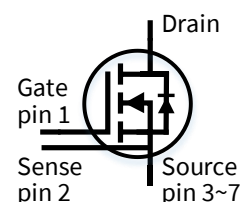


IMBF170R650M1

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

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Maximum ratings

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, $T_{vj} \geq 25^{\circ}\text{C}$	V_{DSS}	1700	V
DC drain current for $R_{th(j-c,max)}$, limited by T_{vjmax} , $V_{GS} = 12\text{V}$, $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	I_D	7.4 5.2	A
Pulsed drain current, t_p limited by T_{vjmax} , $V_{GS} = 12\text{V}$	$I_{D,pulse}^1$	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} $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	P_{tot}	88 44	W
Virtual junction temperature	T_{vj}	-55... 175	$^{\circ}\text{C}$
Storage temperature	T_{stg}	-55... 150	$^{\circ}\text{C}$
Soldering temperature Reflow soldering (MSL1 according to JEDEC J-STD-020)	T_{sold}	260	$^{\circ}\text{C}$

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 $T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 12\text{V}$, $I_D = 1.5\text{A}$, $T_{vj} = 25^{\circ}\text{C}$	-	650	-	mΩ
		$T_{vj} = 100^{\circ}\text{C}$	-	921	-	
		$T_{vj} = 175^{\circ}\text{C}$	-	1324	-	
		$V_{GS} = 15\text{V}$, $I_D = 1.5\text{A}$, $T_{vj} = 25^{\circ}\text{C}$	-	526	580	
Gate-source threshold voltage	$V_{GS(th)}$	(tested after 1 ms pulse at $V_{GS} = 20\text{V}$)				V
		$I_D = 1.7\text{mA}$, $V_{DS} = V_{GS}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	3.5 -	4.5 3.6	5.7 -	
Zero gate voltage drain current	I_{DSS}	$V_{GS} = 0\text{V}$, $V_{DS} = 1700\text{V}$ $T_{vj} = 25^{\circ}\text{C}$	-	0.6	11	μA
		$T_{vj} = 175^{\circ}\text{C}$	-	8	-	
Gate-source leakage current	I_{GSS}	$V_{GS} = 20\text{V}$, $V_{DS} = 0\text{V}$	-	-	100	nA
		$V_{GS} = -10\text{V}$, $V_{DS} = 0\text{V}$	-	-	-100	nA
Transconductance	g_{fs}	$V_{DS} = 20\text{V}$, $I_D = 1.5\text{A}$	-	0.65	-	S
Internal gate resistance	$R_{G,int}$	$f = 1\text{MHz}$, $V_{AC} = 25\text{mV}$	-	25.4	-	Ω

3.2 Dynamic characteristics

Table 5 Dynamic characteristics (at $T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Input capacitance	C_{iss}	$V_{DD} = 1000\text{V}$, $V_{GS} = 0\text{V}$, $f = 1\text{MHz}$, $V_{AC} = 25\text{mV}$	-	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	$V_{DD} = 1000\text{V}$, $I_D = 1.5\text{A}$, $V_{GS} = 0/12\text{V}$, 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, $T_{vj} = 25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(\text{on})}$	$V_{DD} = 1000\text{V}$, $I_D = 1.5\text{A}$, $V_{GS} = 0/12\text{V}$, $R_{G,\text{ext}} = 22\Omega$, $L_{\sigma} = 40\text{nH}$, diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	22	-	ns
Rise time	t_r		-	16	-	
Turn-off delay time	$t_{d(\text{off})}$		-	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, $T_{vj} = 175^{\circ}\text{C}$

Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1000\text{V}$, $I_D = 1.5\text{A}$, $V_{GS} = 0/12\text{V}$, $R_{G,ext} = 22\Omega$, $L_{\sigma} = 40\text{nH}$, diode: body diode at $V_{GS} = 0\text{V}$ 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

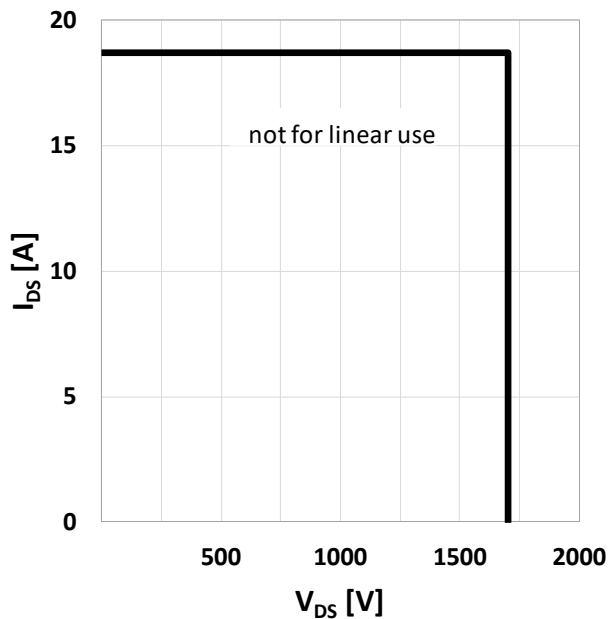


Figure 1 Safe operating area (SOA)
($V_{GS} = 0/12V$, $T_c = 25^\circ C$, $T_j \leq 175^\circ C$)

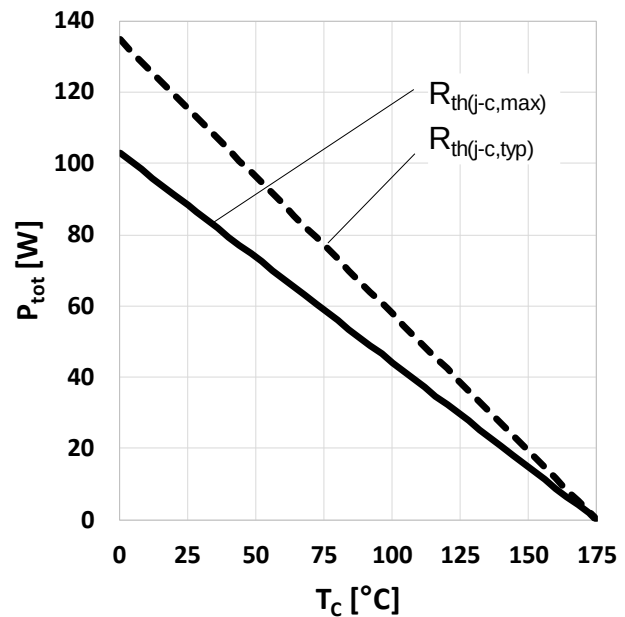


Figure 2 Power dissipation as a function of case temperature limited by bond wire
($P_{tot} = f(T_c)$)

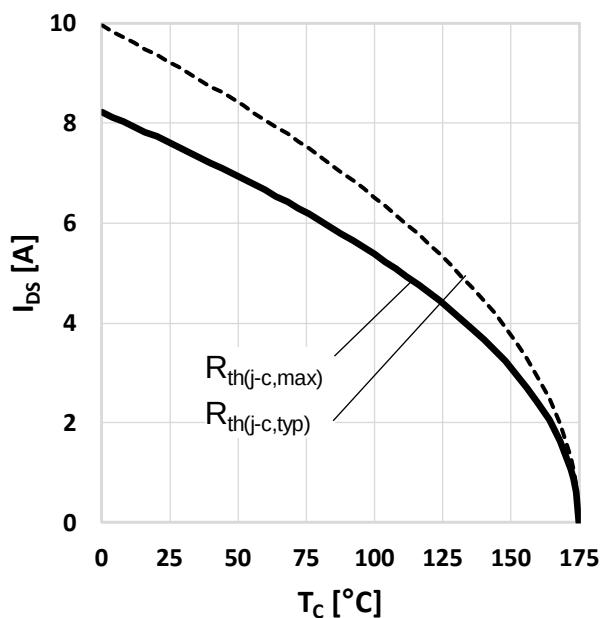


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire ($I_{DS} = f(T_c)$)

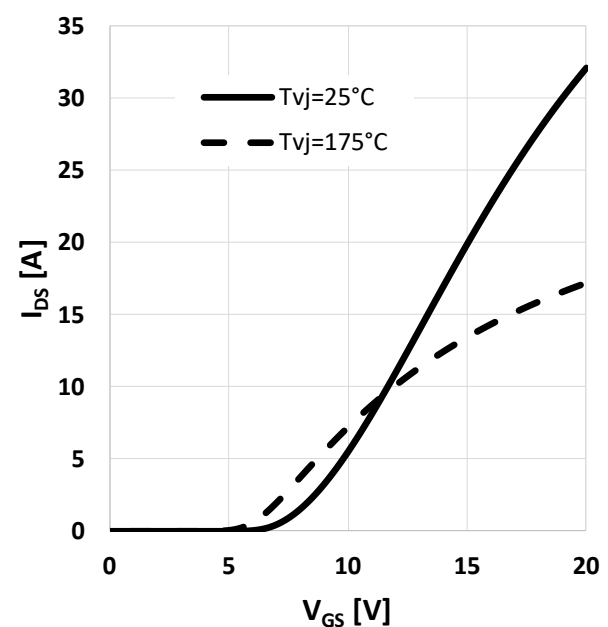


Figure 4 Typical transfer characteristic
($I_{DS} = f(V_{GS})$, $V_{DS} = 20V$, $t_P = 20\mu s$)

Electrical characteristic diagrams

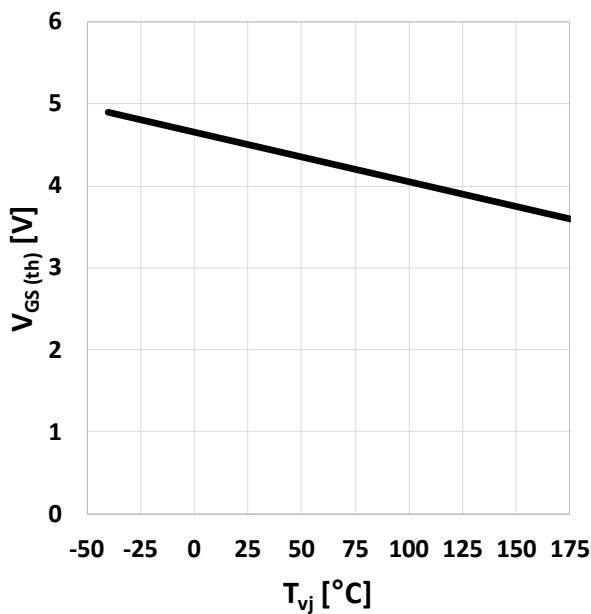


Figure 5 Typical gate-source threshold voltage as a function of junction temperature
 $(V_{GS(th)} = f(T_{vj}), I_{DS} = 1.7\text{mA}, V_{GS} = V_{DS})$

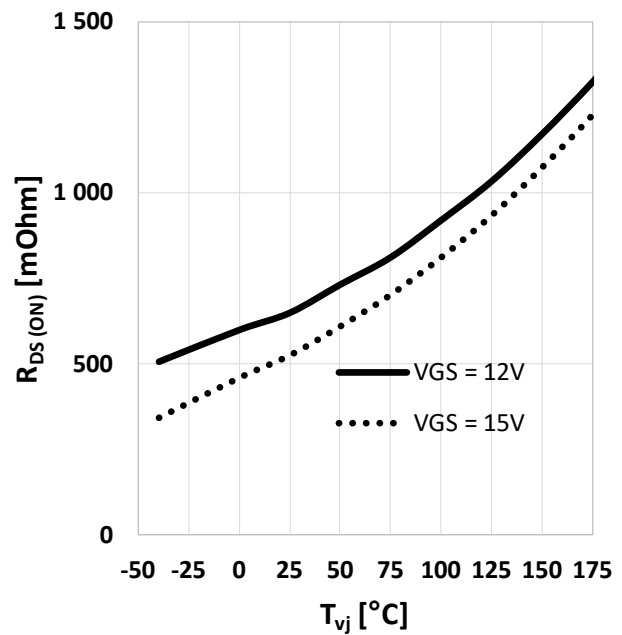


Figure 6 Typical on-resistance as a function of junction temperature
 $(R_{DS(on)} = f(T_{vj}), I_{DS} = 1.5\text{A})$

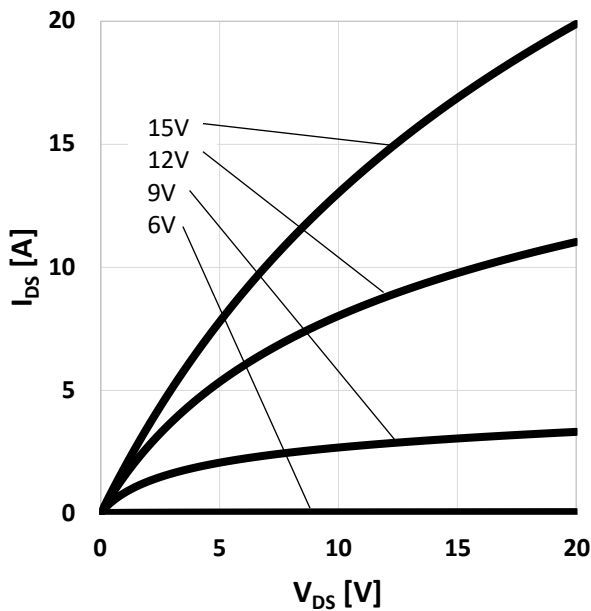


Figure 7 Typical output characteristic, V_{GS} as parameter
 $(I_{DS} = f(V_{DS}), T_{vj} = 25^\circ\text{C}, t_p = 20\mu\text{s})$

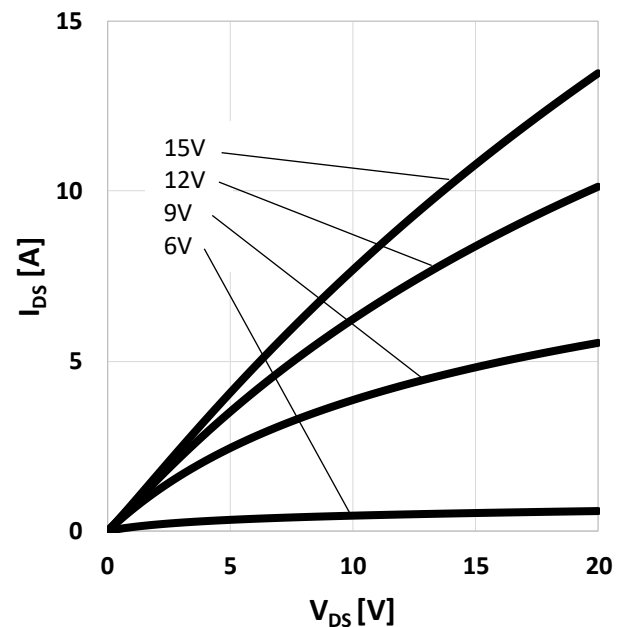


Figure 8 Typical output characteristic, V_{GS} as parameter
 $(I_{DS} = f(V_{DS}), T_{vj} = 175^\circ\text{C}, t_p = 20\mu\text{s})$

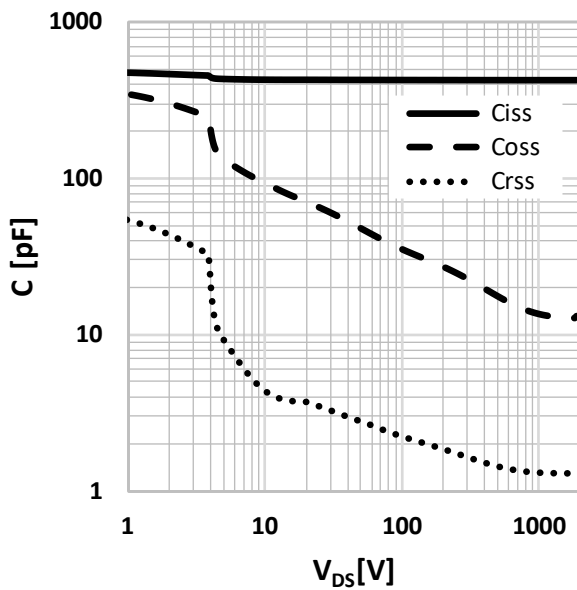


Figure 9 Typical capacitance as a function of drain-source voltage
 $(C = f(V_{DS}), V_{GS} = 0V, f = 1MHz)$

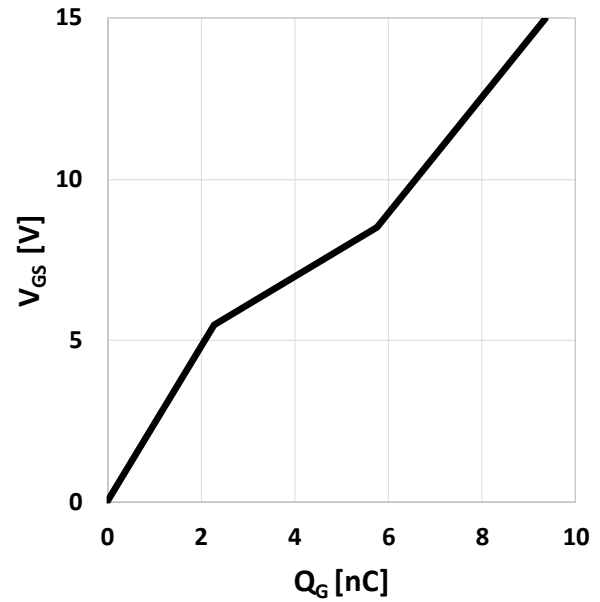


Figure 10 Typical gate charge
 $(V_{GS} = f(Q_G), I_{DS} = 1.5A, V_{DS} = 1000V, \text{turn-on pulse})$

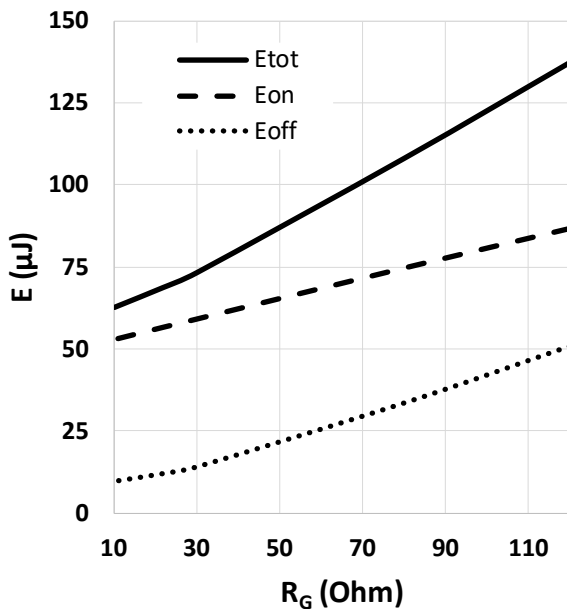


Figure 11 Typical switching energy losses as a function of gate resistance
 $(E = f(R_{G,ext}), V_{DD} = 1000V, V_{GS} = 0V/12V, I_D = 1.5A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V)$

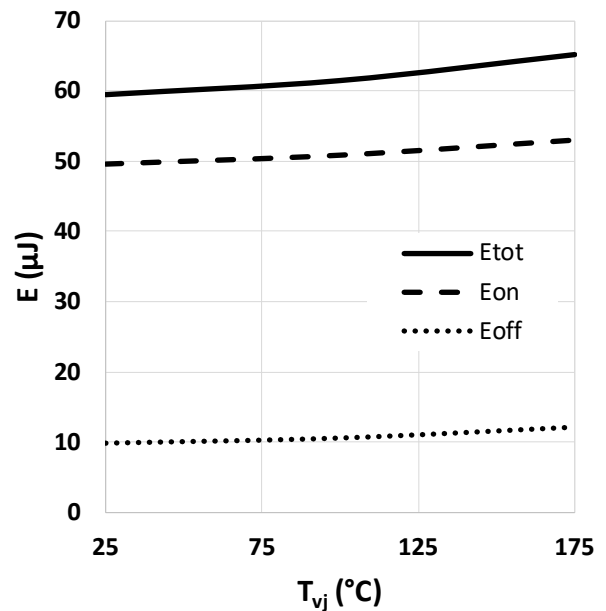


Figure 12 Typical switching energy losses as a function of junction temperature
 $(E = f(T_{vj}), V_{DD} = 1000V, V_{GS} = 0V/12V, R_{G,ext} = 22\Omega, I_D = 1.5A, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V)$

Electrical characteristic diagrams

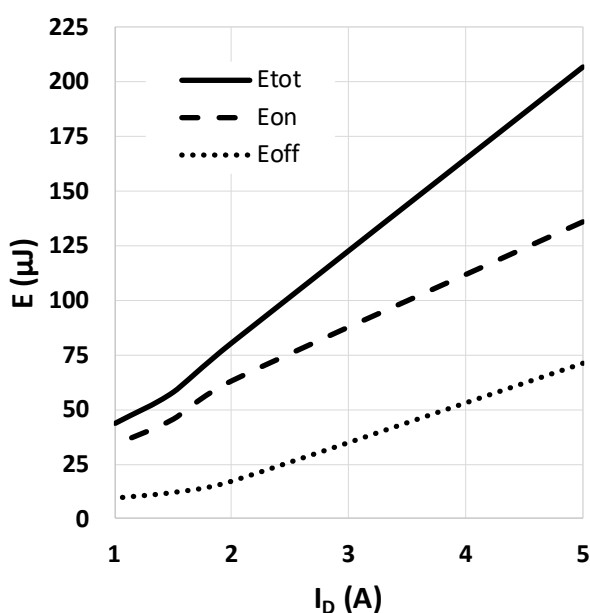


Figure 13 Typical switching energy losses as a function of drain-source current

($E = f(I_{DS})$, $V_{DD} = 1000V$, $V_{GS} = 0V/12V$, $R_{G,ext} = 22\Omega$, $T_{vj} = 175^\circ C$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

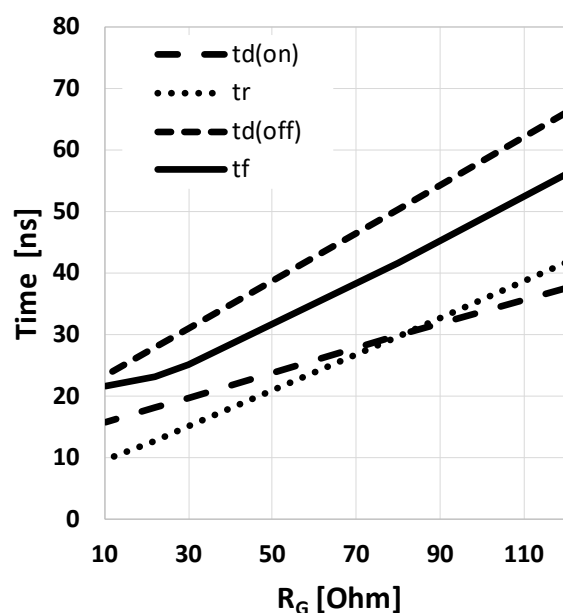


Figure 14 Typical switching times as a function of gate resistor

($t = f(R_{G,ext})$, $V_{DD} = 1000V$, $V_{GS} = 0V/12V$, $I_D = 1.5A$, $T_{vj} = 175^\circ C$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

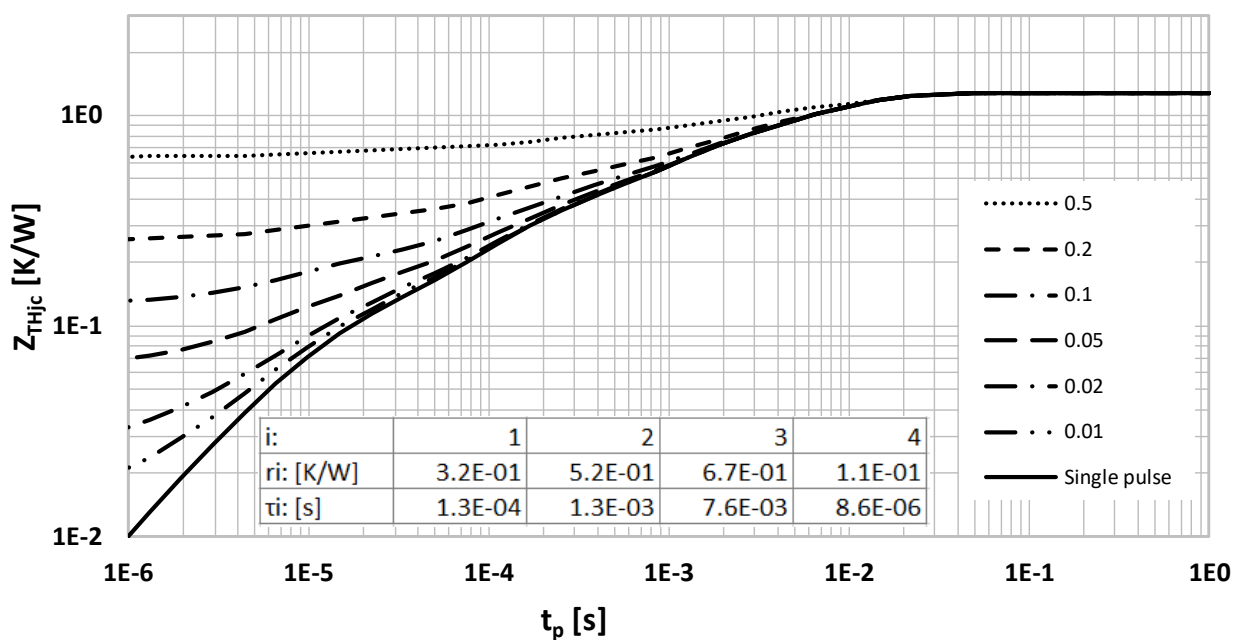


Figure 15 Max. transient thermal resistance (MOSFET)

($Z_{th(j-c,max)} = f(t_p)$, parameter $D = t_p/T$, thermal equivalent circuit in Fig. D)

5 Package drawing

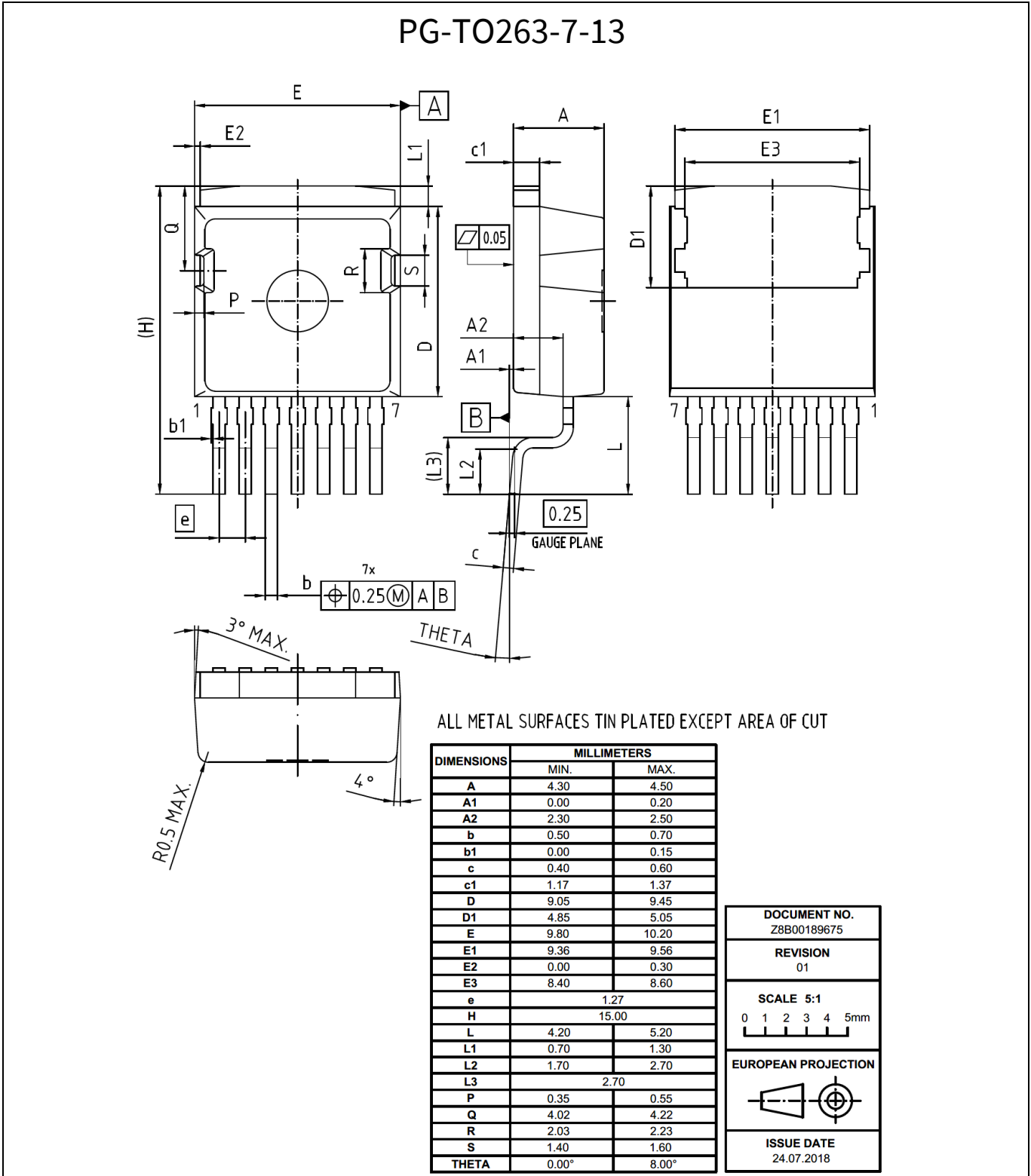


Figure 16 Package drawing

6 Test conditions

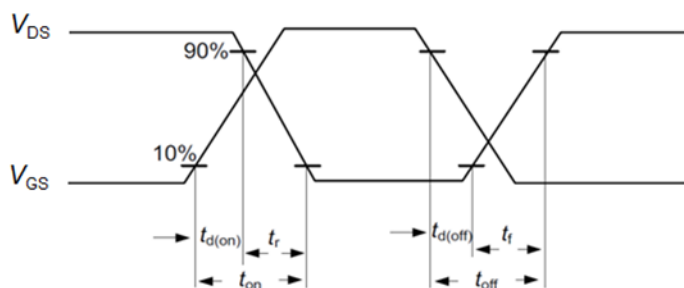


Figure A. Definition of switching times

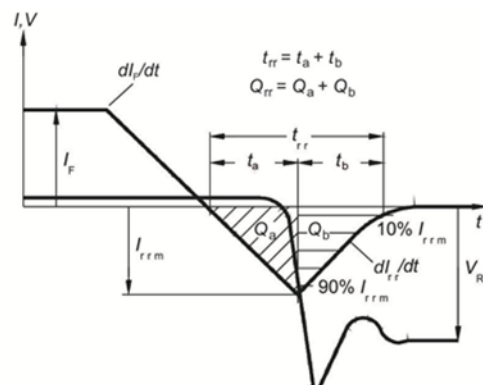


Figure C. Definition of diode switching characteristics

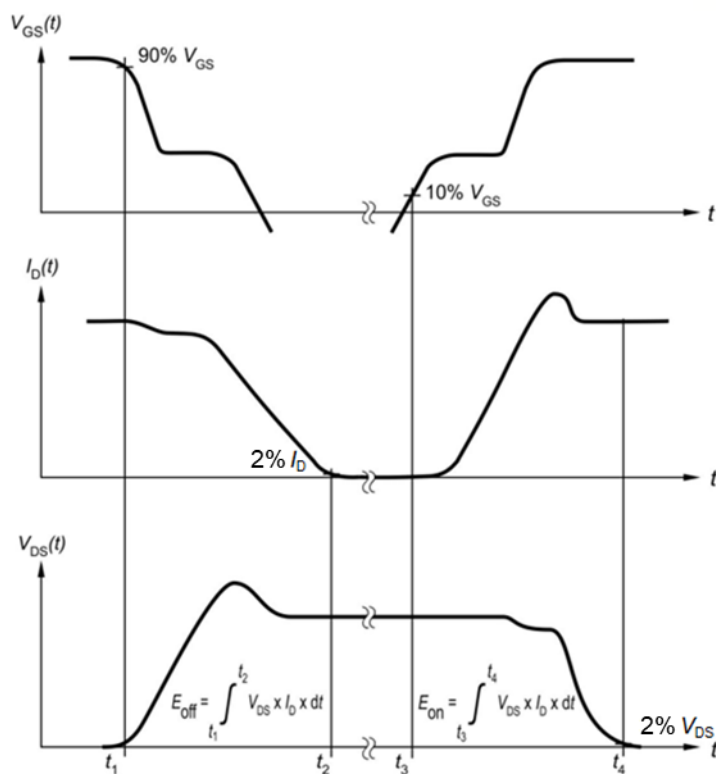


Figure B. Definition of switching losses

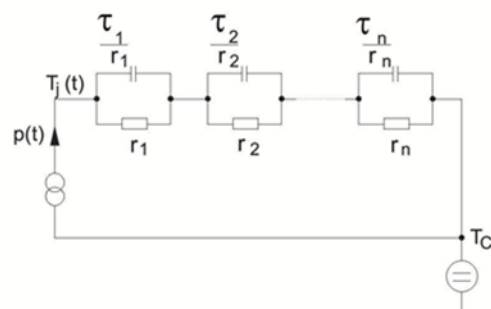


Figure D. Thermal equivalent circuit

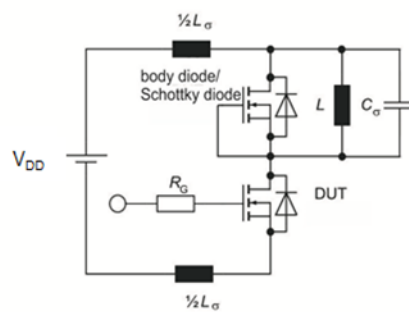


Figure E. Dynamic test circuit

Parasitic inductance L_{σ} ,
parasitic capacitor C_{σ} ,

Figure 17 Test conditions

Revision history**Revision history**

Document version	Date of release	Description of changes
2.1	2020-04-27	Final Datasheet
2.2	2020-12-11	Correction of circuit symbol on page 1
2.3	2021-04-12	Editorial changes

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