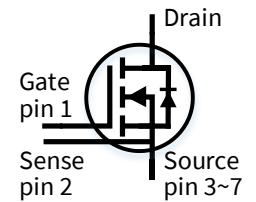


# IMBF170R650M1

## 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><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 = 1.5A, V_{GS} = 12V</math></small>	$T_{vj,max}$	Marking	Package
IMBF170R650M1	1700V	7.4A	650m $\Omega$	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 <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 $T_{vjmax}$			
$T_C = 25^\circ\text{C}$	$P_{tot}$	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	$^\circ\text{C}$

<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.

## 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	-	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	$V_{GS(th)}$	<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	-	$\mu\text{J}$
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 <sup>3</sup>

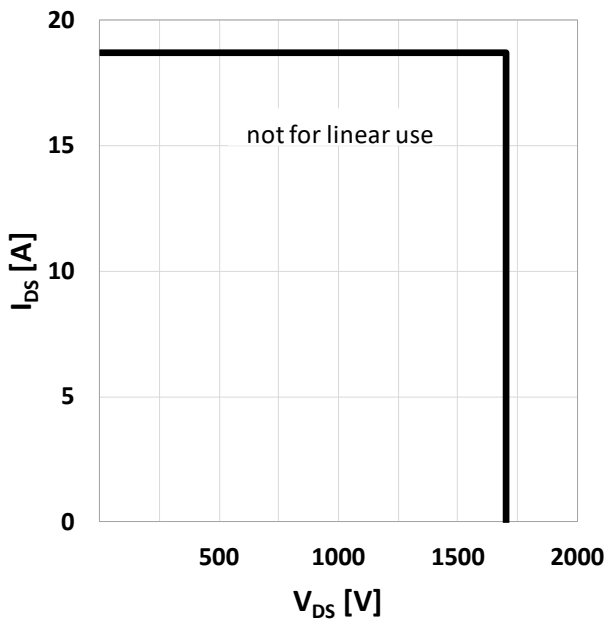
Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>MOSFET Characteristics, <math>T_{vj} = 25^{\circ}\text{C}</math></b>						
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1000\text{V}$ , $I_D = 1.5\text{A}$ , $V_{GS} = 0/12\text{V}$ , $R_{G,ext} = 22\Omega$ , $L_{\sigma} = 40\text{nH}$ , diode: 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,  $T_{vj} = 175^{\circ}\text{C}$** 

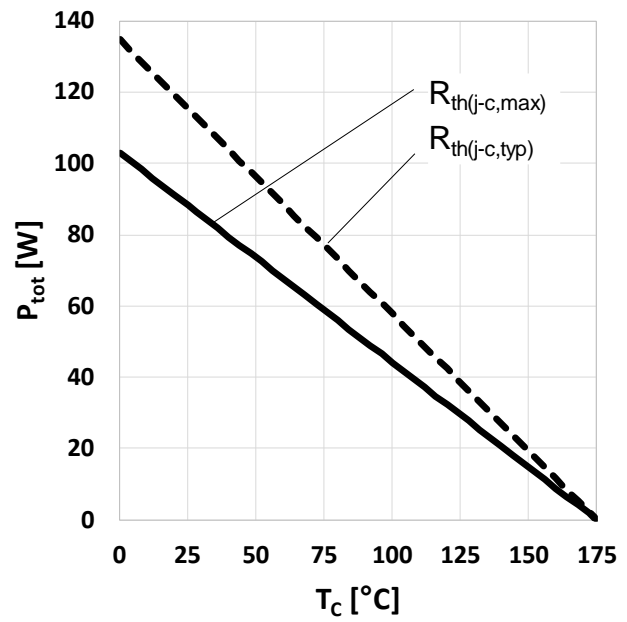
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1000\text{V}$ , $I_D = 1.5\text{A}$ , $V_{GS} = 0/12\text{V}$ , $R_{G,ext} = 22\Omega$ , $L_{\sigma} = 40\text{nH}$ , diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	19	-	ns
Rise time	$t_r$		-	13	-	
Turn-off delay time	$t_{d(off)}$		-	28	-	
Fall time	$t_f$		-	24	-	
Turn-on energy	$E_{on}$		-	54	-	μJ
Turn-off energy	$E_{off}$		-	13	-	
Total switching energy	$E_{tot}$		-	66	-	

<sup>3</sup> 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.

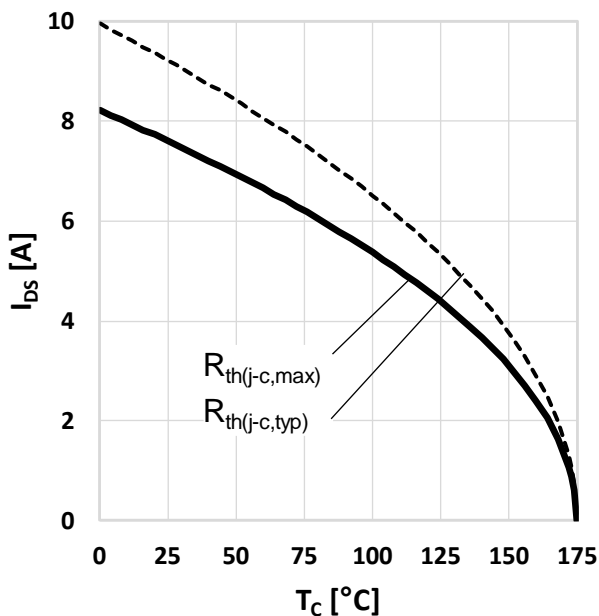
## 4 Electrical characteristic diagrams



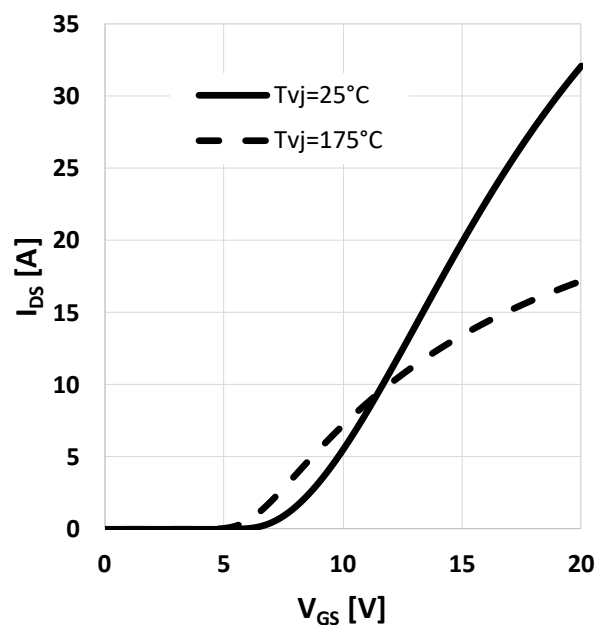
**Figure 1** Safe operating area (SOA)  
( $V_{GS} = 0/12V$ ,  $T_c = 25^\circ C$ ,  $T_j \leq 175^\circ C$ )



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



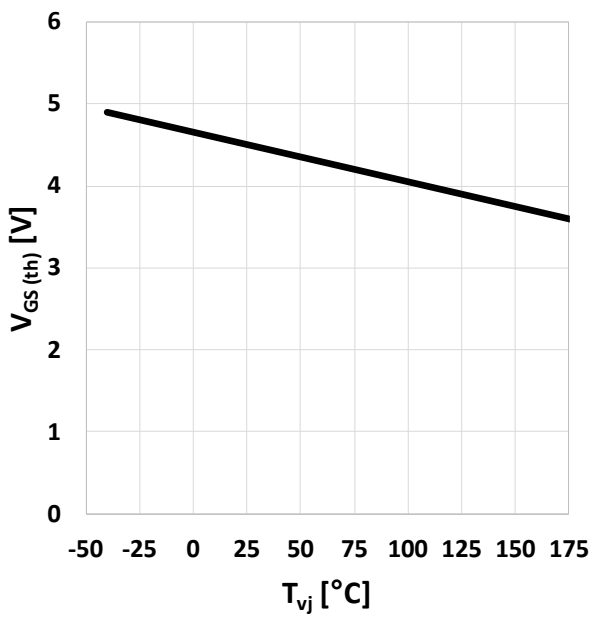
**Figure 3** Maximum DC drain to source current as a function of case temperature limited by bond wire ( $I_{DS} = f(T_c)$ )



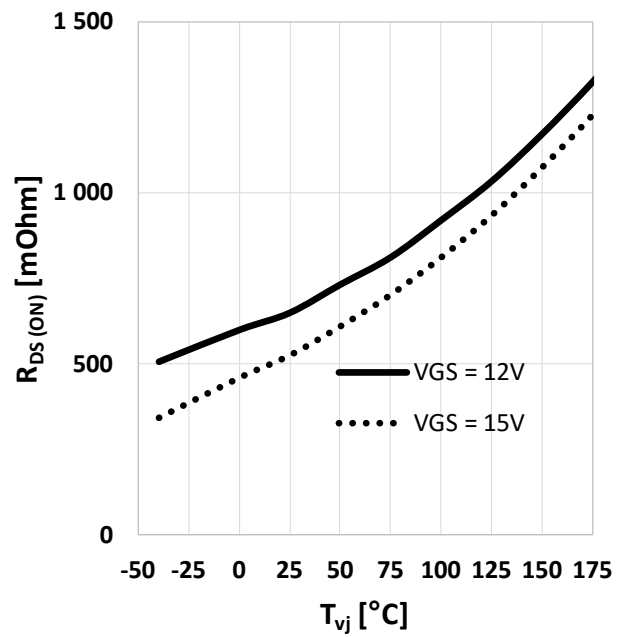
**Figure 4** Typical transfer characteristic  
( $I_{DS} = f(V_{GS})$ ,  $V_{DS} = 20V$ ,  $t_P = 20\mu s$ )



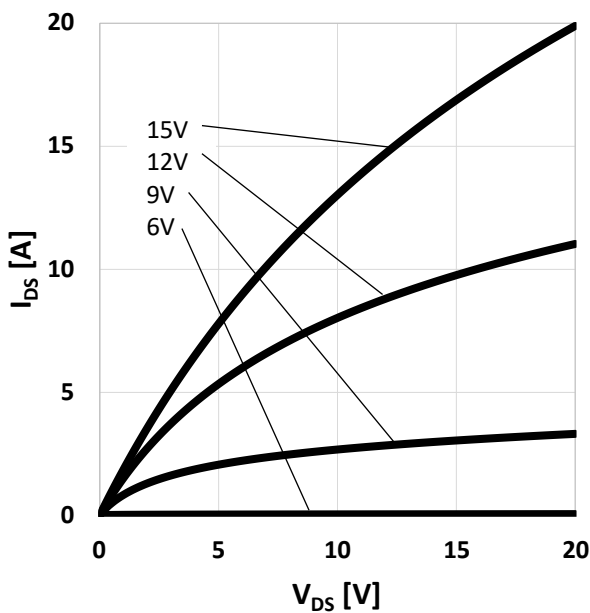
**Electrical characteristic diagrams**



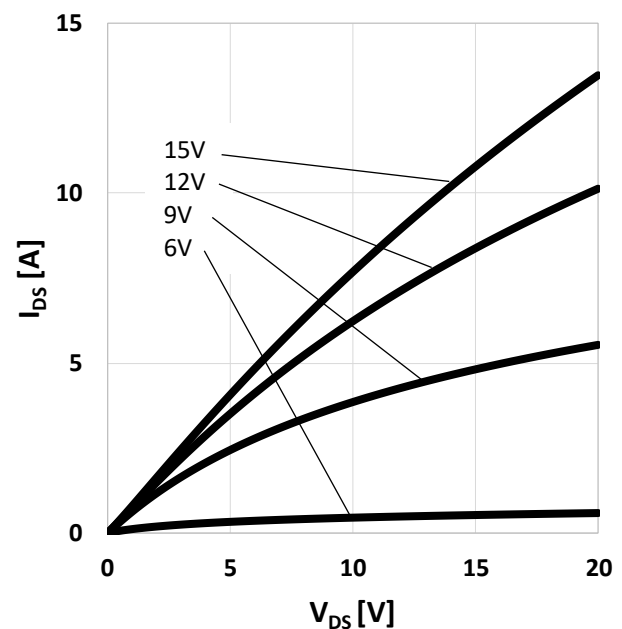
**Figure 5** Typical gate-source threshold voltage as a function of junction temperature  
 $(V_{GS(th)} = f(T_{vj}), I_{DS} = 1.7\text{mA}, V_{GS} = V_{DS})$



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

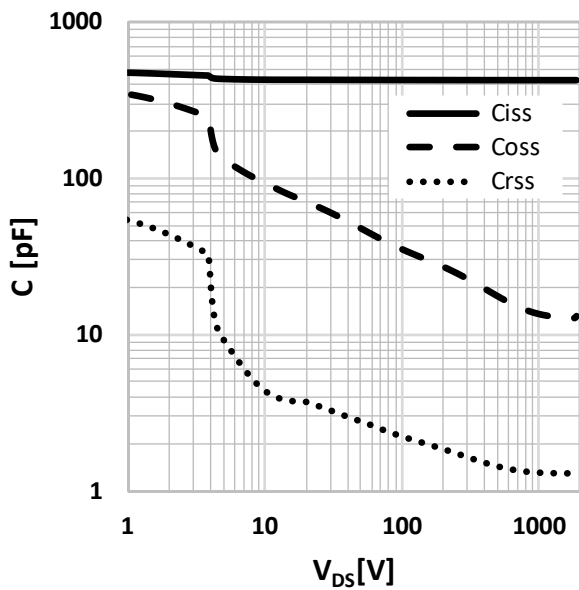


**Figure 7** Typical output characteristic,  $V_{GS}$  as parameter  
 $(I_{DS} = f(V_{DS}), T_{vj} = 25^\circ\text{C}, t_P = 20\mu\text{s})$

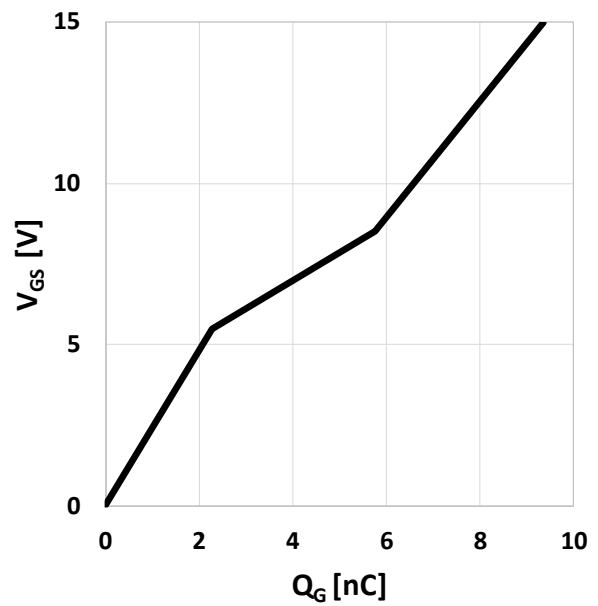


**Figure 8** Typical output characteristic,  $V_{GS}$  as parameter  
 $(I_{DS} = f(V_{DS}), T_{vj} = 175^\circ\text{C}, t_P = 20\mu\text{s})$

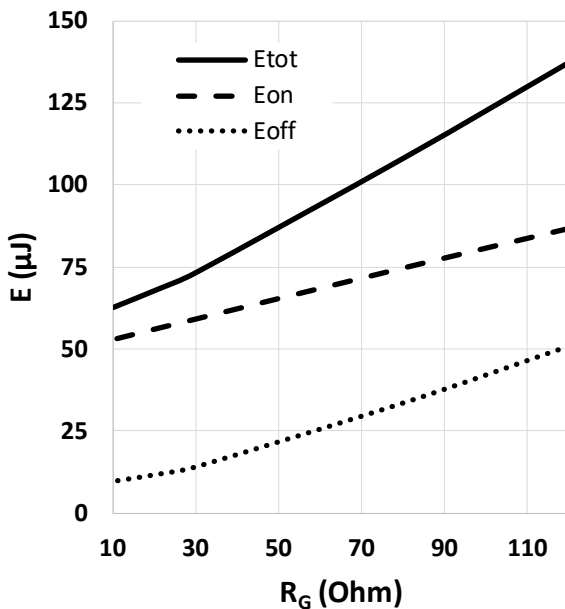
Electrical characteristic diagrams



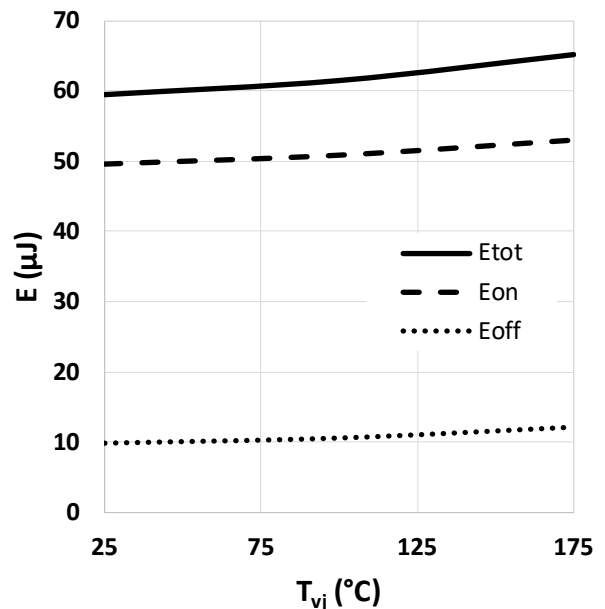
**Figure 9 Typical capacitance as a function of drain-source voltage**  
 ( $C = f(V_{DS}), V_{GS} = 0V, f = 1MHz$ )



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

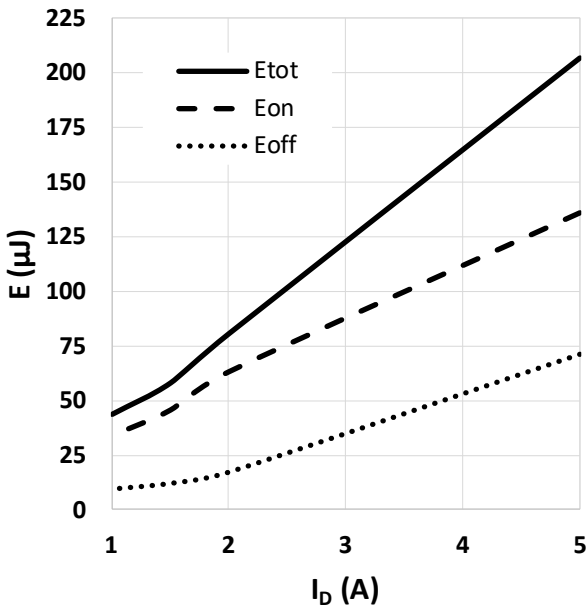


**Figure 11 Typical switching energy losses as a function of gate resistance**  
 ( $E = f(R_{G,ext}), V_{DD} = 1000V, V_{GS} = 0V/12V, I_D = 1.5A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V$ )

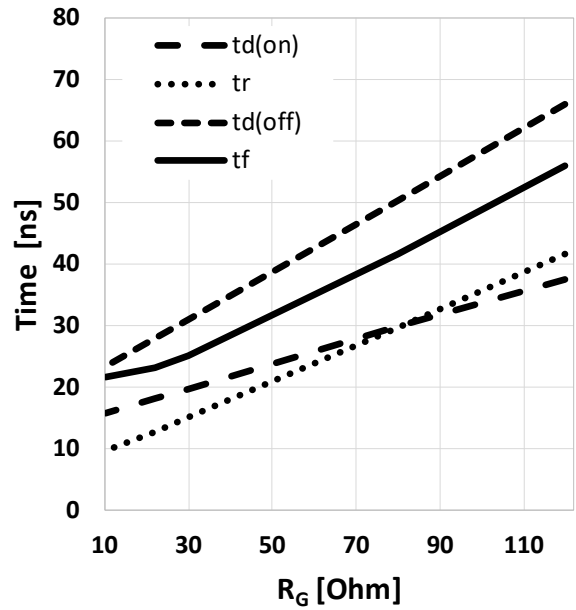


**Figure 12 Typical switching energy losses as a function of junction temperature**  
 ( $E = f(T_{vj}), V_{DD} = 1000V, V_{GS} = 0V/12V, R_{G,ext} = 22\Omega, I_D = 1.5A, \text{ind. load, test circuit in Fig. E, diode: body diode at } V_{GS} = 0V$ )

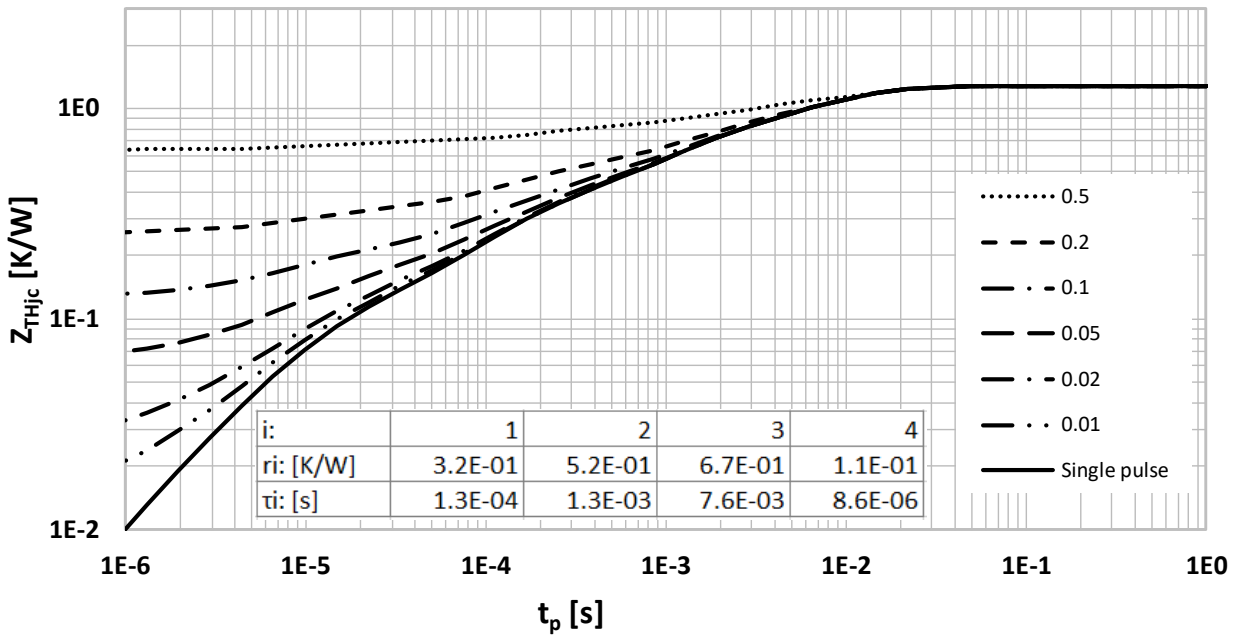
Electrical characteristic diagrams



**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

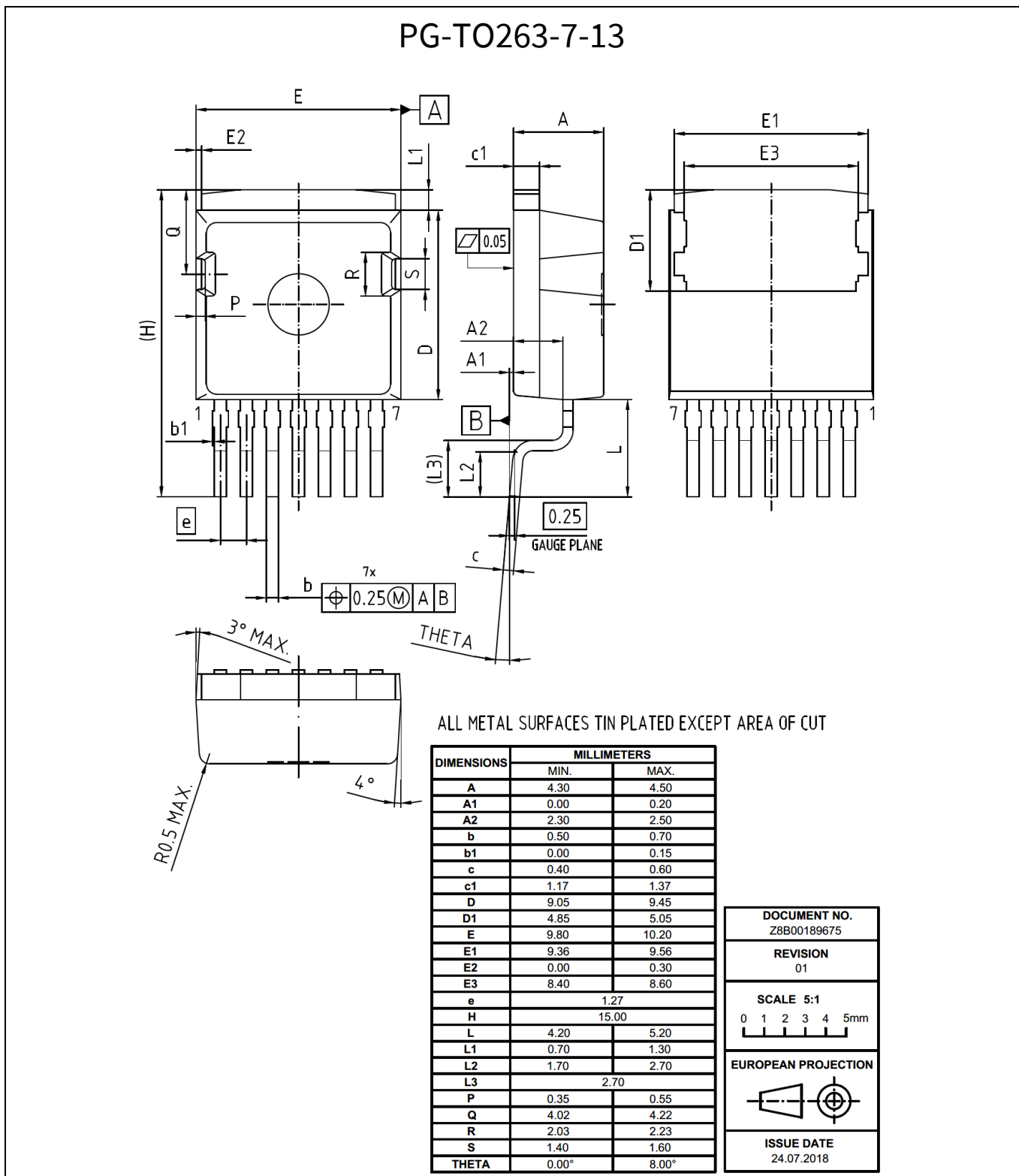


Figure 16 Package drawing

Test conditions

6 Test conditions

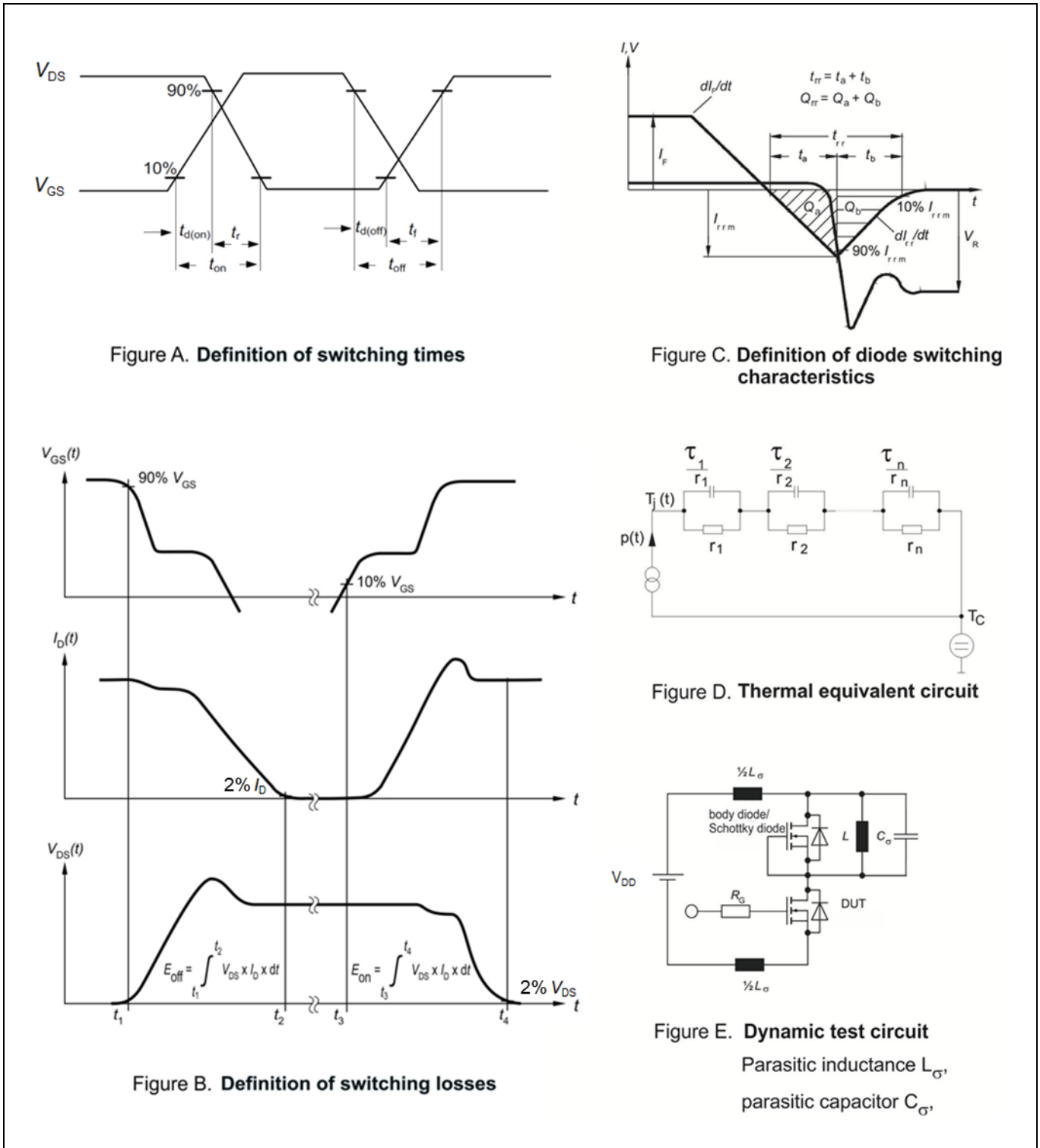


Figure 17 Test conditions

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

<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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