

CoolSiC™ 1200 V SiC Trench MOSFET : Silicon Carbide MOSFET

Features

- $V_{DS} = 1200\text{ V}$ at $T_{vj} = -55...175\text{ °C}$
- $I_{DC} = 104\text{ A}$ at $T_C = 25\text{ °C}$
- $R_{DS(on)} = 19\text{ m}\Omega$ at $V_{GS} = 20\text{ V}$, $T_{vj} = 25\text{ °C}$
- New performance-optimized chip technology (Gen1p) with improved $R_{DS(on)}$ * A FOM
- 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_{Gtot} 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

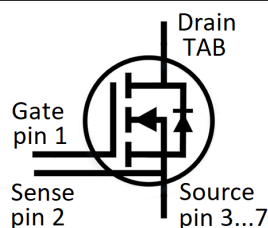
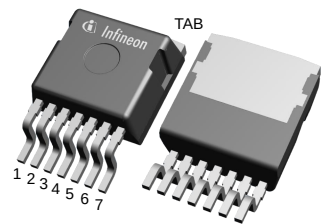
- Qualified for Automotive Applications. Product Validation according to AEC-Q100/101

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
AIMBG120R020M1	PG-TO263-7-HV-ND5.8	AS20MM1



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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	$R_{th(j-c)}$			0.25	0.32	K/W

Note: Not subject to production test. Parameter verified by design/characterization.

2 MOSFET

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	V_{DSS}	$T_{vj} = -55...175\text{ °C}$		1200	V
Continuous DC drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$	I_{DDC}	$V_{GS} = 20\text{ V}$	$T_c = 25\text{ °C}$	104	A
			$T_c = 100\text{ °C}$	74	
Peak drain current, t_p limited by $T_{vj(max)}$	I_{DM}	$V_{GS} = 20\text{ V}$		266	A
Gate-source voltage, max. transient voltage ¹⁾	V_{GS}	$t_p \leq 0.5\text{ }\mu\text{s}$, $D < 0.01$		-10...25	V
Gate-source voltage, max. static voltage	V_{GS}			-5...23	V
Avalanche energy, single pulse	E_{AS}	$I_D = 32\text{ A}$, $V_{DD} = 50\text{ V}$, $L = 0.67\text{ mH}$		340	mJ
Power dissipation, limited by $T_{vj(max)}$	P_{tot}		$T_c = 25\text{ °C}$	468	W
			$T_c = 100\text{ °C}$	234	

1) **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 ¹⁾	$R_{DS(on)}$	$I_D = 43 \text{ A}$	$T_{vj} = 25 \text{ °C}$, $V_{GS(on)} = 20 \text{ V}$		19	25	mΩ
			$T_{vj} = 100 \text{ °C}$, $V_{GS(on)} = 20 \text{ V}$		27		
			$T_{vj} = 175 \text{ °C}$, $V_{GS(on)} = 20 \text{ V}$		38		
			$T_{vj} = 25 \text{ °C}$, $V_{GS(on)} = 18 \text{ V}$		20		
Gate-source threshold voltage ¹⁾	$V_{GS(th)}$	$I_D = 15 \text{ mA}$, $V_{DS} = V_{GS}$ (tested after 1 ms pulse at $V_{GS} = 20 \text{ V}$)	$T_{vj} = 25 \text{ °C}$	3.5	4.3	5.1	V
			$T_{vj} = 175 \text{ °C}$		3.8		
Zero gate-voltage drain current	I_{DSS}	$V_{DS} = 1200 \text{ V}$, $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		0.6	42	μA
			$T_{vj} = 175 \text{ °C}$		1.8		
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}	$I_D = 43 \text{ A}$, $V_{DS} = 20 \text{ V}$			36		S
Short-circuit withstand time	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	$R_{G,int}$	$f = 1 \text{ MHz}$, $V_{AC} = 25 \text{ mV}$			2.2		Ω
Input capacitance	C_{iss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			2667		pF
Output capacitance	C_{oss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			126		pF
Reverse transfer capacitance	C_{rss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			7		pF
C_{oss} stored energy	E_{oss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			52		μJ
Total gate charge	Q_G	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, turn-on pulse			82		nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, turn-on pulse			22		nC
Gate-to-drain charge	Q_{GD}	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, turn-on pulse			14		nC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \text{ } \Omega$, $R_{GS(off)} = 2 \text{ } \Omega$, $L_\sigma = 15 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		9		ns
			$T_{vj} = 175 \text{ °C}$		9		

(table continues...)

Table 4 (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time	t_r	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	13		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	16		
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	27		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	30		
Fall time	t_f	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	10		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	11		
Turn-on energy	E_{on}	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	231		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	341		
Turn-off energy	E_{off}	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	218		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	220		
Total switching energy	E_{tot}	$V_{DD} = 800 \text{ V}$, $I_D = 43 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	449		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	561		
Virtual junction temperature	T_{vj}		-55		175	$^\circ\text{C}$

1) **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.

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

3 Body diode (MOSFET)

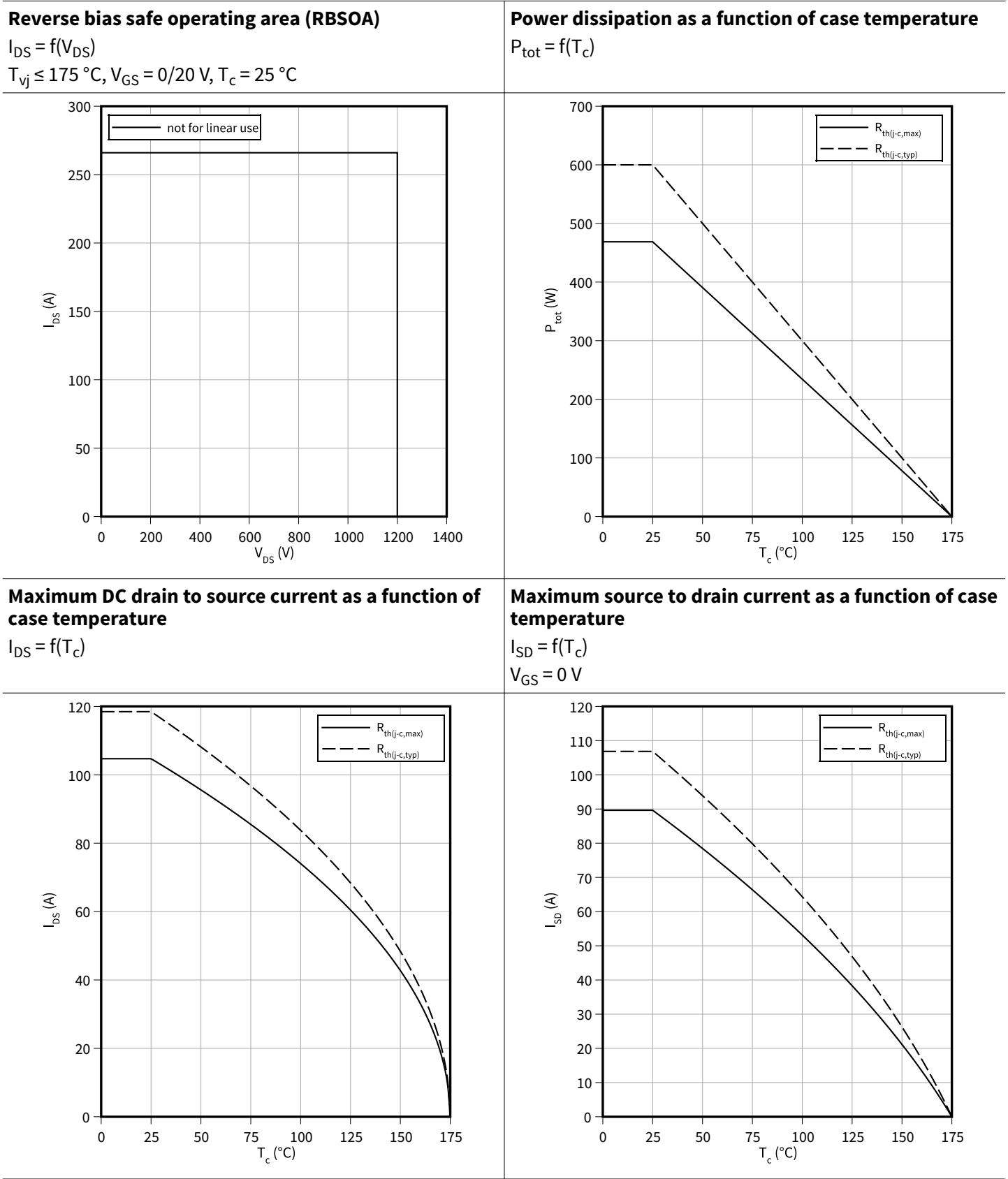
Table 5 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Drain-source voltage	V_{DSS}	$T_{vj} = -55...175\text{ °C}$	1200	V
Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$	I_{SDC}	$V_{GS} = 0\text{ V}$	$T_c = 25\text{ °C}$	A
			$T_c = 100\text{ °C}$	
Peak reverse drain current, t_p limited by $T_{vj(max)}$	I_{SM}	$V_{GS} = 0\text{ V}$	95	A

Table 6 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Drain-source reverse voltage	V_{SD}	$I_{SD} = 43\text{ A}$, $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	3.9	5	V
			$T_{vj} = 100\text{ °C}$	3.8		
			$T_{vj} = 175\text{ °C}$	3.7		
MOSFET forward recovery charge	Q_{fr}	$V_{DD} = 800\text{ V}$, $I_{SD} = 43\text{ A}$, $V_{GS} = 0\text{ V}$, $di_{SD}/dt = 3000\text{ A}/\mu\text{s}$, Q_{fr} includes also Q_C	$T_{vj} = 25\text{ °C}$	166		nC
			$T_{vj} = 175\text{ °C}$	430		
MOSFET peak forward recovery current	I_{frm}	$V_{DD} = 800\text{ V}$, $I_{SD} = 43\text{ A}$, $V_{GS} = 0\text{ V}$, $di_{SD}/dt = 3000\text{ A}/\mu\text{s}$, Q_{fr} includes also Q_C	$T_{vj} = 25\text{ °C}$	15		A
			$T_{vj} = 175\text{ °C}$	21		
Virtual junction temperature	T_{vj}		-55		175	°C

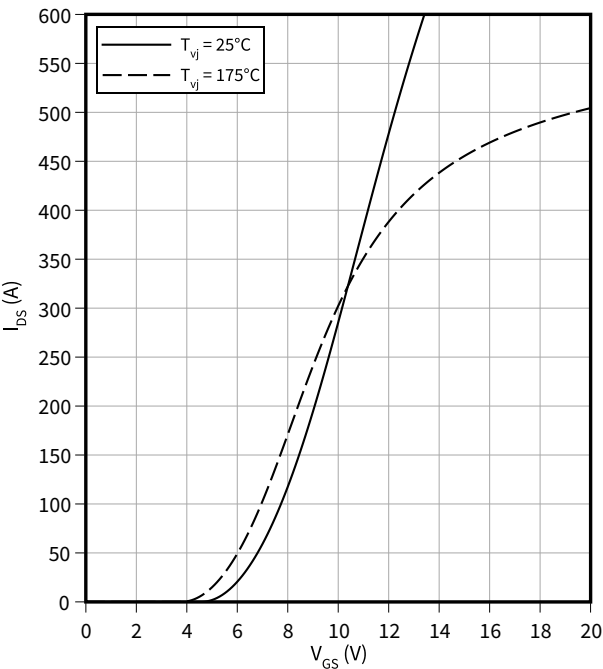
4 Characteristics diagrams



4 Characteristics diagrams

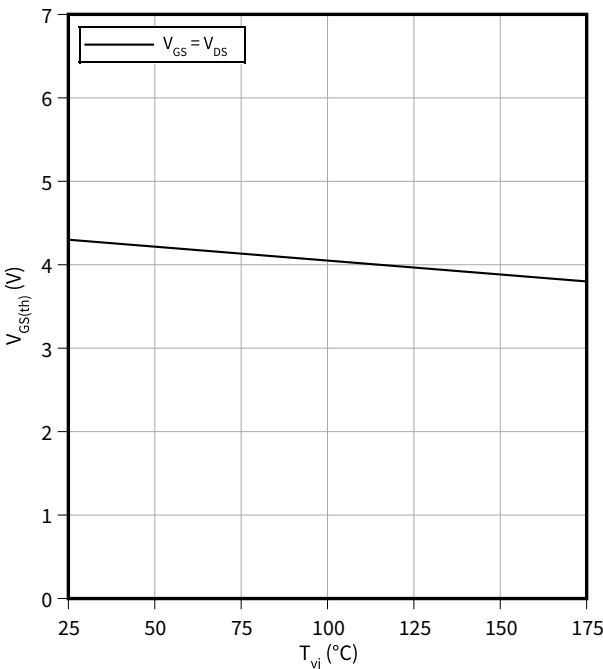
Typical transfer characteristic

$I_{DS} = f(V_{GS})$
 $V_{DS} = 20\text{ V}$



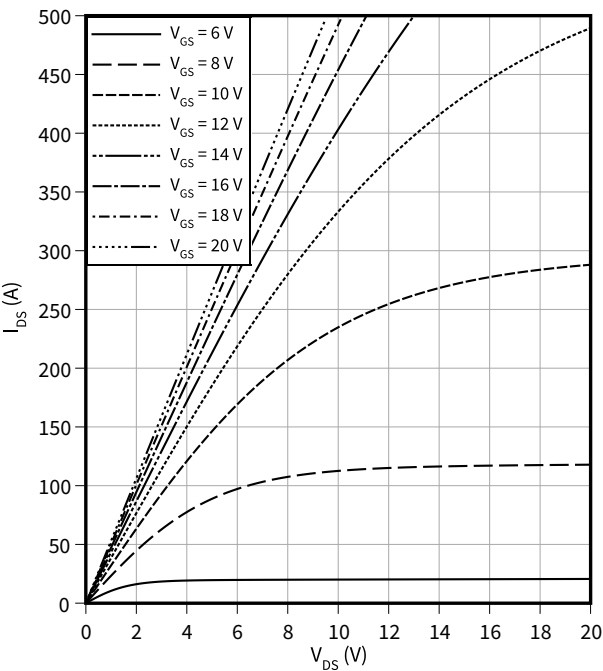
Typical gate-source threshold voltage as a function of junction temperature

$V_{GS(th)} = f(T_{vj})$
 $I_D = 15\text{ mA}$



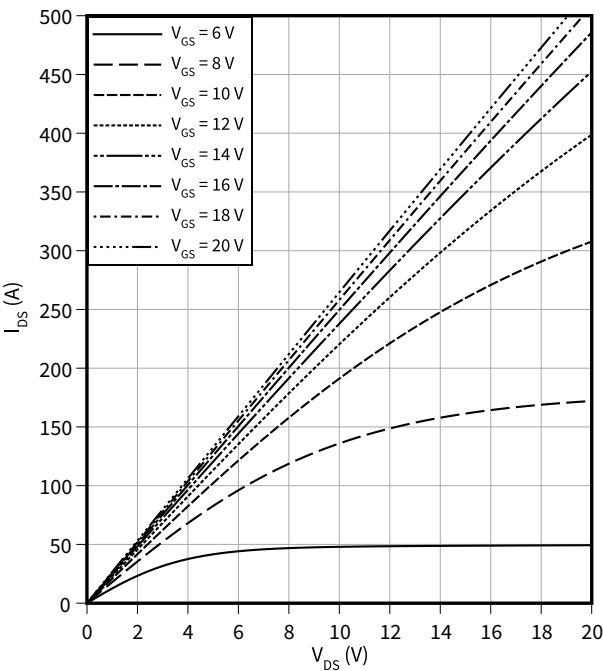
Typical output characteristic, V_{GS} as parameter

$I_{DS} = f(V_{DS})$
 $T_{vj} = 25\text{ }^\circ\text{C}$



Typical output characteristic, V_{GS} as parameter

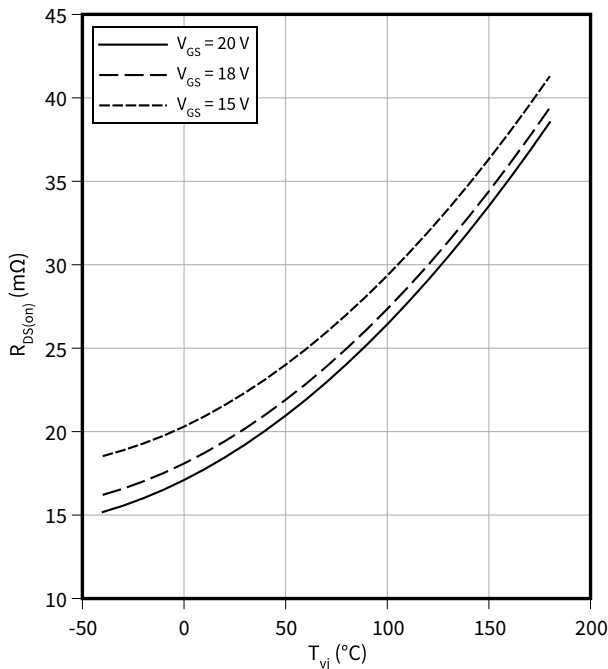
$I_{DS} = f(V_{DS})$
 $T_{vj} = 175\text{ }^\circ\text{C}$



4 Characteristics diagrams

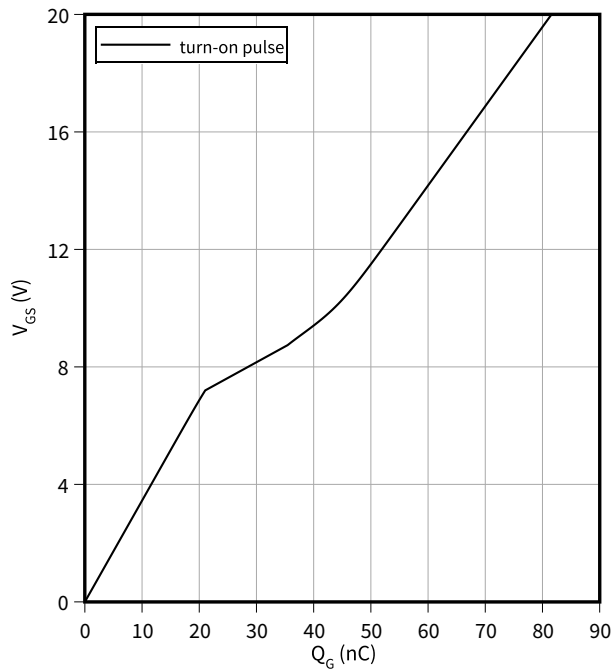
Typical on-state resistance as a function of junction temperature

$R_{DS(on)} = f(T_{vj})$
 $I_D = 43\text{ A}$



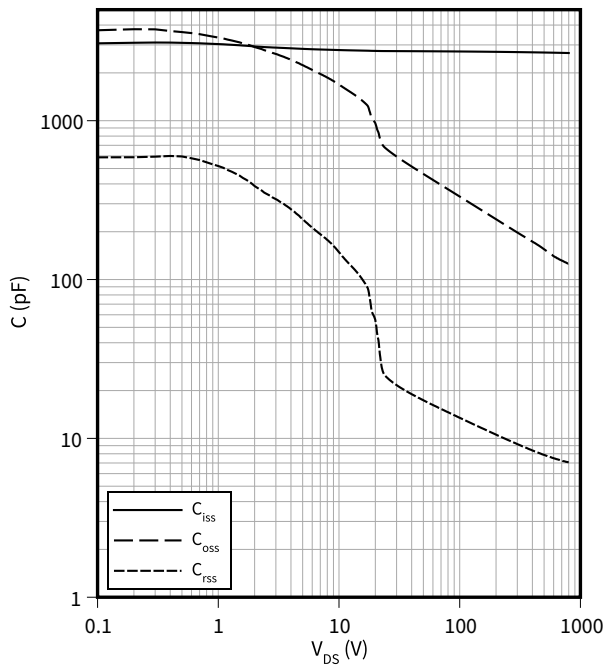
Typical gate charge

$V_{GS} = f(Q_G)$
 $I_D = 43\text{ A}, V_{DS} = 800\text{ V}$



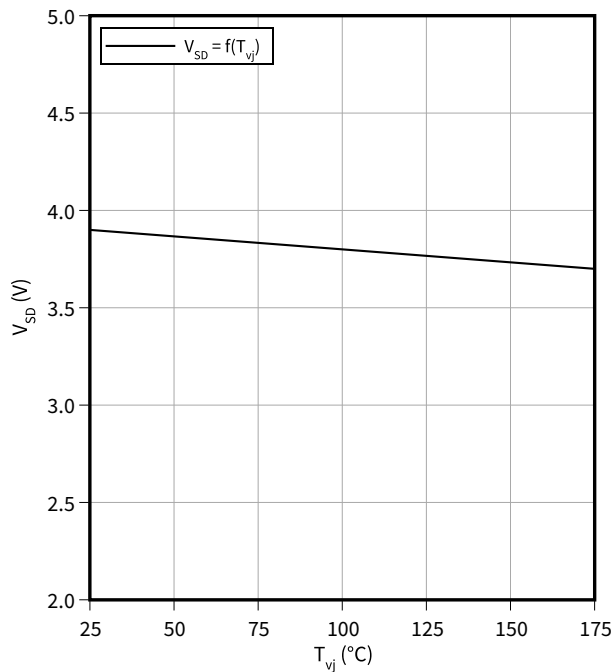
Typical capacitance as a function of drain-source voltage

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



Typical reverse drain voltage as function of junction temperature

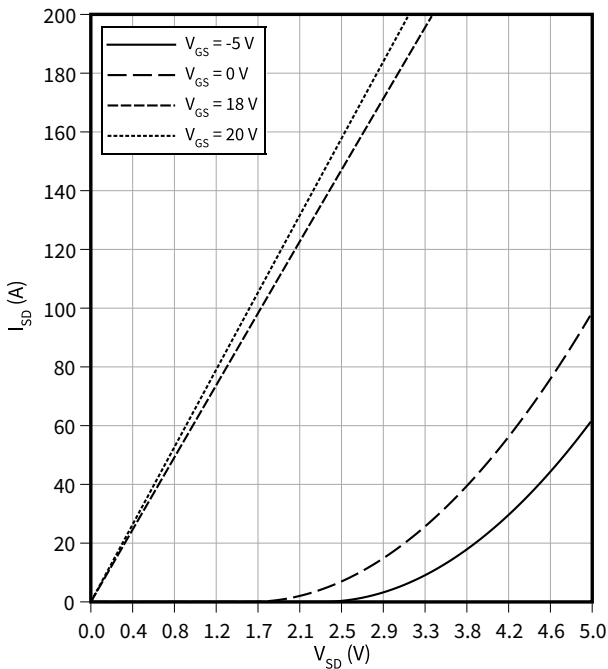
$V_{SD} = f(T_{vj})$
 $I_{SD} = 43\text{ A}, V_{GS} = 0\text{ V}$



4 Characteristics diagrams

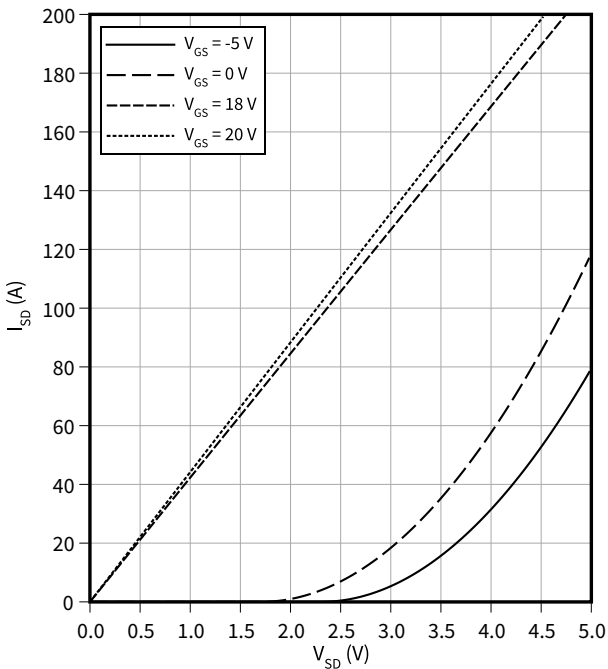
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

$I_{SD} = f(V_{SD})$
 $T_{vj} = 25\text{ °C}$



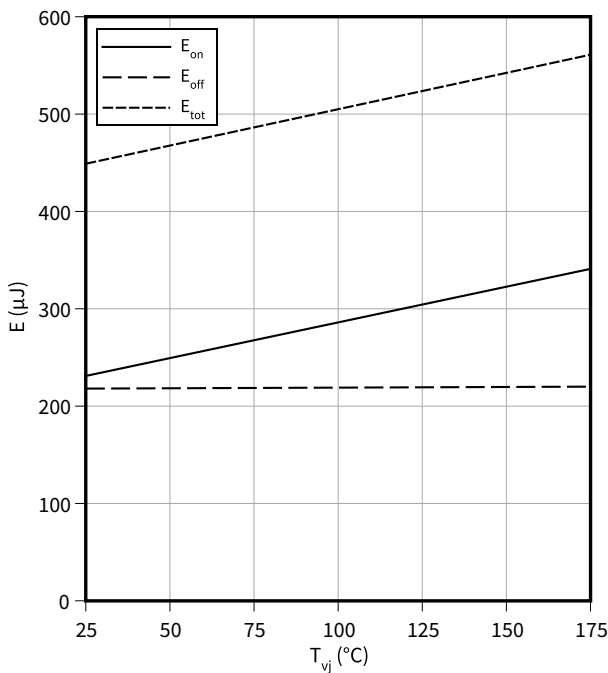
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

$I_{SD} = f(V_{SD})$
 $T_{vj} = 175\text{ °C}$



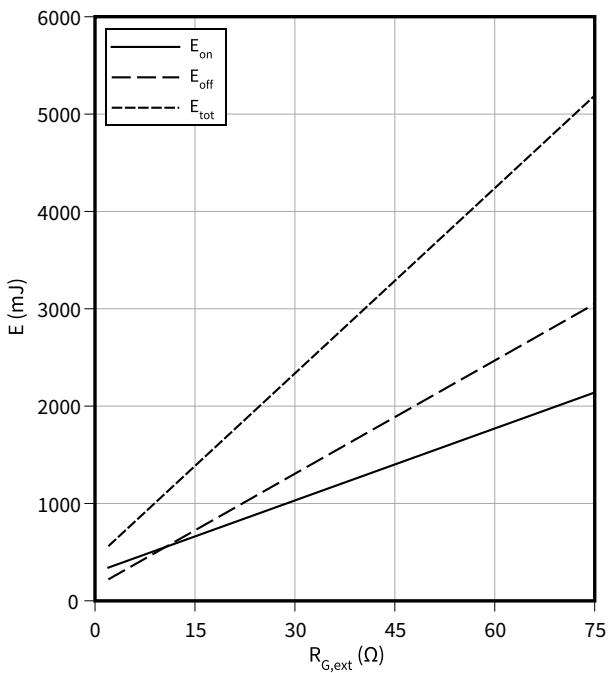
Typical switching energy as a function of junction temperature, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0\text{ V}$

$E = f(T_{vj})$
 $V_{GS} = 0/20\text{ V}$, $I_D = 43\text{ A}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 800\text{ V}$



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

$E = f(R_{G,ext})$
 $V_{GS} = 0/20\text{ V}$, $I_D = 43\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{DD} = 800\text{ V}$

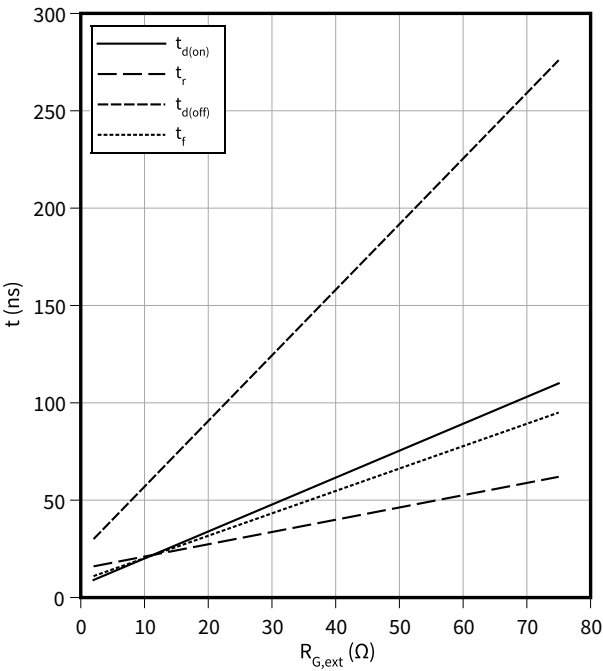


4 Characteristics diagrams

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

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

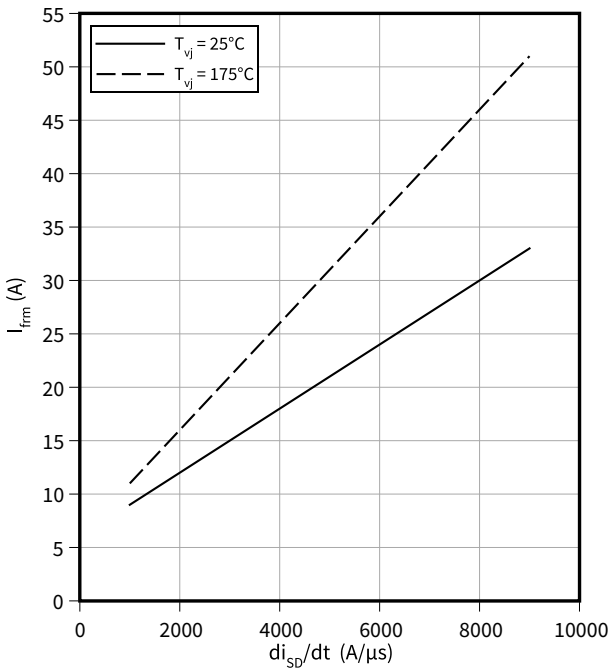
$V_{GS} = 0/20\text{ V}$, $I_D = 43\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{DD} = 800\text{ V}$



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

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

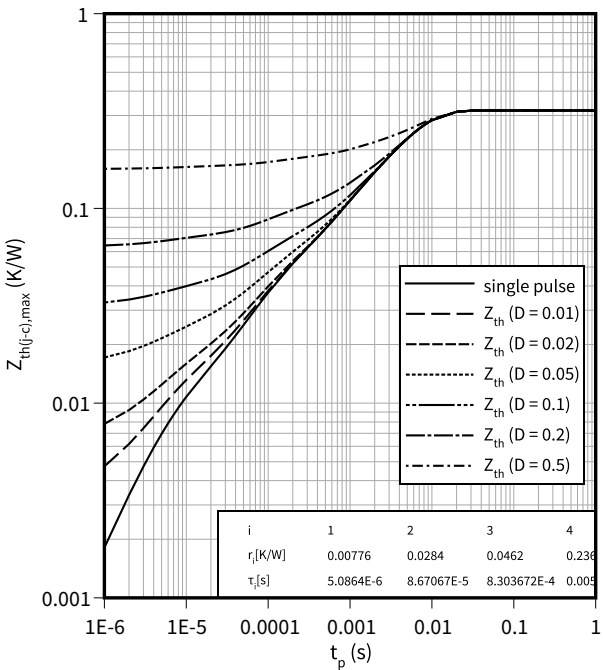
$V_{GS} = 0/20\text{ V}$, $I_{SD} = 43\text{ A}$, $V_{DD} = 800\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

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

$D = t_p/T$



5 Package outlines

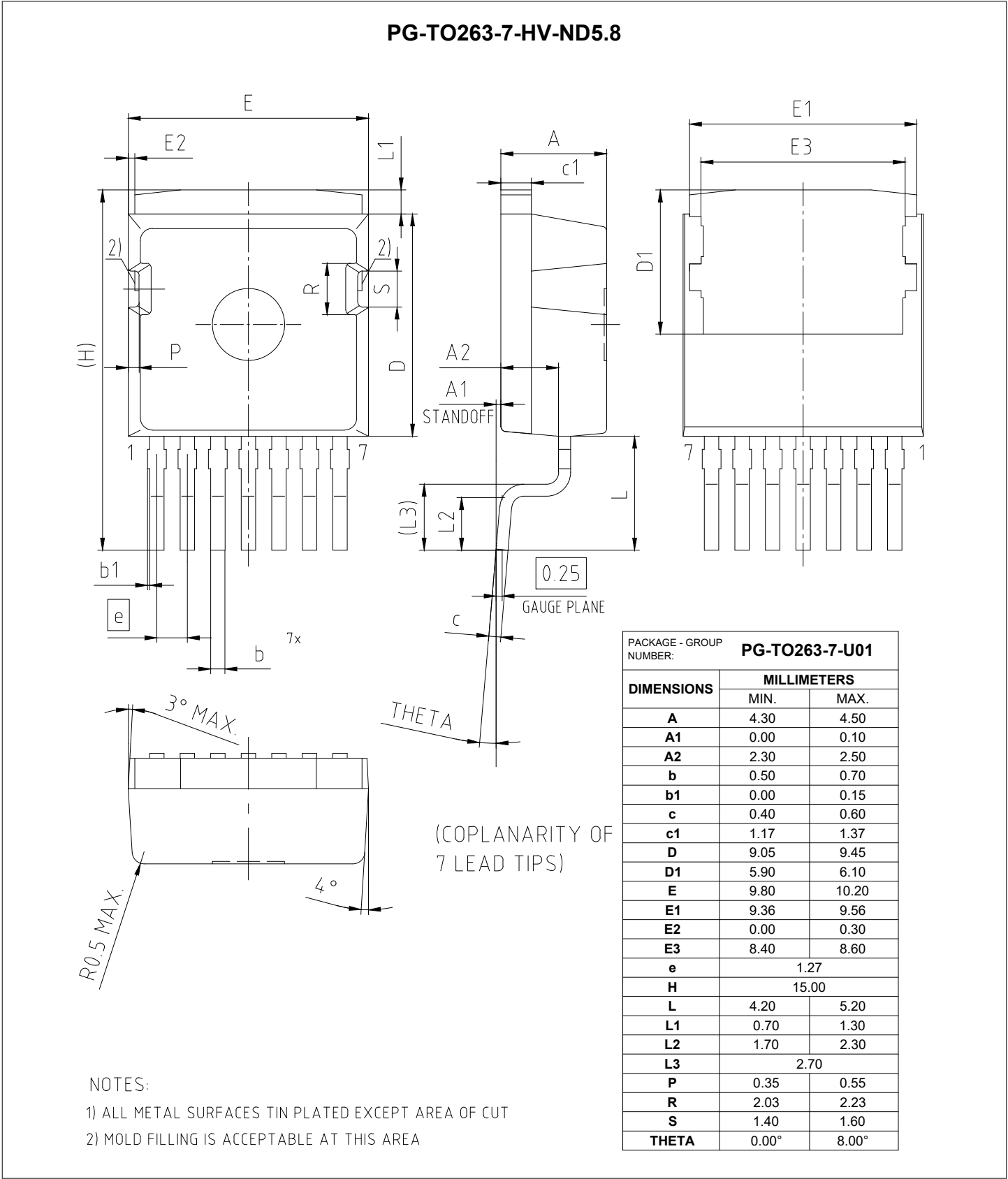


Figure 1

6 Testing conditions

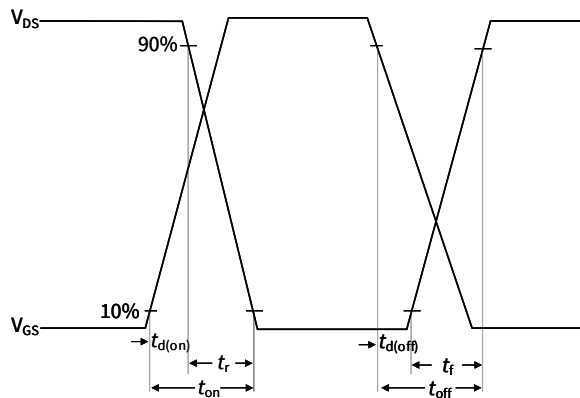


Figure A. Definition of switching times

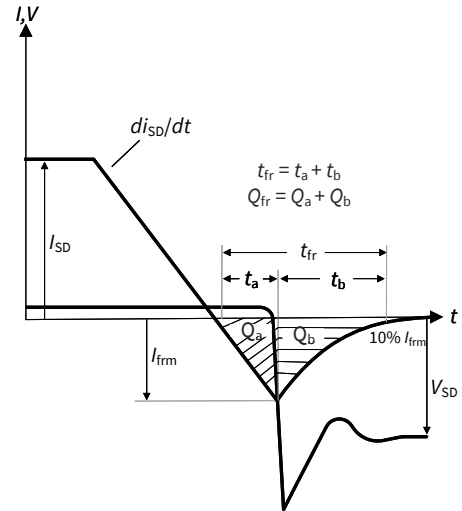


Figure B. Definition of body diode switching characteristics

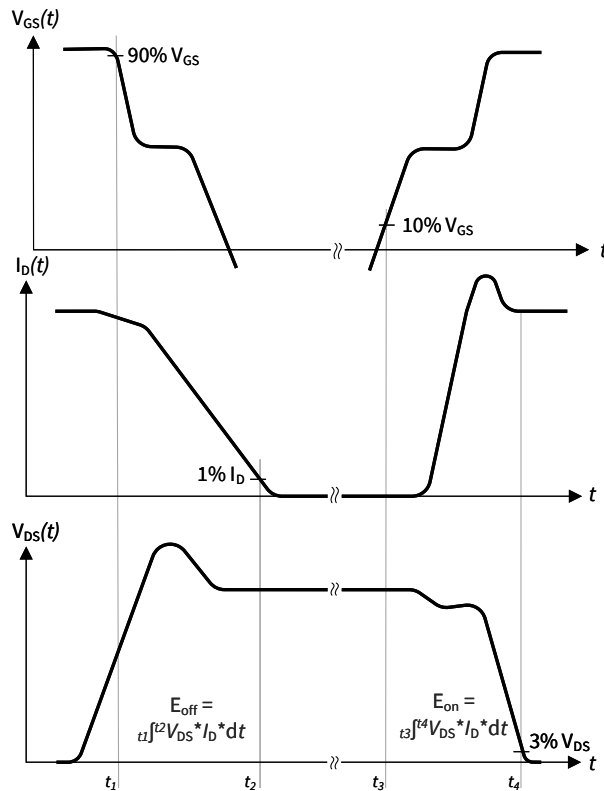


Figure C. Definition of switching losses

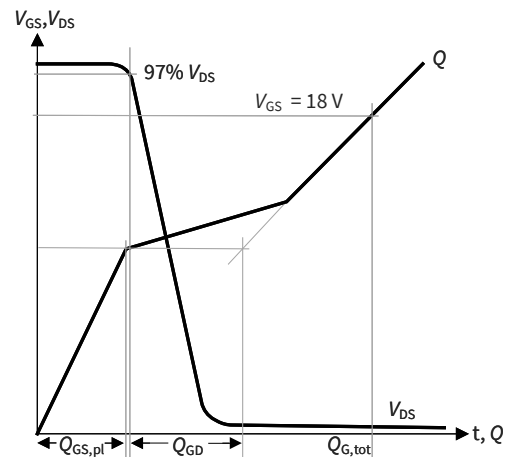


Figure D. Definition of QGD

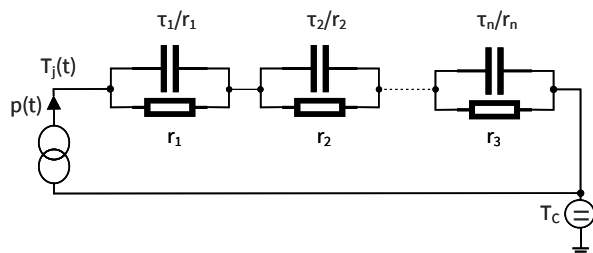


Figure E. Thermal equivalent circuit

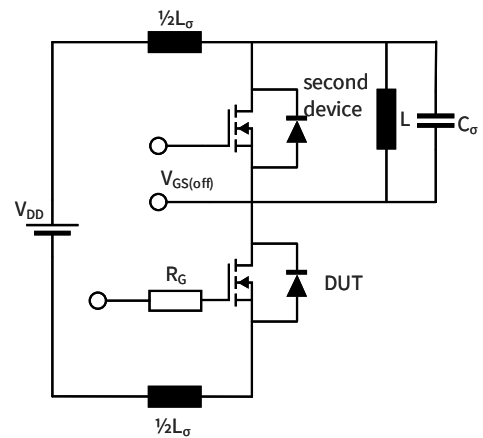


Figure F. Dynamic test circuit

Parasitic inductance L_{σ} ,
Parasitic capacitor C_{σ} ,

Revision history

Document revision	Date of release	Description of changes
0.10	2022-12-08	Preliminary datasheet
1.00	2023-05-12	Final datasheet

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