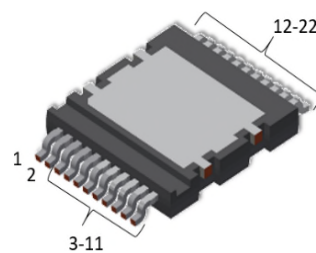


Final datasheet

CoolSiC™ Automotive MOSFET 1200 V in HDSOP-22-3 package

Features

- $V_{DS} = 1200\text{ V}$ at $T_{vj} = -55...175^{\circ}\text{C}$
- $I_{DC} = 44\text{ A}$ 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 $R_{DS(on)}$ * 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
- Drive (Kelvin) Source pin for better gate control and reduced switching losses
- Creepage distance $> 4.75\text{ mm}$ fitting $V_{rms(max)} > 950\text{ V}$ based on IEC60664 for material group I, pollution degree 2
- SMT package for automated assembly and reduced system costs
- Low R_{th} Top-Side Cooled package for best thermal performance and power density



Potential applications

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

Product validation

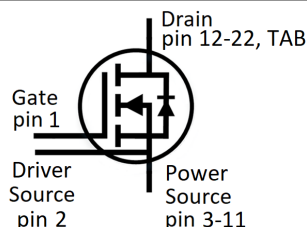
- Qualified for Automotive Applications. Product Validation according to AEC-Q100/101

Description

Pin definition:

- Pin 1 - Gate
- Pin 2 - Drive Source
- Pin 3...11 - Power Source
- Pin 12...22, TAB - Drain

Note: the drive source and power source pins are not exchangeable, their exchange might lead to malfunction



Type	Package	Marking
AIMCQ120R060M1T	PG-HDSOP-22-3	12A060M1



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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 ¹⁾	$R_{th(j-c)}$			0.45	0.58	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 ¹⁾	V_{DSS}	$T_{vj} = -55...175\text{ °C}$		1200	V
Continuous DC drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$ ²⁾	I_{DDC}	$V_{GS} = 20\text{ V}$	$T_c = 25\text{ °C}$	44	A
			$T_c = 100\text{ °C}$	31	
Peak drain current, t_p limited by $T_{vj(max)}$ ²⁾	I_{DM}	$V_{GS} = 20\text{ V}$		112	A
Gate-source voltage, max. transient voltage ³⁾	V_{GS}	$t_p \leq 0.5\text{ }\mu\text{s}$, $D < 0.01$		-10/25	V
Gate-source voltage, max. static voltage ³⁾	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 $T_{vj(max)}$ ²⁾	P_{tot}		$T_c = 25\text{ °C}$	259	W
			$T_c = 100\text{ °C}$	129	

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 ¹⁾	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	$t_{d(on)}$	$V_{DD} = 800\text{ V}$, $I_D = 13\text{ A}$, $V_{GS} = 0/20\text{ V}$, $R_{G,ext} = 2\text{ }\Omega$, $L_\sigma = 13\text{ nH}$, diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		7.1		ns
			$T_{vj} = 175\text{ °C}$		7		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time	t_r	$V_{DD} = 800 \text{ V}$, $I_D = 13 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 2 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	4.5		ns
			$T_{vj} = 175 \text{ °C}$	5.3		
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800 \text{ V}$, $I_D = 13 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 2 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	13.5		ns
			$T_{vj} = 175 \text{ °C}$	14.3		
Fall time	t_f	$V_{DD} = 800 \text{ V}$, $I_D = 13 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 2 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	9		ns
			$T_{vj} = 175 \text{ °C}$	9.3		
Turn-on energy	E_{on}	$V_{DD} = 800 \text{ V}$, $I_D = 13 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 2 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	88		μJ
			$T_{vj} = 175 \text{ °C}$	113		
Turn-off energy	E_{off}	$V_{DD} = 800 \text{ V}$, $I_D = 13 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 2 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	25		μJ
			$T_{vj} = 175 \text{ °C}$	27		
Total switching energy	E_{tot}	$V_{DD} = 800 \text{ V}$, $I_D = 13 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 2 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$	120		μJ
			$T_{vj} = 175 \text{ °C}$	145		
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 ¹⁾	V_{DSS}	$T_{vj} = -55...175 \text{ °C}$	1200	V
Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$ ²⁾	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 $T_{vj(max)}$ ²⁾	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

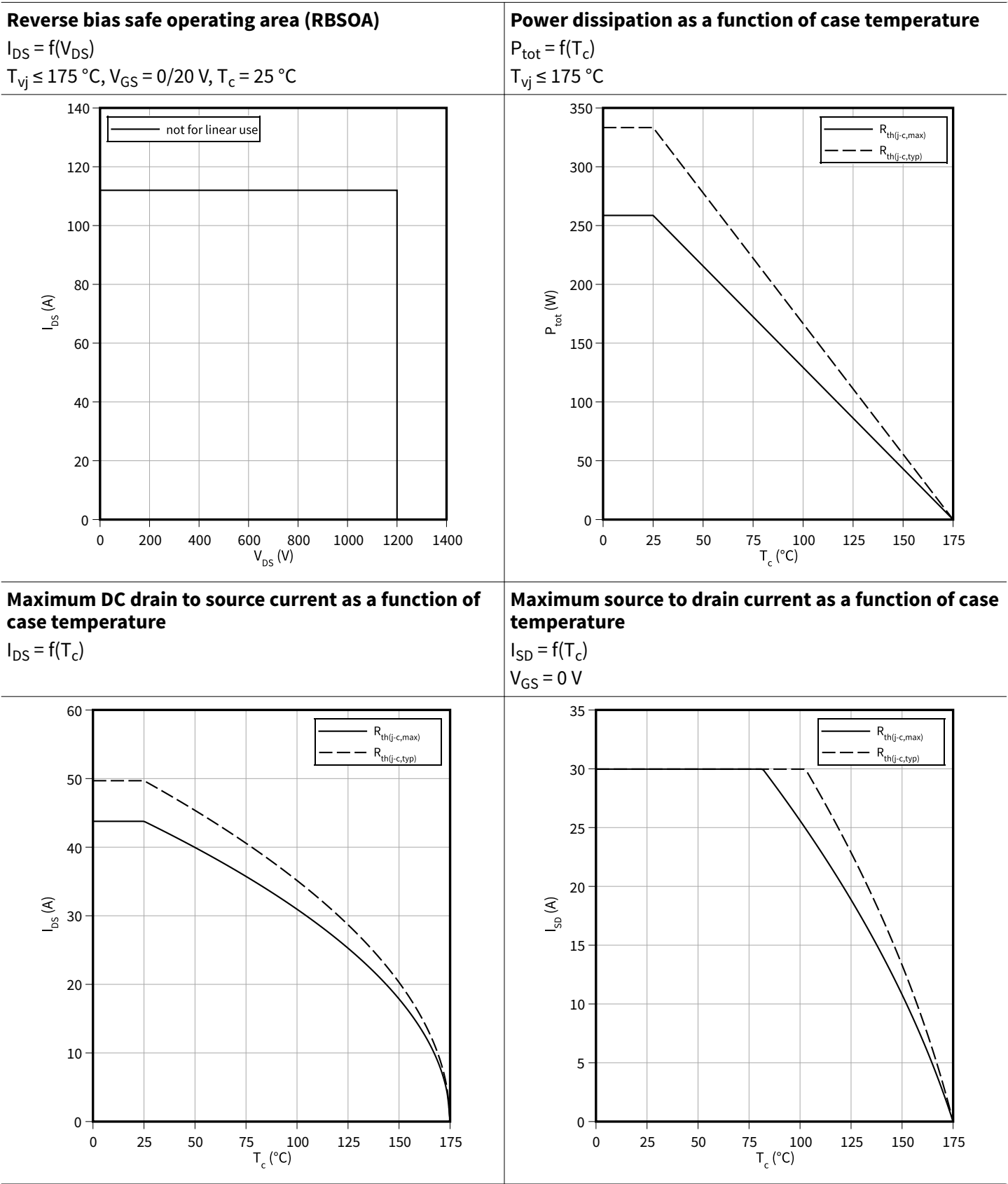
3 Body diode (MOSFET)

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	$T_{vj} = 25 \text{ °C}$		154		nC
			$T_{vj} = 175 \text{ °C}$		233		
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	$T_{vj} = 25 \text{ °C}$		15		A
			$T_{vj} = 175 \text{ °C}$		20		
Virtual junction temperature	T_{vj}			-55		175	°C

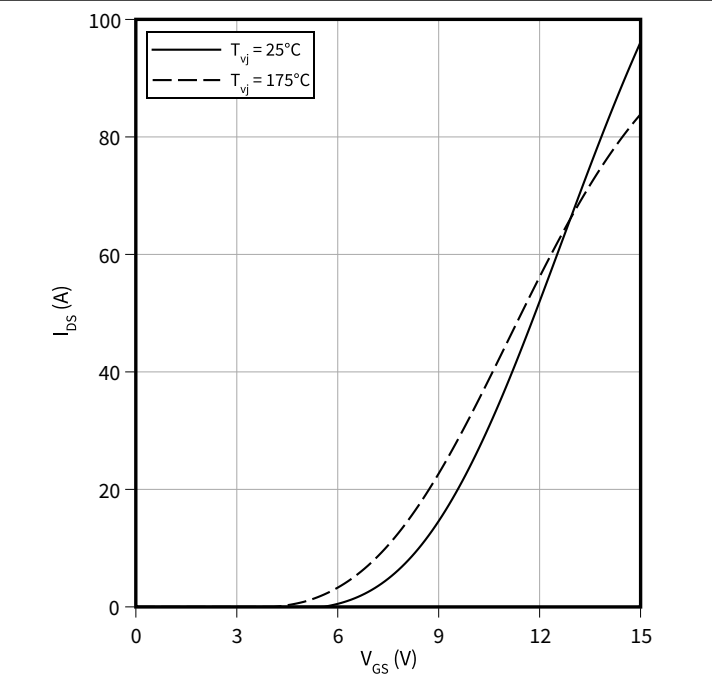
4 Characteristics diagrams



4 Characteristics diagrams

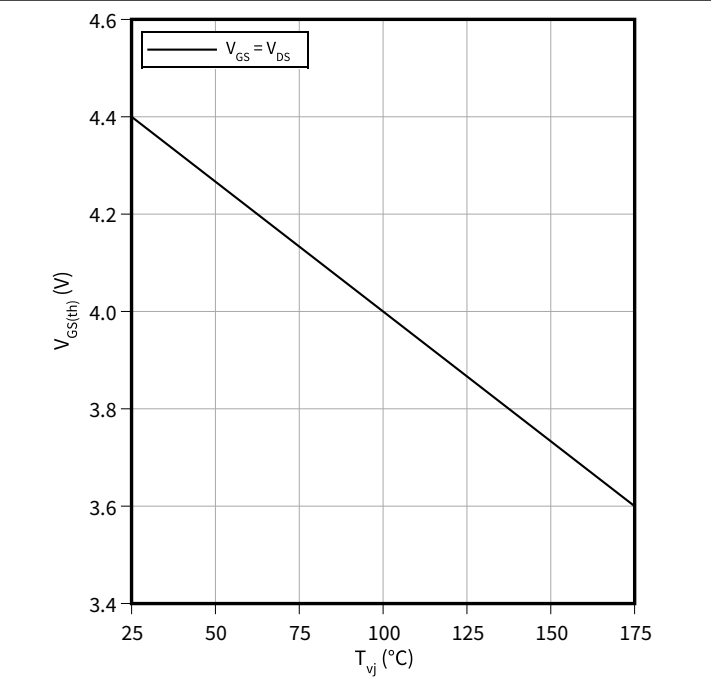
Typical transfer characteristic

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



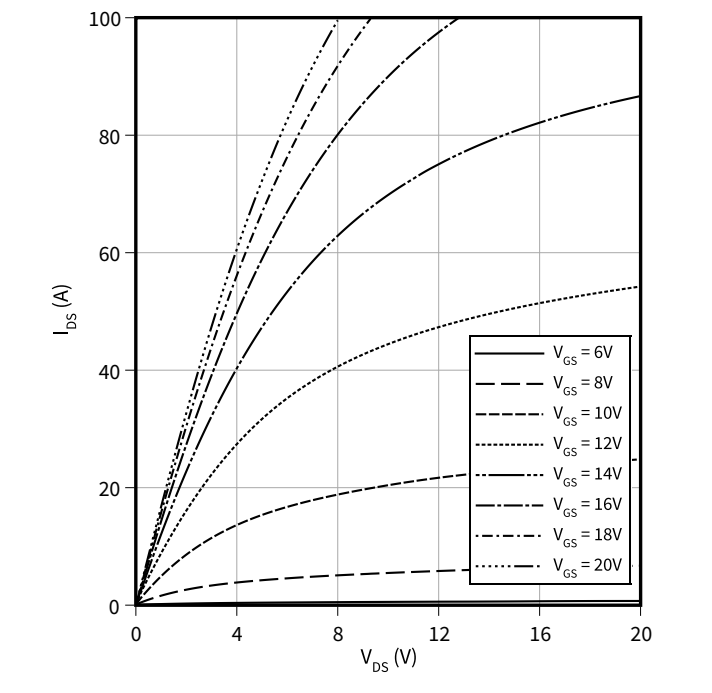
Typical gate-source threshold voltage as a function of junction temperature

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



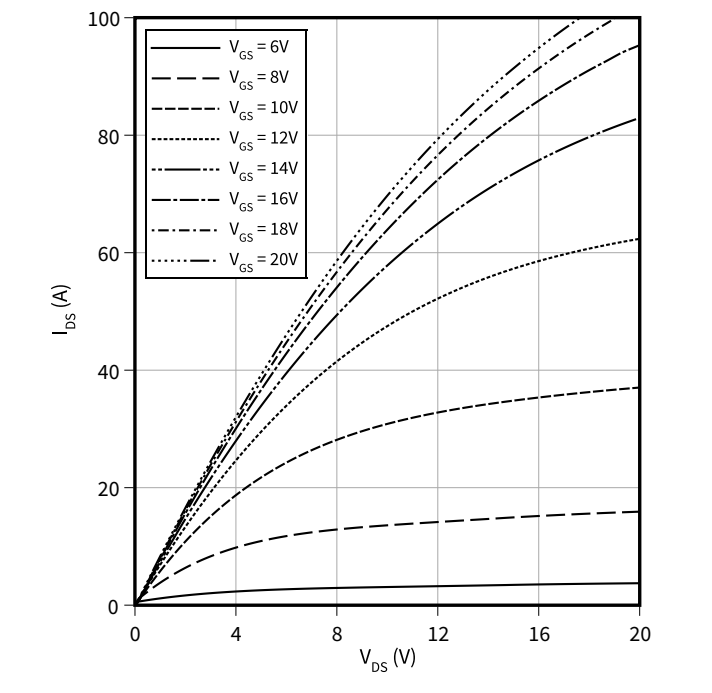
Typical output characteristic, V_{GS} as parameter

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



Typical output characteristic, V_{GS} as parameter

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

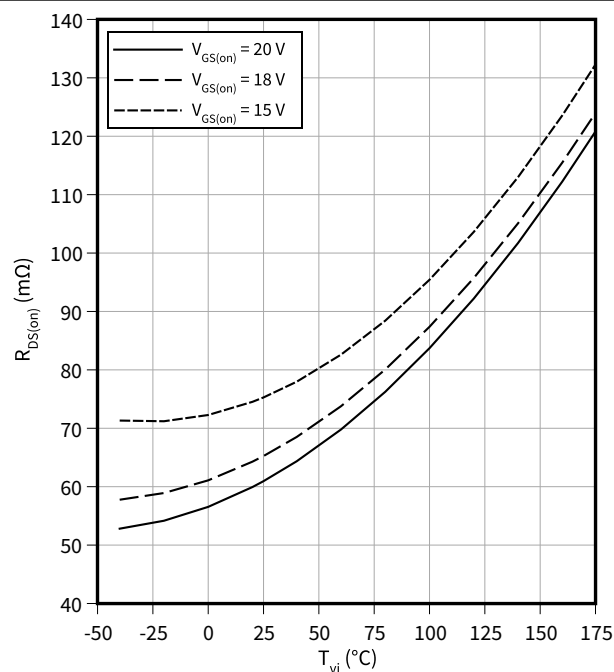


4 Characteristics diagrams

Typical on-state resistance as a function of junction temperature

$$R_{DS(on)} = f(T_{vj})$$

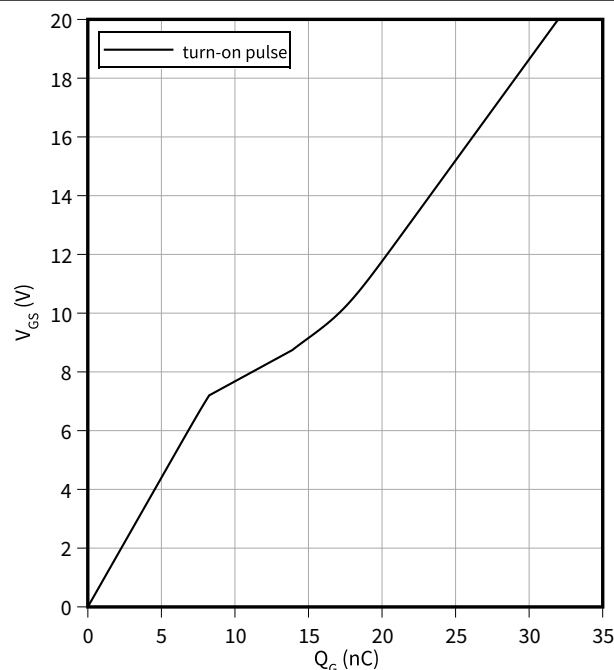
$I_D = 13 \text{ A}$



Typical gate charge

$$V_{GS} = f(Q_G)$$

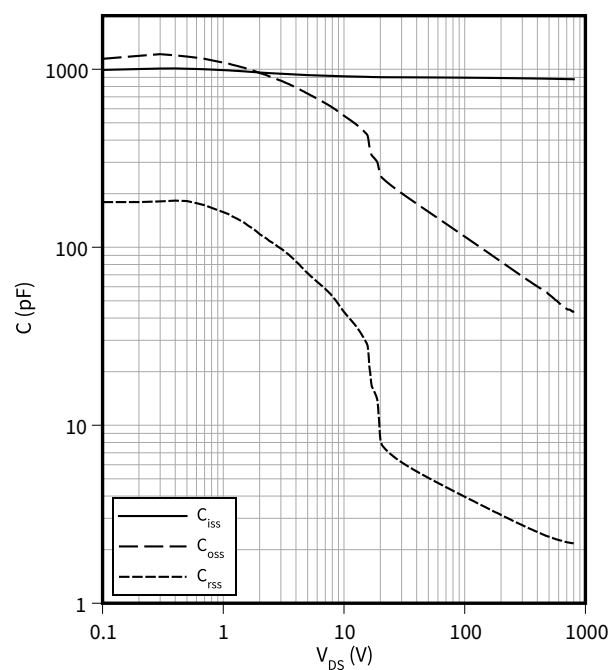
$I_D = 13 \text{ A}, V_{DS} = 800 \text{ V}$



Typical capacitance as a function of drain-source voltage

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

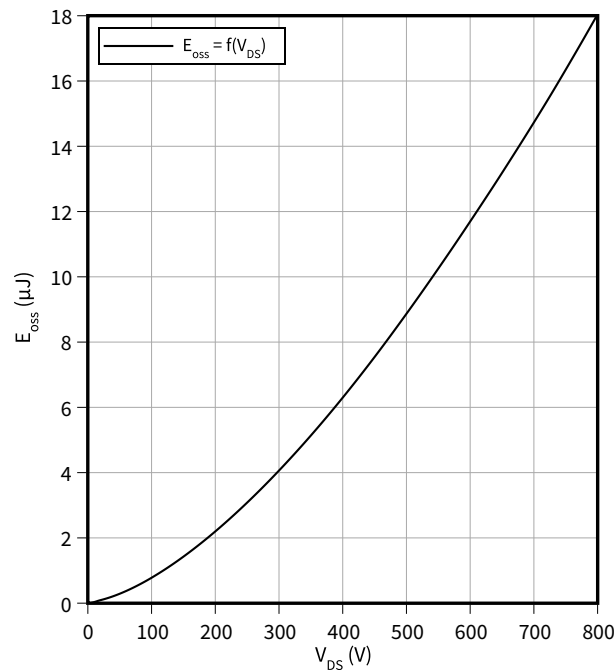
$f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$



Typical C_{OSS} stored energy

$$E_{OSS} = f(V_{DS})$$

$f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$

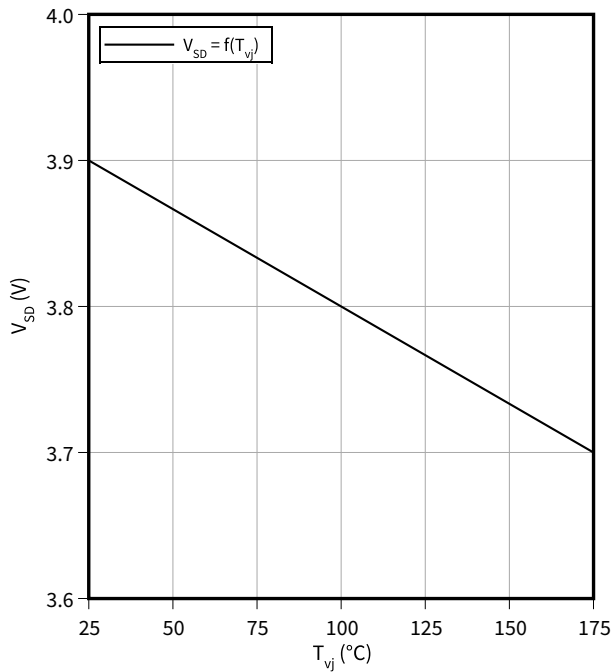


4 Characteristics diagrams

Typical reverse drain voltage as function of junction temperature

$$V_{SD} = f(T_{vj})$$

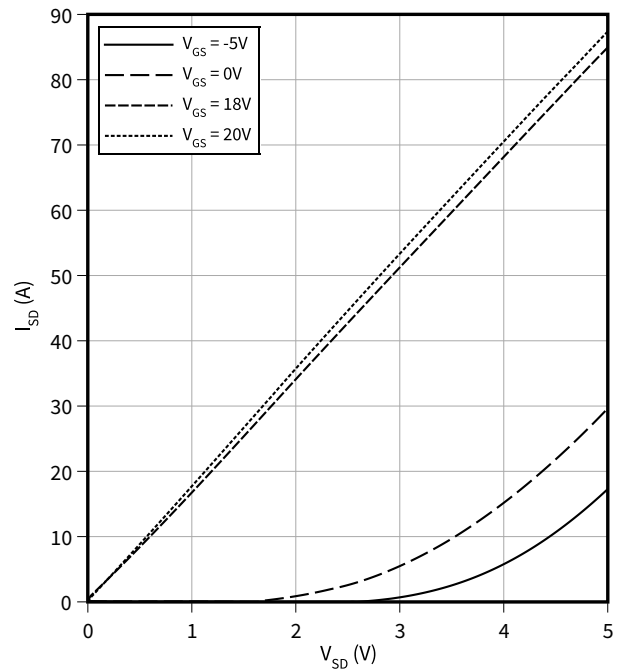
$$I_{SD} = 13 \text{ A}, V_{GS} = 0 \text{ V}$$



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

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

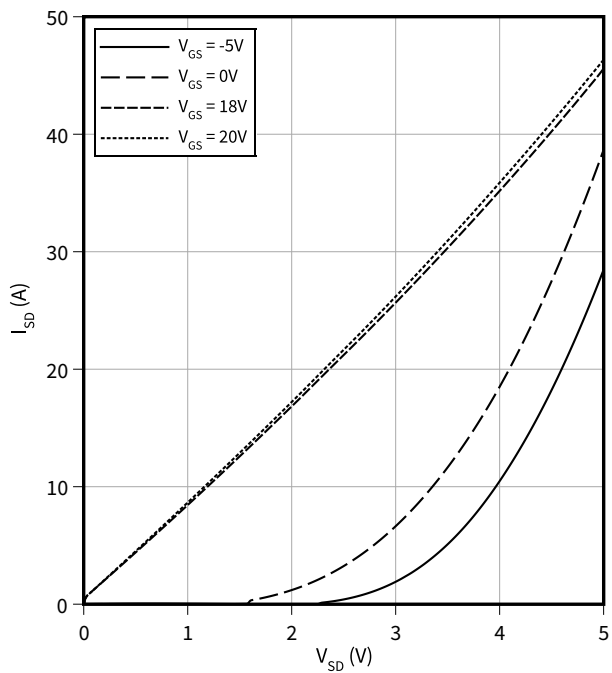
$$T_{vj} = 25 \text{ °C}, t_p = 20 \text{ } \mu\text{s}$$



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

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

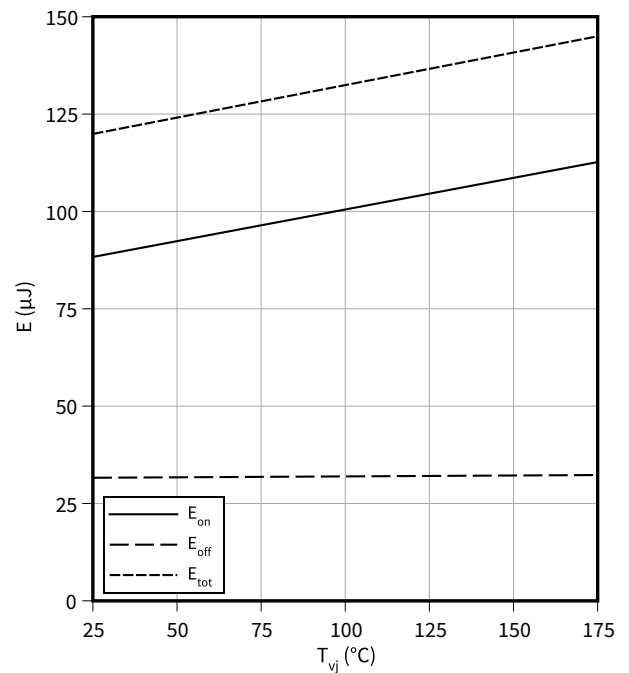
$$T_{vj} = 175 \text{ °C}, t_p = 20 \text{ } \mu\text{s}$$



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

$$E = f(T_{vj})$$

$$V_{GS} = 0/20 \text{ V}, I_D = 13 \text{ A}, R_{G,ext} = 2 \text{ } \Omega, V_{DD} = 800 \text{ V}$$

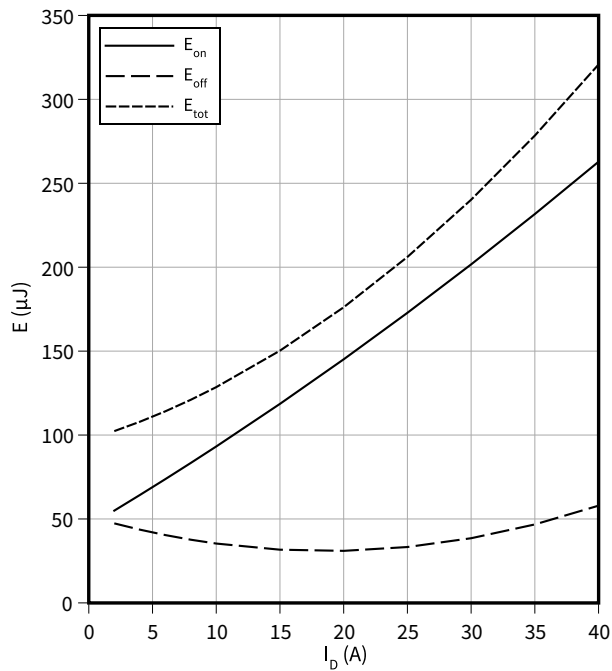


4 Characteristics diagrams

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

$E = f(I_D)$

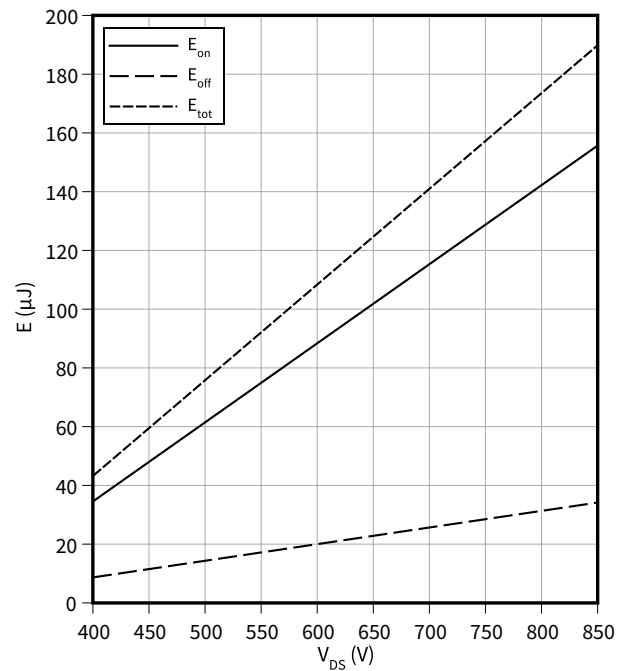
$V_{GS} = 0/20$ V, $T_{vj} = 175$ °C, $R_{G,ext} = 2$ Ω , $V_{DD} = 800$ V



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

$E = f(V_{DS})$

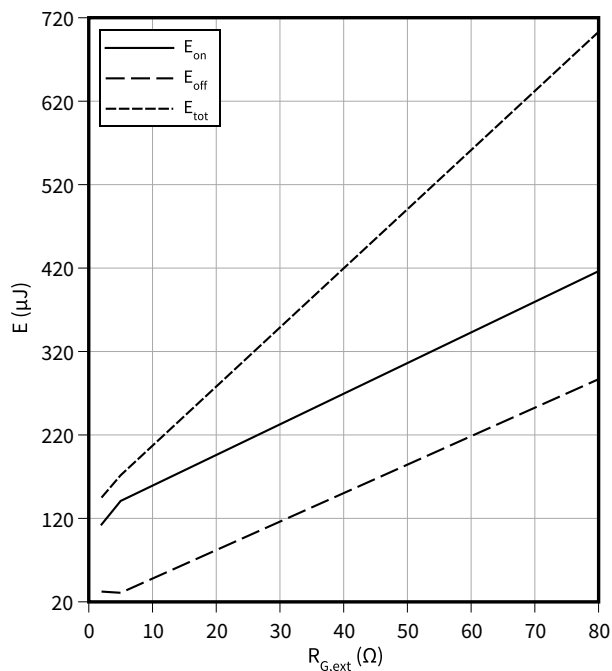
$V_{GS} = 0/20$ V, $I_D = 13$ A, $T_{vj} = 175$ °C, $R_{G,ext} = 2$ Ω



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

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

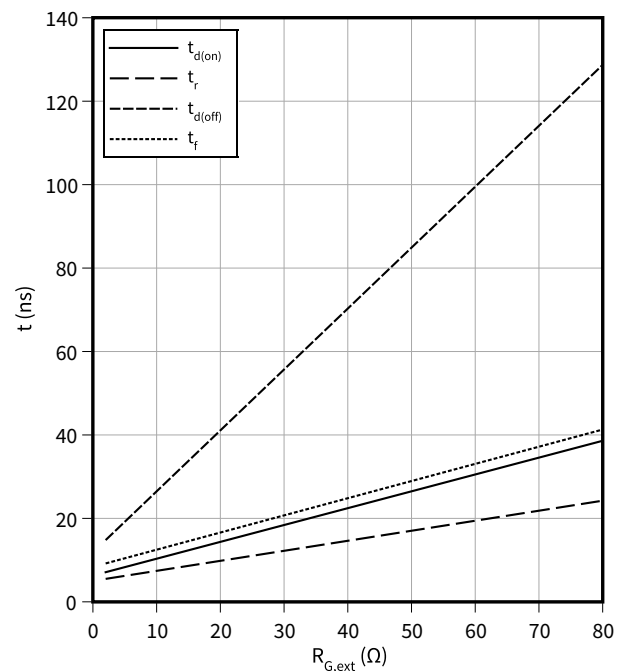
$V_{GS} = 0/20$ V, $I_D = 13$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



Typical switching times as a function of gate resistance

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

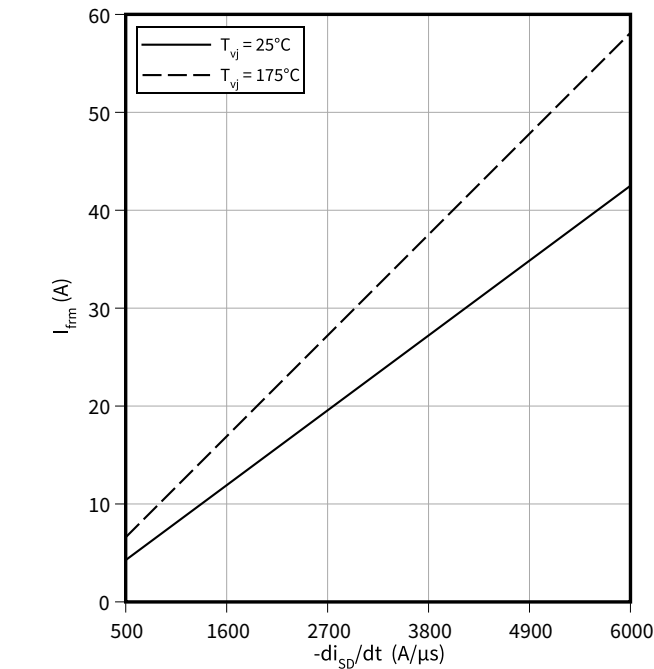
$V_{GS} = 0/20$ V, $I_D = 13$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



4 Characteristics diagrams

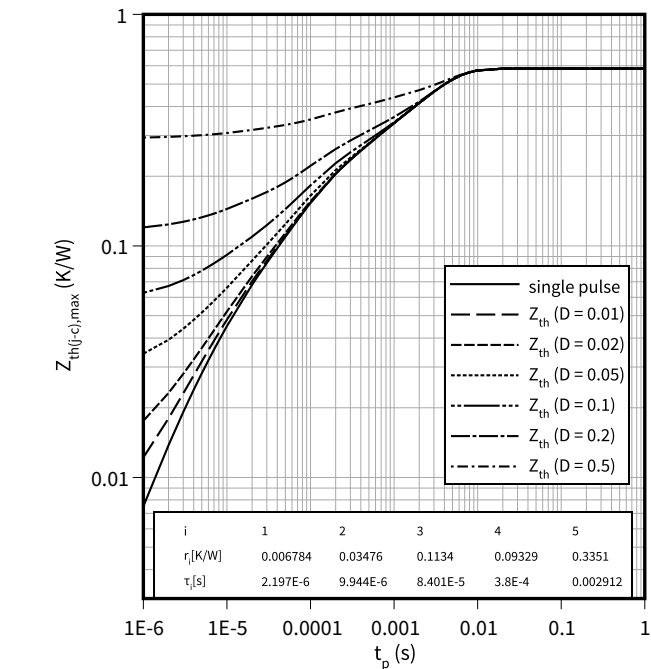
Typical MOSFET peak forward recovery current as a function of reverse drain current slope

$I_{frm} = f(-di_{SD}/dt)$
 $V_{GS} = 0/20\text{ V}, I_{SD} = 13\text{ A}, V_{DD} = 800\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

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



5 Package outlines

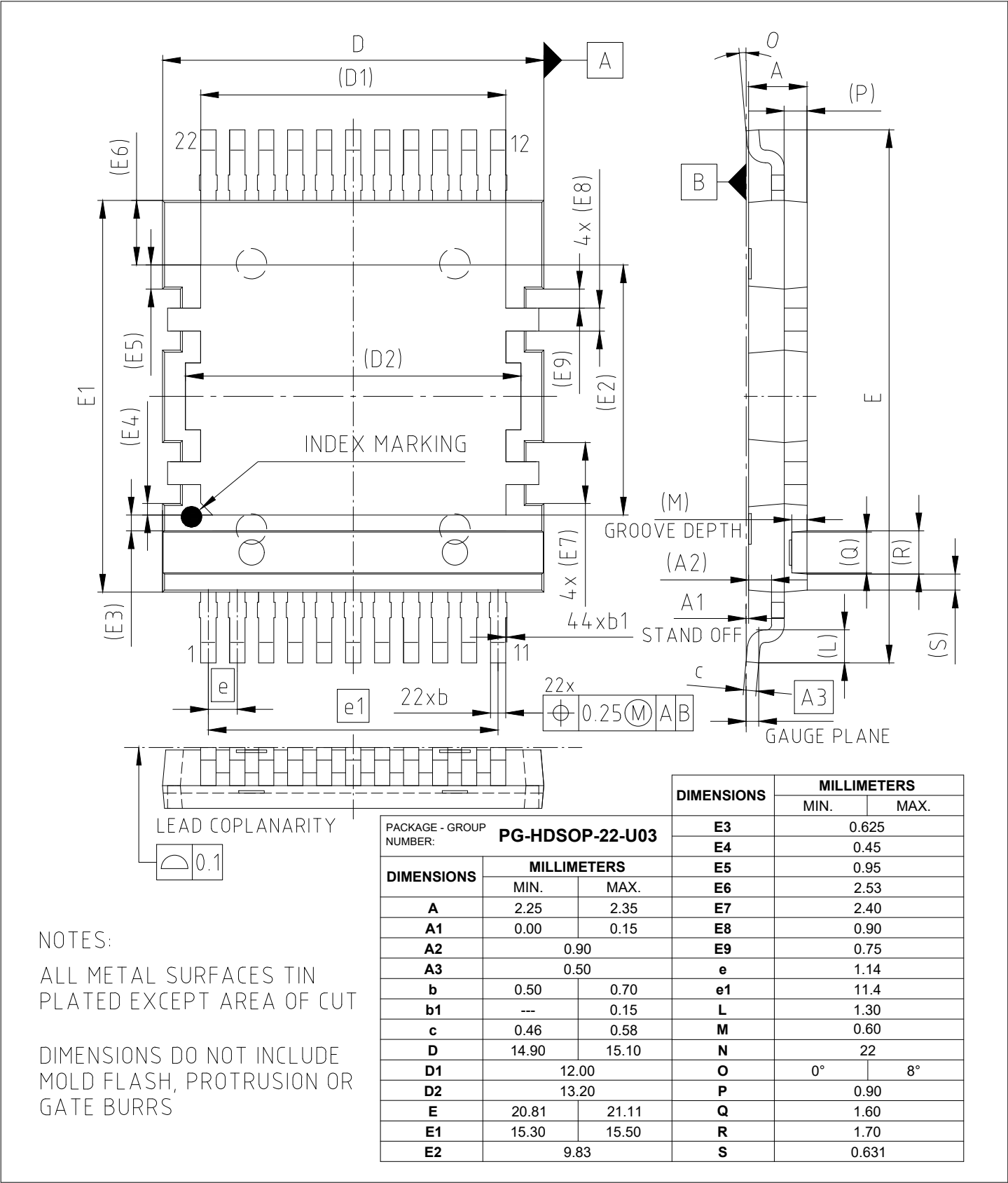


Figure 1

6 Testing conditions

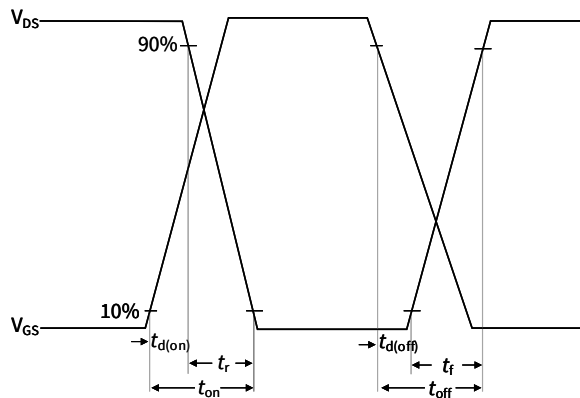


Figure A. Definition of switching times

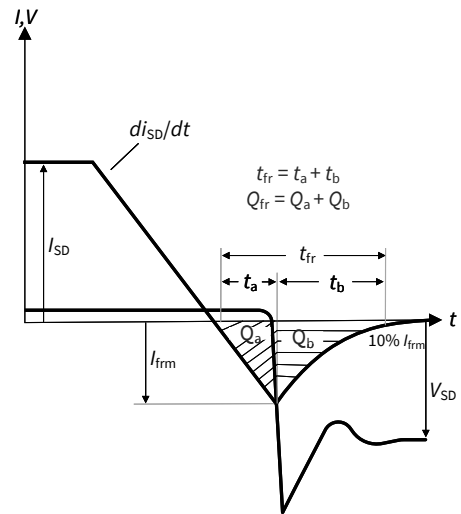


Figure B. Definition of body diode switching characteristics

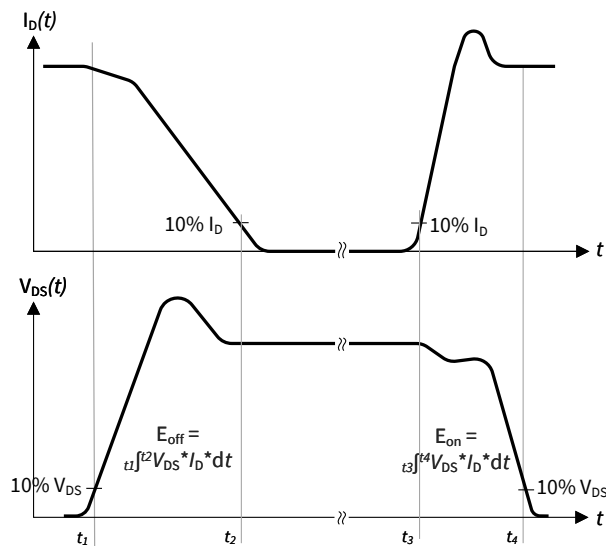


Figure C. Definition of switching losses

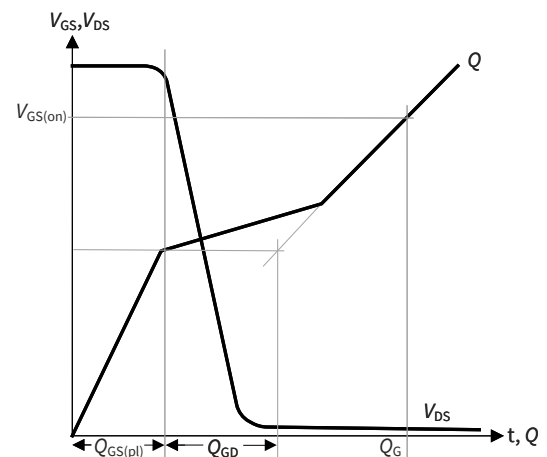


Figure D. Definition of Q_{GD}

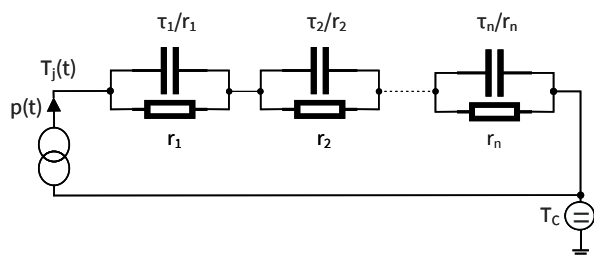


Figure E. Thermal equivalent circuit

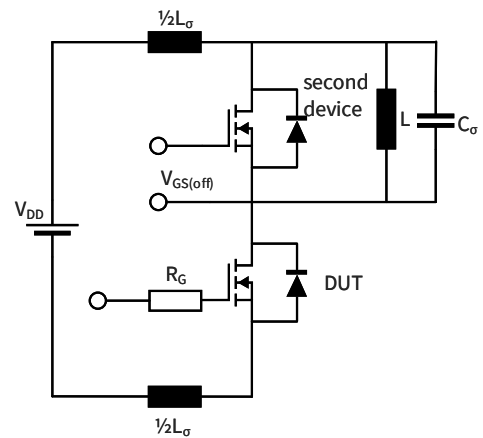


Figure F. Dynamic test circuit

Parasitic inductance L_σ ,
Parasitic capacitor C_σ ,

Figure 2



Revision history

Revision history

Document revision	Date of release	Description of changes
0.10	2023-01-17	Target datasheet
0.20	2024-05-02	Preliminary datasheet
1.00	2024-07-22	Final datasheet

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