



**THE DATASHEET OF
IMBF170R650M1XTMA1**

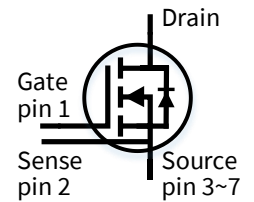


IMBF170R650M1

CoolSiC™ 1700V SiC Trench MOSFET Silicon Carbide MOSFET

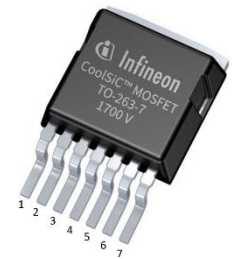
Features

- 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 <small>$T_C = 25^\circ C, R_{th(j-c,max)}$</small>	$R_{DS(on)}$ <small>$T_{vj} = 25^\circ C, I_D = 1.5A, V_{GS} = 12V$</small>	$T_{vj,max}$	Marking	Package
IMBF170R650M1	1700V	7.4A	650m Ω	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} , $V_{GS} = 12\text{V}$, $T_C = 25^\circ\text{C}$	I_D	7.4	A
$T_C = 100^\circ\text{C}$		5.2	
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	V_{GS}	-10... 20	V
Recommended turn-on gate voltage	$V_{GS,on}$	12... 15	
Recommended turn-off gate voltage	$V_{GS,off}$	0	
Power dissipation, limited by T_{vjmax}			
$T_C = 25^\circ\text{C}$	P_{tot}	88	W
$T_C = 100^\circ\text{C}$		44	
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.

Thermal resistances

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	-	m Ω
		$T_{vj} = 100^{\circ}\text{C}$	-	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	$V_{GS(th)}$	<i>(tested after 1 ms pulse at</i> $V_{GS} = 20\text{V})$ $I_D = 1.7\text{mA}, V_{DS} = V_{GS}$ $T_{vj} = 25^{\circ}\text{C}$	3.5	4.5	5.7	V
		$T_{vj} = 175^{\circ}\text{C}$	-	3.6	-	
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

Electrical Characteristics

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	$V_{DD} = 1000\text{V}, I_D = 1.5\text{A},$ $V_{GS} = 0/12\text{V}, \text{turn-on pulse}$	-	8	-	nC
Gate to source charge	$Q_{GS,pl}$		-	2.3	-	
Gate to drain charge	Q_{GD}		-	3.3	-	

Electrical Characteristics

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	$t_{d(on)}$	$V_{DD} = 1000\text{V}$, $I_D = 1.5\text{A}$, $V_{GS} = 0/12\text{V}$, $R_{G,ext} = 22\Omega$, $L_{\sigma} = 40\text{nH}$, diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	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, $T_{vj} = 175^{\circ}\text{C}$

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.

Electrical characteristic diagrams

4 Electrical characteristic diagrams

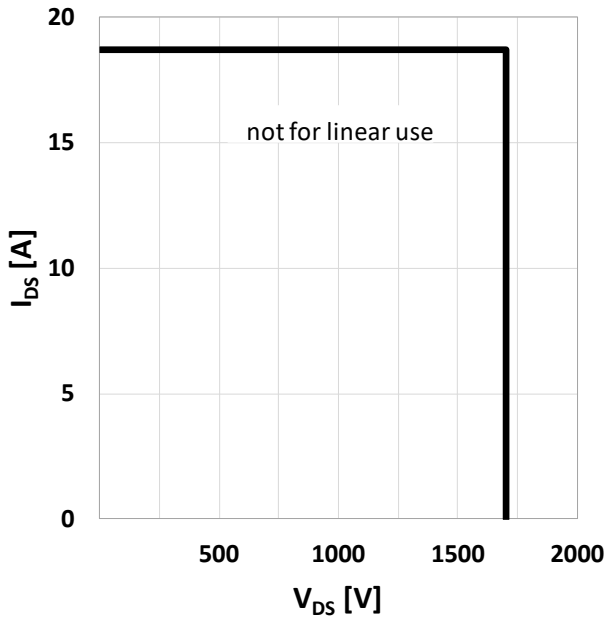


Figure 1 Safe operating area (SOA)
($V_{GS} = 0/12V, T_c = 25^\circ C, T_j \leq 175^\circ C$)

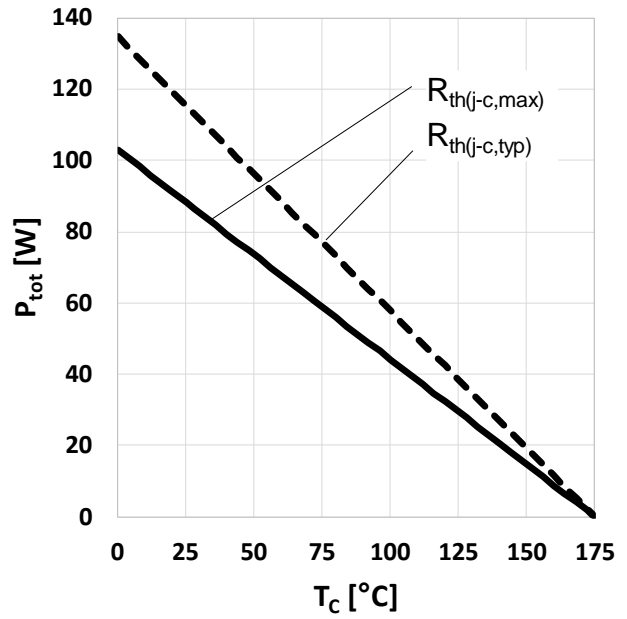


Figure 2 Power dissipation as a function of case temperature limited by bond wire
($P_{tot} = f(T_c)$)

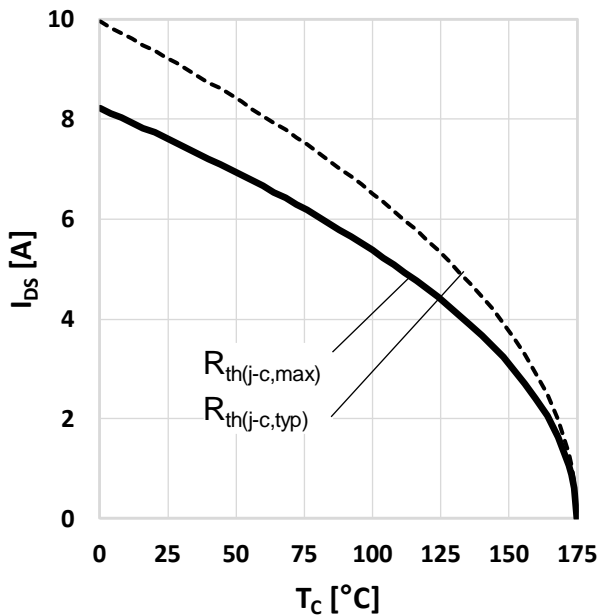


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire ($I_{DS} = f(T_c)$)

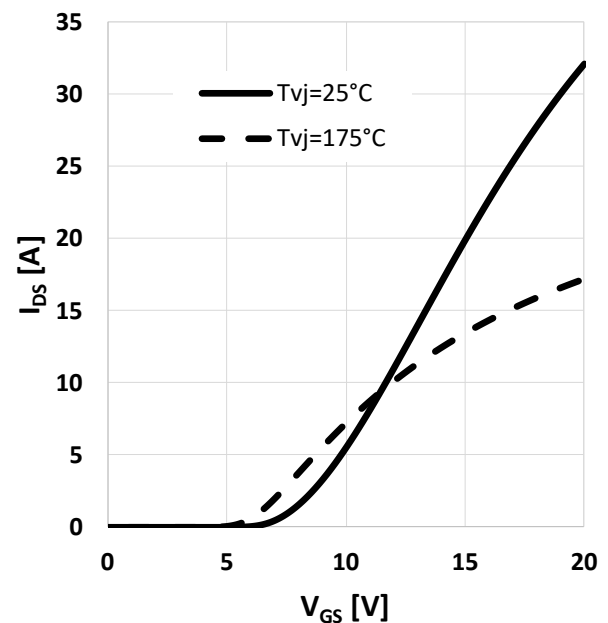


Figure 4 Typical transfer characteristic
($I_{DS} = f(V_{GS}), V_{DS} = 20V, t_P = 20\mu s$)

Electrical characteristic diagrams

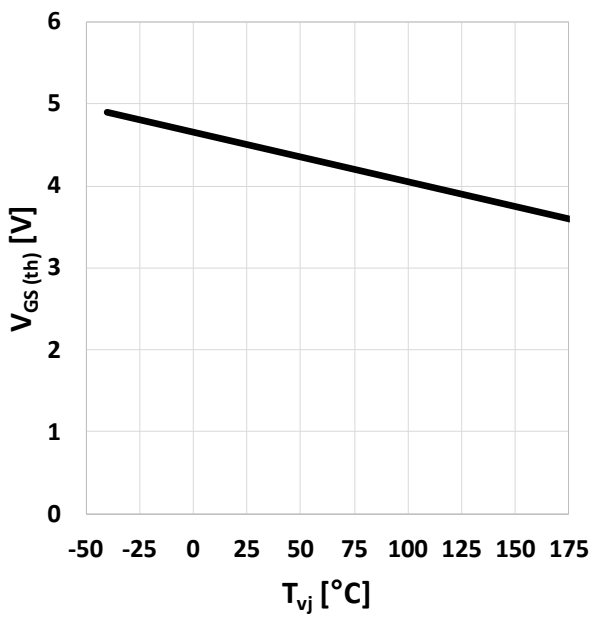


Figure 5 Typical gate-source threshold voltage as a function of junction temperature
($V_{GS(th)} = f(T_{vj})$, $I_{DS} = 1.7\text{mA}$, $V_{GS} = V_{DS}$)

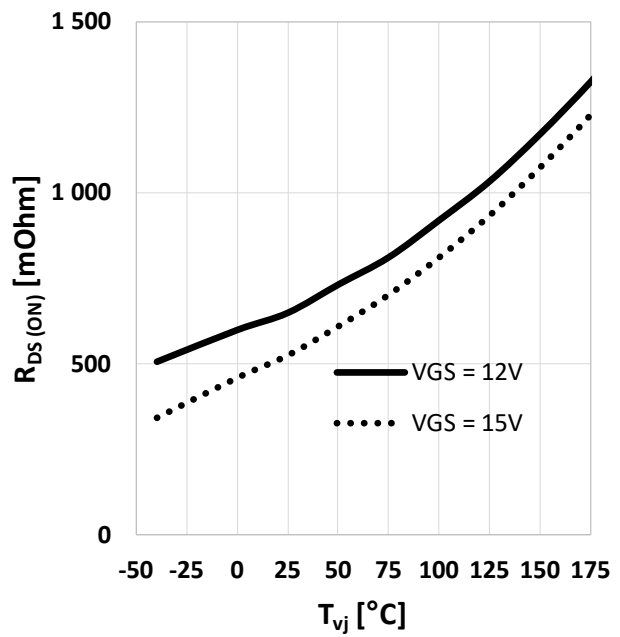


Figure 6 Typical on-resistance as a function of junction temperature
($R_{DS(on)} = f(T_{vj})$, $I_{DS} = 1.5\text{A}$)

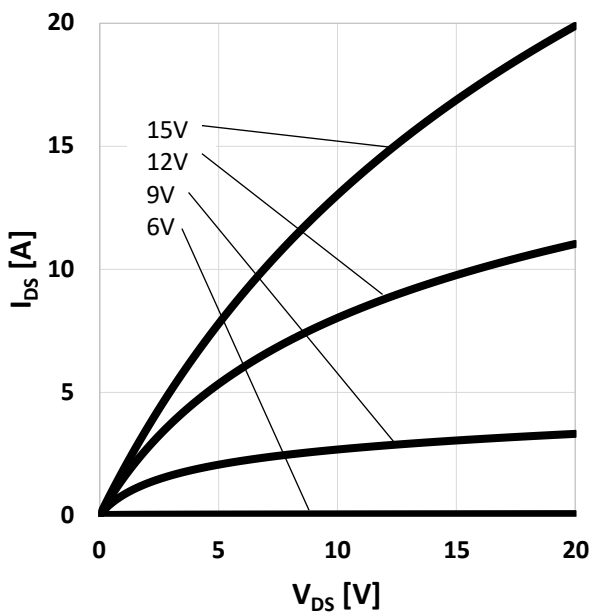


Figure 7 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS})$, $T_{vj} = 25^\circ\text{C}$, $t_P = 20\mu\text{s}$)

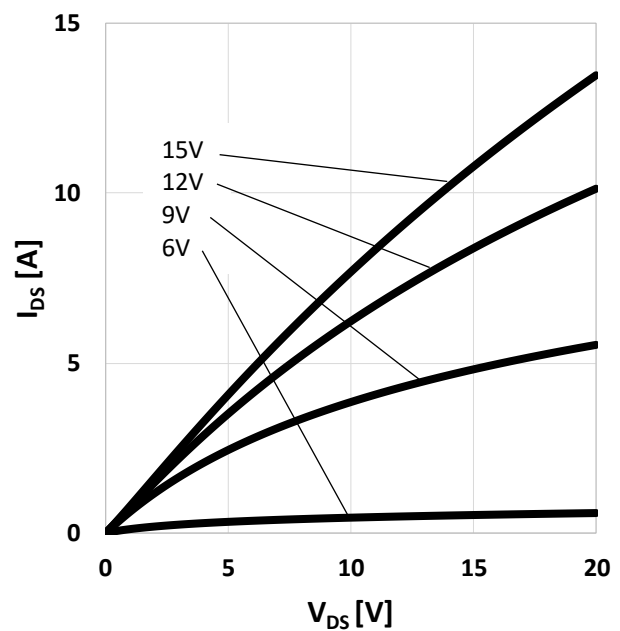


Figure 8 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS})$, $T_{vj} = 175^\circ\text{C}$, $t_P = 20\mu\text{s}$)

Electrical characteristic diagrams

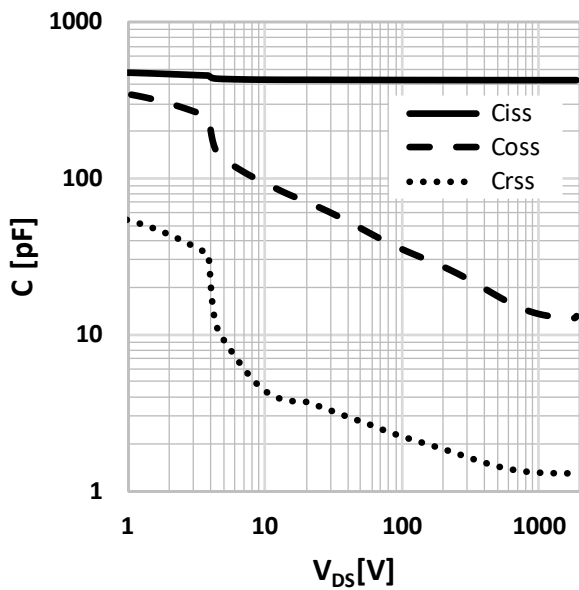


Figure 9 Typical capacitance as a function of drain-source voltage
 ($C = f(V_{DS}), V_{GS} = 0V, f = 1MHz$)

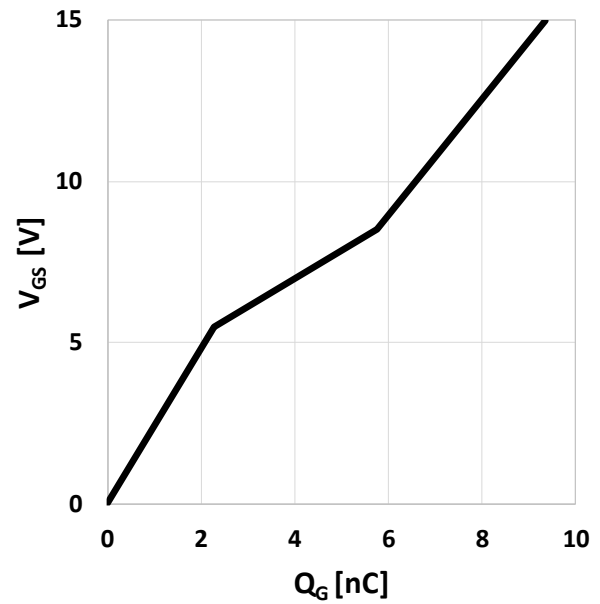


Figure 10 Typical gate charge
 ($V_{GS} = f(Q_G), I_{DS} = 1.5A, V_{DS} = 1000V, \text{turn-on pulse}$)

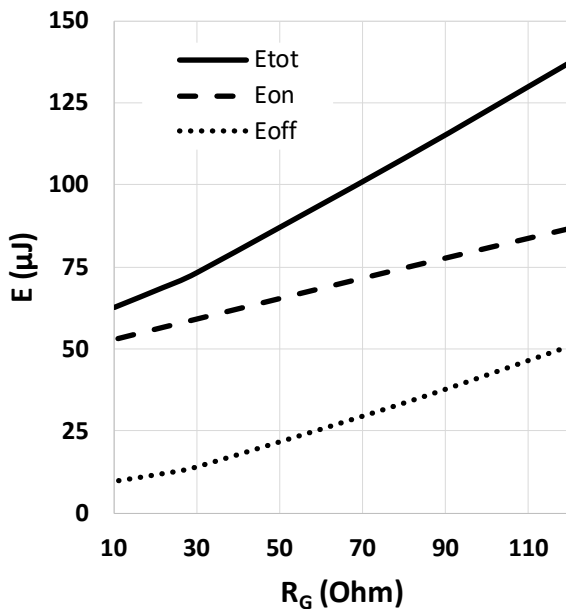


Figure 11 Typical switching energy losses as a function of gate resistance
 ($E = f(R_{G,ext}), V_{DD} = 1000V, V_{GS} = 0V/12V, I_D = 1.5A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V$)

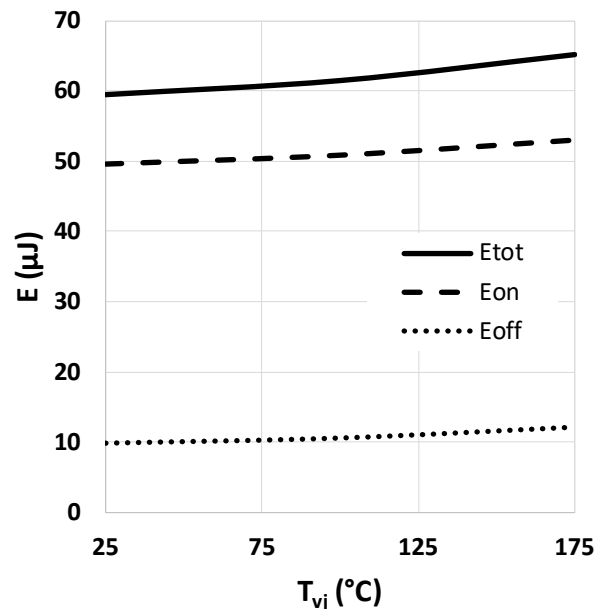


Figure 12 Typical switching energy losses as a function of junction temperature
 ($E = f(T_{vj}), V_{DD} = 1000V, V_{GS} = 0V/12V, R_{G,ext} = 22\Omega, I_D = 1.5A, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V$)

Electrical characteristic diagrams

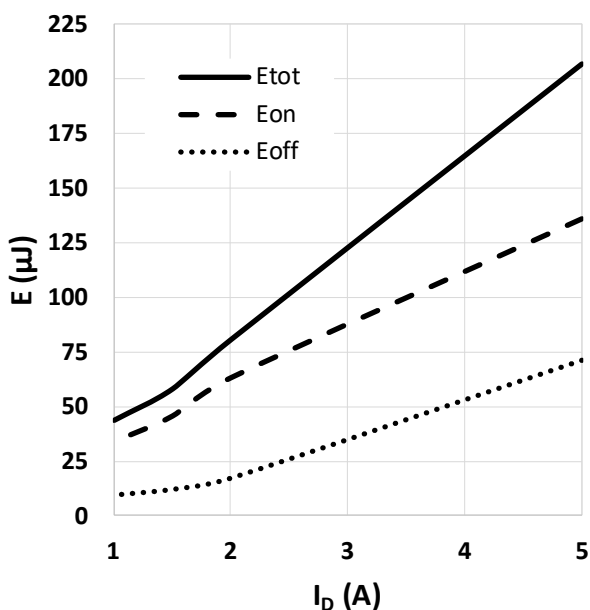


Figure 13 Typical switching energy losses as a function of drain-source current

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

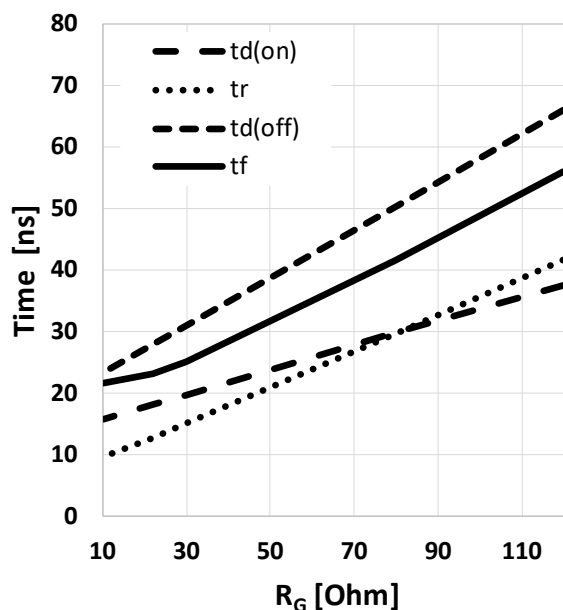


Figure 14 Typical switching times as a function of gate resistor

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

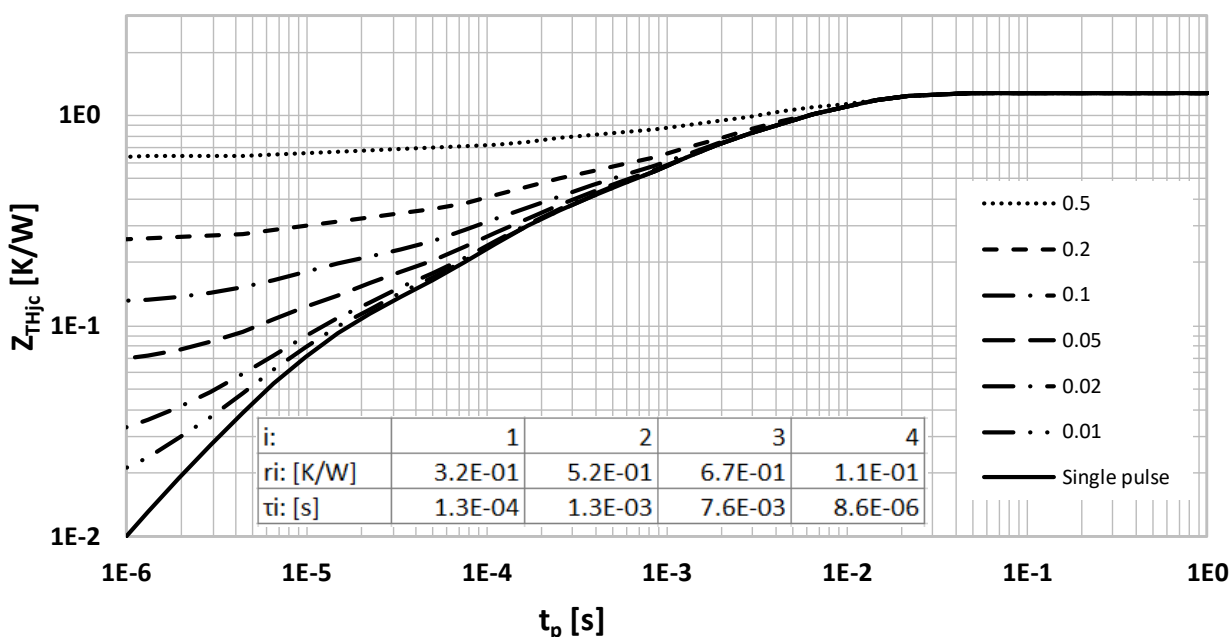


Figure 15 Max. transient thermal resistance (MOSFET)

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

5 Package drawing

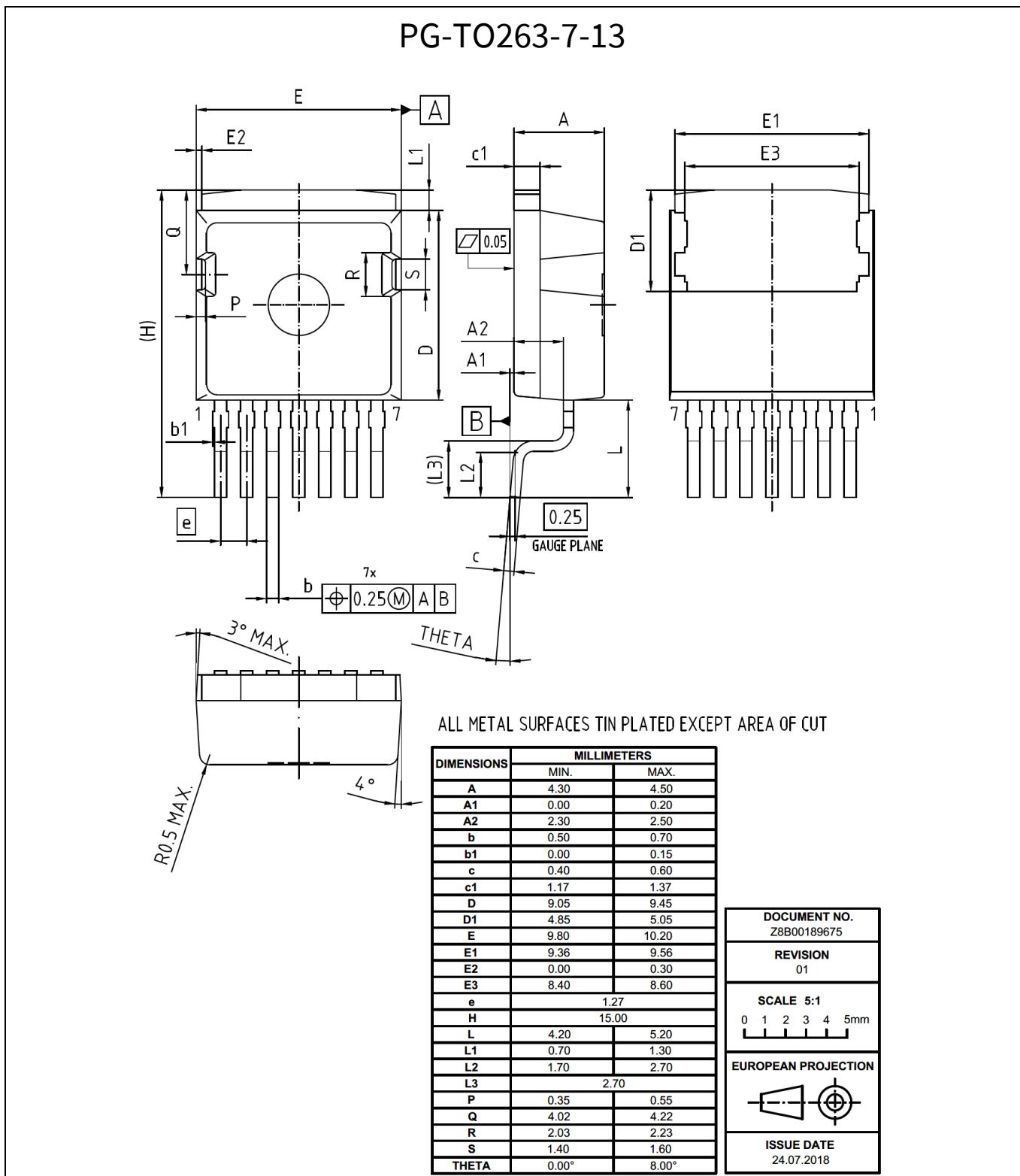


Figure 16 Package drawing

Test conditions

6 Test conditions

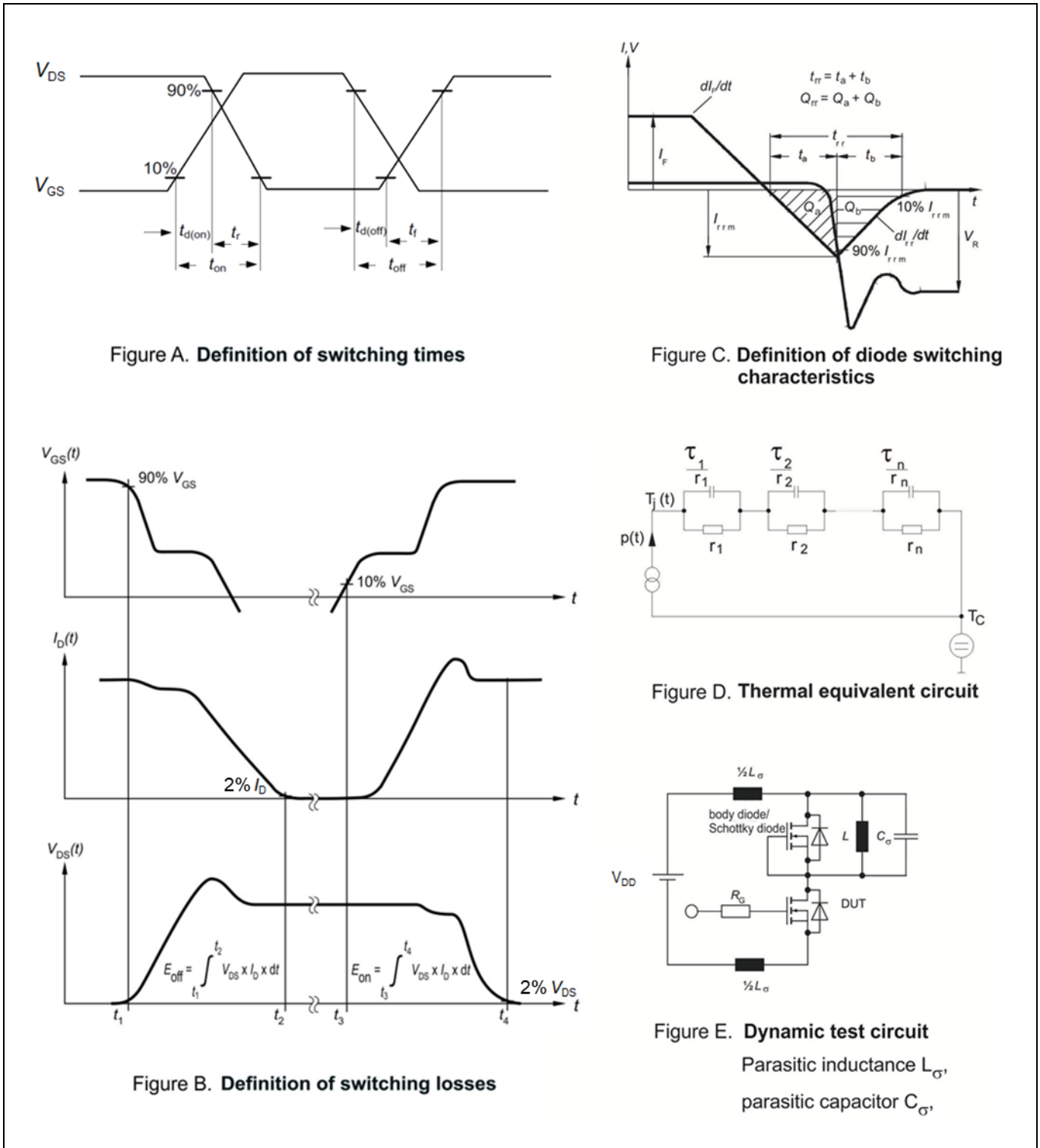


Figure 17 Test conditions

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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