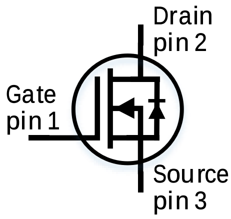
THE DATASHEET OF

AIMW120R060M1HXKSA1

AIMW120R060M1H

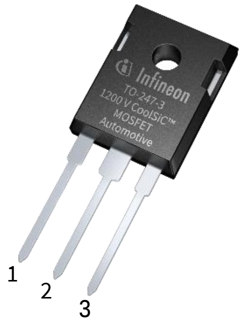
CoolSiC™ Automotive 1200V SiC Trench MOSFET 1200V G1

Silicon Carbide MOSFET



Features

- Revolutionary semiconductor material - Silicon Carbide
- Very low switching losses
- Threshold-free on state characteristic
- IGBT-compatible driving voltage (18V 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

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 = 13A, V_{GS} = 18V)	T_{vjmax}	Marking	Package
AIMW120R060M1H	1200V	36A	60mΩ	175°C	A120M1060	PG-TO247-3-41

1200V SiC Trench MOSFET

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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 $R_{th(j\text{-}c,max)}$, limited by T_{vjmax}, $V_{GS} = 18V$, $T_C = 25°C$ $T_C = 100°C$	I_D	 36 26	A
Pulsed drain current, t_p limited by T_{vjmax}, $V_{GS} = 18V$	$I_{D,pulse}$[1]	74	A
DC body diode forward current for $R_{th(j\text{-}c,max)}$, limited by T_{vjmax}, $V_{GS} = 0V$ $T_C = 25°C$ $T_C = 100°C$	I_{SD}	 36 22	A
Pulsed body diode current, t_p limited by T_{vjmax}	$I_{SD,pulse}$[1]	38	A
Gate-source voltage[2] Max transient voltage, < 1% duty cycle Recommended turn-on gate voltage Recommended turn-off gate voltage	 V_{GS} $V_{GS,on}$ $V_{GS,off}$	 -7… 23 18 0	V
Power dissipation, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	P_{tot}	 150 75	W
Virtual junction temperature	T_{vj}	-55… 175	°C
Storage temperature	T_{stg}	-55… 150	°C
Soldering temperature, wave soldering 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	$R_{th(j-c)}$		-	0.8	1	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} = 18V, I_D = 13A, T_{vj} = 25°C T_{vj} = 100°C T_{vj} = 175°C	- - -	60 76 113	78 - -	mΩ
Body diode forward voltage	V_{SD}	V_{GS} = 0V, I_{SD} = 13A T_{vj} = 25°C T_{vj} = 100°C T_{vj} = 175°C	- - -	3.8 3.7 3.6	5.2 - -	V
Gate-source threshold voltage	$V_{GS(th)}$	*(tested after 1 ms pulse at* V_{GS} = 20V*)* I_D = 5,6mA, 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	- -	1 30	180 -	µA
Gate-source leakage current	I_{GSS}	V_{GS} = 23V, V_{DS} = 0V	-	-	100	nA
		V_{GS} = -7V, V_{DS} = 0V	-	-	-100	nA
Transconductance	g_{fs}	V_{DS} = 20V, I_D = 13A	-	7	-	S
Internal gate resistance	$R_{G,int}$	f = 1MHz, V_{AC} = 25mV	-	6	-	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_{DD} = 800V, V_{GS} = 0V, f = 1MHz, V_{AC} = 25mV	-	1060	-	pF
Output capacitance	C_{oss}		-	58	-	
Reverse capacitance	C_{rss}		-	6.5	-	
C_{oss} stored energy	E_{oss}		-	22	-	µJ
Total gate charge	Q_G	V_{DD} = 800V, I_D = 13A, V_{GS} = 0/18V, turn-on pulse	-	31	-	nC
Gate to source charge	$Q_{GS,pl}$		-	9	-	
Gate to drain charge	Q_{GD}		-	7	-	

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 = 13A, V_{GS} = 0/18V, $R_{G,ext}$ = 2Ω, L_σ = 40nH, diode: body diode at V_{GS} = 0V see Fig. E	-	8	-	ns
Rise time	t_r		-	16	-	ns
Turn-off delay time	$t_{d(off)}$		-	16	-	ns
Fall time	t_f		-	13	-	ns
Turn-on energy	E_{on}		-	167	-	µJ
Turn-off energy	E_{off}		-	79	-	µJ
Total switching energy	E_{tot}		-	246	-	µJ
Body Diode Characteristics, T_{vj} = 25°C						
Diode reverse recovery charge	Q_{rr}	V_{DD} = 800V, I_{SD} = 13A, V_{GS} at diode = 0V, di_f/dt = 1000A/µs, Q_{rr} includes also Q_C, see Fig. C	-	116	-	nC
Diode peak reverse recovery current	I_{rrm}		-	5	-	A
MOSFET Characteristics, T_{vj} = 175°C						
Turn-on delay time	$t_{d(on)}$	V_{DD} = 800V, I_D = 13A, V_{GS} = 0/18V, $R_{G,ext}$ = 2Ω, L_σ = 40nH, diode: body diode at V_{GS} = 0V see Fig. E	-	8	-	ns
Rise time	t_r		-	19	-	ns
Turn-off delay time	$t_{d(off)}$		-	17	-	ns
Fall time	t_f		-	13	-	ns
Turn-on energy	E_{on}		-	241	-	µJ
Turn-off energy	E_{off}		-	103	-	µJ
Total switching energy	E_{tot}		-	344	-	µJ
Body Diode Characteristics, T_{vj} = 175°C						
Diode reverse recovery charge	Q_{rr}	V_{DD} = 800V, I_{SD} = 13A, V_{GS} at diode = 0V, di_f/dt = 1000A/µs, Q_{rr} includes also Q_C, see Fig. C	-	244	-	nC
Diode peak reverse recovery current	I_{rrm}		-	7	-	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

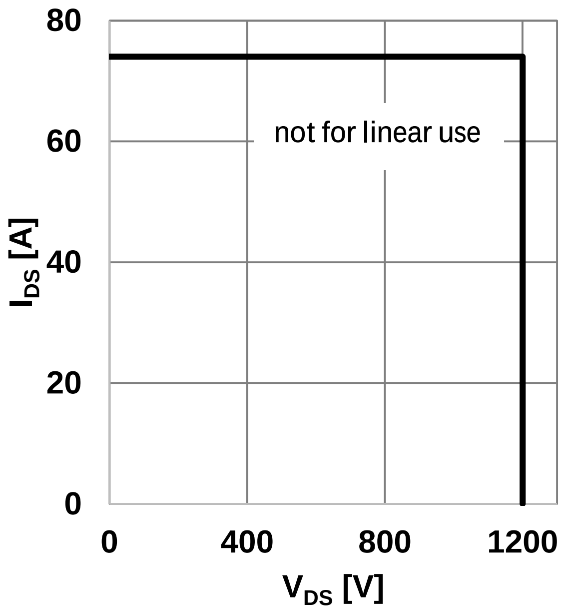


Figure 1 **Safe operating area (SOA)**
(V_{GS} = 0/18V, T_c = 25°C, T_j ≤ 175°C)

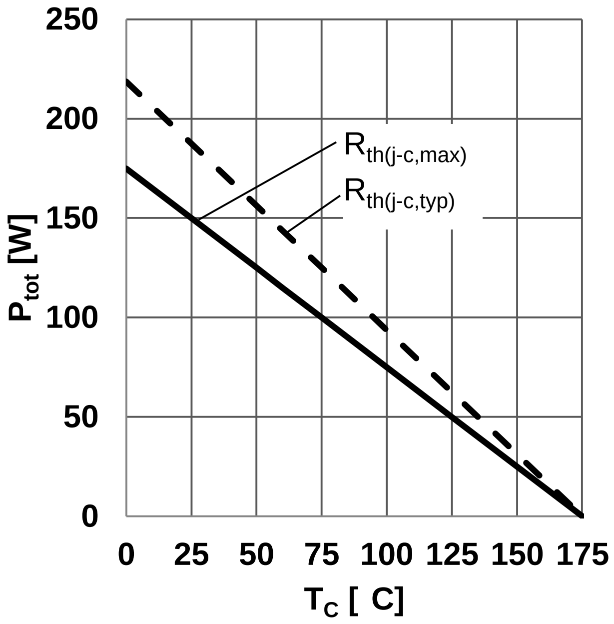


Figure 2 **Power dissipation as a function of case temperature limited by bond wire**
(P_{tot} = f(T_C))

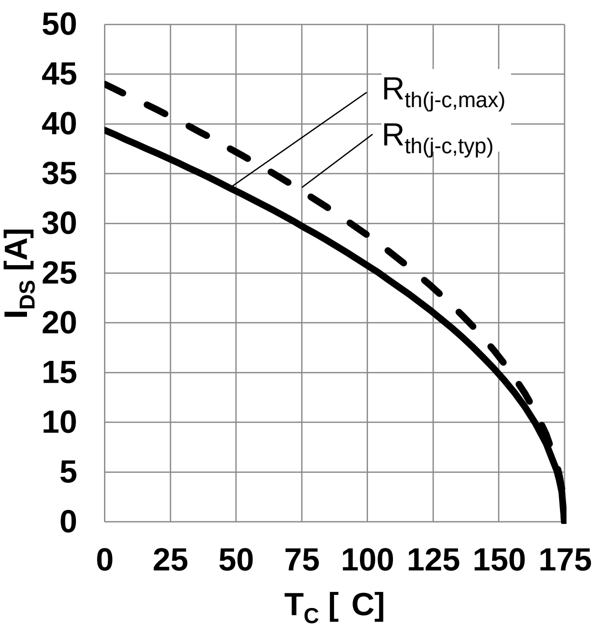


Figure 3 **Maximum DC drain to source current as a function of case temperature limited by bond wire** (I_{DS} = f(T_C))

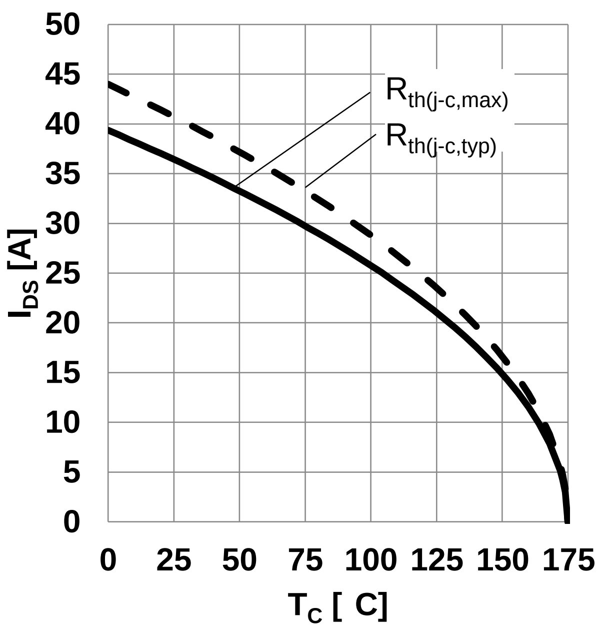


Figure 4 **Maximum source to drain current as a function of case temperature limited by bond wire** (I_{SD} = f(T_C), V_{GS} = 0V)

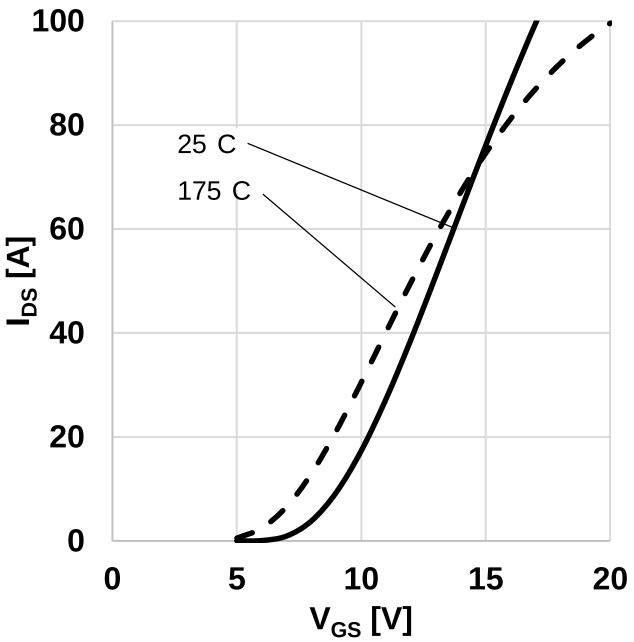


Figure 5 **Typical transfer characteristic**
(I_{DS} = f(V_{GS}), V_{DS} = 20V, t_P = 20µs)

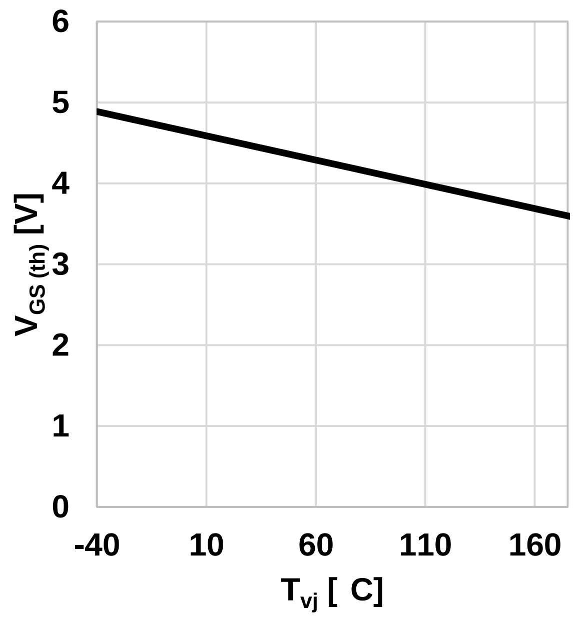


Figure 6 **Typical gate-source threshold voltage as a function of junction temperature**
($V_{GS(th)}$ = f(T_{vj}), I_{DS} = 5,6mA, V_{GS} = V_{DS})

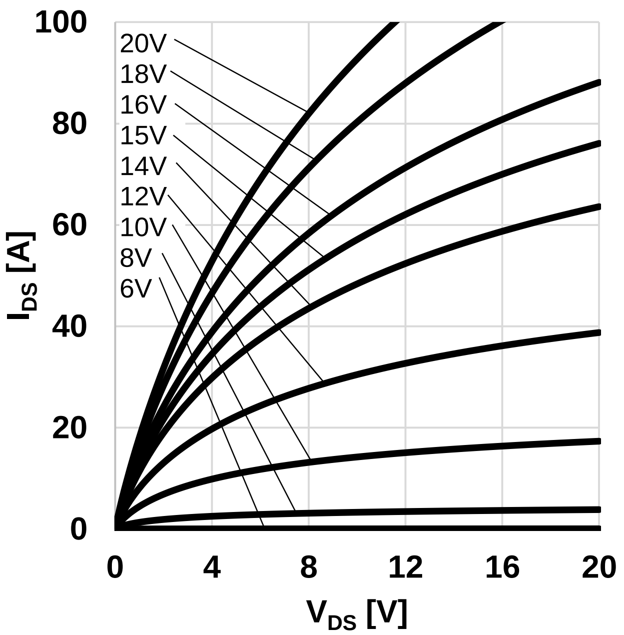


Figure 7 **Typical output characteristic, V_{GS} as parameter**
(I_{DS} = f(V_{DS}), T_{vj}=25°C, t_P = 20µs)

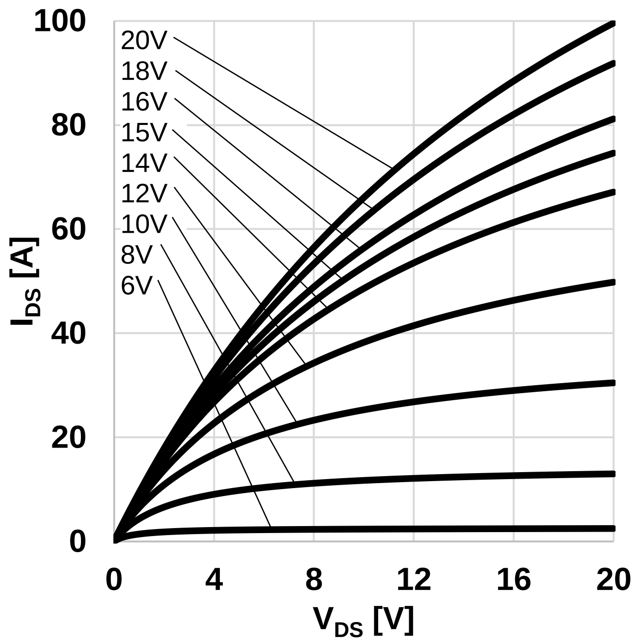


Figure 8 **Typical output characteristic, V_{GS} as parameter**
(I_{DS} = f(V_{DS}), T_{vj}=175°C, t_P = 20µs)

Electrical characteristic diagrams

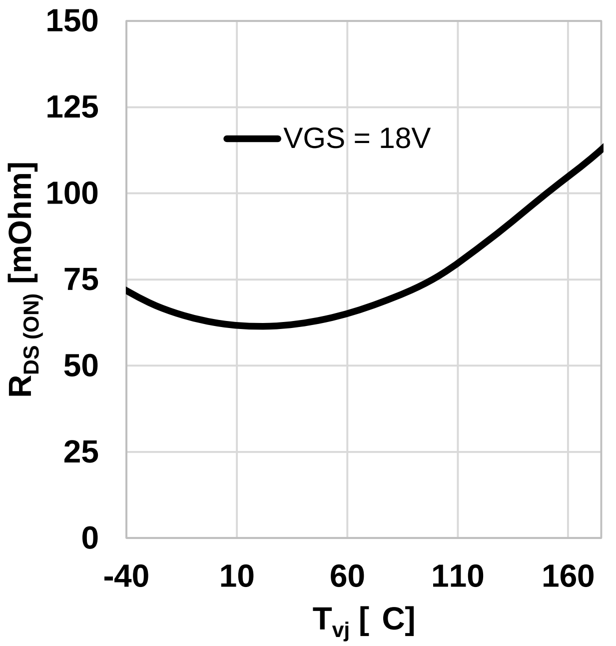


Figure 9 **Typical on-resistance as a function of junction temperature**
($R_{DS(on)}$ = f(T_{vj}), I_{DS} = 13A)

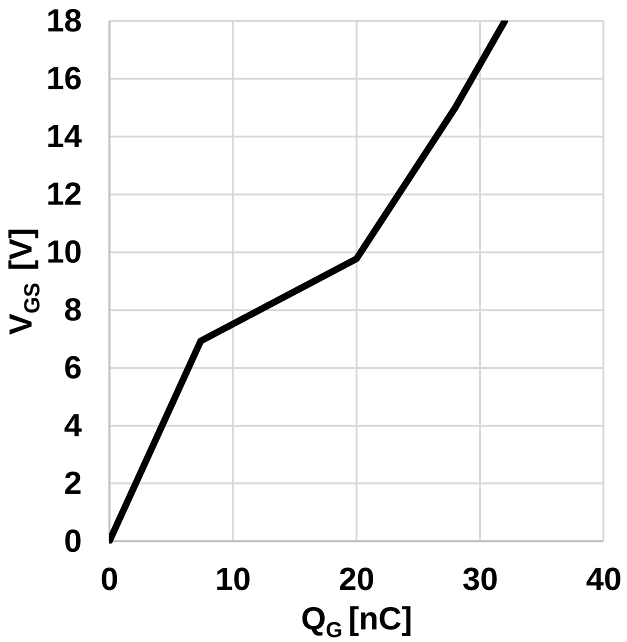


Figure 10 **Typical gate charge**
(V_{GS} = f(Q_G), I_{DS} = 13A, V_{DS} = 800V, turn-on pulse)

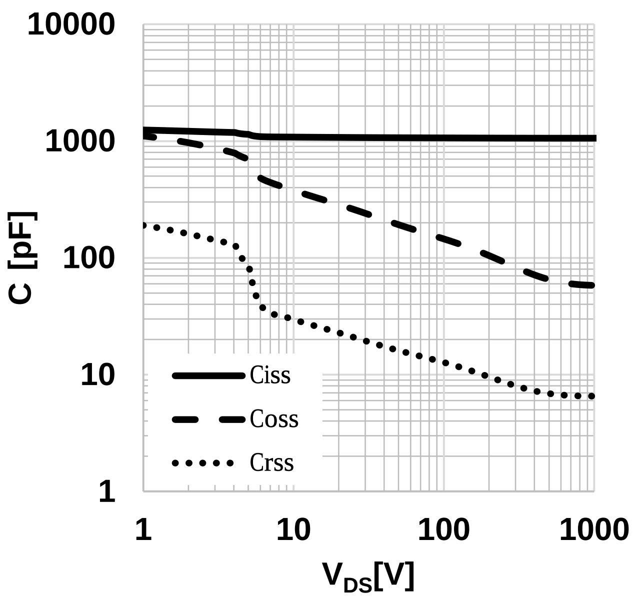


Figure 11 **Typical capacitance as a function of drain-source voltage**
(C = f(V_{DS}), V_{GS} = 0V, f = 1MHz)

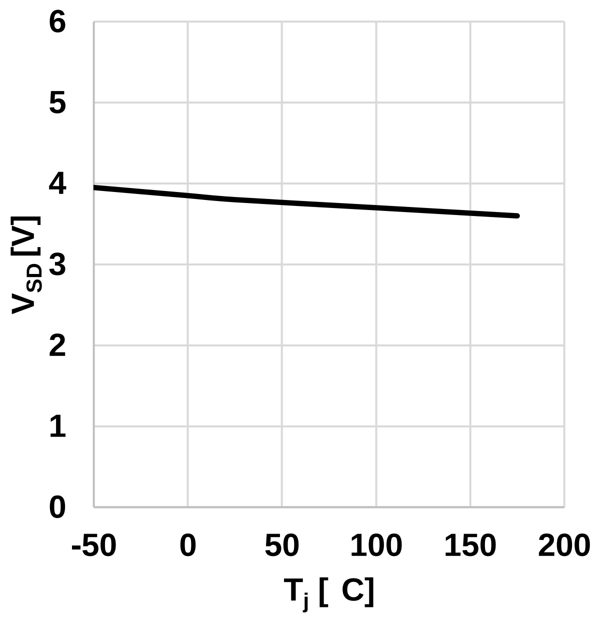


Figure 12 **Typical body diode forward voltage as function of junction temperature**
(V_{SD}=f(T_{vj}), V_{GS}=0V, I_{SD}=13A)

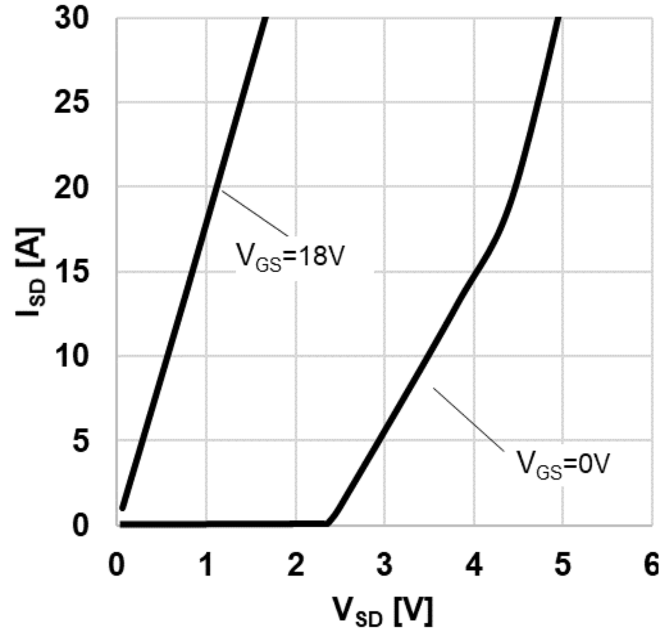


Figure 13 **Typical body diode forward current as function of forward voltage, V_{GS} as parameter**
(I_{SD} = f(V_{SD}), T_{vj} = 25°C, t_P = 20µs)

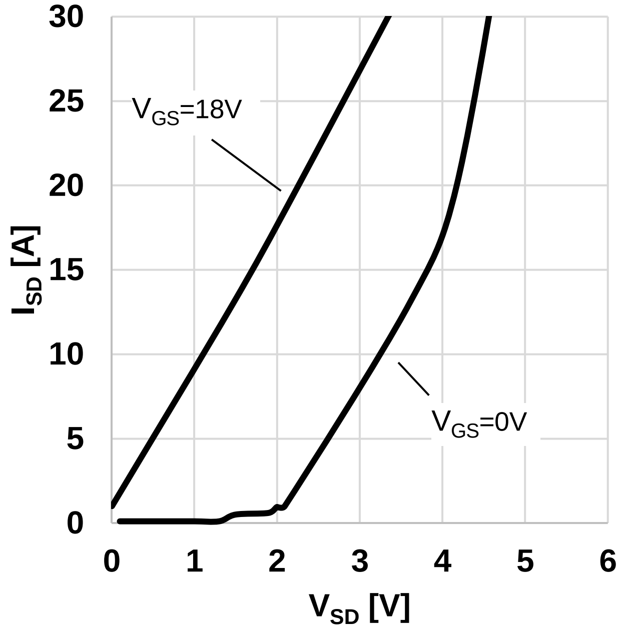


Figure 14 **Typical body diode forward current as function of forward voltage, V_{GS} as parameter**
(I_{SD} = f(V_{SD}), T_{vj} = 175°C, t_P = 20µs)

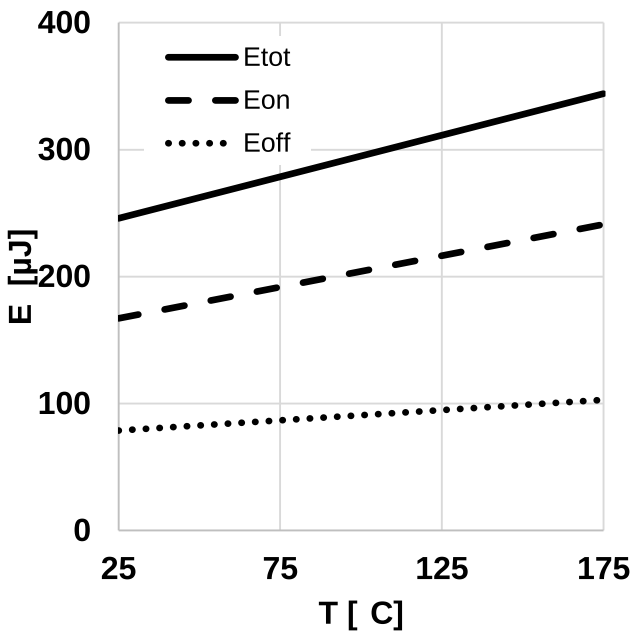


Figure 15 **Typical switching energy losses as a function of junction temperature**
(E = f(T_{vj}), V_{DD} = 800V, V_{GS} = 0V/18V, $R_{G,ext}$ = 2Ω, I_D = 13A, ind. load, test circuit in Fig. E, diode: body diode at V_{GS} = 0V)

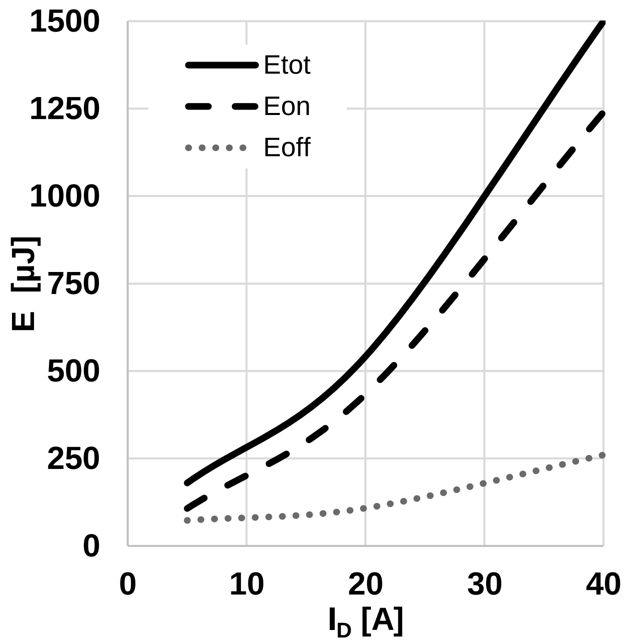


Figure 16 **Typical switching energy losses as a function of drain-source current**
(E = f(I_{DS}), V_{DD} = 800V, V_{GS} = 0V/18V, $R_{G,ext}$ = 2Ω, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode at V_{GS} = 0V)

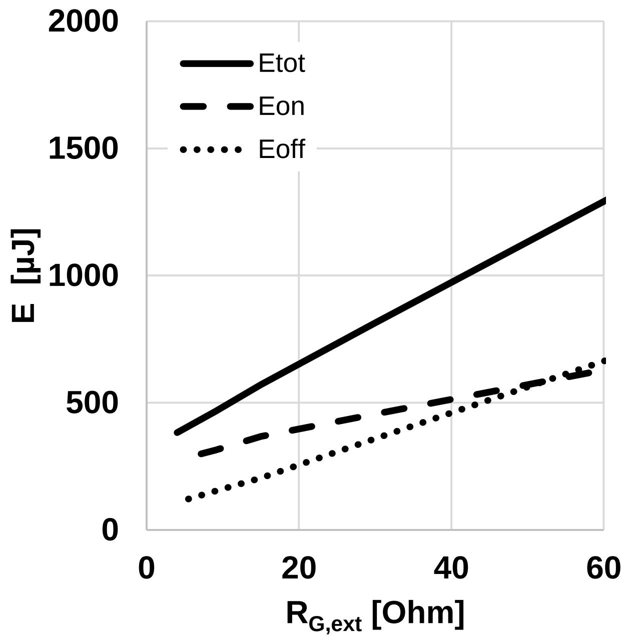


Figure 17 **Typical switching energy losses as a function of gate resistance**
(E = f($R_{G,ext}$), V_{DD} = 800V, V_{GS} = 0V/18V, I_D = 13A, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode at V_{GS} = 0V)

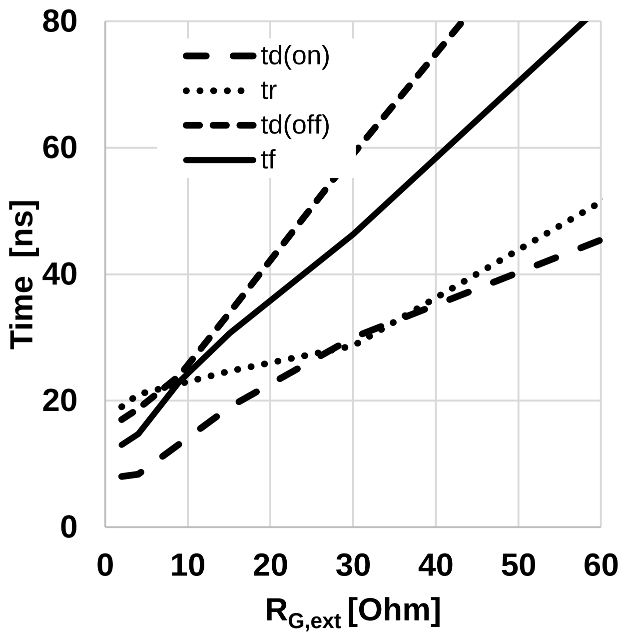


Figure 18 **Typical switching times as a function of gate resistor**
(t = f($R_{G,ext}$), V_{DD} = 800V, V_{GS} = 0V/18V, I_D = 13A, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode at V_{GS} = 0V)

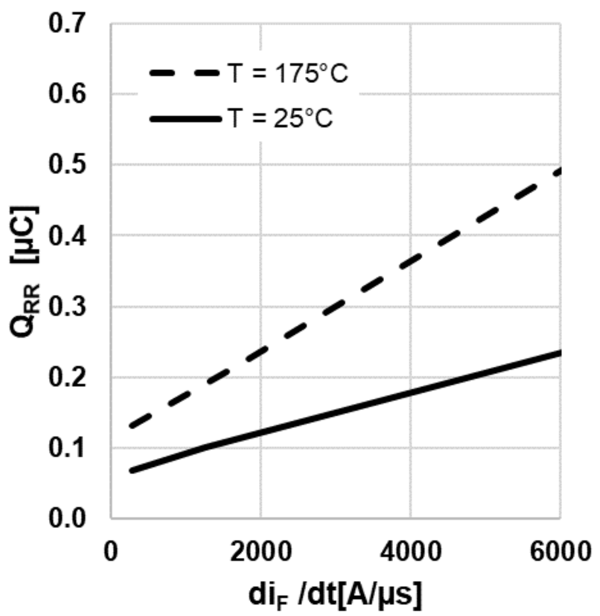


Figure 19 **Typical reverse recovery charge as a function of diode current slope**
(Q_{rr} = f(di_f/dt), V_{DD} = 800V, V_{GS} = 0V/18V, I_D = 13A, ind. load, test circuit in Fig.E, body diode at V_{GS} = 0V)

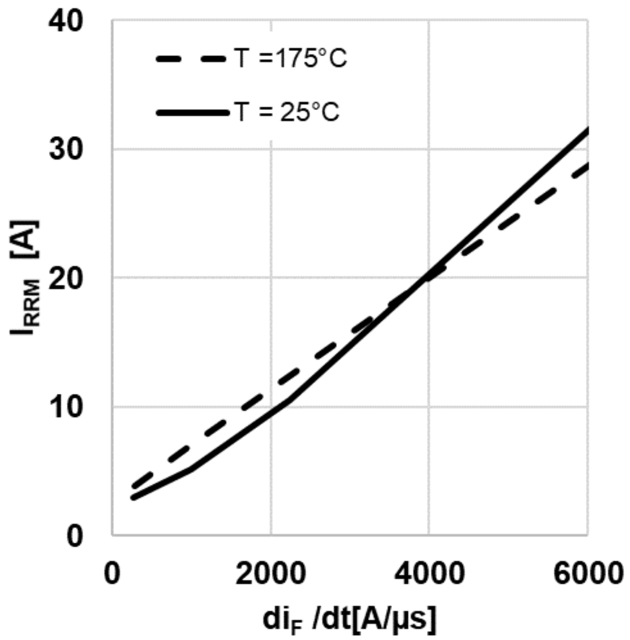
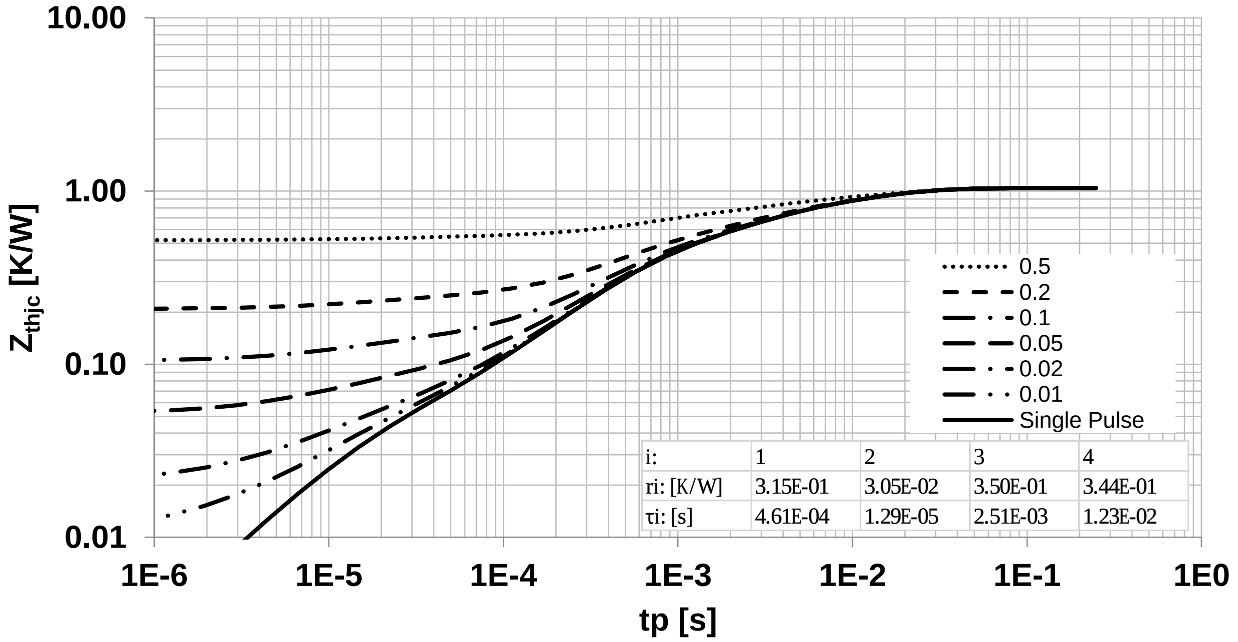


Figure 20 **Typical reverse recovery current as a function of diode current slope**
(I_{rrm} = f(di_f/dt), V_{DD} = 800V, V_{GS} = 0V/18V, I_D = 13A, ind. load, test circuit in Fig.E, body diode at V_{GS} = 0V)

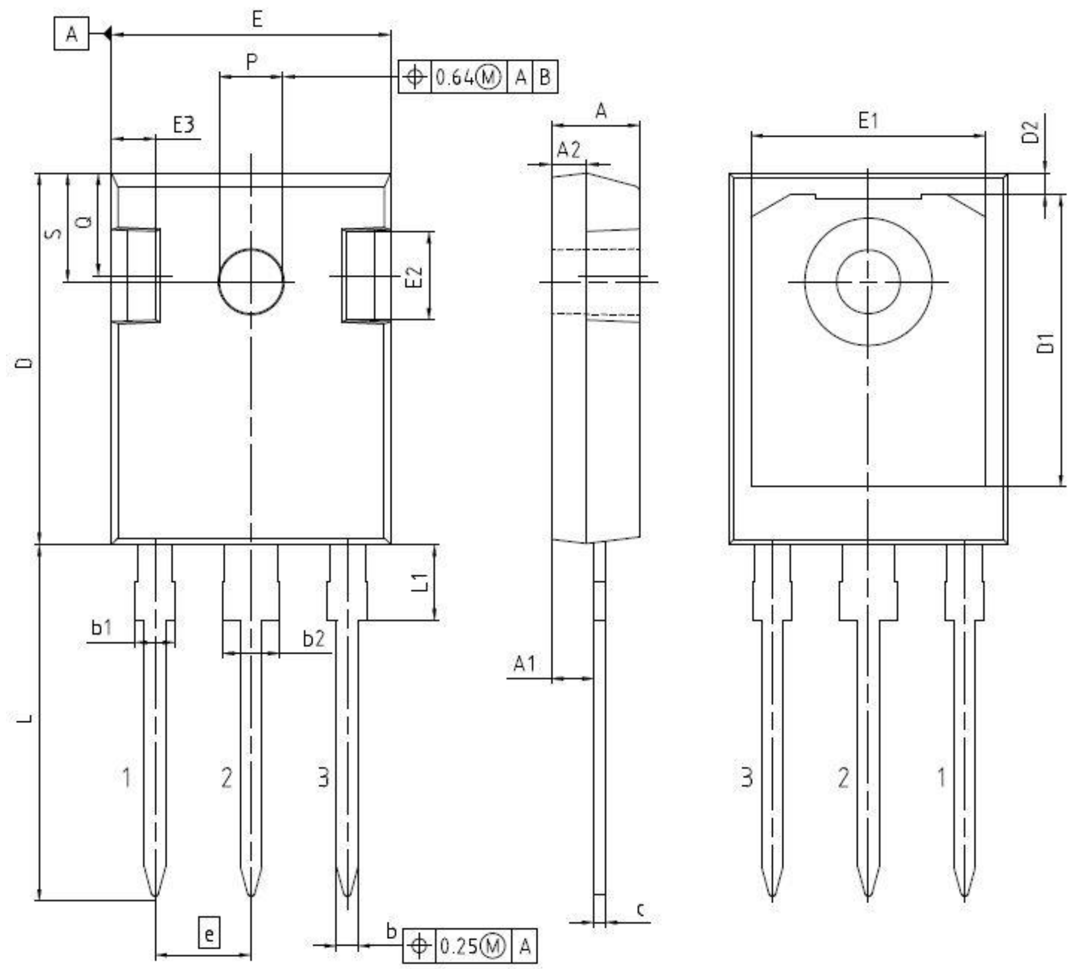


i:	1	2	3	4
ri: [K/W]	3.15E-01	3.05E-02	3.50E-01	3.44E-01
τi: [s]	4.61E-04	1.29E-05	2.51E-03	1.23E-02

Figure 21 Max. transient thermal resistance (MOSFET/diode)
($Z_{th(j\text{-}c,max)} = f(t_P)$, 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. Z8B00003327
REVISION 06
SCALE 3:1 0 1 2 3 4 5mm
EUROPEAN PROJECTION
ISSUE DATE 25.07.2018

Figure 22 Package drawing

6 Test conditions

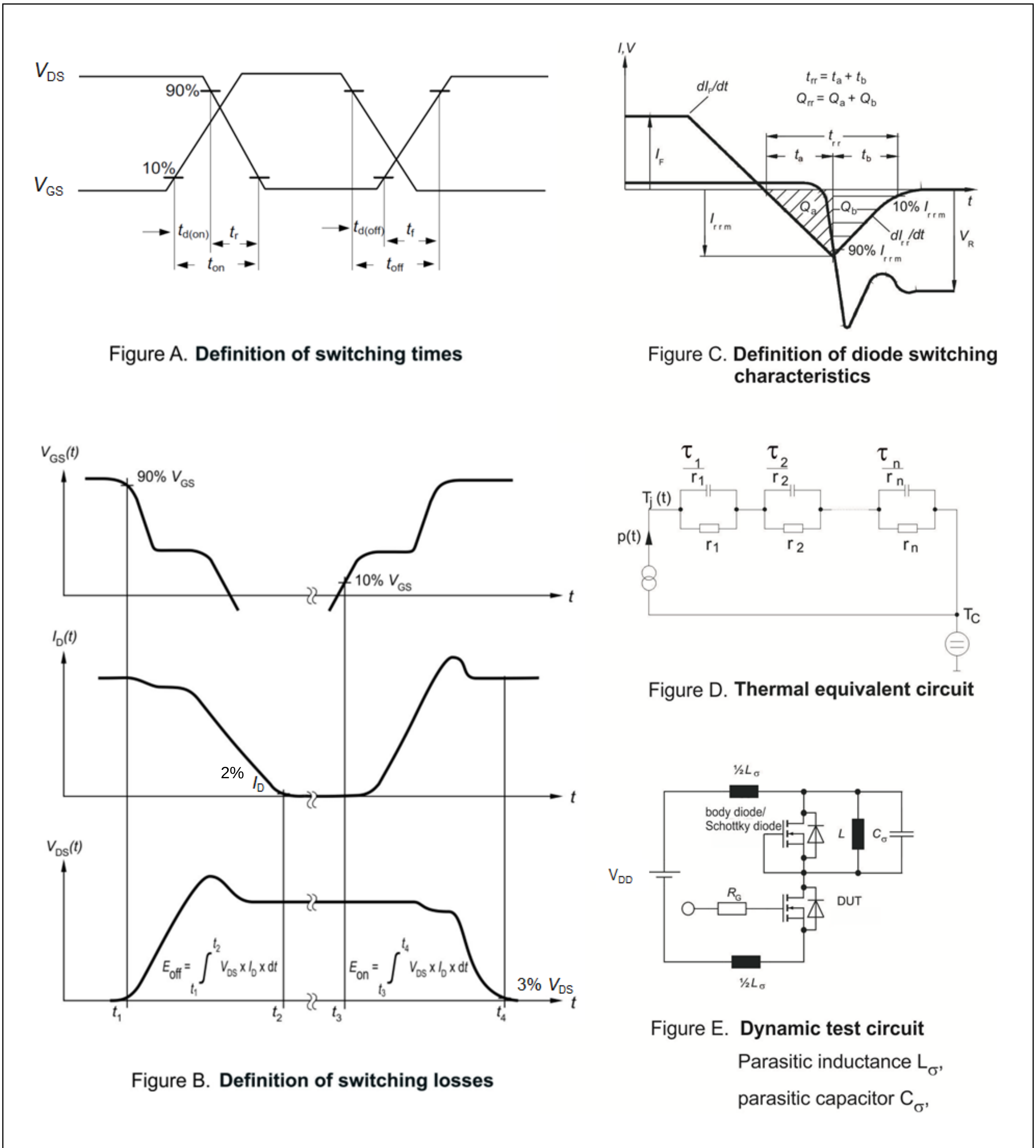


Figure 23 Test conditions

Revision history

Document version	Date of release	Description of changes
V01_00	2021-03-09	-
V01_10	2023-01-18	$I_{SD,pulse}$ value adjusted

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Published by

Infineon Technologies AG

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