

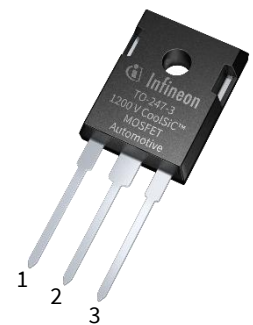
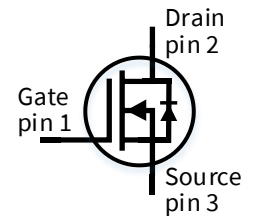
# AIMW120R060M1H

## CoolSiC™ Automotive 1200V SiC Trench MOSFET 1200V G1

### Silicon Carbide MOSFET

#### Features

- Revolutionary semiconductor material - Silicon Carbide
- Very low switching losses
- Threshold-free on state characteristic
- IGBT-compatible driving voltage (18V for turn-on)
- 0V turn-off gate voltage
- Benchmark gate threshold voltage,  $V_{GS(th)}=4.5V$
- Fully controllable dv/dt
- Commutation robust body diode, ready for synchronous rectification
- Temperature independent turn-off switching losses



#### Benefits

- Efficiency improvement
- Enabling higher frequency
- Increased power density
- Cooling effort reduction
- Reduction of system complexity and cost

#### Potential Applications

- On-board Charger/PFC
- Booster/DC-DC Converter



#### Product validation

Qualified for Automotive Applications. Product Validation according to AEC-Q100/101

**Table 1 Key Performance and Package Parameters**

Type	$V_{DS}$	$I_D$ ( $T_C=25^\circ C, R_{th(j-c,max)}$ )	$R_{DS(on),typ}$ ( $T_{vj} = 25^\circ C, I_D = 13A,$ $V_{GS} = 18V$ )	$T_{vjmax}$	Marking	Package
AIMW120R060M1H	1200V	36A	60m $\Omega$	175°C	A120M1060	PG-TO247-3-41

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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<sup>1</sup>

Parameter	Symbol	Value	Unit	
Drain-source voltage, $T_{vj} \geq 25^\circ\text{C}$	$V_{DSS}$	1200	V	
DC drain current for $R_{th(j-c,max)}$ , limited by $T_{vjmax}$ , $V_{GS} = 18\text{V}$ , $T_C = 25^\circ\text{C}$	$I_D$	36	A	
$T_C = 100^\circ\text{C}$		26		
Pulsed drain current, $t_p$ limited by $T_{vjmax}$ , $V_{GS} = 18\text{V}$	$I_{D,pulse}^1$	74	A	
DC body diode forward current for $R_{th(j-c,max)}$ , limited by $T_{vjmax}$ , $V_{GS} = 0\text{V}$	$I_{SD}$	36	A	
$T_C = 100^\circ\text{C}$		22		
Pulsed body diode current, $t_p$ limited by $T_{vjmax}$	$I_{SD,pulse}^1$	74	A	
Gate-source voltage <sup>2</sup>	$V_{GS}$	-7... 23	V	
Max transient voltage, < 1% duty cycle		$V_{GS,on}$		18
Recommended turn-off gate voltage		$V_{GS,off}$		0
Power dissipation, limited by $T_{vjmax}$	$P_{tot}$	150	W	
$T_C = 100^\circ\text{C}$		75		
Virtual junction temperature	$T_{vj}$	-55... 175	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-55... 150	$^\circ\text{C}$	
Soldering temperature, wave soldering only allowed at leads, 1.6mm (0.063 in.) from case for 10 s	$T_{sold}$	260	$^\circ\text{C}$	
Mounting torque, M3 screw Maximum of mounting processes: 3	$M$	0.6	Nm	

<sup>1</sup> v Not subject to production test. Parameter verified by design/characterization.

<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 Thermal resistances<sup>1</sup>**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET/body diode thermal resistance, junction – case	$R_{th(j-c)}$		-	0.8	1	K/W
Thermal resistance, junction – ambient	$R_{th(j-a)}$	leaded	-	-	62	K/W

<sup>1</sup> Not subject to production test. Parameter verified by design/characterization.

**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 <sup>2</sup>	$R_{DS(on)}$	$V_{GS} = 18\text{V}, I_D = 13\text{A},$	-	60	78	mΩ
		$T_{vj} = 25^\circ\text{C}$	-	76	-	
		$T_{vj} = 100^\circ\text{C}$	-	113	-	
		$T_{vj} = 175^\circ\text{C}$	-	-	-	
Body diode forward voltage	$V_{SD}$	$V_{GS} = 0\text{V}, I_{SD} = 13\text{A}$	-	3.8	5.2	V
		$T_{vj} = 25^\circ\text{C}$	-	3.7	-	
		$T_{vj} = 100^\circ\text{C}$	-	3.6	-	
		$T_{vj} = 175^\circ\text{C}$	-	-	-	
Gate-source threshold voltage	$V_{GS(th)}$	(tested after 1 ms pulse at $V_{GS} = 20\text{V}$ )	-	-	-	V
		$I_D = 5,6\text{mA}, V_{DS} = V_{GS}$	3.5	4.5	5.7	
		$T_{vj} = 25^\circ\text{C}$	-	3.6	-	
		$T_{vj} = 175^\circ\text{C}$	-	-	-	
Zero gate voltage drain current	$I_{DSS}$	$V_{GS} = 0\text{V}, V_{DS} = 1200\text{V}$	-	1	180	μA
		$T_{vj} = 25^\circ\text{C}$	-	30	-	
		$T_{vj} = 175^\circ\text{C}$	-	-	-	
Gate-source leakage current	$I_{GSS}$	$V_{GS} = 23\text{V}, V_{DS} = 0\text{V}$	-	-	100	nA
		$V_{GS} = -7\text{V}, V_{DS} = 0\text{V}$	-	-	-100	nA
Transconductance	$g_{fs}$	$V_{DS} = 20\text{V}, I_D = 13\text{A}$	-	7	-	S
Internal gate resistance	$R_{G,int}$	$f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	6	-	Ω

<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.

## 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	$C_{iss}$	$V_{DD} = 800\text{V}, V_{GS} = 0\text{V},$ $f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	1060	-	pF
Output capacitance	$C_{oss}$		-	58	-	
Reverse capacitance	$C_{rss}$		-	6.5	-	
$C_{oss}$ stored energy	$E_{oss}$		-	22	-	$\mu\text{J}$
Total gate charge	$Q_G$	$V_{DD} = 800\text{V}, I_D = 13\text{A},$ $V_{GS} = 0/18\text{V}, \text{turn-on pulse}$	-	31	-	nC
Gate to source charge	$Q_{GS,pl}$		-	9	-	
Gate to drain charge	$Q_{GD}$		-	7	-	

**Electrical Characteristics**

**3.3 Switching characteristics**

**Table 6 Switching characteristics, Inductive load <sup>4</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	$t_{d(on)}$	$V_{DD} = 800\text{V}, I_D = 13\text{A},$ $V_{GS} = 0/18\text{V}, R_{G,ext} = 2\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	8	-	ns
Rise time	$t_r$		-	16	-	
Turn-off delay time	$t_{d(off)}$		-	16	-	
Fall time	$t_f$		-	13	-	
Turn-on energy	$E_{on}$		-	167	-	$\mu\text{J}$
Turn-off energy	$E_{off}$		-	79	-	
Total switching energy	$E_{tot}$	-	246	-		
<b>Body Diode Characteristics, <math>T_{vj} = 25^{\circ}\text{C}</math></b>						
Diode reverse recovery charge	$Q_{rr}$	$V_{DD} = 800\text{V}, I_{SD} = 13\text{A},$ $V_{GS}$ at diode = $0\text{V},$ $di_f/dt = 1000\text{A}/\mu\text{s},$ $Q_{rr}$ includes also $Q_C,$ see Fig. C	-	116	-	nC
Diode peak reverse recovery current	$I_{rrm}$		-	5	-	A

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

Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{V}, I_D = 13\text{A},$ $V_{GS} = 0/18\text{V}, R_{G,ext} = 2\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	8	-	ns
Rise time	$t_r$		-	19	-	
Turn-off delay time	$t_{d(off)}$		-	17	-	
Fall time	$t_f$		-	13	-	
Turn-on energy	$E_{on}$		-	241	-	$\mu\text{J}$
Turn-off energy	$E_{off}$		-	103	-	
Total switching energy	$E_{tot}$	-	344	-		
<b>Body Diode Characteristics, <math>T_{vj} = 175^{\circ}\text{C}</math></b>						
Diode reverse recovery charge	$Q_{rr}$	$V_{DD} = 800\text{V}, I_{SD} = 13\text{A},$ $V_{GS}$ at diode = $0\text{V},$ $di_f/dt = 1000\text{A}/\mu\text{s},$ $Q_{rr}$ includes also $Q_C,$ see Fig. C	-	244	-	nC
Diode peak reverse recovery current	$I_{rrm}$		-	7	-	A

<sup>4</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.

Electrical characteristic diagrams

4 Electrical characteristic diagrams

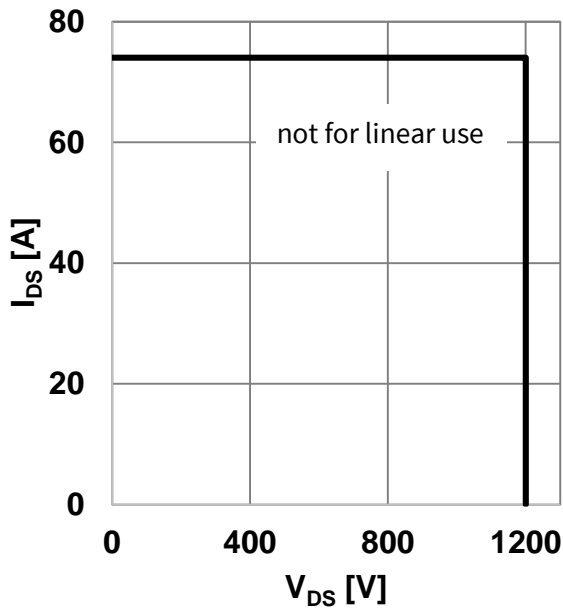


Figure 1 Safe operating area (SOA)  
( $V_{GS} = 0/18V$ ,  $T_c = 25^\circ C$ ,  $T_j \leq 175^\circ C$ )

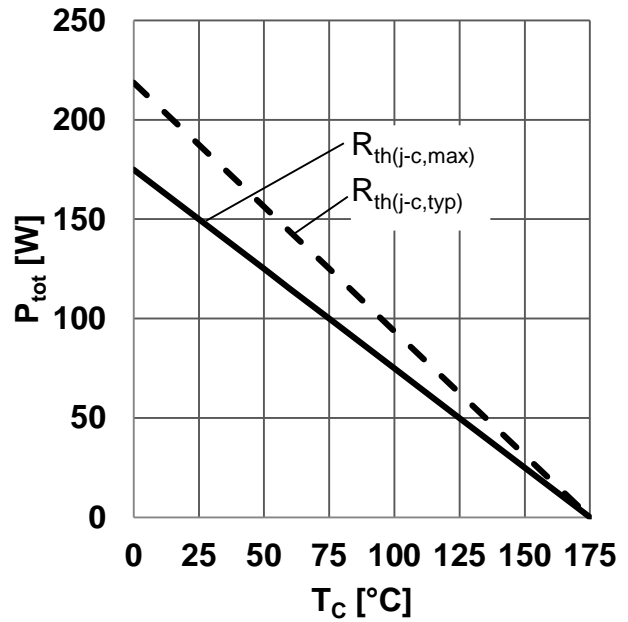


Figure 2 Power dissipation as a function of case temperature limited by bond wire  
( $P_{tot} = f(T_c)$ )

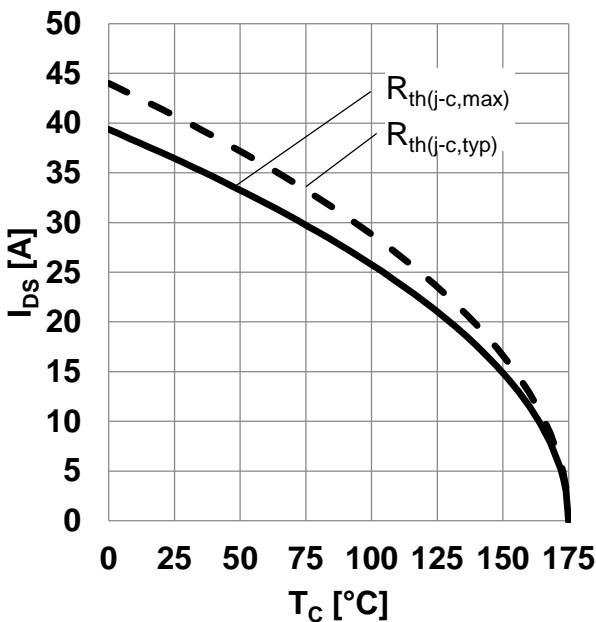


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire ( $I_{DS} = f(T_c)$ )

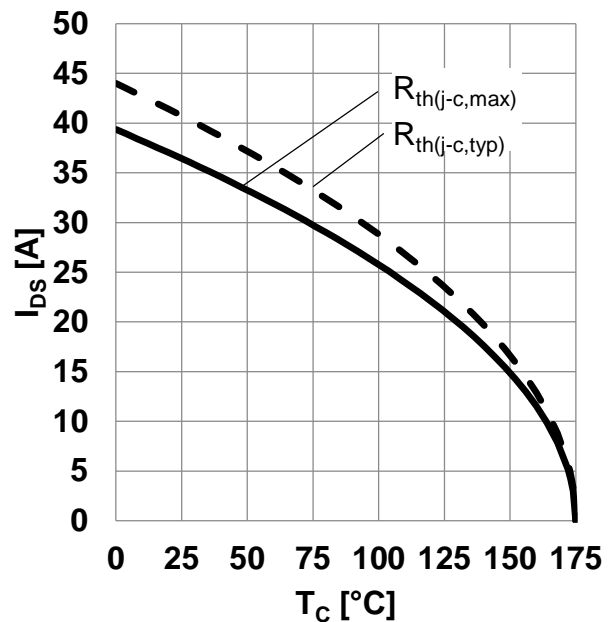
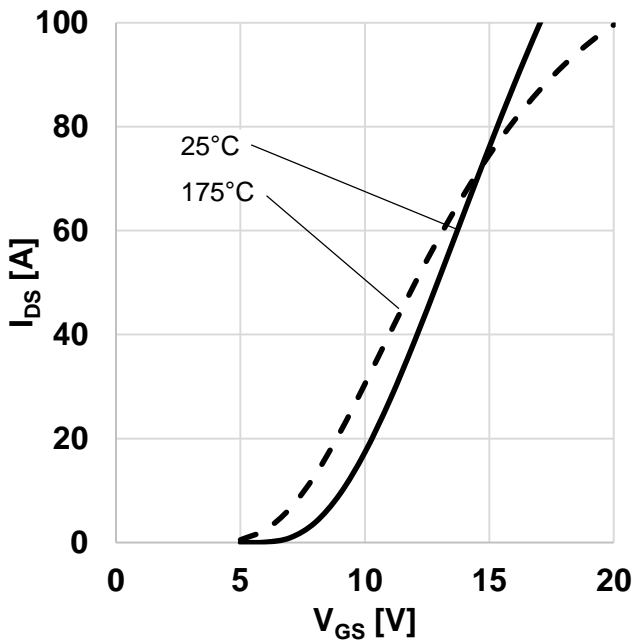


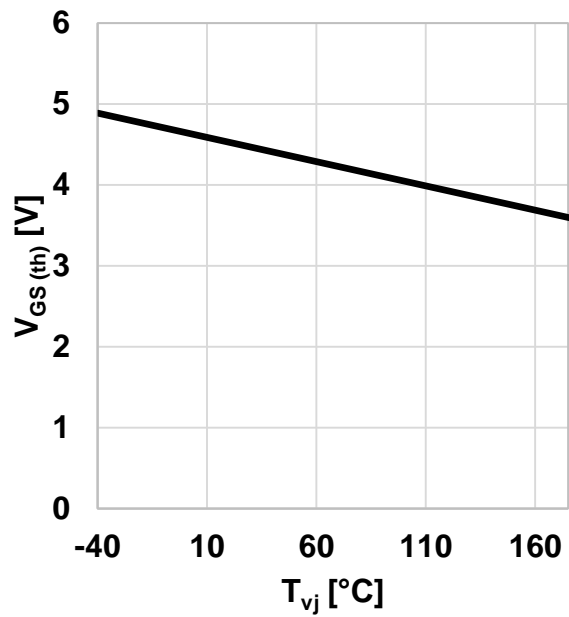
Figure 4 Maximum source to drain current as a function of case temperature limited by bond wire ( $I_{SD} = f(T_c)$ ,  $V_{GS} = 0V$ )



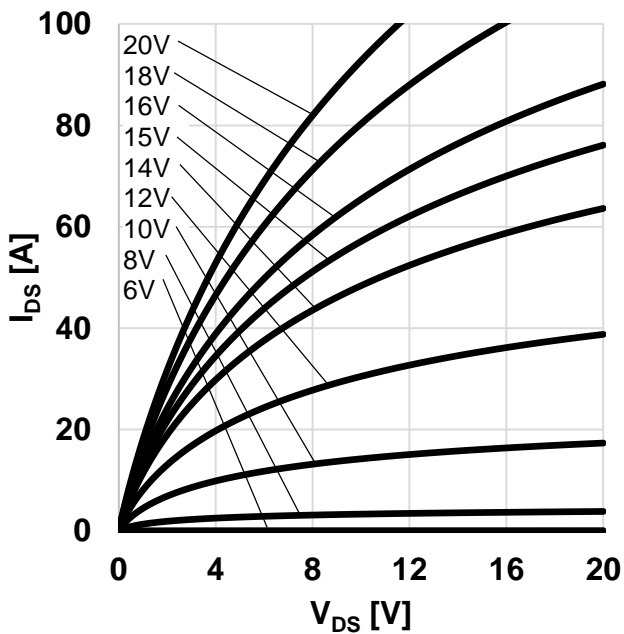
Electrical characteristic diagrams



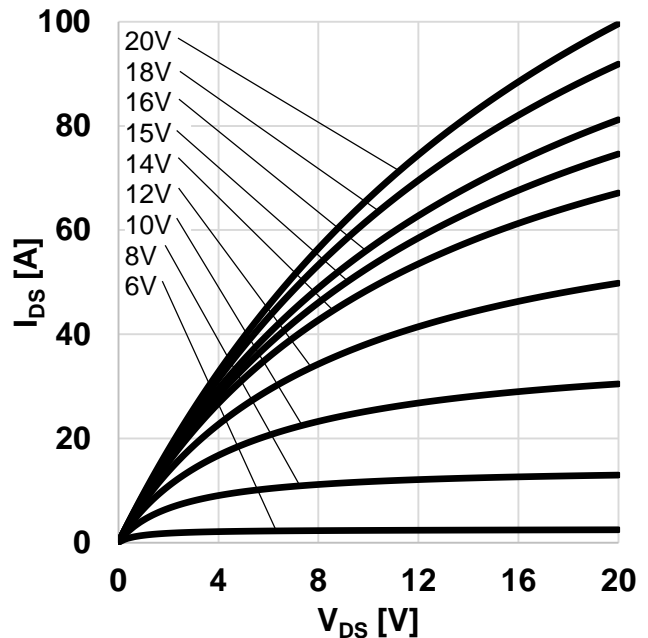
**Figure 5** Typical transfer characteristic  
( $I_{DS} = f(V_{GS})$ ,  $V_{DS} = 20V$ ,  $t_P = 20\mu s$ )



**Figure 6** Typical gate-source threshold voltage as a function of junction temperature  
( $V_{GS(th)} = f(T_{vj})$ ,  $I_{DS} = 5,6mA$ ,  $V_{GS} = V_{DS}$ )



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



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

Electrical characteristic diagrams

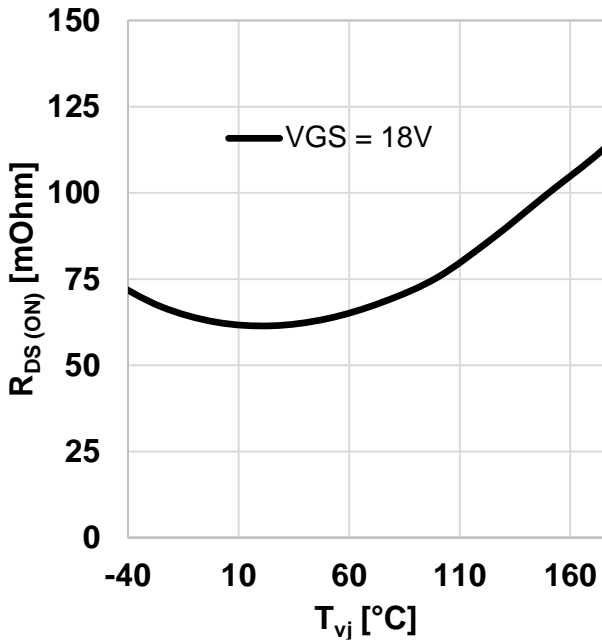


Figure 9 Typical on-resistance as a function of junction temperature  
( $R_{DS(on)} = f(T_{vj}), I_{DS} = 13A$ )

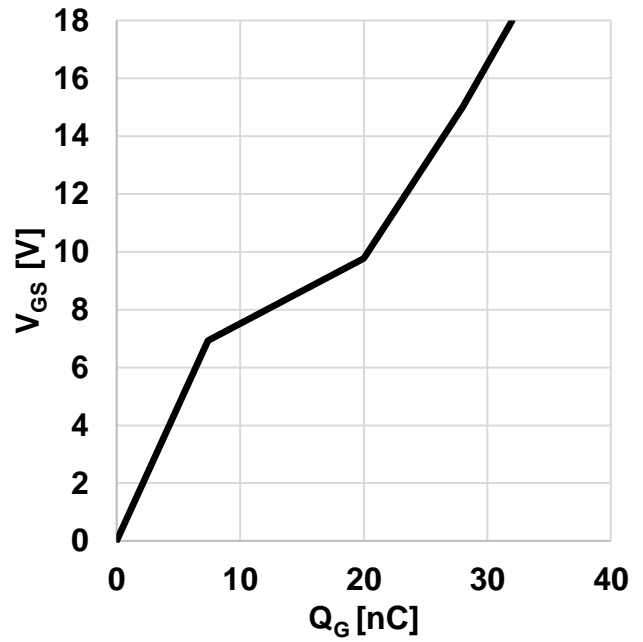


Figure 10 Typical gate charge  
( $V_{GS} = f(Q_G), I_{DS} = 13A, V_{DS} = 800V, \text{turn-on pulse}$ )

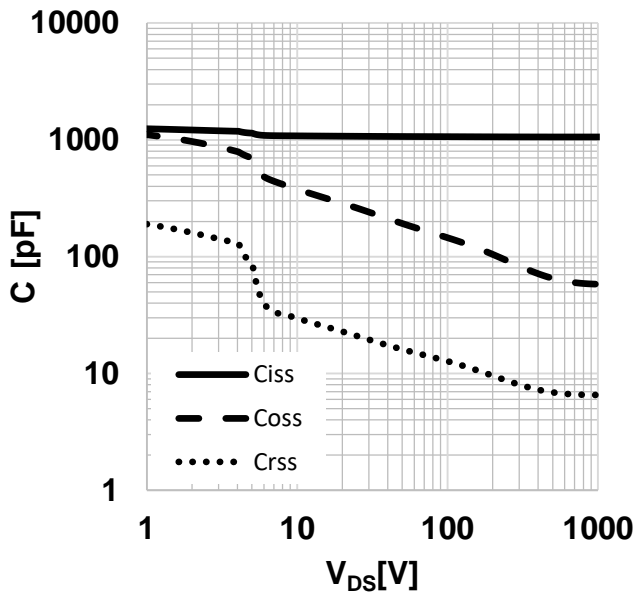


Figure 11 Typical capacitance as a function of drain-source voltage  
( $C = f(V_{DS}), V_{GS} = 0V, f = 1MHz$ )

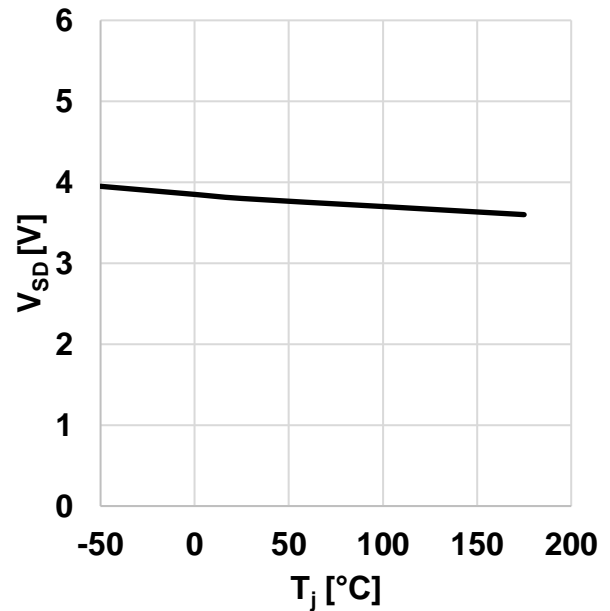
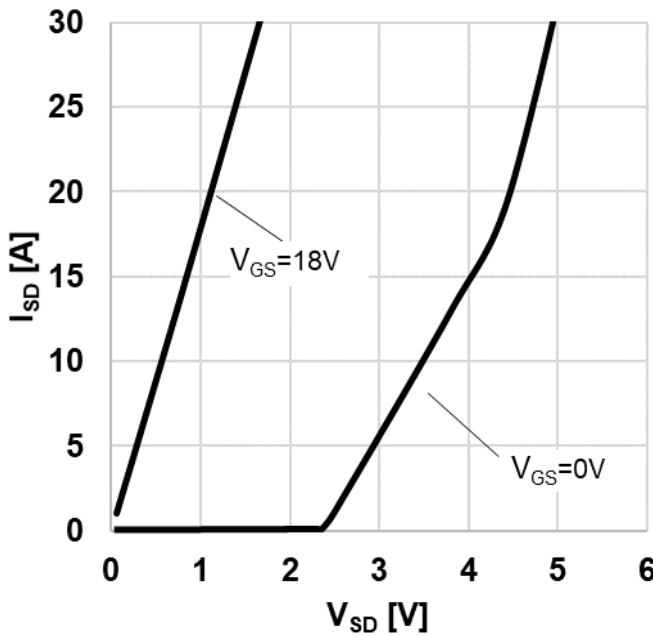
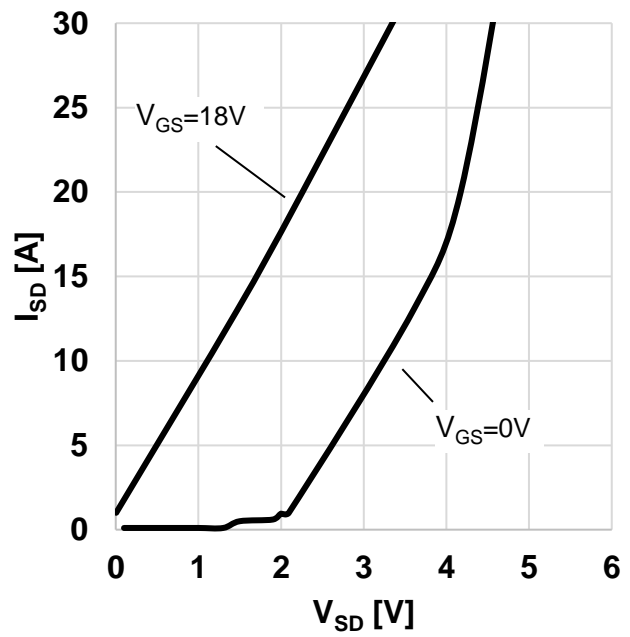


Figure 12 Typical body diode forward voltage as function of junction temperature  
( $V_{SD} = f(T_{vj}), V_{GS} = 0V, I_{SD} = 13A$ )

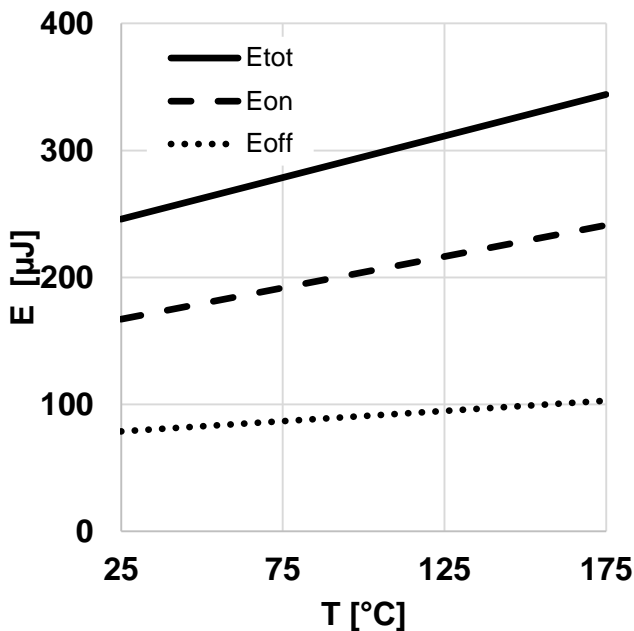
Electrical characteristic diagrams



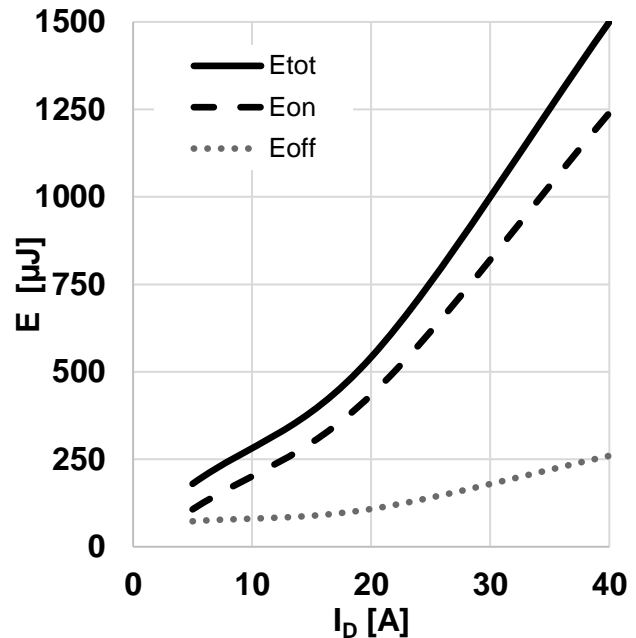
**Figure 13** Typical body diode forward current as function of forward voltage,  $V_{GS}$  as parameter  
( $I_{SD} = f(V_{SD})$ ,  $T_{vj} = 25^{\circ}C$ ,  $t_P = 20\mu s$ )



**Figure 14** Typical body diode forward current as function of forward voltage,  $V_{GS}$  as parameter  
( $I_{SD} = f(V_{SD})$ ,  $T_{vj} = 175^{\circ}C$ ,  $t_P = 20\mu s$ )

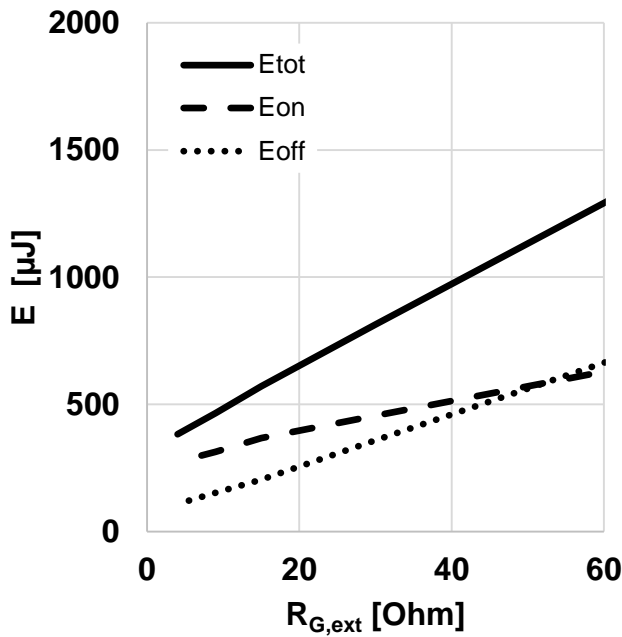


**Figure 15** Typical switching energy losses as a function of junction temperature  
( $E = f(T_{vj})$ ,  $V_{DD} = 800V$ ,  $V_{GS} = 0V/18V$ ,  $R_{G,ext} = 2\Omega$ ,  $I_D = 13A$ , ind. load, test circuit in Fig. E, diode: body diode at  $V_{GS} = 0V$ )

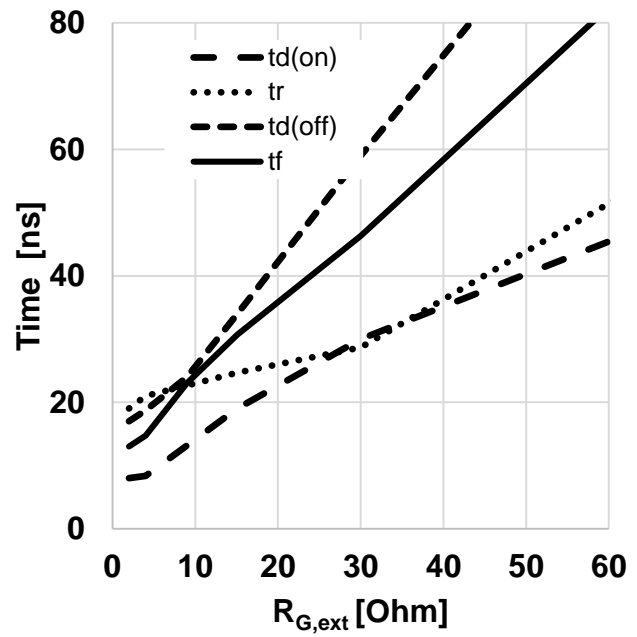


**Figure 16** Typical switching energy losses as a function of drain-source current  
( $E = f(I_{DS})$ ,  $V_{DD} = 800V$ ,  $V_{GS} = 0V/18V$ ,  $R_{G,ext} = 2\Omega$ ,  $T_{vj} = 175^{\circ}C$ , ind. load, test circuit in Fig. E, diode: body diode at  $V_{GS} = 0V$ )

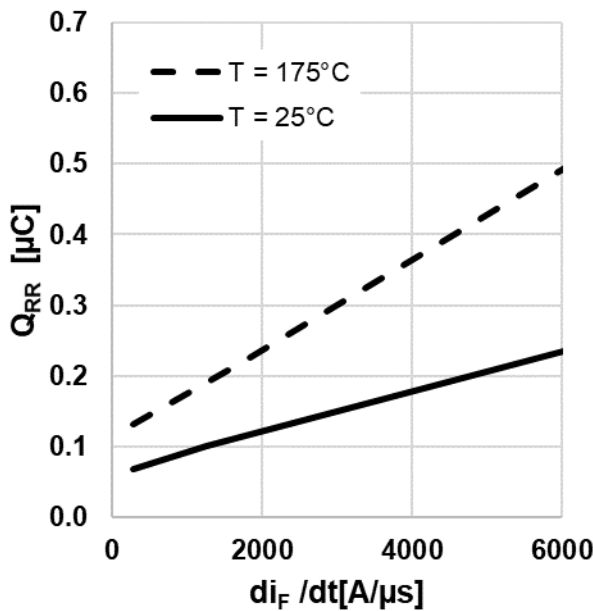
Electrical characteristic diagrams



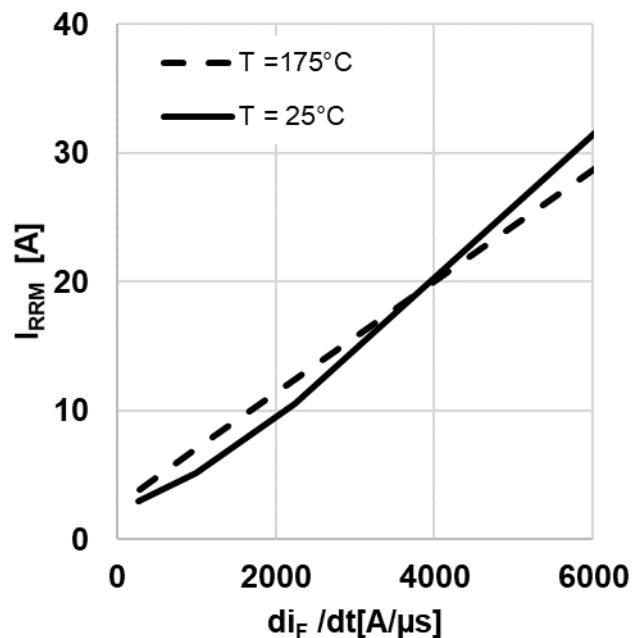
**Figure 17** Typical switching energy losses as a function of gate resistance  
 $(E = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/18V,$   
 $I_D = 13A, T_{vj} = 175^\circ C, \text{ind. load, test circuit}$   
 in Fig. E, diode: body diode at  $V_{GS} = 0V$ )



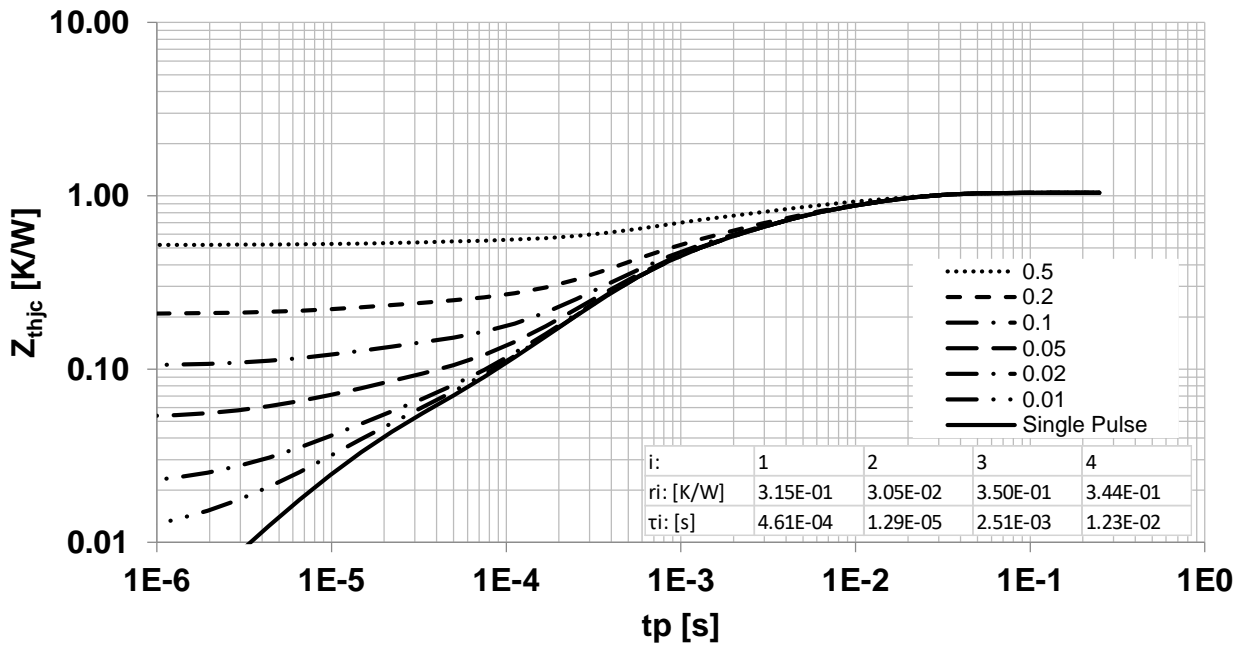
**Figure 18** Typical switching times as a function of gate resistor  
 $(t = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/18V,$   
 $I_D = 13A, T_{vj} = 175^\circ C, \text{ind. load, test circuit}$   
 in Fig. E, diode: body diode at  $V_{GS} = 0V$ )



**Figure 19** Typical reverse recovery charge as a function of diode current slope  
 $(Q_{rr} = f(di_i/dt), V_{DD} = 800V, V_{GS} = 0V/18V,$   
 $I_D = 13A, \text{ind. load, test circuit in Fig.E,}$   
 body diode at  $V_{GS} = 0V$ )



**Figure 20** Typical reverse recovery current as a function of diode current slope  
 $(I_{rrm} = f(di_i/dt), V_{DD} = 800V, V_{GS} = 0V/18V,$   
 $I_D = 13A, \text{ind. load, test circuit in Fig.E,}$   
 body diode at  $V_{GS} = 0V$ )



**Figure 21 Max. transient thermal resistance (MOSFET/diode)**  
 ( $Z_{th(j-c,max)} = f(t_p)$ , parameter  $D = t_p/T$ , thermal equivalent circuit in Fig. D)

### 5 Package drawing

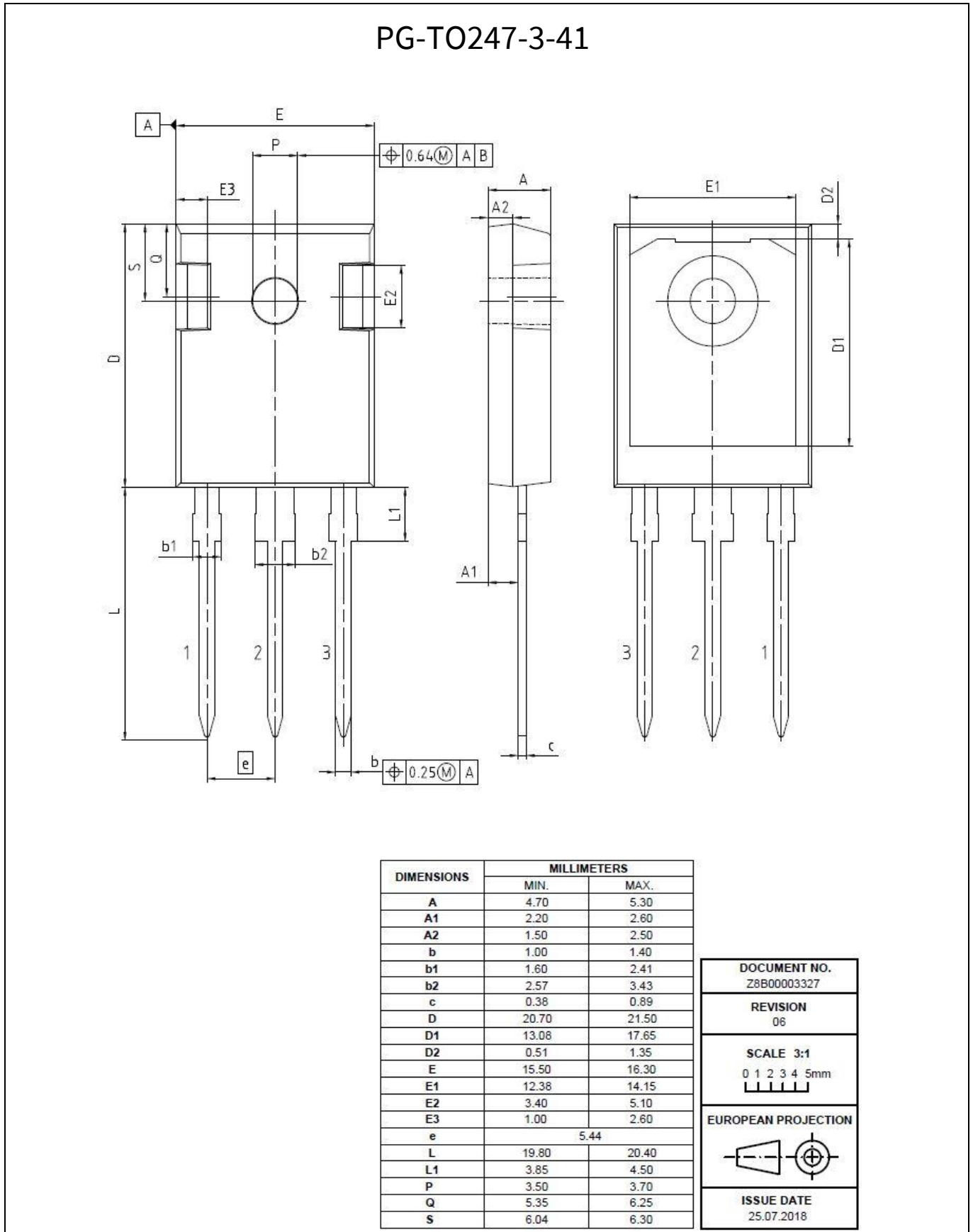
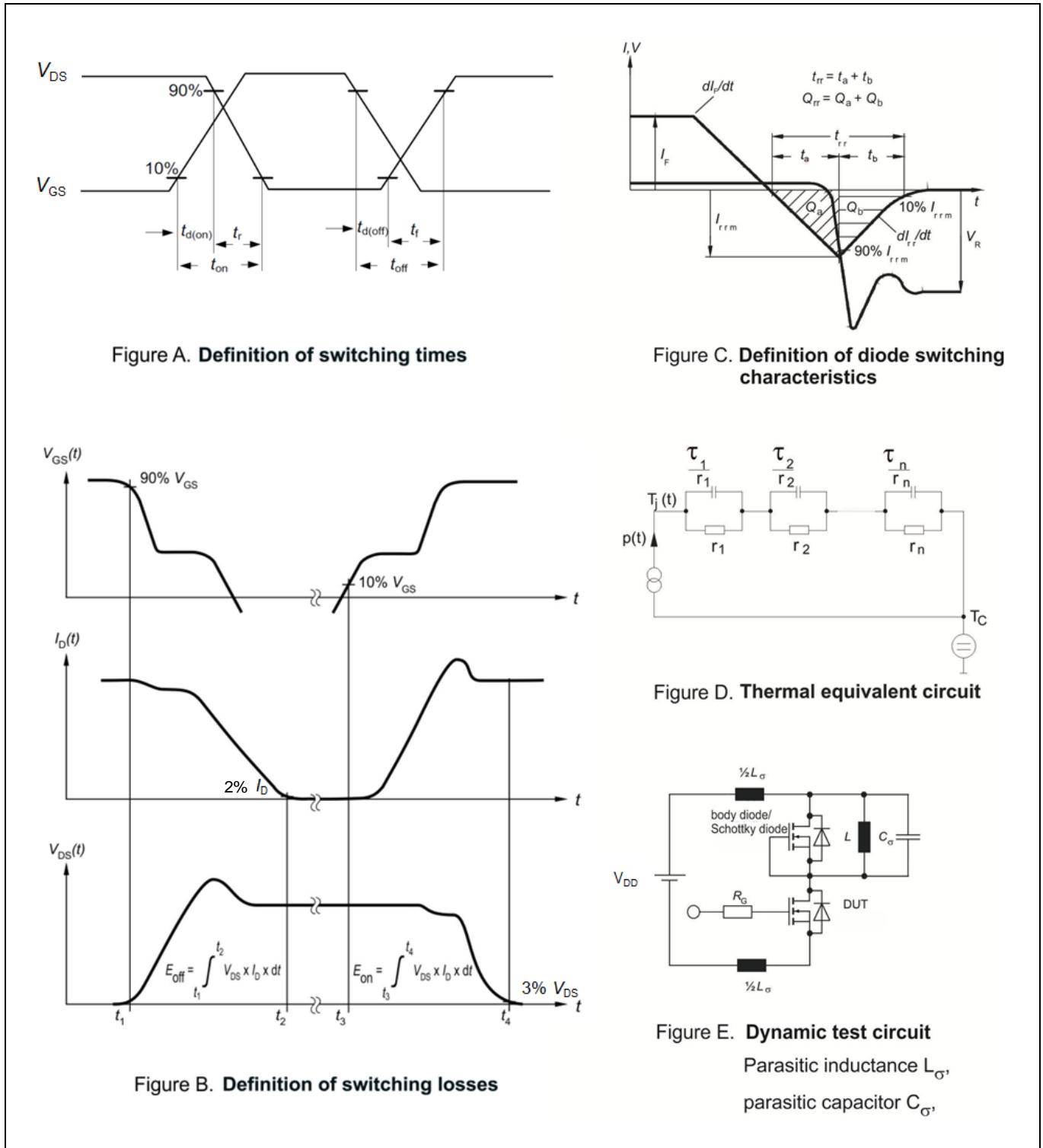


Figure 22 Package drawing

Test conditions

## 6 Test conditions



**Figure 23 Test conditions**

**Revision history**

**Revision history**

<b>Document version</b>	<b>Date of release</b>	<b>Description of changes</b>
V01_00	2021-03-09	-



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**Infineon Technologies AG**

**81726 München, Germany**

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