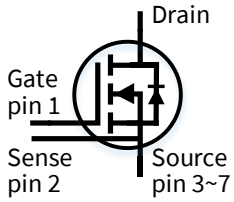
IMBF170R650M1

CoolSiC™ 1700V SiC Trench MOSFET
Silicon Carbide MOSFET

Features



- Revolutionary semiconductor material - Silicon Carbide
- Optimized for fly-back topologies
- 12V/0V gate-source voltage compatible with most fly-back controllers
- Very low switching losses
- Benchmark gate threshold voltage, $V_{GS(th)}$ = 4.5V
- Fully controllable dV/dt for EMI optimization

Benefits

- Reduction of system complexity
- Directly drive from fly-back controller
- Efficiency improvement and cooling effort reduction
- Enabling higher frequency

Potential applications

- Energy generation
  - Solar string inverter
  - Solar Central inverter
- Industrial power supplies
  - Industrial UPS
  - Industrial SMPS
- Infrastructure – Charger
  - Charger

Product validation

Qualified for industrial applications according to the relevant tests of JEDEC 47/20/22

Note: *the source and sense pins are not exchangeable, their exchange might lead to malfunction recommended for forward operation mode only*

Table 1 Key Performance and Package Parameters

Type	V_{DS}	I_D T_C = 25°C, $R_{th(j\text{-}c,max)}$	$R_{DS(on)}$ T_{vj} = 25°C, I_D = 1.5A, V_{GS} = 12V	$T_{vj,max}$	Marking	Package
IMBF170R650M1	1700V	7.4A	650mΩ	175°C	170M1650	PG-TO263-7

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1 Maximum ratings

For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

Table 2 Maximum ratings

Parameter	Symbol	Value	Unit
Drain-source voltage, $T_{vj} \geq 25°C$	V_{DSS}	1700	V
DC drain current for $R_{th(j-c,max)}$, limited by T_{vjmax}, V_{GS} = 12V, T_C = 25°C T_C = 100°C	I_D	 7.4 5.2	A
Pulsed drain current, t_p limited by T_{vjmax}, V_{GS} = 12V	$I_{D,pulse}$[1]	18.7	A
Gate-source voltage[2] Max transient voltage, < 1% duty cycle Recommended turn-on gate voltage Recommended turn-off gate voltage	 V_{GS} $V_{GS,on}$ $V_{GS,off}$	 -10… 20 12… 15 0	V
Power dissipation, limited by T_{vjmax} T_C = 25°C T_C = 100°C	P_{tot}	 88 44	W
Virtual junction temperature	T_{vj}	-55… 175	°C
Storage temperature	T_{stg}	-55… 150	°C
Soldering temperature Reflow soldering (MSL1 according to JEDEC J-STD-020)	T_{sold}	260	°C

[1] verified by design
[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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET thermal resistance, junction – case	$R_{th(j-c)}$		-	1.3	1.7	K/W
Thermal resistance, junction – ambient	$R_{th(j-a)}$	leaded	-	-	62	K/W

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	$R_{DS(on)}$	V_{GS} = 12V, I_D = 1.5A, T_{vj} = 25°C T_{vj} = 100°C T_{vj} = 175°C V_{GS} = 15V, I_D = 1.5A, T_{vj} = 25°C	 - - - -	 650 921 1324 526	 - - - 580	mΩ
Gate-source threshold voltage	$V_{GS(th)}$	*(tested after 1 ms pulse at* V_{GS} = 20V*)* I_D = 1.7mA, 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} = 1700V T_{vj} = 25°C T_{vj} = 175°C	 - -	 0.6 8	 11 -	µA
Gate-source leakage current	I_{GSS}	V_{GS} = 20V, V_{DS} = 0V	-	-	100	nA
		V_{GS} = -10V, V_{DS} = 0V	-	-	-100	nA
Transconductance	g_{fs}	V_{DS} = 20V, I_D = 1.5A	-	0.65	-	S
Internal gate resistance	$R_{G,int}$	f = 1MHz, V_{AC} = 25mV	-	25.4	-	Ω

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} = 1000V, V_{GS} = 0V, f = 1MHz, V_{AC} = 25mV	-	422	-	pF
Output capacitance	C_{oss}		-	12	-	
Reverse capacitance	C_{rss}		-	1.1	-	
C_{oss} stored energy	E_{oss}		-	2	-	µJ
Total gate charge	Q_G	V_{DD} = 1000V, I_D = 1.5A, V_{GS} = 0/12V, turn-on pulse	-	8	-	nC
Gate to source charge	$Q_{GS,pl}$		-	2.3	-	
Gate to drain charge	Q_{GD}		-	3.3	-	

3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load [3]

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET Characteristics, T_{vj} = 25°C						
Turn-on delay time	$t_{d(on)}$	V_{DD} = 1000V, I_D = 1.5A, V_{GS} = 0/12V, $R_{G,ext}$ = 22Ω, L_σ = 40nH, diode: body diode at V_{GS} = 0V see Fig. E	-	22	-	ns
Rise time	t_r		-	16	-	
Turn-off delay time	$t_{d(off)}$		-	24	-	
Fall time	t_f		-	22	-	
Turn-on energy	E_{on}		-	50	-	µJ
Turn-off energy	E_{off}		-	10	-	
Total switching energy	E_{tot}		-	60	-	
MOSFET Characteristics, T_{vj} = 175°C						
Turn-on delay time	$t_{d(on)}$	V_{DD} = 1000V, I_D = 1.5A, V_{GS} = 0/12V, $R_{G,ext}$ = 22Ω, L_σ = 40nH, diode: body diode at V_{GS} = 0V see Fig. E	-	19	-	ns
Rise time	t_r		-	13	-	
Turn-off delay time	$t_{d(off)}$		-	28	-	
Fall time	t_f		-	24	-	
Turn-on energy	E_{on}		-	54	-	µJ
Turn-off energy	E_{off}		-	13	-	
Total switching energy	E_{tot}		-	66	-	

[3] The chip technology was characterized up to 200 kV/µs. The measured dV/dt was limited by measurement test setup and package. In applications, e.g. fly-back topology, the switching behavior highly depends on the circuitry (transformer, snubber…), the switching loss in the application will be different from the datasheet value.

4 Electrical characteristic diagrams

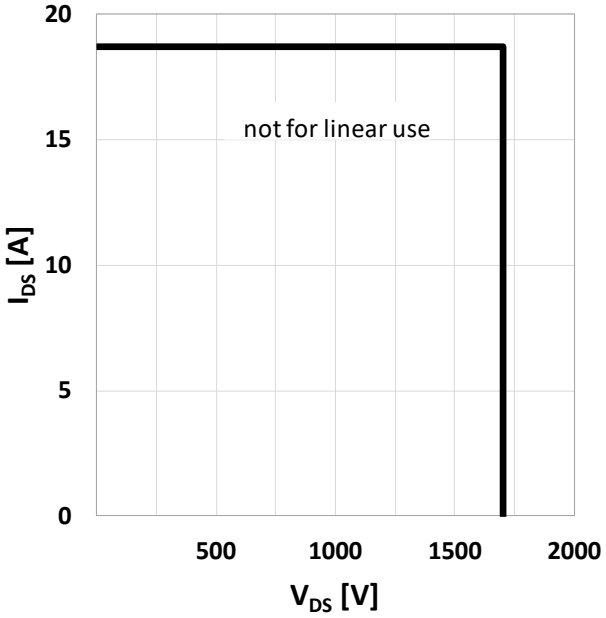


Figure 1 **Safe operating area (SOA)**
(V_{GS} = 0/12V, T_c = 25°C, T_j ≤ 175°C)

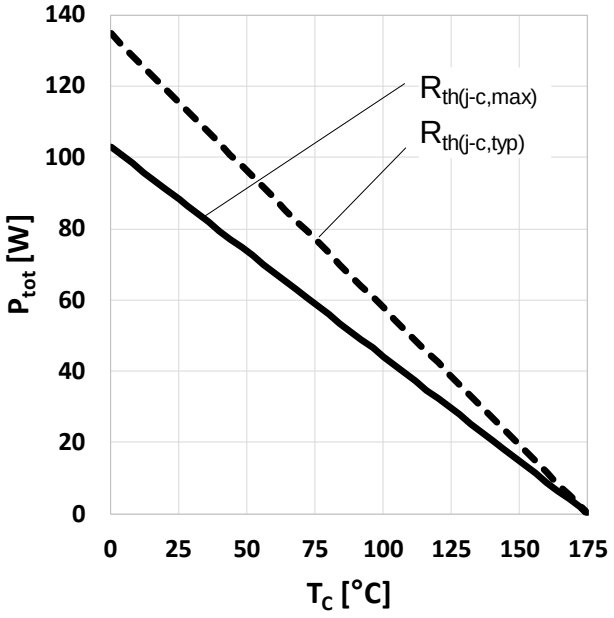


Figure 2 **Power dissipation as a function of case temperature limited by bond wire**
(P_{tot} = f(T_C))

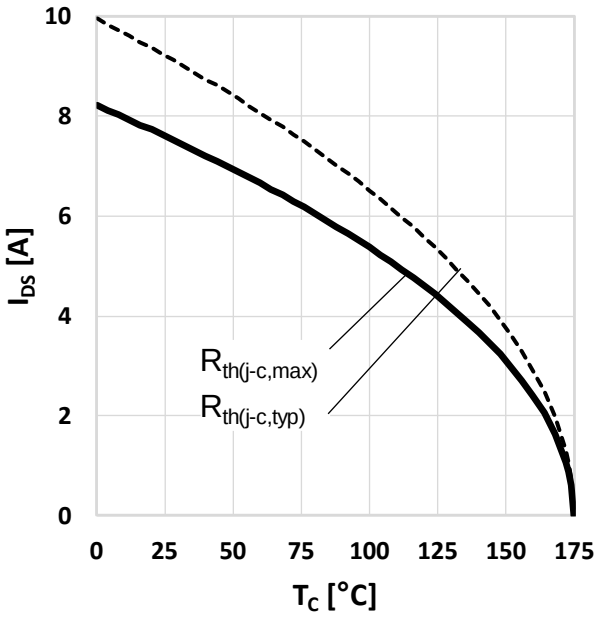


Figure 3 **Maximum DC drain to source current as a function of case temperature limited by bond wire** (I_{DS} = f(T_C))

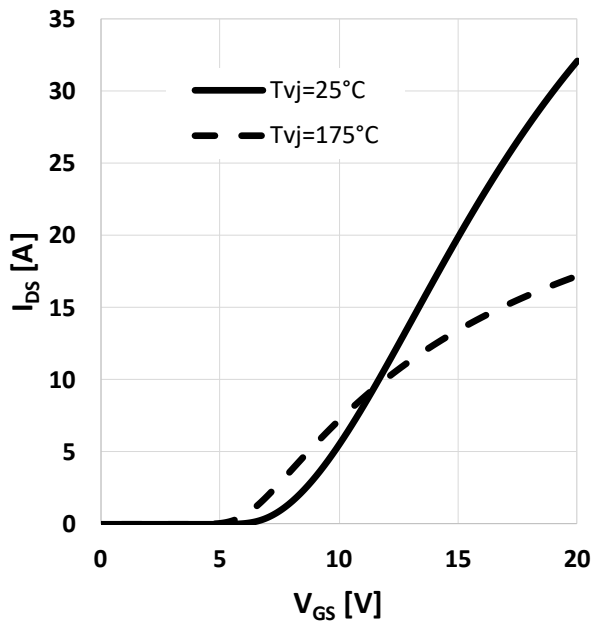


Figure 4 **Typical transfer characteristic**
(I_{DS} = f(V_{GS}), V_{DS} = 20V, t_P = 20µs)

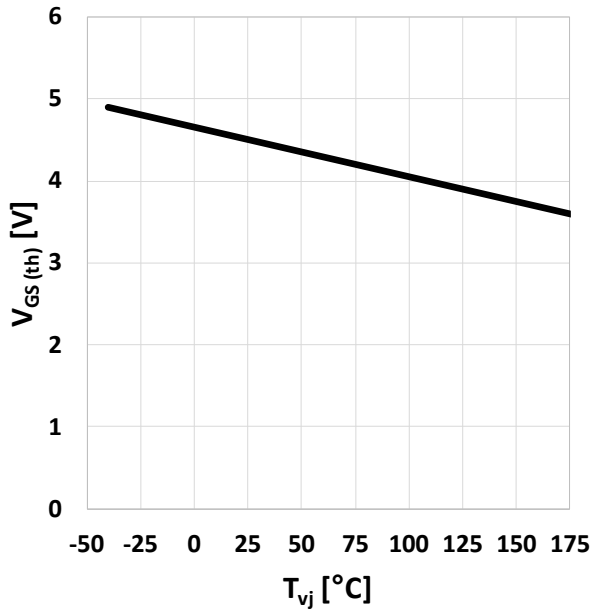


Figure 5 **Typical gate-source threshold voltage as a function of junction temperature**
($V_{GS(th)} = f(T_{vj})$, I_{DS} = 1.7mA, $V_{GS} = V_{DS}$)

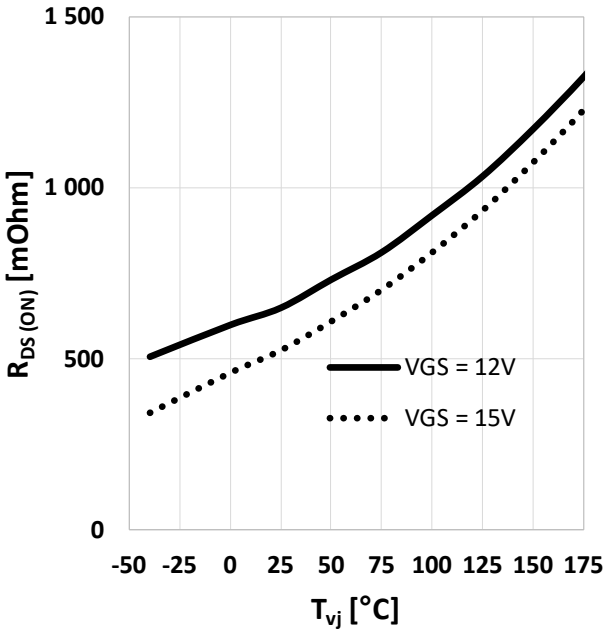


Figure 6 **Typical on-resistance as a function of junction temperature**
($R_{DS(on)} = f(T_{vj})$, I_{DS} = 1.5A)

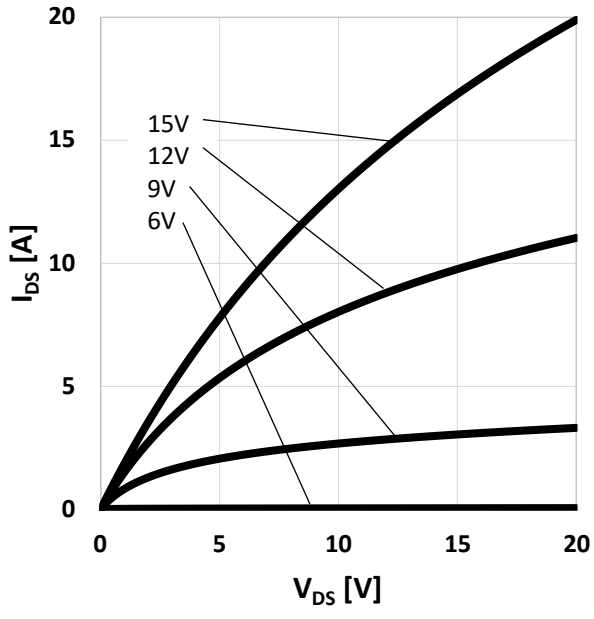


Figure 7 **Typical output characteristic, V_{GS} as parameter**
($I_{DS} = f(V_{DS})$, T_{vj}=25°C, t_P = 20µs)

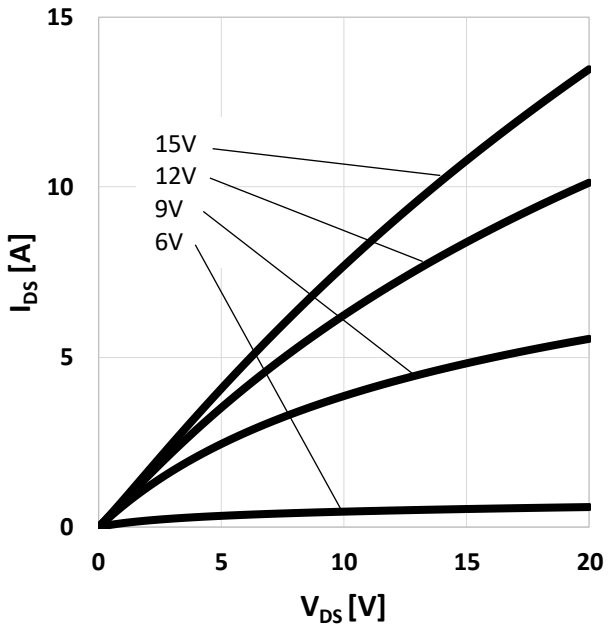


Figure 8 **Typical output characteristic, V_{GS} as parameter**
($I_{DS} = f(V_{DS})$, T_{vj}=175°C, t_P = 20µs)

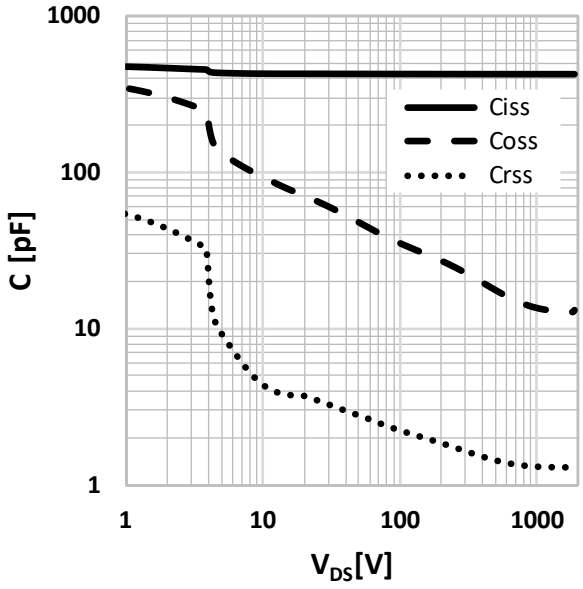


Figure 9 **Typical capacitance as a function of drain-source voltage**
($C = f(V_{DS})$, $V_{GS} = 0V$, $f = 1MHz$)

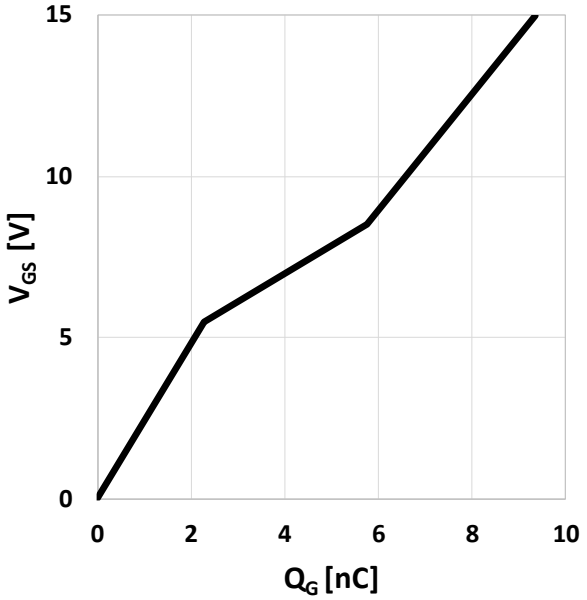


Figure 10 **Typical gate charge**
($V_{GS} = f(Q_G)$, $I_{DS} = 1.5A$, $V_{DS} = 1000V$, turn-on pulse)

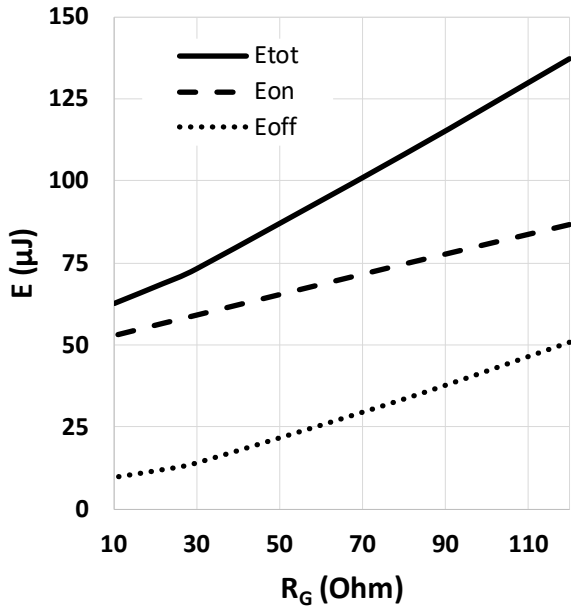


Figure 11 **Typical switching energy losses as a function of gate resistance**
($E = f(R_{G,ext})$, $V_{DD} = 1000V$, $V_{GS} = 0V/12V$, $I_D = 1.5A$, $T_{vj} = 175°C$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

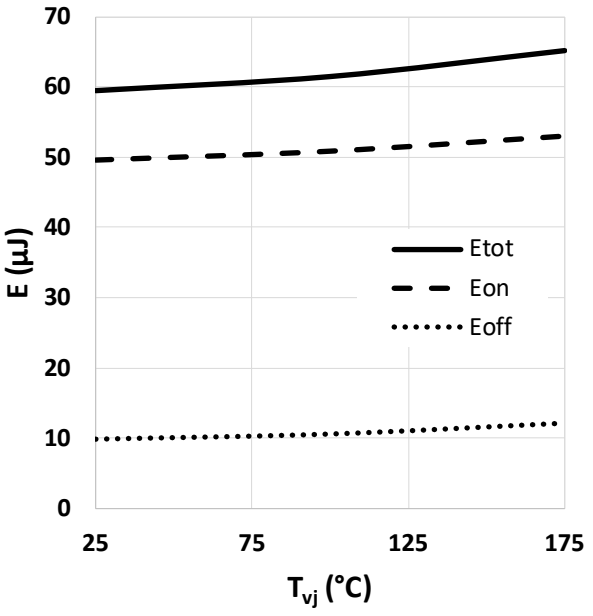


Figure 12 **Typical switching energy losses as a function of junction temperature**
($E = f(T_{vj})$, $V_{DD} = 1000V$, $V_{GS} = 0V/12V$, $R_{G,ext} = 22\Omega$, $I_D = 1.5A$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

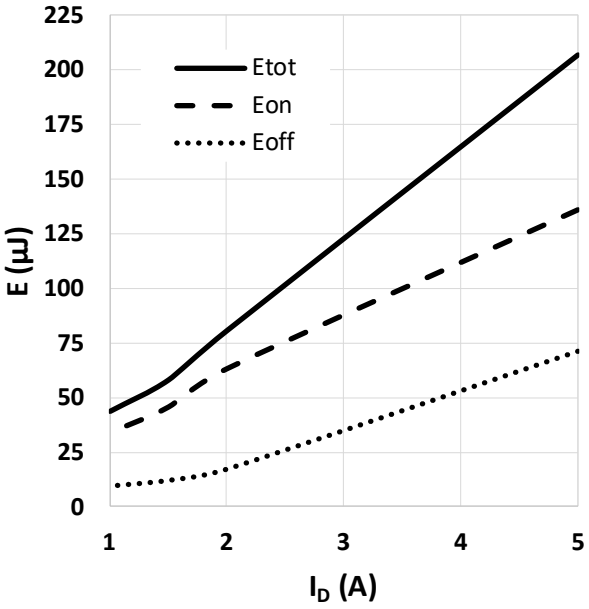


Figure 13 **Typical switching energy losses as a function of drain-source current**
($E = f(I_{DS})$, V_{DD} = 1000V, V_{GS} = 0V/12V, $R_{G,ext}$ = 22Ω, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode at V_{GS} = 0V)

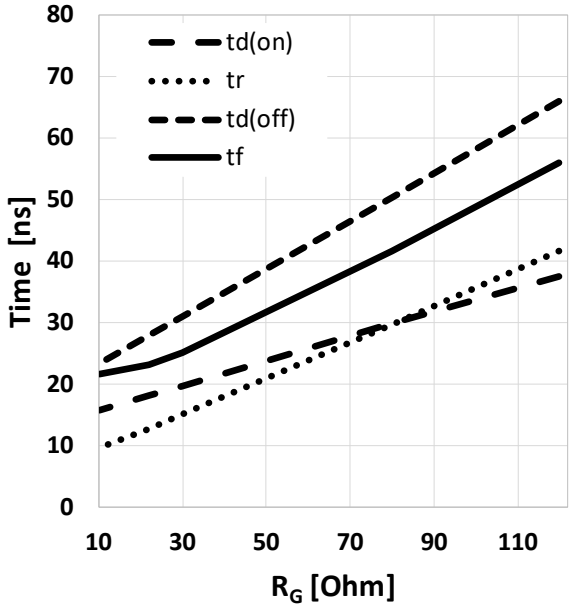


Figure 14 **Typical switching times as a function of gate resistor**
($t = f(R_{G,ext})$, V_{DD} = 1000V, V_{GS} = 0V/12V, I_D = 1.5A, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode at V_{GS} = 0V)

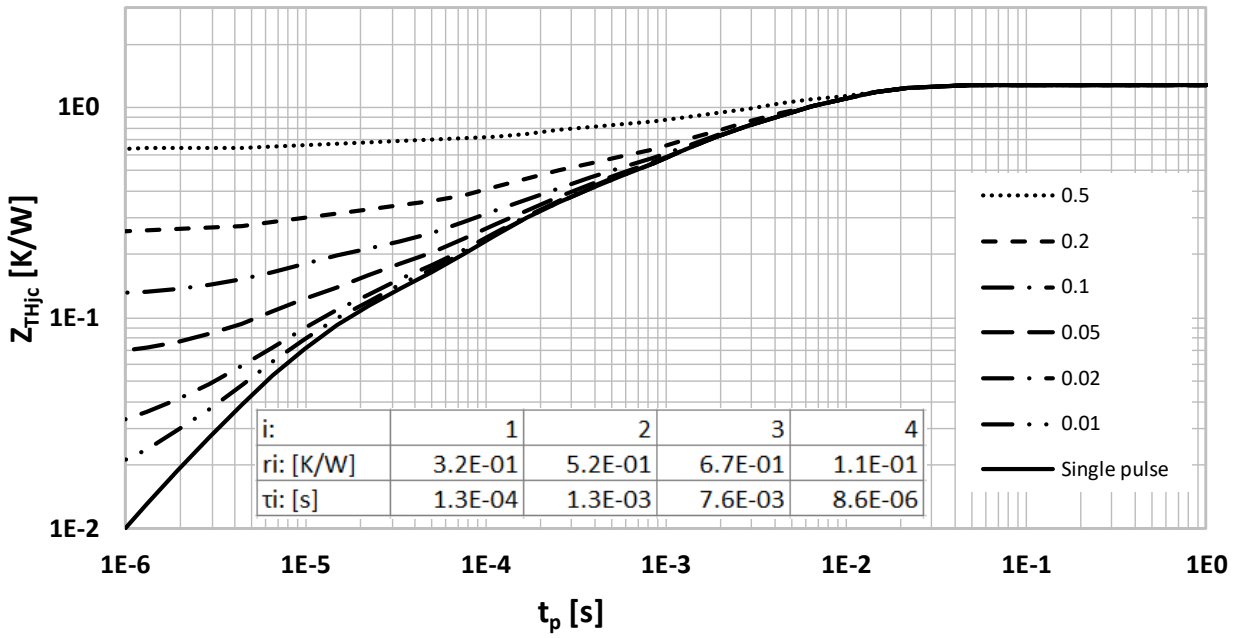
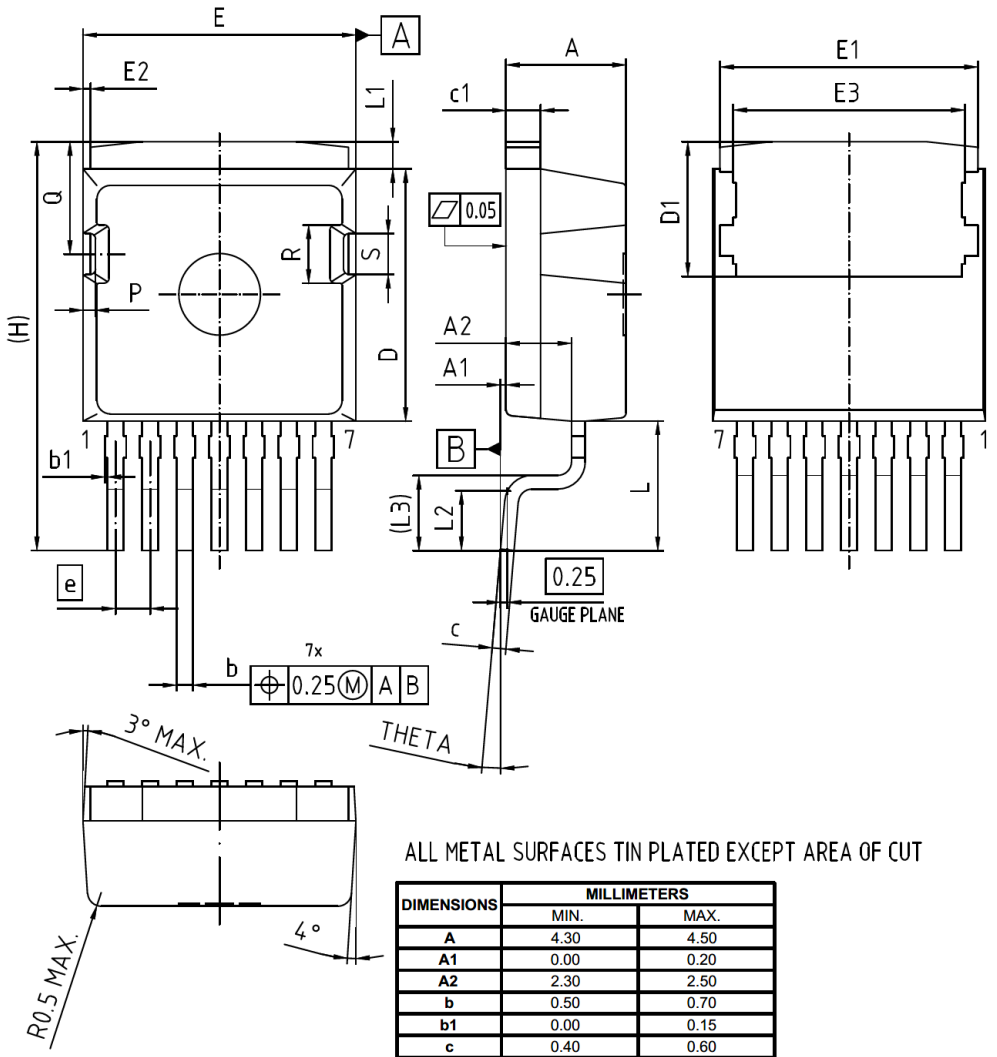


Figure 15 **Max. transient thermal resistance (MOSFET)**
($Z_{th(j-c,max)} = f(t_P)$, parameter $D = t_p/T$, thermal equivalent circuit in Fig. D)

5 Package drawing

PG-TO263-7-13



ALL METAL SURFACES TIN PLATED EXCEPT AREA OF CUT

DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.30	4.50
A1	0.00	0.20
A2	2.30	2.50
b	0.50	0.70
b1	0.00	0.15
c	0.40	0.60
c1	1.17	1.37
D	9.05	9.45
D1	4.85	5.05
E	9.80	10.20
E1	9.36	9.56
E2	0.00	0.30
E3	8.40	8.60
e	1.27	
H	15.00	
L	4.20	5.20
L1	0.70	1.30
L2	1.70	2.70
L3	2.70	
P	0.35	0.55
Q	4.02	4.22
R	2.03	2.23
S	1.40	1.60
THETA	0.00°	8.00°

DOCUMENT NO. Z8B00189675
REVISION 01
SCALE 5:1 0 1 2 3 4 5mm
EUROPEAN PROJECTION
ISSUE DATE 24.07.2018

Figure 16 Package drawing

6 Test conditions

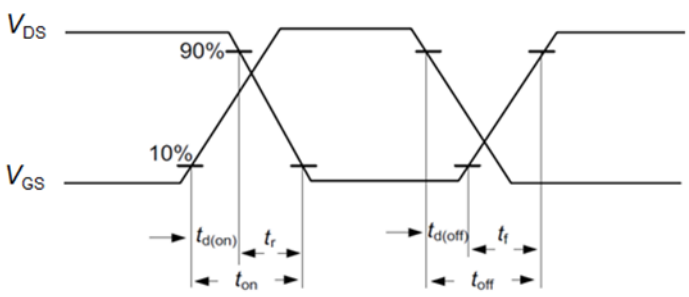


Figure A. **Definition of switching times**

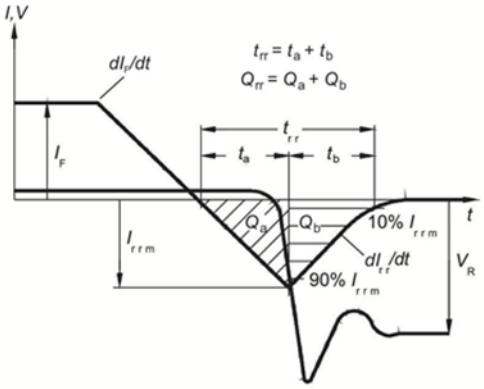


Figure C. **Definition of diode switching characteristics**

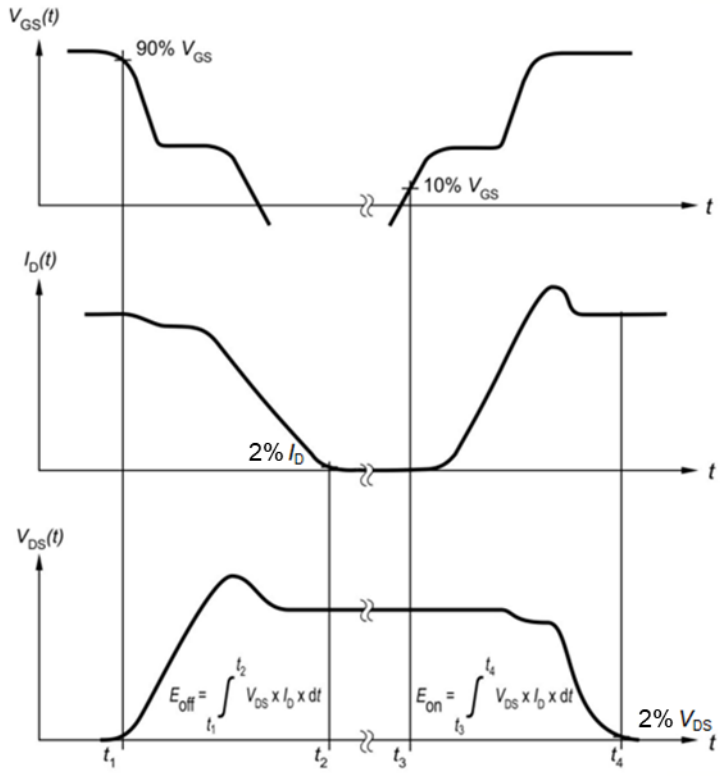


Figure B. **Definition of switching losses**

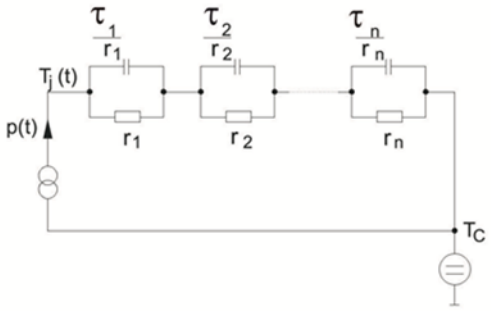


Figure D. **Thermal equivalent circuit**

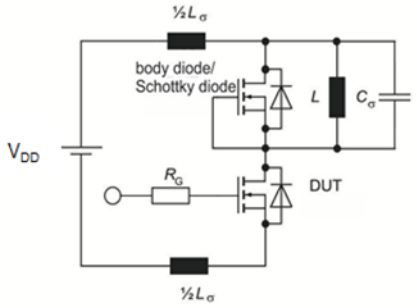


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,

Figure 17 Test conditions

Revision history

Document version	Date of release	Description of changes
2.1	2020-12-11	Final Datasheet
2.2	2020-12-11	Correction of circuit symbol on page 1

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