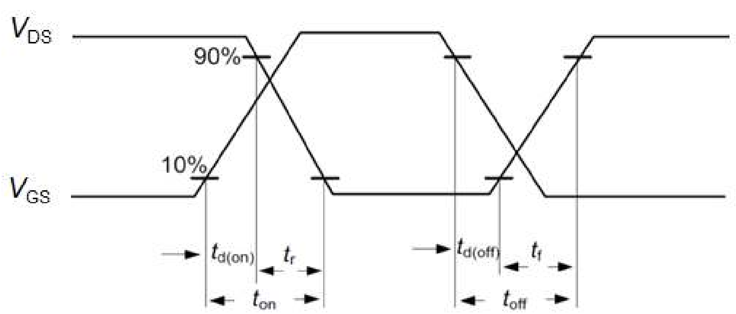

Figure A. **Definition of switching times**

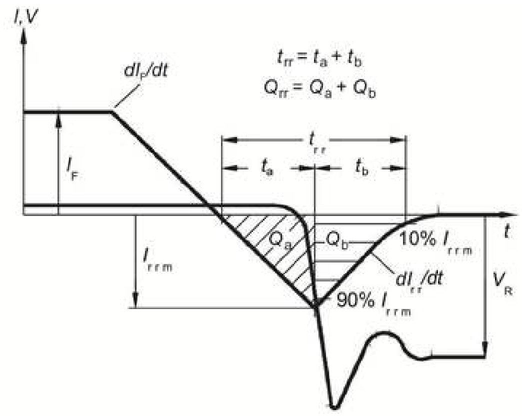

Figure C. **Definition of diode switching characteristics**

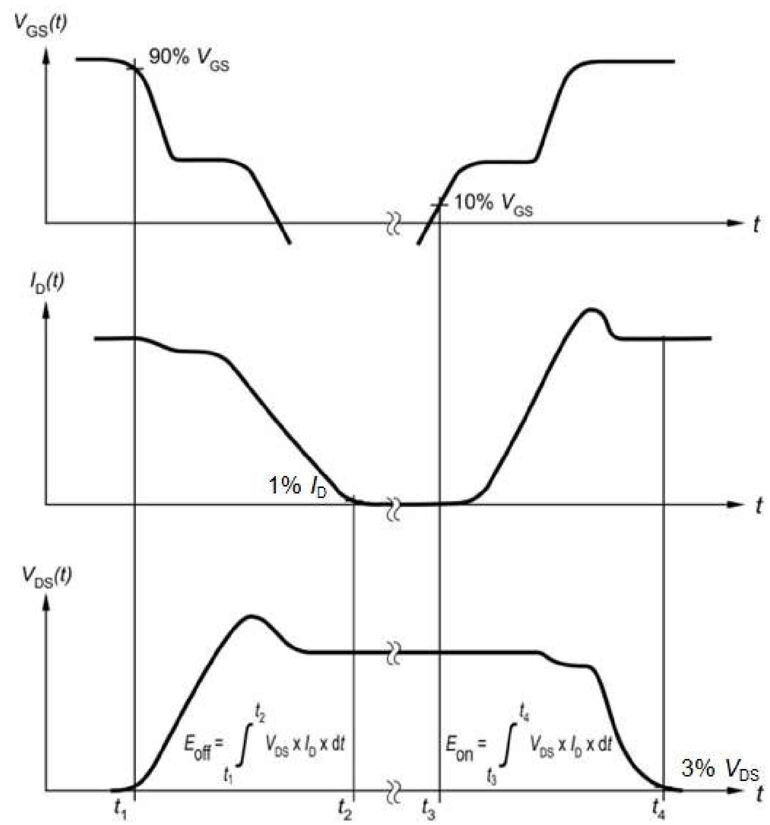

Figure B. **Definition of switching losses**

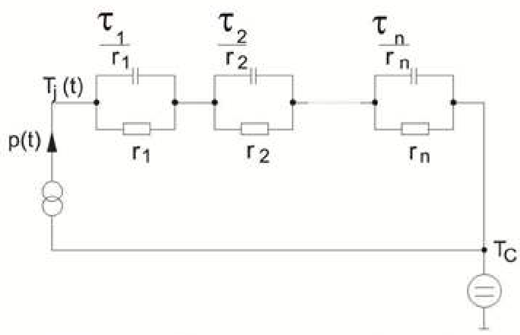

Figure D. **Thermal equivalent circuit**

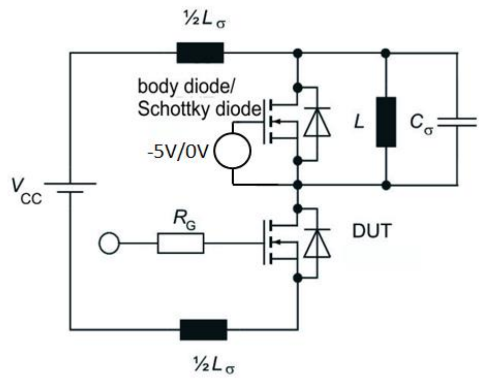

Figure E. **Dynamic test circuit**

Parasitic inductance L_{σ},

parasitic capacitor C_{σ},

Figure 23 Test conditions

Revision History

Major changes since the last revision

Page or Reference	Description of change
All pages	First release of datasheet V3.0
Page 3	$I_{SD,pulse}$ value adjusted

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81726 München, Germany
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