



**THE DATASHEET OF  
IMBF170R450M1XTMA1**

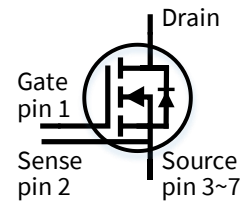


# IMBF170R450M1

## 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><math>T_C = 25^\circ C, R_{th(j-c,max)}</math></small>	$R_{DS(on)}$ <small><math>T_{vj} = 25^\circ C, I_D = 2A, V_{GS} = 12V</math></small>	$T_{vj,max}$	Marking	Package
IMBF170R450M1	1700V	9.8A	450m $\Omega$	175°C	170M1450	PG-TO263-7

## Table of contents

<b>Features .....</b>	<b>1</b>
<b>Benefits .....</b>	<b>1</b>
<b>Potential applications .....</b>	<b>1</b>
<b>Product validation .....</b>	<b>1</b>
<b>Table of contents .....</b>	<b>2</b>
<b>1 Maximum ratings .....</b>	<b>3</b>
<b>2 Thermal resistances .....</b>	<b>4</b>
<b>3 Electrical Characteristics .....</b>	<b>5</b>
3.1 Static characteristics .....	5
3.2 Dynamic characteristics .....	6
3.3 Switching characteristics .....	7
<b>4 Electrical characteristic diagrams .....</b>	<b>8</b>
<b>5 Package drawing .....</b>	<b>12</b>
<b>6 Test conditions .....</b>	<b>13</b>
<b>Revision history .....</b>	<b>14</b>

## 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 $T_{vj,max}$ , $V_{GS} = 12\text{V}$ , $T_C = 25^\circ\text{C}$	$I_D$	9.8	A
$T_C = 100^\circ\text{C}$		6.9	
Pulsed drain current, $t_p$ limited by $T_{vj,max}$ , $V_{GS} = 12\text{V}$	$I_{D,pulse}^1$	24.8	A
Gate-source voltage <sup>2</sup>			
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 $T_{vj,max}$			
$T_C = 25^\circ\text{C}$	$P_{tot}$	107	W
$T_C = 100^\circ\text{C}$		53	
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	$^\circ\text{C}$

<sup>1</sup> verified by design

<sup>2</sup> **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	$R_{th(j-c)}$		-	1.1	1.4	K/W
Thermal resistance, junction – ambient	$R_{th(j-a)}$	leaded	-	-	62	K/W

## Electrical Characteristics

### 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	$R_{DS(on)}$	$V_{GS} = 12\text{V}, I_D = 2\text{A},$ $T_{vj} = 25^{\circ}\text{C}$	-	450	-	mΩ
		$T_{vj} = 100^{\circ}\text{C}$	-	638	-	
		$T_{vj} = 175^{\circ}\text{C}$	-	917	-	
		$V_{GS} = 15\text{V}, I_D = 2\text{A},$ $T_{vj} = 25^{\circ}\text{C}$	-	364	390	
Gate-source threshold voltage	$V_{GS(th)}$	(tested after 1 ms pulse at $V_{GS} = 20\text{V}$ ) $I_D = 2.5\text{mA}, V_{DS} = V_{GS}$ $T_{vj} = 25^{\circ}\text{C}$	3.5	4.5	5.7	V
		$T_{vj} = 175^{\circ}\text{C}$	-	3.6	-	
Zero gate voltage drain current	$I_{DSS}$	$V_{GS} = 0\text{V}, V_{DS} = 1700\text{V}$ $T_{vj} = 25^{\circ}\text{C}$	-	0.9	11	μA
		$T_{vj} = 175^{\circ}\text{C}$	-	10	-	
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	$g_{fs}$	$V_{DS} = 20\text{V}, I_D = 2\text{A}$	-	0.9	-	S
Internal gate resistance	$R_{G,int}$	$f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	20	-	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	$C_{iss}$	$V_{DD} = 1000\text{V}, V_{GS} = 0\text{V},$ $f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	610	-	pF
Output capacitance	$C_{oss}$		-	16	-	
Reverse capacitance	$C_{rss}$		-	1.7	-	
$C_{oss}$ stored energy	$E_{oss}$		-	2.9	-	$\mu\text{J}$
Total gate charge	$Q_G$	$V_{DD} = 1000\text{V}, I_D = 2\text{A},$ $V_{GS} = 0/12\text{V}, \text{turn-on pulse}$	-	11	-	nC
Gate to source charge	$Q_{GS,pl}$		-	3.3	-	
Gate to drain charge	$Q_{GD}$		-	5.9	-	

## Electrical Characteristics

## 3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load <sup>3</sup>

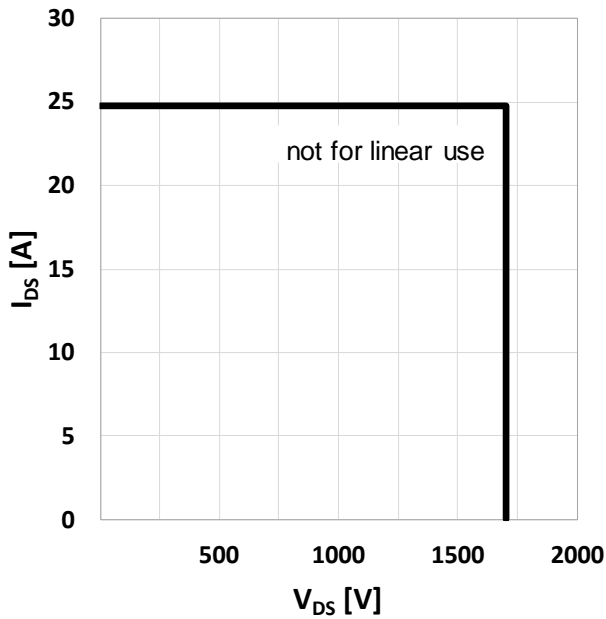
Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>MOSFET Characteristics, <math>T_{vj} = 25^{\circ}\text{C}</math></b>						
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1000\text{V}, I_D = 2\text{A},$ $V_{GS} = 0/12\text{V}, R_{G,ext} = 22\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	27	-	ns
Rise time	$t_r$		-	20	-	
Turn-off delay time	$t_{d(off)}$		-	32	-	
Fall time	$t_f$		-	24	-	
Turn-on energy	$E_{on}$		-	76	-	$\mu\text{J}$
Turn-off energy	$E_{off}$		-	15	-	
Total switching energy	$E_{tot}$		-	91	-	

**MOSFET Characteristics,  $T_{vj} = 175^{\circ}\text{C}$** 

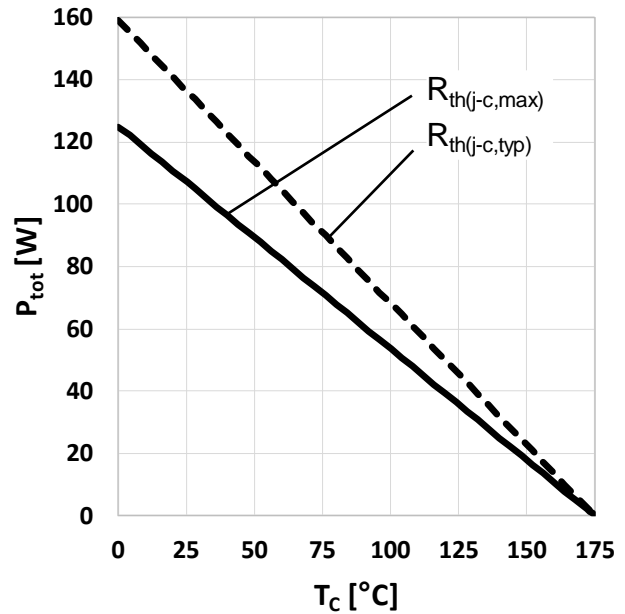
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1000\text{V}, I_D = 2\text{A},$ $V_{GS} = 0/12\text{V}, R_{G,ext} = 22\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	22	-	ns
Rise time	$t_r$		-	16	-	
Turn-off delay time	$t_{d(off)}$		-	36	-	
Fall time	$t_f$		-	27	-	
Turn-on energy	$E_{on}$		-	81	-	$\mu\text{J}$
Turn-off energy	$E_{off}$		-	21	-	
Total switching energy	$E_{tot}$		-	101	-	

<sup>3</sup> The chip technology was characterized up to 200 kV/ $\mu\text{s}$ . 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.

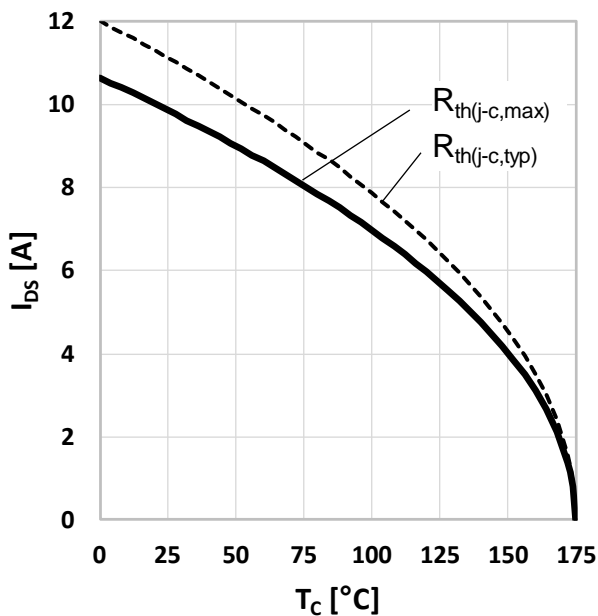
## 4 Electrical characteristic diagrams



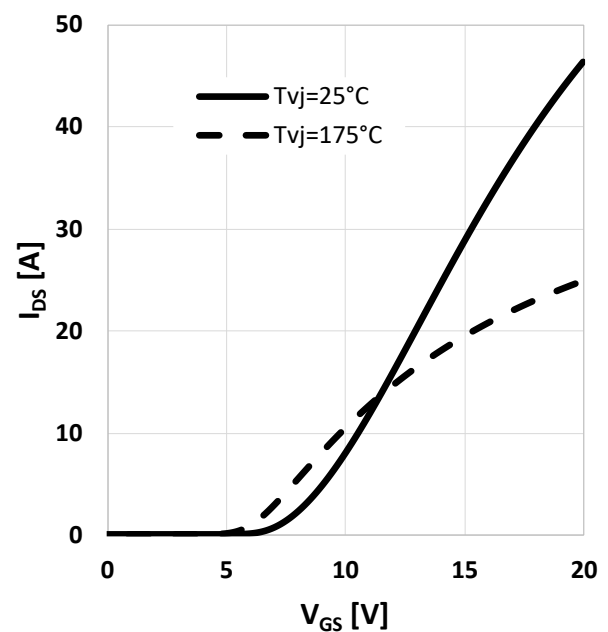
**Figure 1** Safe operating area (SOA)  
( $V_{GS} = 0/12V, T_c = 25^\circ C, T_j \leq 175^\circ C$ )



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

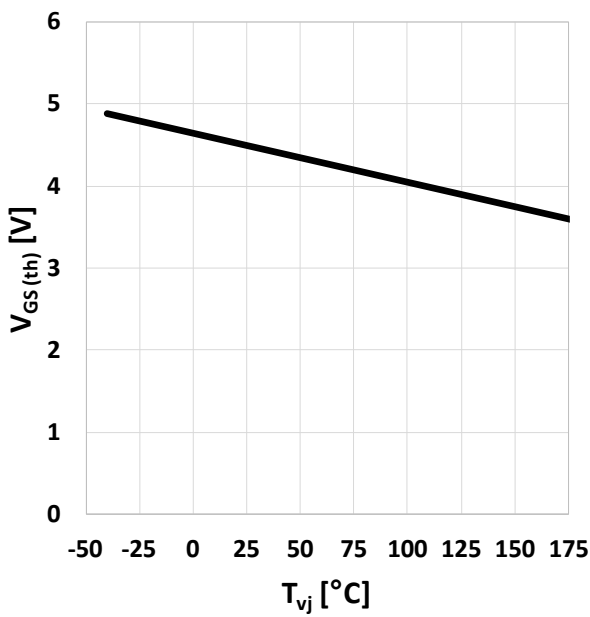


**Figure 3** Maximum DC drain to source current as a function of case temperature limited by bond wire ( $I_{DS} = f(T_c)$ )

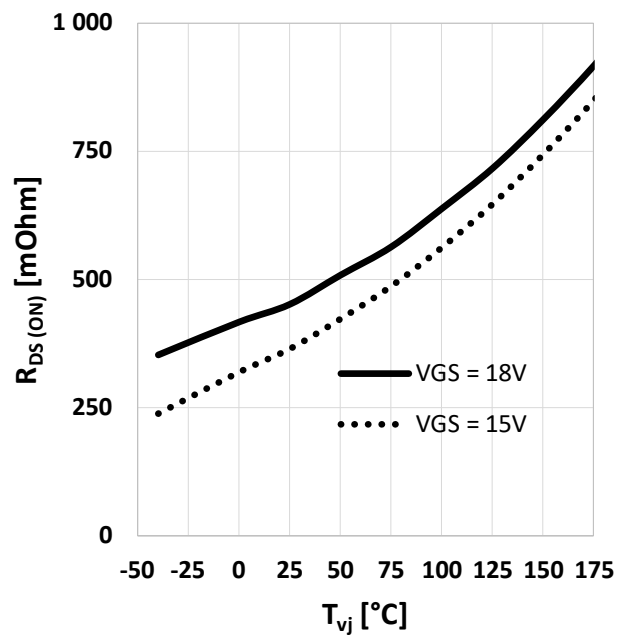


**Figure 4** Typical transfer characteristic  
( $I_{DS} = f(V_{GS}), V_{DS} = 20V, t_P = 20\mu s$ )

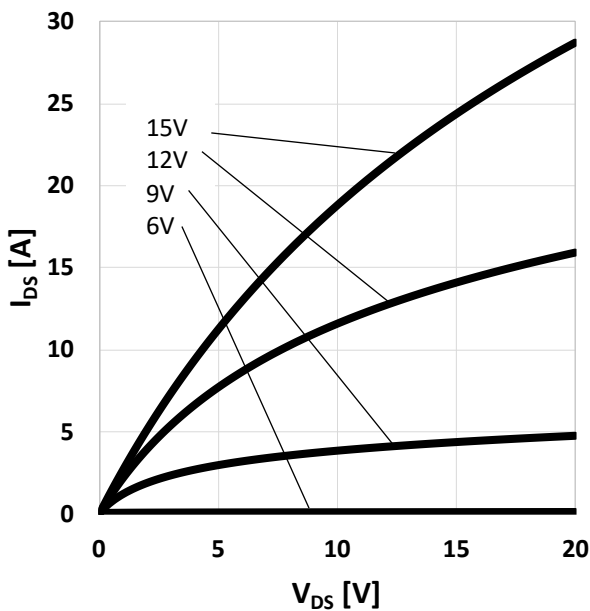
**Electrical characteristic diagrams**



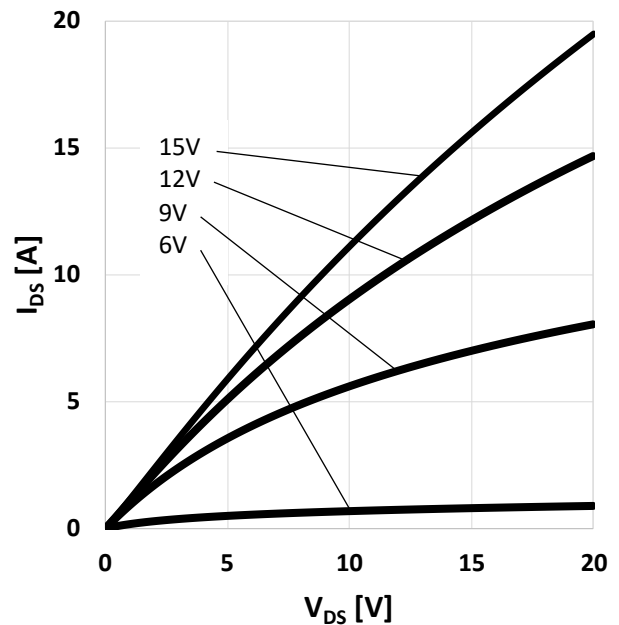
**Figure 5** Typical gate-source threshold voltage as a function of junction temperature  
 $(V_{GS(th)} = f(T_{vj}), I_{DS} = 2.5\text{mA}, V_{GS} = V_{DS})$



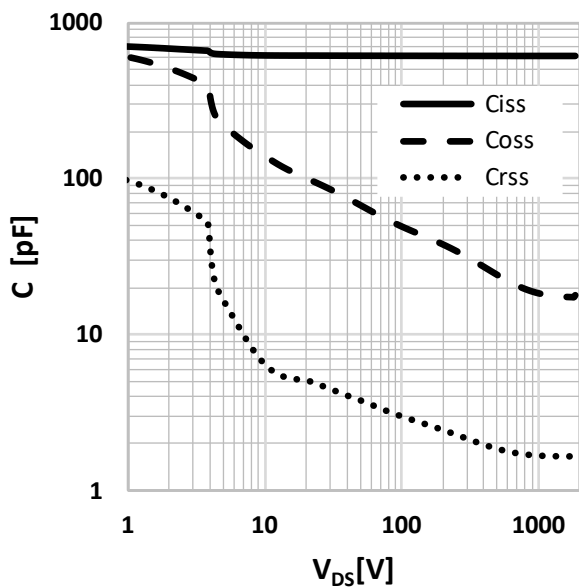
**Figure 6** Typical on-resistance as a function of junction temperature  
 $(R_{DS(on)} = f(T_{vj}), I_{DS} = 2\text{A})$



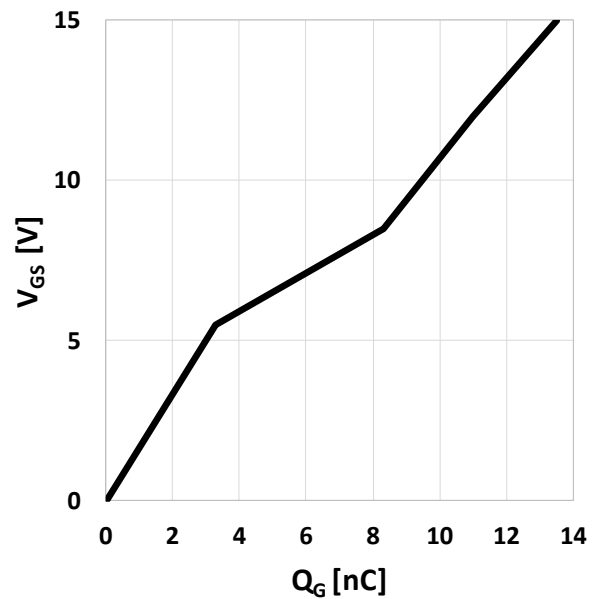
**Figure 7** Typical output characteristic,  $V_{GS}$  as parameter  
 $(I_{DS} = f(V_{DS}), T_{vj} = 25^\circ\text{C}, t_p = 20\mu\text{s})$



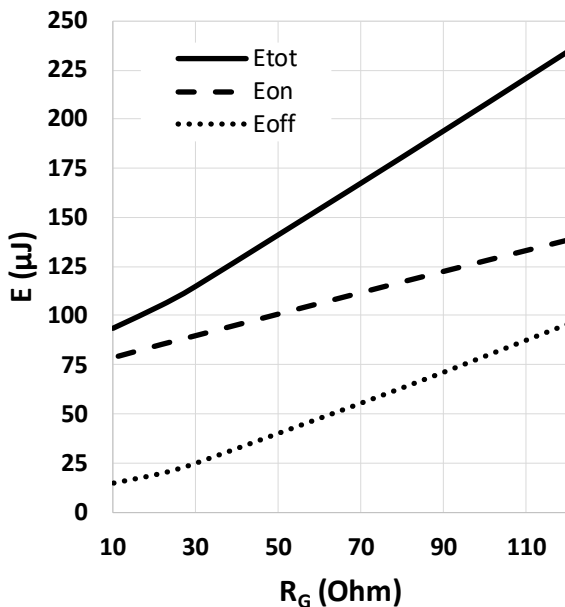
**Figure 8** Typical output characteristic,  $V_{GS}$  as parameter  
 $(I_{DS} = f(V_{DS}), T_{vj} = 175^\circ\text{C}, t_p = 20\mu\text{s})$



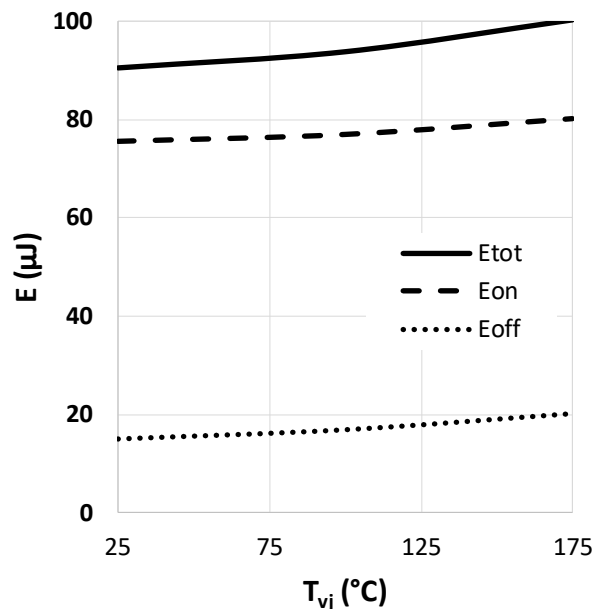
**Figure 9 Typical capacitance as a function of drain-source voltage**  
 $(C = f(V_{DS}), V_{GS} = 0V, f = 1MHz)$



**Figure 10 Typical gate charge**  
 $(V_{GS} = f(Q_G), I_{DS} = 2A, V_{DS} = 1000V, \text{turn-on pulse})$

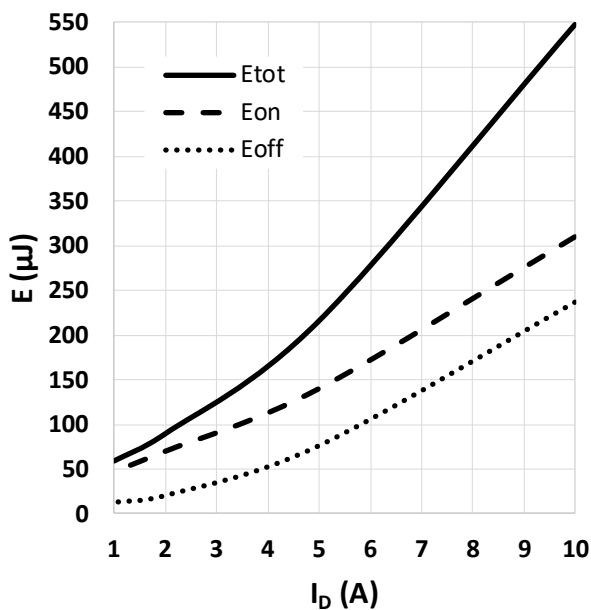


**Figure 11 Typical switching energy losses as a function of gate resistance**  
 $(E = f(R_{G,ext}), V_{DD} = 1000V, V_{GS} = 0V/12V, I_D = 2A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V)$



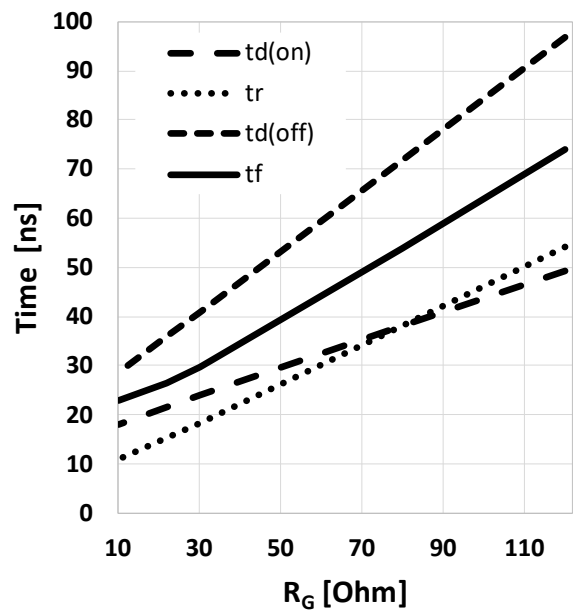
**Figure 12 Typical switching energy losses as a function of junction temperature**  
 $(E = f(T_{vj}), V_{DD} = 1000V, V_{GS} = 0V/12V, R_{G,ext} = 22\Omega, I_D = 2A, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V)$

Electrical characteristic diagrams



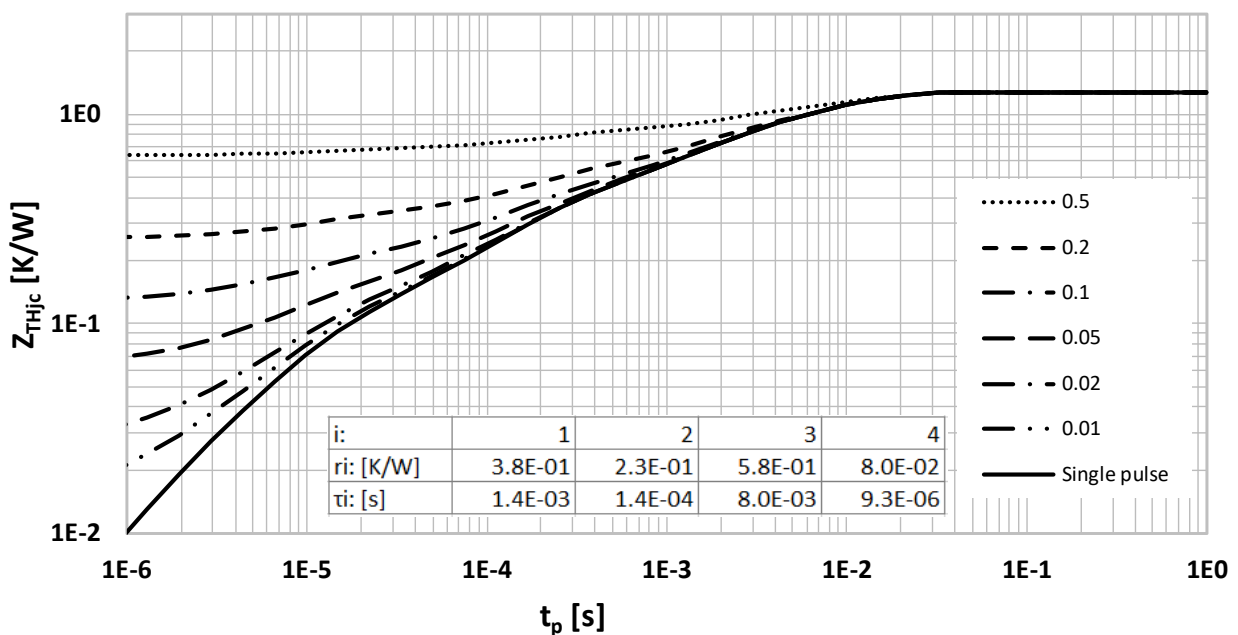
**Figure 13** Typical switching energy losses as a function of drain-source current

( $E = f(I_{DS})$ ,  $V_{DD} = 1000V$ ,  $V_{GS} = 0V/12V$ ,  $R_{G,ext} = 22\Omega$ ,  $T_{vj} = 175^\circ C$ , 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

( $t = f(R_{G,ext})$ ,  $V_{DD} = 1000V$ ,  $V_{GS} = 0V/12V$ ,  $I_D = 2A$ ,  $T_{vj} = 175^\circ C$ , 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

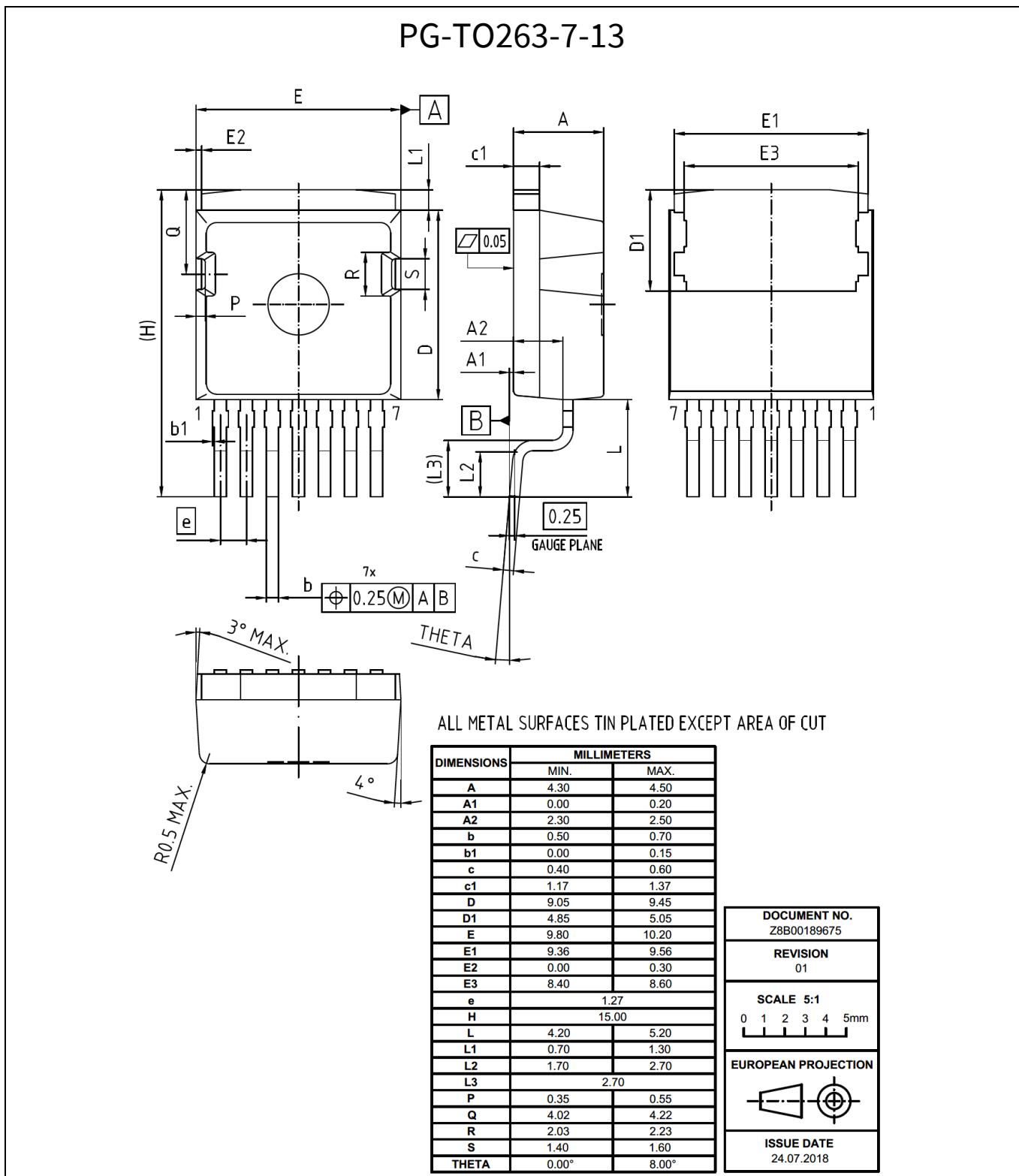


Figure 16 Package drawing

Test conditions

6 Test conditions

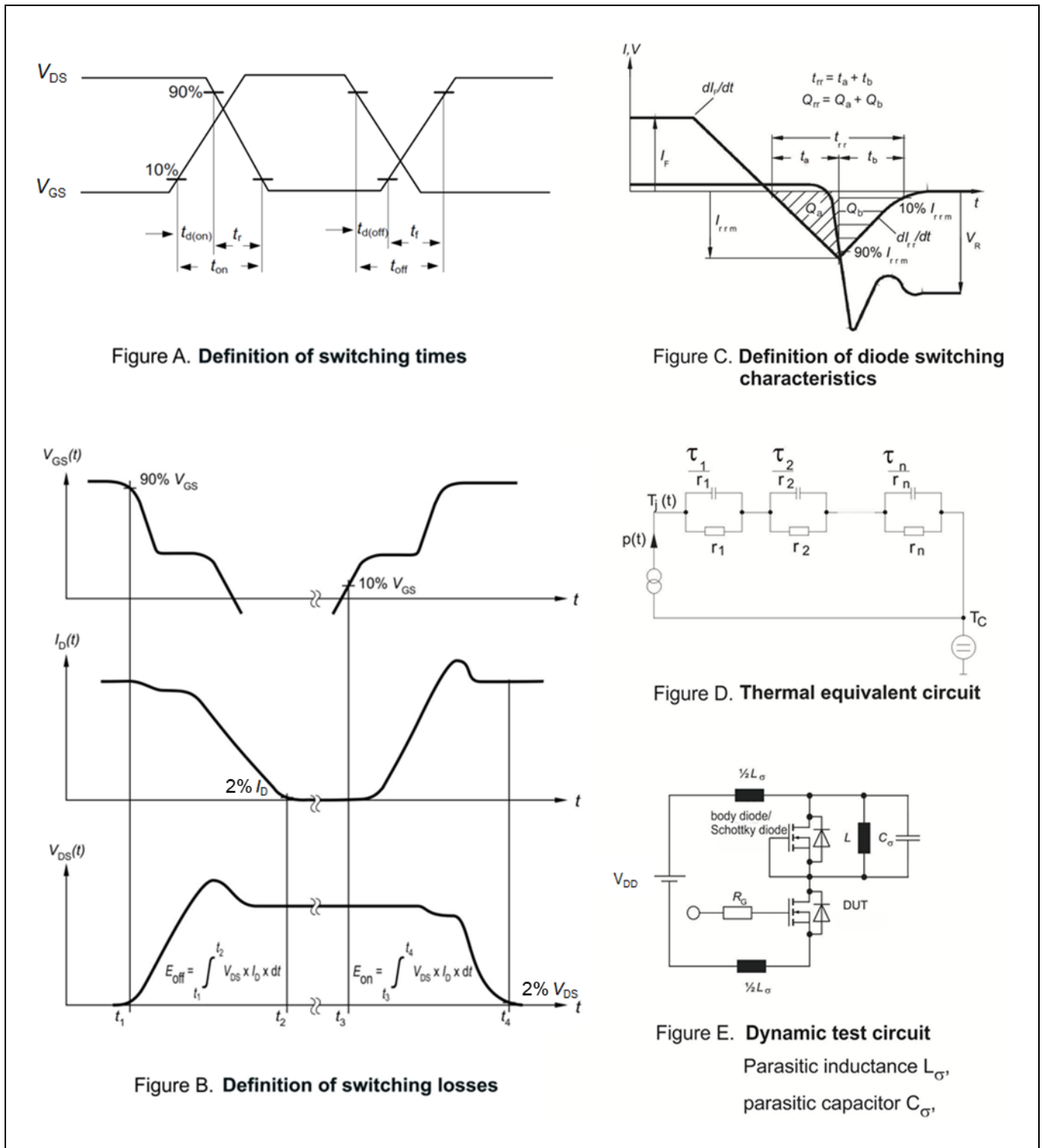


Figure 17 Test conditions

**Revision history****Revision history**

<b>Document version</b>	<b>Date of release</b>	<b>Description of changes</b>
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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