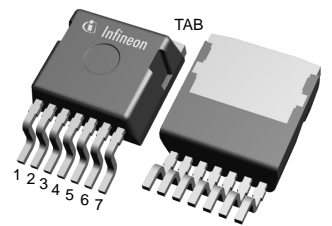


## Final datasheet

### CoolSiC™ 1200 V SiC Trench MOSFET : Silicon Carbide MOSFET

#### Features

- $V_{DS} = 1200\text{ V}$  at  $T_{vj} = -55...175^\circ\text{C}$
- $I_{DC} = 38\text{ A}$  at  $T_C = 25^\circ\text{C}$
- $R_{DS(on)} = 60\text{ m}\Omega$  at  $V_{GS} = 20\text{ V}$ ,  $T_{vj} = 25^\circ\text{C}$
- New performance-optimized chip technology (Gen1p) with improved  $R_{DS(on)}^* \text{ A}$
- Best in class switching energy for lower switching losses and reduced cooling efforts
- Lowest device capacitances for higher switching speeds and higher power density
- A combination of low  $C_{rss}/C_{iss}$  ratio and high  $V_{GS(th)}$  to avoid parasitic turn-on and enable unipolar gate driving
- Reduced total gate charge  $Q_G$  for lower driving power and losses
- Increased recommended turn-on voltage ( $V_{GS(on)} = 20\text{ V}$ ) for lower  $R_{DS(on)}$
- .XT die attach technology for best in class thermal performance
- Low package stray inductance for faster and cleaner switching
- Sense (Kelvin) source pin for better gate control and reduced switching losses
- Minimal creepage distance 5.85 mm (material group II) to fit 800 V applications without coating
- SMT package for automated assembly and reduced system costs



#### Potential applications

- On-board charger
- DC/DC converter
- Auxiliary drives

#### Product validation

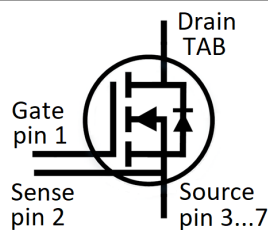
- Qualified for Automotive Applications. Product Validation according to AEC-Q100/101

#### Description

Pin definition:

- Pin 1 - Gate
- Pin 2 - Kelvin sense contact
- Pin 3...7 - Source
- Tab - Drain

Note: The source and sense pins are not exchangeable, their exchange might lead to malfunction



Type	Package	Marking
AIMBG120R060M1	PG-TO263-7-HV-ND5.8	AS60MM1

## Table of contents

	<b>Description</b> .....	1
	<b>Features</b> .....	1
	<b>Potential applications</b> .....	1
	<b>Product validation</b> .....	1
	<b>Table of contents</b> .....	2
<b>1</b>	<b>Package</b> .....	3
<b>2</b>	<b>MOSFET</b> .....	3
<b>3</b>	<b>Body diode (MOSFET)</b> .....	5
<b>4</b>	<b>Characteristics diagrams</b> .....	7
<b>5</b>	<b>Package outlines</b> .....	13
<b>6</b>	<b>Testing conditions</b> .....	14
	<b>Revision history</b> .....	15
	<b>Disclaimer</b> .....	16

1 Package

## 1 Package

**Table 1** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Storage temperature	$T_{stg}$		-55		150	°C
Soldering temperature	$T_{sold}$				260	°C
MOSFET/body diode thermal resistance, junction-case <sup>1)</sup>	$R_{th(j-c)}$			0.57	0.74	K/W

1) not subject to production test - verified by design/characterization

## 2 MOSFET

**Table 2** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Drain-source voltage <sup>1)</sup>	$V_{DSS}$	$T_{vj} = -55...175\text{ °C}$	1200	V	
Continuous DC drain current for $R_{th(j-c,max)}$ , limited by $T_{vj(max)}$ <sup>2)</sup>	$I_{DDC}$	$V_{GS} = 20\text{ V}$	$T_c = 25\text{ °C}$	38	A
			$T_c = 100\text{ °C}$	27	
Peak drain current, $t_p$ limited by $T_{vj(max)}$ <sup>2)</sup>	$I_{DM}$	$V_{GS} = 20\text{ V}$	97	A	
Gate-source voltage, max. transient voltage <sup>3)</sup>	$V_{GS}$	$t_p \leq 0.5\text{ }\mu\text{s}, D < 0.01$	-10...25	V	
Gate-source voltage, max. static voltage <sup>3)</sup>	$V_{GS}$		-5...23	V	
Avalanche energy, single pulse	$E_{AS}$	$I_D = 10\text{ A}, V_{DD} = 50\text{ V}, L = 3.6\text{ mH}$	180	mJ	
Power dissipation, limited by $T_{vj(max)}$ <sup>2)</sup>	$P_{tot}$		$T_c = 25\text{ °C}$	202	W
			$T_c = 100\text{ °C}$	101	

1) Tested at  $T_{vj}=25\text{ °C}$ , verified by design/characterization over full temperature range

2) not subject to production test - verified by design/characterization

3) **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.

**Table 3** Recommended values

Parameter	Symbol	Note or test condition	Values	Unit
Recommended turn-on gate voltage	$V_{GS(on)}$		20	V
Recommended turn-off gate voltage	$V_{GS(off)}$		0	V

**Table 4** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Drain-source on-state resistance	$R_{DS(on)}$	$I_D = 13\text{ A}$	$T_{vj} = 25\text{ °C}$ , $V_{GS(on)} = 20\text{ V}$		60	75	mΩ
			$T_{vj} = 100\text{ °C}$ , $V_{GS(on)} = 20\text{ V}$		84		
			$T_{vj} = 175\text{ °C}$ , $V_{GS(on)} = 20\text{ V}$		120		
			$T_{vj} = 25\text{ °C}$ , $V_{GS(on)} = 18\text{ V}$		65		
Gate-source threshold voltage	$V_{GS(th)}$	$I_D = 4.3\text{ mA}$ , $V_{DS} = V_{GS}$ (tested after 1 ms pulse at $V_{GS} = 20\text{ V}$ )	$T_{vj} = 25\text{ °C}$	3.7	4.4	5.1	V
			$T_{vj} = 175\text{ °C}$		3.6		
Zero gate-voltage drain current	$I_{DSS}$	$V_{DS} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		0.3	13	μA
			$T_{vj} = 175\text{ °C}$		10		
Gate leakage current	$I_{GSS}$	$V_{DS} = 0\text{ V}$	$V_{GS} = 25\text{ V}$			100	nA
			$V_{GS} = -10\text{ V}$			-100	
Forward transconductance	$g_{fs}$	$I_D = 13\text{ A}$ , $V_{DS} = 20\text{ V}$		8.1		S	
Short-circuit withstand time <sup>1)</sup>	$t_{SC}$	$V_{DD} \leq 800\text{ V}$ , $V_{DS,peak} < 1200\text{ V}$ , $T_{vj(start)} = 25\text{ °C}$ , $R_{G,ext} = 2\text{ }\Omega$	$V_{GS(on)} = 20\text{ V}$		1.5		μs
			$V_{GS(on)} = 18\text{ V}$		2		
			$V_{GS(on)} = 15\text{ V}$		2.5		
Internal gate resistance	$R_{G,int}$	$f = 1\text{ MHz}$ , $V_{AC} = 25\text{ mV}$		4		Ω	
Input capacitance	$C_{iss}$	$V_{DD} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		880		pF	
Output capacitance	$C_{oss}$	$V_{DD} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		43		pF	
Reverse transfer capacitance	$C_{rss}$	$V_{DD} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		2		pF	
$C_{oss}$ stored energy	$E_{oss}$	$V_{DD} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		18		μJ	
Total gate charge	$Q_G$	$V_{DD} = 800\text{ V}$ , $I_D = 13\text{ A}$ , $V_{GS} = 0/20\text{ V}$ , turn-on pulse		32		nC	
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800\text{ V}$ , $I_D = 13\text{ A}$ , $V_{GS} = 0/20\text{ V}$ , turn-on pulse		8		nC	
Gate-to-drain charge	$Q_{GD}$	$V_{DD} = 800\text{ V}$ , $I_D = 13\text{ A}$ , $V_{GS} = 0/20\text{ V}$ , turn-on pulse		5		nC	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{ V}$ , $I_D = 13\text{ A}$ , $V_{GS} = 0/20\text{ V}$ , $R_{G,ext} = 2\text{ }\Omega$ , $L_\sigma = 20\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		6.2		ns
			$T_{vj} = 175\text{ °C}$		6.2		

(table continues...)

**Table 4** (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time	$t_r$	$V_{DD} = 800 \text{ V}, I_D = 13 \text{ A}, V_{GS} = 0/20 \text{ V}, R_{G,ext} = 2 \Omega, L_\sigma = 20 \text{ nH},$ diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	5.4		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	6.4		
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800 \text{ V}, I_D = 13 \text{ A}, V_{GS} = 0/20 \text{ V}, R_{G,ext} = 2 \Omega, L_\sigma = 20 \text{ nH},$ diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	13		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	13.9		
Fall time	$t_f$	$V_{DD} = 800 \text{ V}, I_D = 13 \text{ A}, V_{GS} = 0/20 \text{ V}, R_{G,ext} = 2 \Omega, L_\sigma = 20 \text{ nH},$ diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	8		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	8.5		
Turn-on energy	$E_{on}$	$V_{DD} = 800 \text{ V}, I_D = 13 \text{ A}, V_{GS} = 0/20 \text{ V}, R_{G,ext} = 2 \Omega, L_\sigma = 20 \text{ nH},$ diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	79.3		$\mu\text{J}$
			$T_{vj} = 175 \text{ }^\circ\text{C}$	113.3		
Turn-off energy	$E_{off}$	$V_{DD} = 800 \text{ V}, I_D = 13 \text{ A}, V_{GS} = 0/20 \text{ V}, R_{G,ext} = 2 \Omega, L_\sigma = 20 \text{ nH},$ diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	31.5		$\mu\text{J}$
			$T_{vj} = 175 \text{ }^\circ\text{C}$	30.7		
Total switching energy	$E_{tot}$	$V_{DD} = 800 \text{ V}, I_D = 13 \text{ A}, V_{GS} = 0/20 \text{ V}, R_{G,ext} = 2 \Omega, L_\sigma = 20 \text{ nH},$ diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	110.8		$\mu\text{J}$
			$T_{vj} = 175 \text{ }^\circ\text{C}$	144		
Virtual junction temperature	$T_{vj}$		-55		175	$^\circ\text{C}$

1) not subject to production test - verified by design/characterization

**Note:** Characteristics at  $T_{vj} = 25^\circ\text{C}$ , unless otherwise specified.

### 3 Body diode (MOSFET)

**Table 5** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Drain-source voltage <sup>1)</sup>	$V_{DSS}$	$T_{vj} = -55\dots175 \text{ }^\circ\text{C}$	1200	V	
Continuous reverse drain current for $R_{th(j-c,max)}$ , limited by $T_{vj(max)}$ <sup>2)</sup>	$I_{SDC}$	$V_{GS} = 0 \text{ V}$	$T_c = 25 \text{ }^\circ\text{C}$	30	A
			$T_c = 100 \text{ }^\circ\text{C}$	21	
Peak reverse drain current, $t_p$ limited by $T_{vj(max)}$ <sup>2)</sup>	$I_{SM}$	$V_{GS} = 0 \text{ V}$	30	A	

1) Tested at  $T_{vj}=25^\circ\text{C}$ , verified by design/characterization over full temperature range

**3 Body diode (MOSFET)**

2) not subject to production test - verified by design/characterization

**Table 6 Characteristic values**

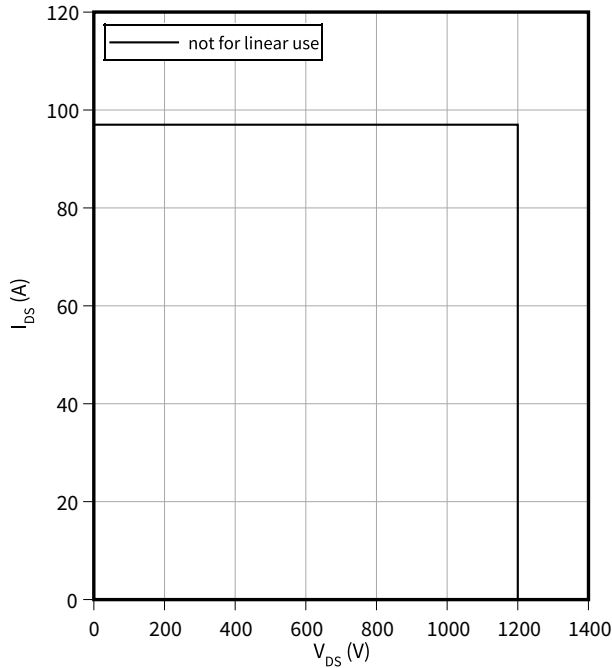
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Drain-source reverse voltage	$V_{SD}$	$I_{SD} = 13 \text{ A}, V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	3.9	5	V
			$T_{vj} = 100 \text{ °C}$	3.8		
			$T_{vj} = 175 \text{ °C}$	3.7		
MOSFET forward recovery charge	$Q_{fr}$	$V_{DD} = 800 \text{ V},$ $I_{SD} = 13 \text{ A}, V_{GS} = 0 \text{ V},$ $-di_{SD}/dt = 2000 \text{ A}/\mu\text{s}, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25 \text{ °C}$	106		nC
			$T_{vj} = 175 \text{ °C}$	207		
MOSFET peak forward recovery current	$I_{frm}$	$V_{DD} = 800 \text{ V},$ $I_{SD} = 13 \text{ A}, V_{GS} = 0 \text{ V},$ $-di_{SD}/dt = 2000 \text{ A}/\mu\text{s}, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25 \text{ °C}$	7.8		A
			$T_{vj} = 175 \text{ °C}$	10.1		
Virtual junction temperature	$T_{vj}$		-55		175	°C

## 4 Characteristics diagrams

### Reverse bias safe operating area (RBSOA)

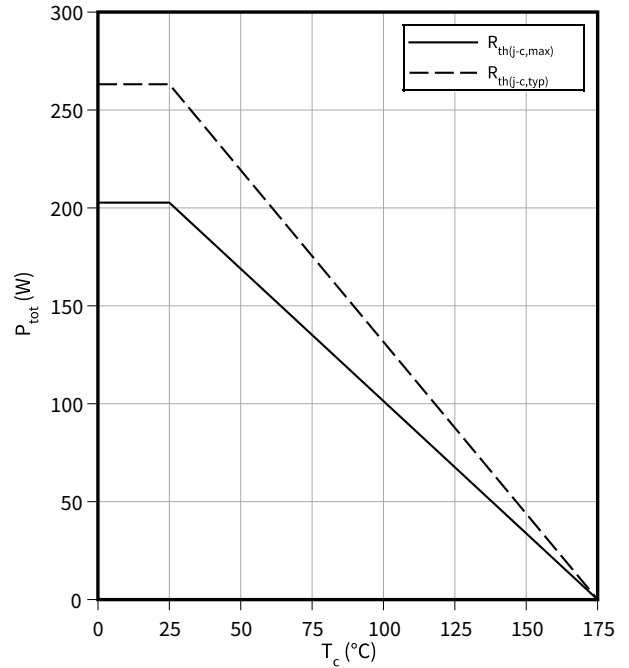
$$I_{DS} = f(V_{DS})$$

$$T_{vj} \leq 175\text{ °C}, V_{GS} = 0/20\text{ V}, T_c = 25\text{ °C}$$



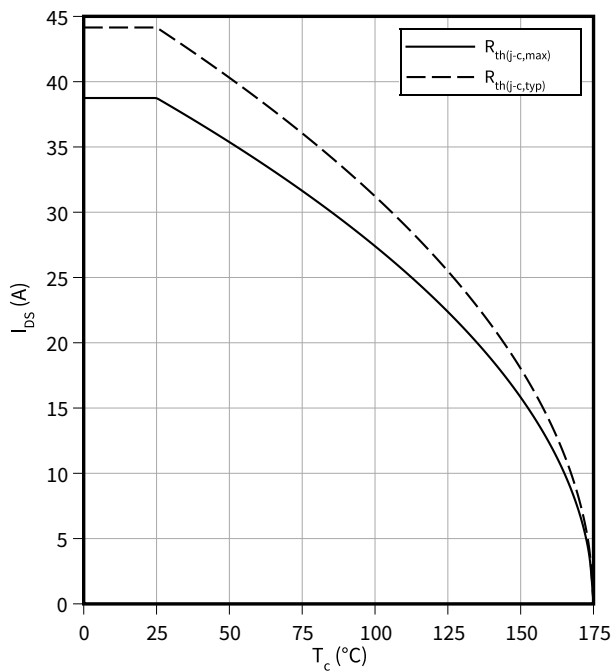
### Power dissipation as a function of case temperature

$$P_{tot} = f(T_c)$$



### Maximum DC drain to source current as a function of case temperature

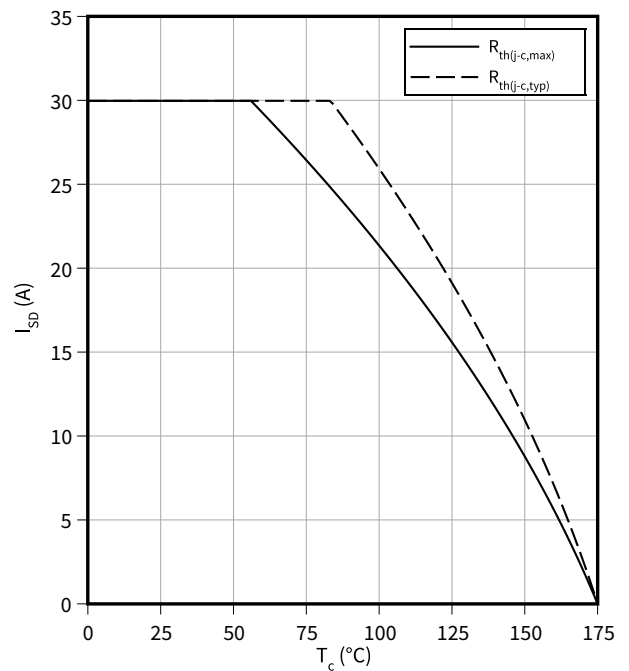
$$I_{DS} = f(T_c)$$



### Maximum source to drain current as a function of case temperature

$$I_{SD} = f(T_c)$$

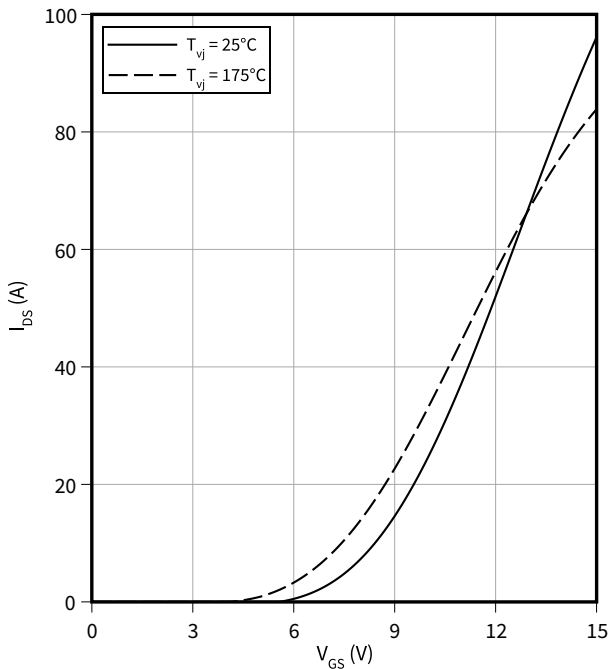
$$V_{GS} = 0\text{ V}$$



4 Characteristics diagrams

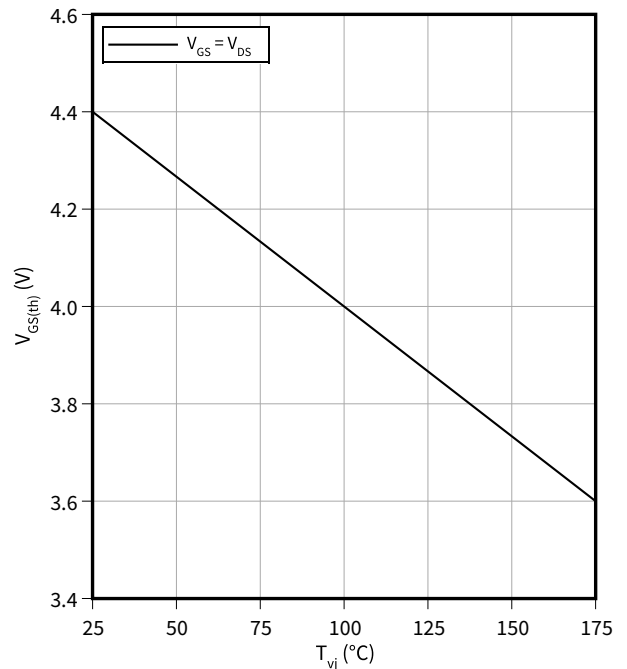
**Typical transfer characteristic**

$I_{DS} = f(V_{GS})$   
 $V_{DS} = 20 \text{ V}$ ,  $t_p = 20 \mu\text{s}$



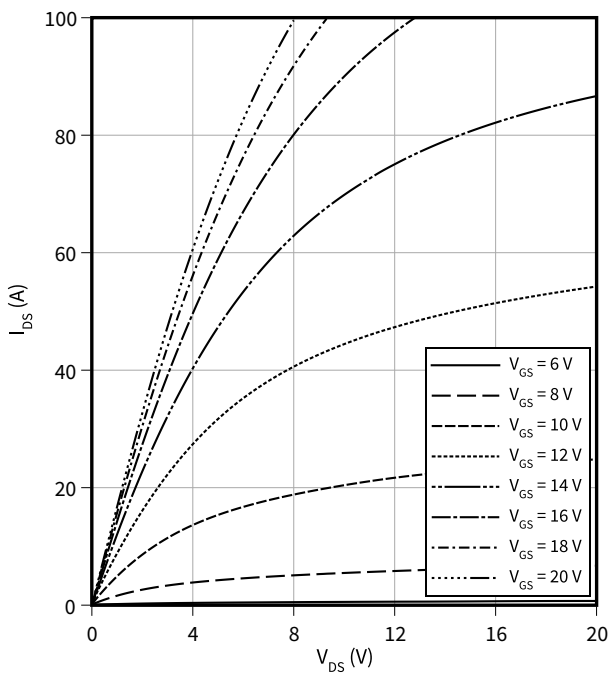
**Typical gate-source threshold voltage as a function of junction temperature**

$V_{GS(th)} = f(T_{vj})$   
 $I_D = 4.3 \text{ mA}$



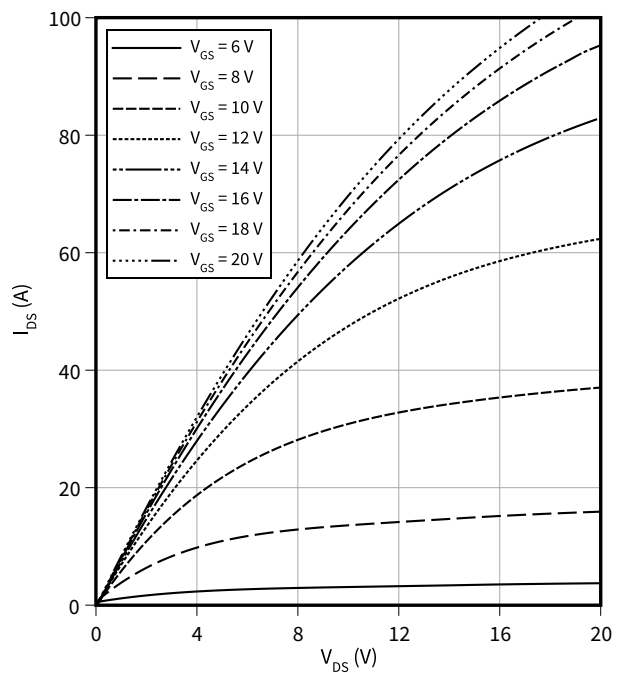
**Typical output characteristic,  $V_{GS}$  as parameter**

$I_{DS} = f(V_{DS})$   
 $T_{vj} = 25^\circ\text{C}$ ,  $t_p = 20 \mu\text{s}$



**Typical output characteristic,  $V_{GS}$  as parameter**

$I_{DS} = f(V_{DS})$   
 $T_{vj} = 175^\circ\text{C}$ ,  $t_p = 20 \mu\text{s}$

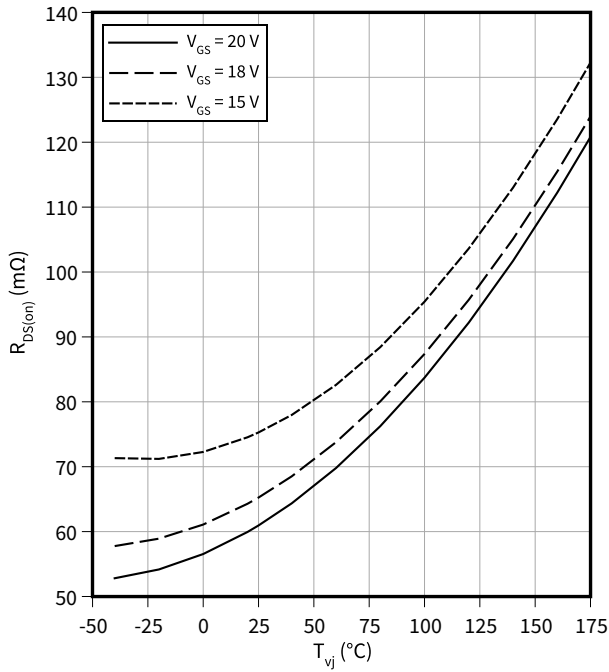




4 Characteristics diagrams

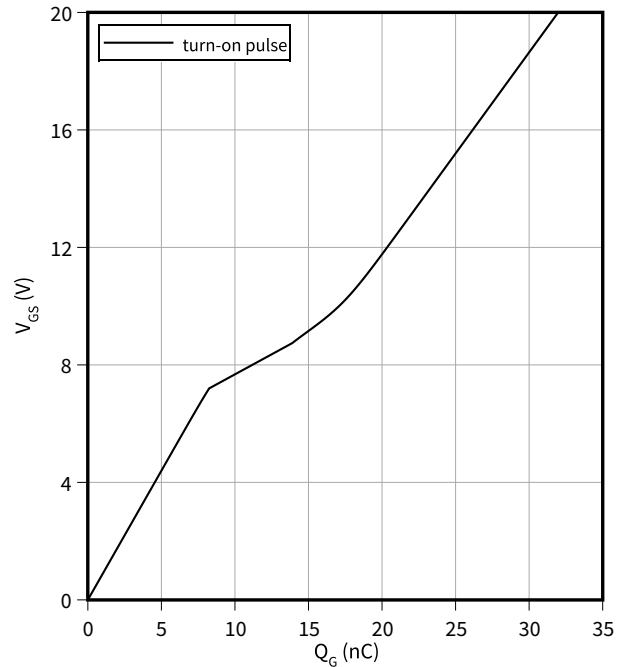
**Typical on-state resistance as a function of junction temperature**

$R_{DS(on)} = f(T_{vj})$   
 $I_D = 13 \text{ A}$



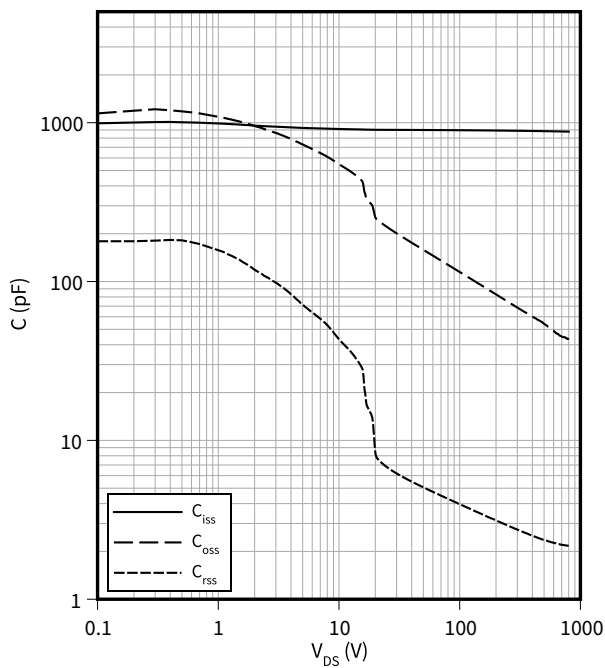
**Typical gate charge**

$V_{GS} = f(Q_G)$   
 $I_D = 13 \text{ A}, V_{DS} = 800 \text{ V}$



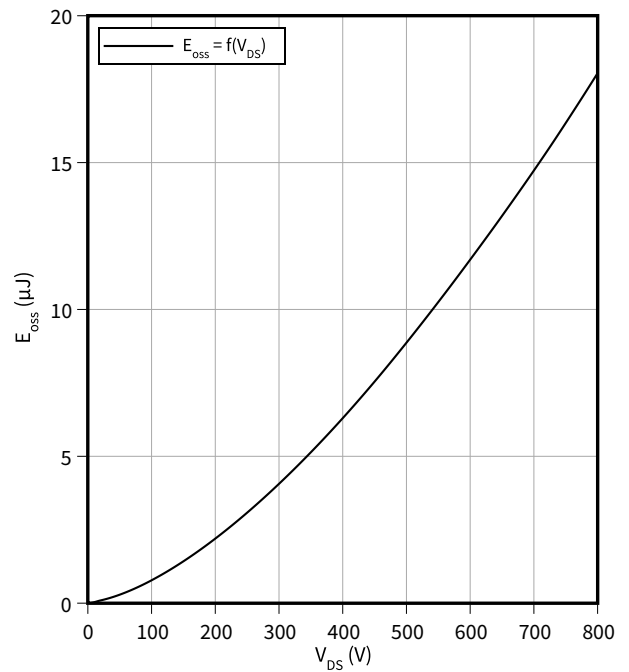
**Typical capacitance as a function of drain-source voltage**

$C = f(V_{DS})$   
 $f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$



**Typical  $C_{OSS}$  stored energy**

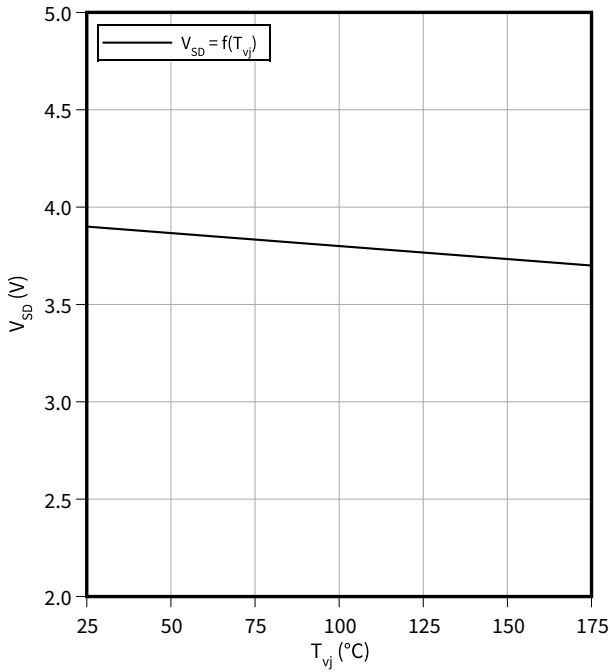
$E_{OSS} = f(V_{DS})$   
 $f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$



4 Characteristics diagrams

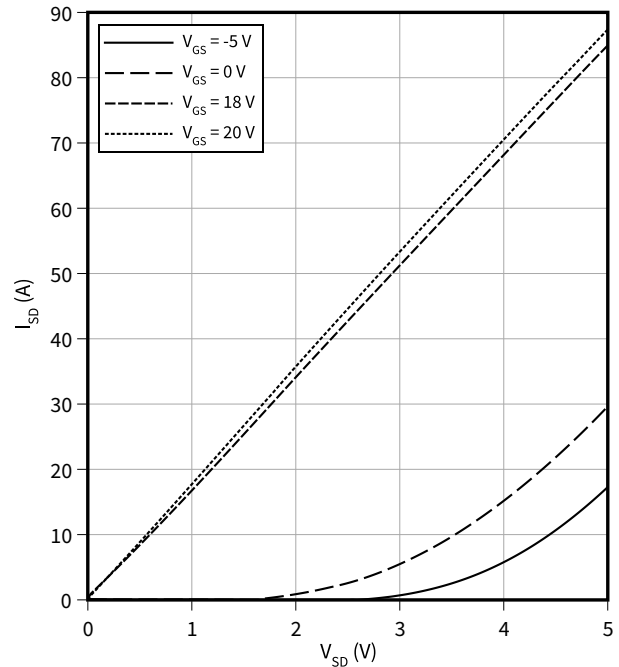
**Typical reverse drain voltage as function of junction temperature**

$V_{SD} = f(T_{vj})$   
 $I_{SD} = 13 \text{ A}, V_{GS} = 0 \text{ V}$



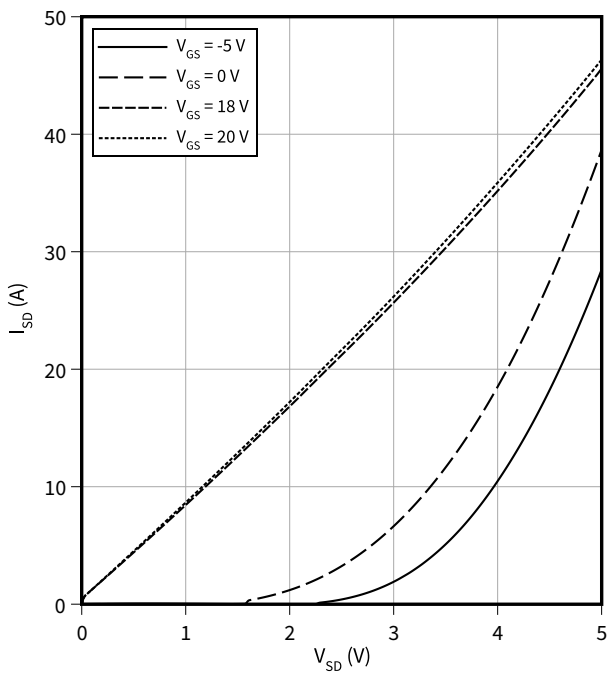
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter**

$I_{SD} = f(V_{SD})$   
 $T_{vj} = 25 \text{ °C}, t_p = 20 \mu\text{s}$



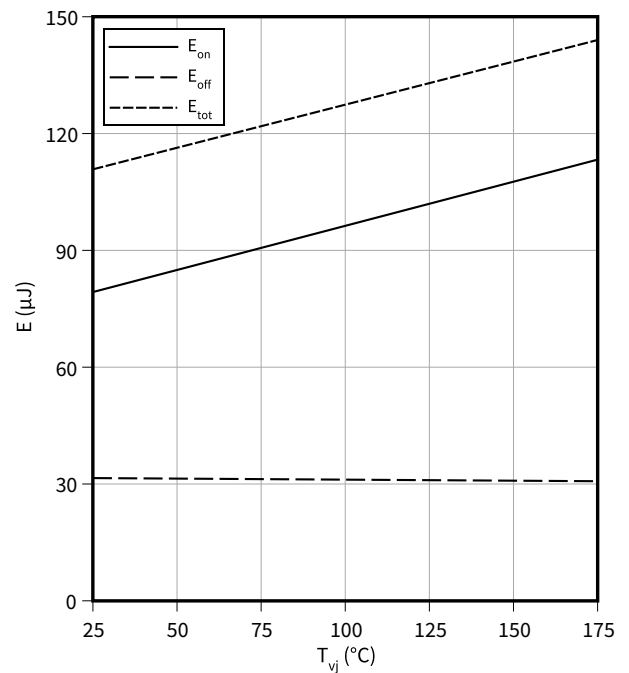
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter**

$I_{SD} = f(V_{SD})$   
 $T_{vj} = 175 \text{ °C}, t_p = 20 \mu\text{s}$



**Typical switching energy as a function of junction temperature, test circuit in Fig. F, 2nd device own body diode:  $V_{GS} = 0 \text{ V}$**

$E = f(T_{vj})$   
 $V_{GS} = 0/20 \text{ V}, I_D = 13 \text{ A}, R_{G,ext} = 2 \Omega, V_{DD} = 800 \text{ V}$

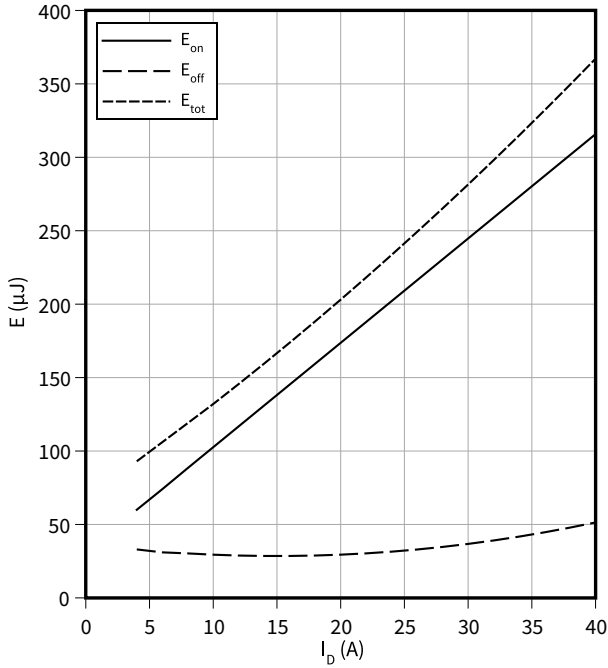


4 Characteristics diagrams

**Typical switching energy as a function of drain current, test circuit in Fig. F, 2nd device own body diode:  $V_{GS} = 0\text{ V}$**

$E = f(I_D)$

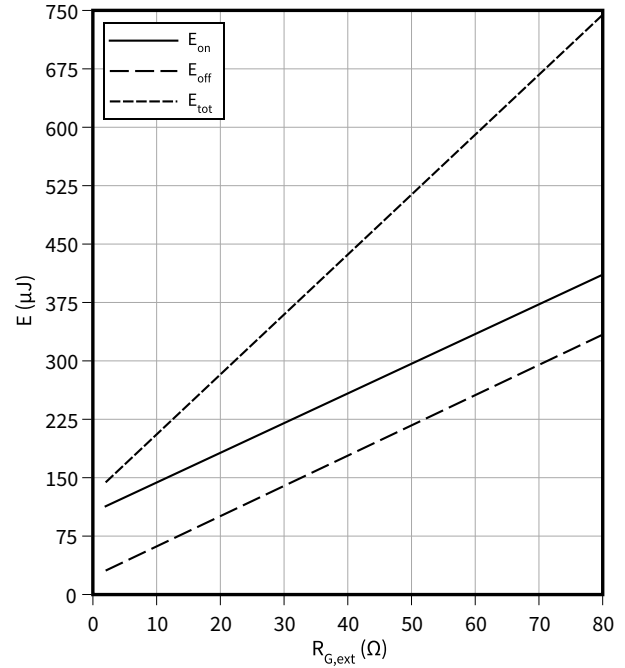
$V_{GS} = 0/20\text{ V}$ ,  $T_{vj} = 175\text{ °C}$ ,  $R_{G,ext} = 2\ \Omega$ ,  $V_{DD} = 800\text{ V}$



**Typical switching energy as a function of gate resistance, test circuit in Fig. F, 2nd device own body diode:  $V_{GS} = 0\text{ V}$**

$E = f(R_{G,ext})$

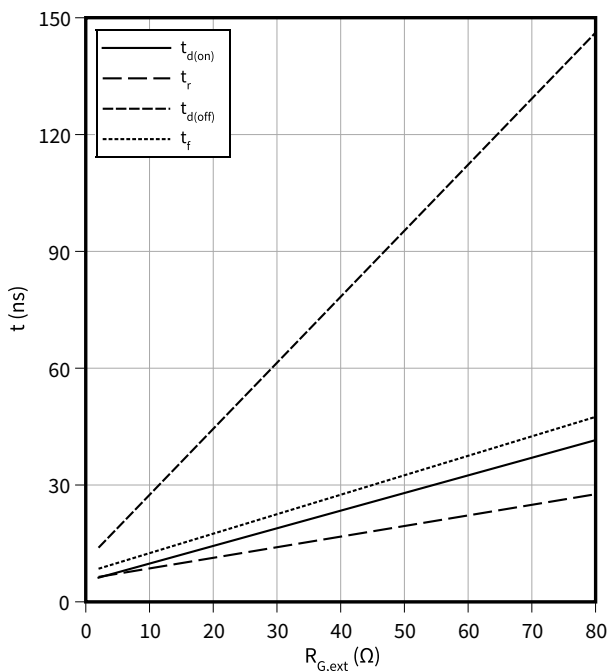
$V_{GS} = 0/20\text{ V}$ ,  $I_D = 13\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{DD} = 800\text{ V}$



**Typical switching times as a function of gate resistance, test circuit in Fig. F, 2nd device own body diode:  $V_{GS} = 0\text{ V}$**

$t = f(R_{G,ext})$

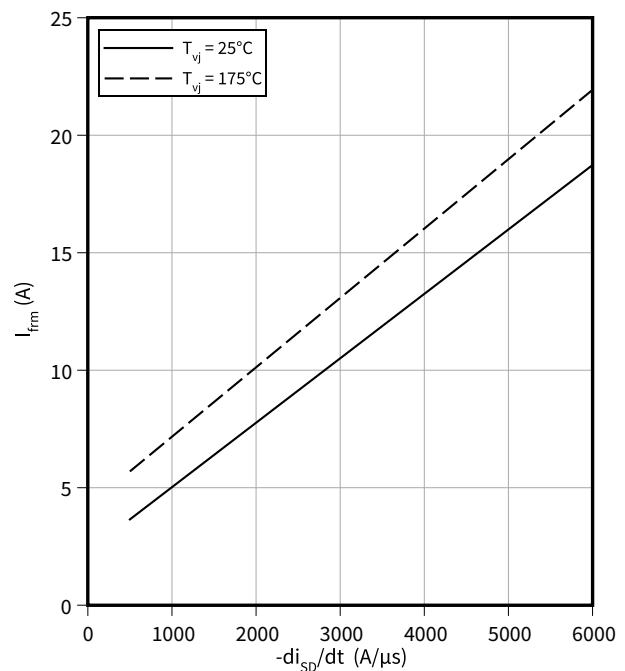
$V_{GS} = 0/20\text{ V}$ ,  $I_D = 13\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{DD} = 800\text{ V}$



**Typical MOSFET peak forward recovery current as a function of reverse drain current slope**

$I_{frm} = f(-di_{SD}/dt)$

$V_{GS} = 0/20\text{ V}$ ,  $I_{SD} = 13\text{ A}$ ,  $V_{DD} = 800\text{ V}$

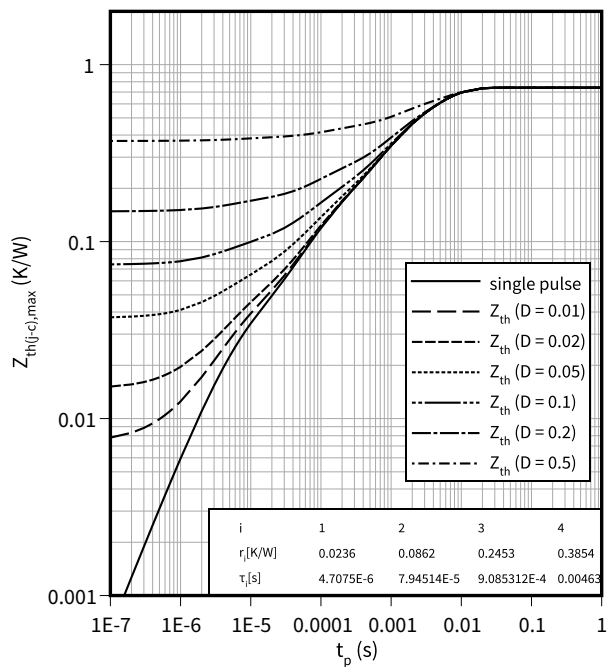


4 Characteristics diagrams

**Max. transient thermal impedance (MOSFET/diode)**

$$Z_{th(j-c),max} = f(t_p)$$

$$D = t_p/T$$



5 Package outlines

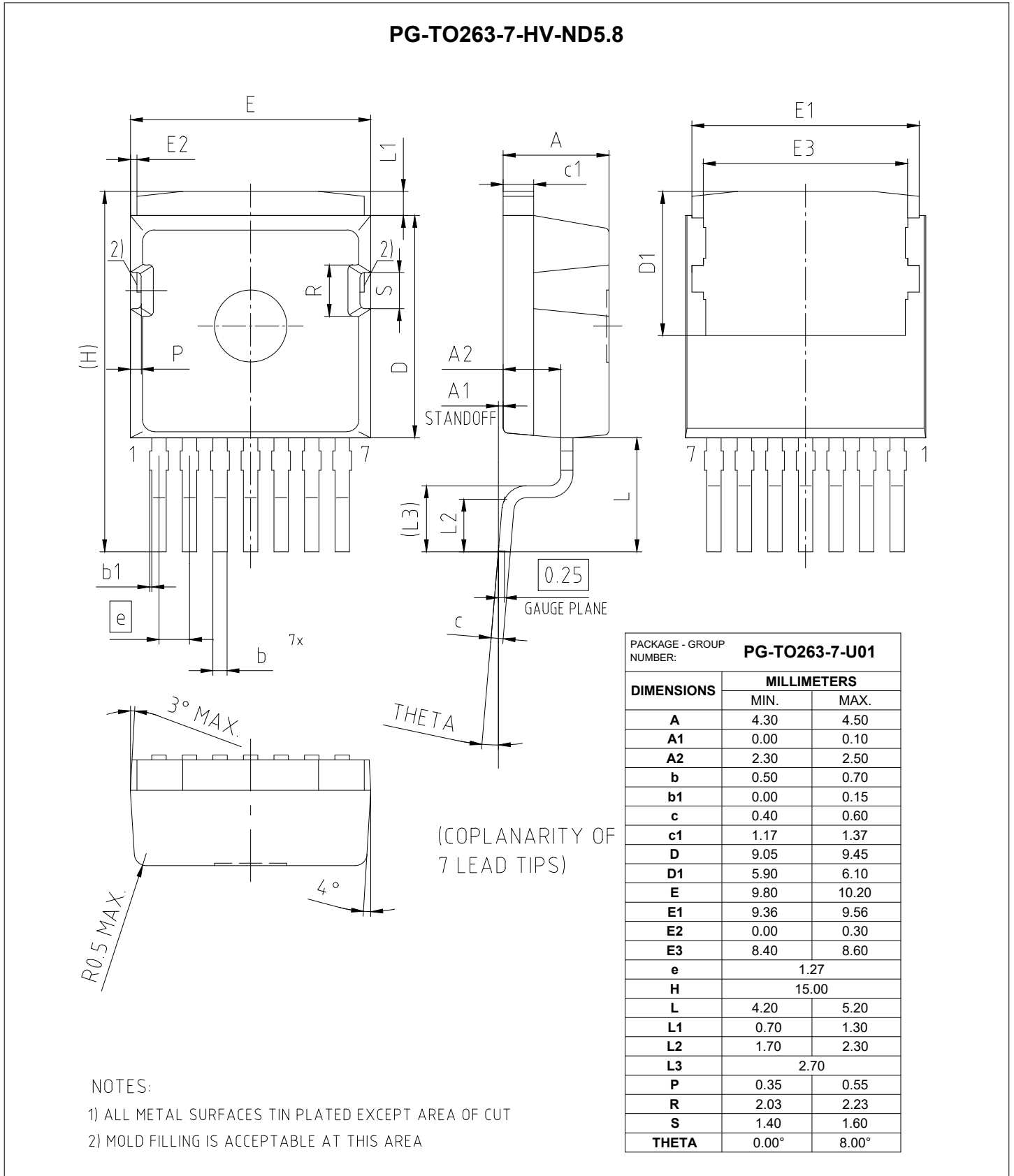


Figure 1

## 6 Testing conditions

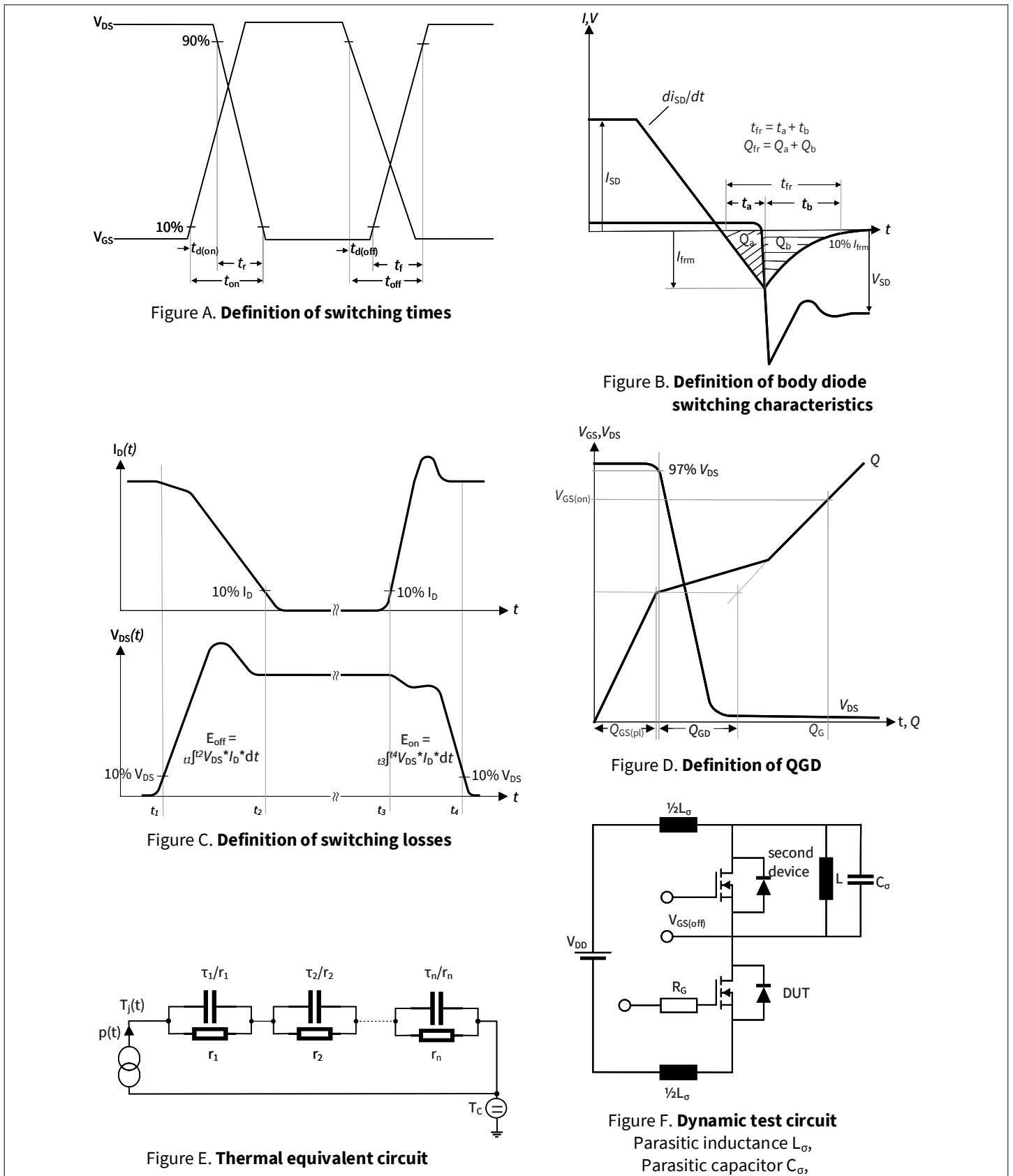


Figure 2

Revision history

**Revision history**

Document revision	Date of release	Description of changes
0.10	2022-12-08	Preliminary datasheet
0.20	2022-12-09	Update of "Drain-source on-state resistance", value ' <b>Max.</b> ' for 25°C, in Table 4 "Characteristic values"
1.00	2023-05-16	Final datasheet
1.10	2024-03-26	Updated table values: $V_{gsth}$ , $I_{dss}$ , $g_{fs}$ , $t_{don}$ , $t_r$ , $t_{doff}$ , $t_f$ , $E_{on}$ , $E_{off}$ , $E_{tot}$ , $Q_{fr}$ , $I_{frm}$ Updated graphs: $I_{DS} = f(V_{GS})$ , $V_{GS(th)} = f(T_{vj})$ , $I_{DS} = f(V_{DS})$ , $R_{DS(on)} = f(T_{vj})$ , $I_{SD} = f(V_{SD})$ , $E = f(T_{vj})$ , $E = f(R_{G,ext})$ , $t = f(R_{G,ext})$ , $I_{frm} = f(-diSD/dt)$ Added new graphs: $E = f(I_D)$ , $E_{oss} = f(V_{DS})$ No change to the product, new values based on additional characterization

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