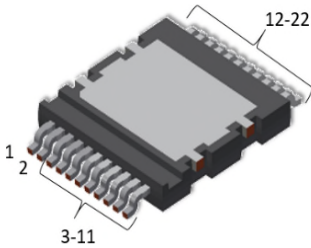


Final datasheet
CoolSiC™ Automotive MOSFET 1200 V in HDSOP-22-3 package

Features

- $V_{DS} = 1200\text{ V}$ at $T_{vj} = -55...175^{\circ}\text{C}$
- $I_{DC} = 24\text{ A}$ at $T_C = 25^{\circ}\text{C}$
- $R_{DS(on)} = 117\text{ m}\Omega$ at $V_{GS} = 20\text{ V}$, $T_{vj} = 25^{\circ}\text{C}$
- New performance-optimized chip technology (Gen1p) with improved $R_{DSon} \cdot A$
- 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



- Halogen-free
- AEC-Q100 Qualified
- Lead-free
- RoHS

Potential applications

- On-board charger
- DC/DC converter

Product validation

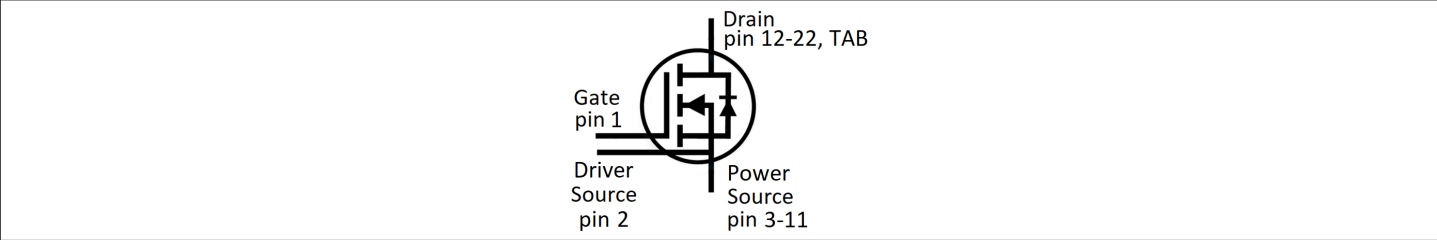
- Qualified for Automotive Applications. Product Validation according to AEC-Q100/101

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
AIMCQ120R120M1T	PG-HDSOP-22-3	12A120M1



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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 ¹⁾	$R_{th(j-c)}$			0.72	0.93	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}	$V_{GS} = 20\text{ V}$	$T_c = 25\text{ °C}$	24	A
			$T_c = 100\text{ °C}$	17	
Peak drain current, t_p limited by $T_{vj(max)}$ ²⁾	I_{DM}	$V_{GS} = 20\text{ V}$		61	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}	$I_D = 5.1\text{ A}$, $V_{DD} = 50\text{ V}$, $L = 7.02\text{ mH}$		92	mJ
Power dissipation, limited by $T_{vj(max)}$ ²⁾	P_{tot}		$T_c = 25\text{ °C}$	161	W
			$T_c = 100\text{ °C}$	81	

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	$R_{DS(on)}$	$I_D = 7\text{ A}$	$T_{vj} = 25\text{ °C}$, $V_{GS(on)} = 20\text{ V}$		117	150	mΩ
			$T_{vj} = 100\text{ °C}$, $V_{GS(on)} = 20\text{ V}$		164		
			$T_{vj} = 175\text{ °C}$, $V_{GS(on)} = 20\text{ V}$		234		
			$T_{vj} = 25\text{ °C}$, $V_{GS(on)} = 18\text{ V}$		126		
Gate-source threshold voltage	$V_{GS(th)}$	$I_D = 2.2\text{ mA}$, $V_{DS} = V_{GS}$ (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}	$V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		0.1	6	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}	$I_D = 7\text{ A}$, $V_{DS} = 20\text{ V}$			4.2		S
Short-circuit withstand time ¹⁾	t_{SC}	$V_{DD} \leq 800\text{ V}$, $V_{DS,peak} < 1200\text{ V}$, $T_{vj(start)} = 25\text{ °C}$, $R_{G,ext} = 5\text{ Ω}$	$V_{GS(on)} = 20\text{ V}$		1.5		μs
			$V_{GS(on)} = 18\text{ V}$		2		
			$V_{GS(on)} = 15\text{ V}$		2.5		
Internal gate resistance	$R_{G,int}$	$f = 1\text{ MHz}$, $V_{AC} = 25\text{ mV}$			3.6		Ω
Input capacitance	C_{iss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			458		pF
Output capacitance	C_{oss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			25		pF
Reverse transfer capacitance	C_{rss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			1		pF
C_{oss} stored energy	E_{oss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			10.5		μJ
Total gate charge	Q_G	$V_{DD} = 800\text{ V}$, $I_D = 7\text{ A}$, $V_{GS} = 0/20\text{ V}$, turn-on pulse			18		nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800\text{ V}$, $I_D = 7\text{ A}$, $V_{GS} = 0/20\text{ V}$, turn-on pulse			5		nC
Gate-to-drain charge	Q_{GD}	$V_{DD} = 800\text{ V}$, $I_D = 7\text{ A}$, $V_{GS} = 0/20\text{ V}$, turn-on pulse			3		nC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{ V}$, $I_D = 7\text{ A}$, $V_{GS} = 0/20\text{ V}$, $R_{G,ext} = 5\text{ Ω}$, $L_\sigma = 13\text{ nH}$, diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		6.2		ns
			$T_{vj} = 175\text{ °C}$		6.5		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time	t_r	$V_{DD} = 800 \text{ V}$, $I_D = 7 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 5 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	3.9		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	4.2		
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800 \text{ V}$, $I_D = 7 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 5 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	10.4		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	11.6		
Fall time	t_f	$V_{DD} = 800 \text{ V}$, $I_D = 7 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 5 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	15		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	16.2		
Turn-on energy	E_{on}	$V_{DD} = 800 \text{ V}$, $I_D = 7 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 5 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	54.7		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	64.6		
Turn-off energy	E_{off}	$V_{DD} = 800 \text{ V}$, $I_D = 7 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 5 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	26.7		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	26.1		
Total switching energy	E_{tot}	$V_{DD} = 800 \text{ V}$, $I_D = 7 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{G,ext} = 5 \Omega$, $L_\sigma = 13 \text{ nH}$, diode: body diode at $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	81.4		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	90.7		
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}	$T_{vj} = -55...175 \text{ }^\circ\text{C}$	1200	V
Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$ ²⁾	I_{SDC}	$V_{GS} = 0 \text{ V}$	$T_c = 25 \text{ }^\circ\text{C}$	A
			$T_c = 100 \text{ }^\circ\text{C}$	
Peak reverse drain current, t_p limited by $T_{vj(max)}$ ²⁾	I_{SM}	$V_{GS} = 0 \text{ V}$	15.4	A

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

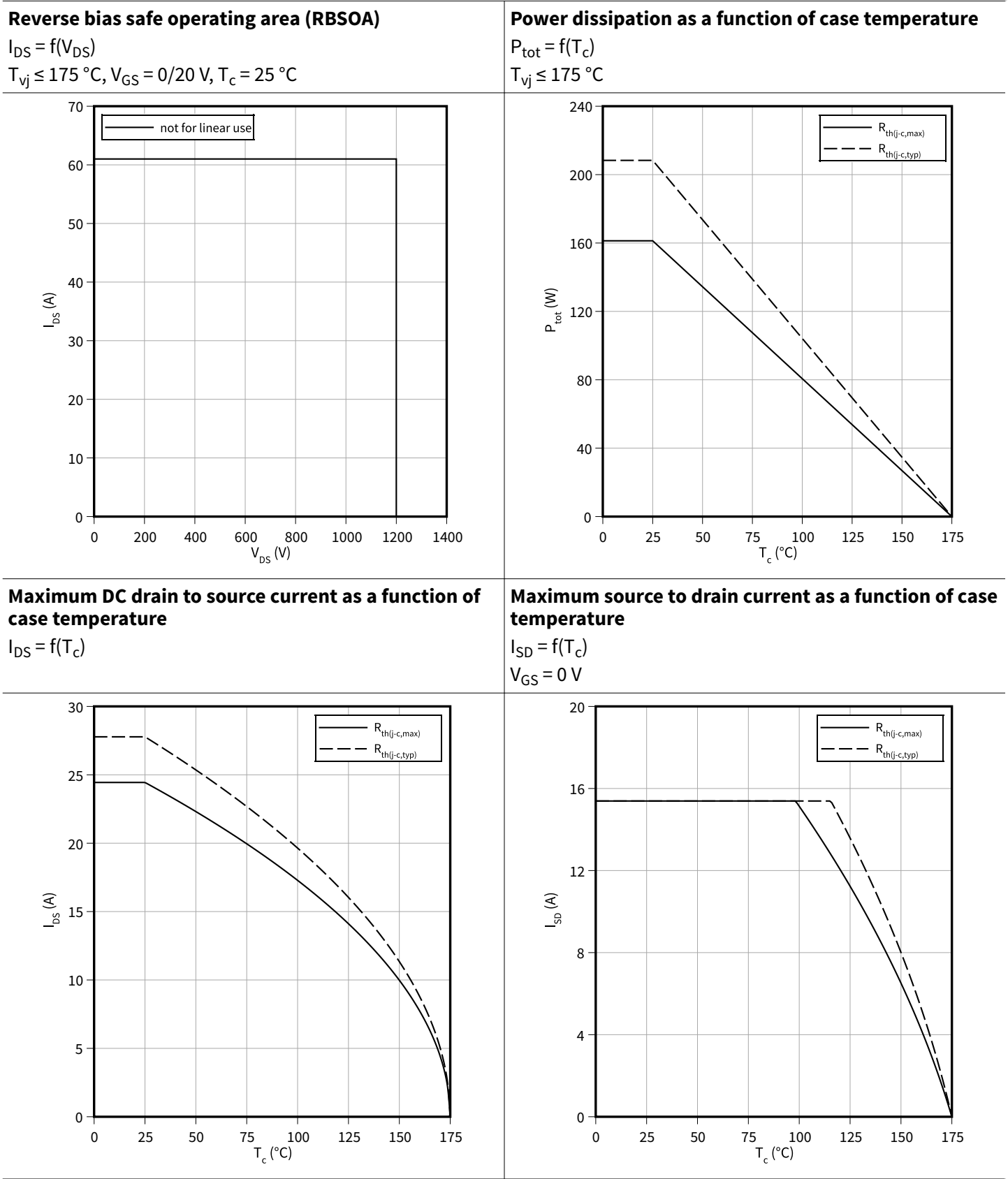
3 Body diode (MOSFET)

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}	$I_{SD} = 7 \text{ A}$, $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		3.9	5	V
			$T_{vj} = 100 \text{ °C}$		3.8		
			$T_{vj} = 175 \text{ °C}$		3.7		
MOSFET forward recovery charge	Q_{fr}	$V_{DD} = 800 \text{ V}$, $I_{SD} = 7 \text{ A}$, $V_{GS} = 0 \text{ V}$, $-di_{SD}/dt = 1000 \text{ A}/\mu\text{s}$, Q_{fr} includes also Q_C	$T_{vj} = 25 \text{ °C}$		114		nC
			$T_{vj} = 175 \text{ °C}$		148		
MOSFET peak forward recovery current	I_{frm}	$V_{DD} = 800 \text{ V}$, $I_{SD} = 7 \text{ A}$, $V_{GS} = 0 \text{ V}$, $-di_{SD}/dt = 1000 \text{ A}/\mu\text{s}$, Q_{fr} includes also Q_C	$T_{vj} = 25 \text{ °C}$		7.2		A
			$T_{vj} = 175 \text{ °C}$		8		
Virtual junction temperature	T_{vj}			-55		175	°C

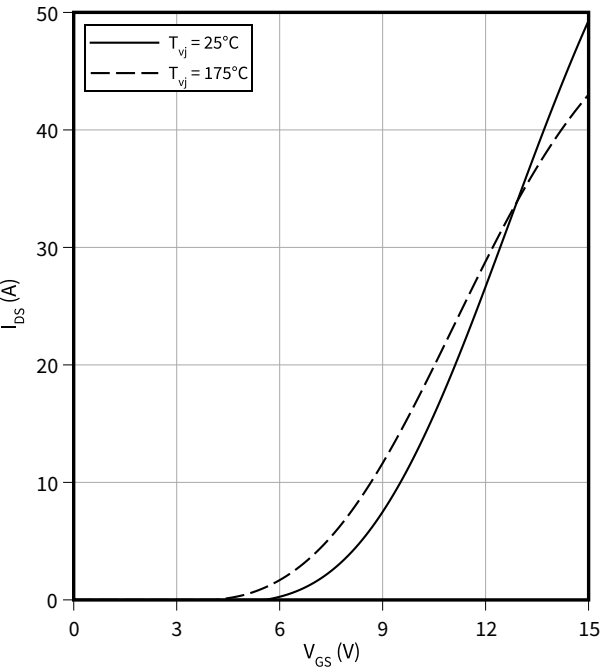
4 Characteristics diagrams



4 Characteristics diagrams

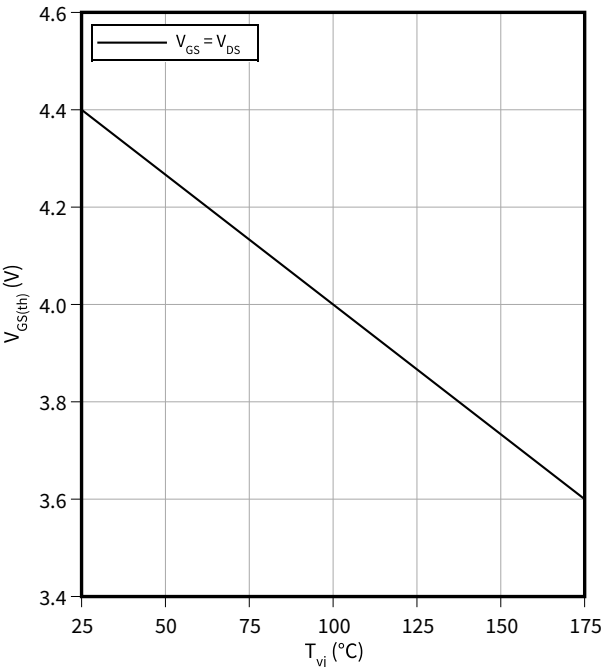
Typical transfer characteristic

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



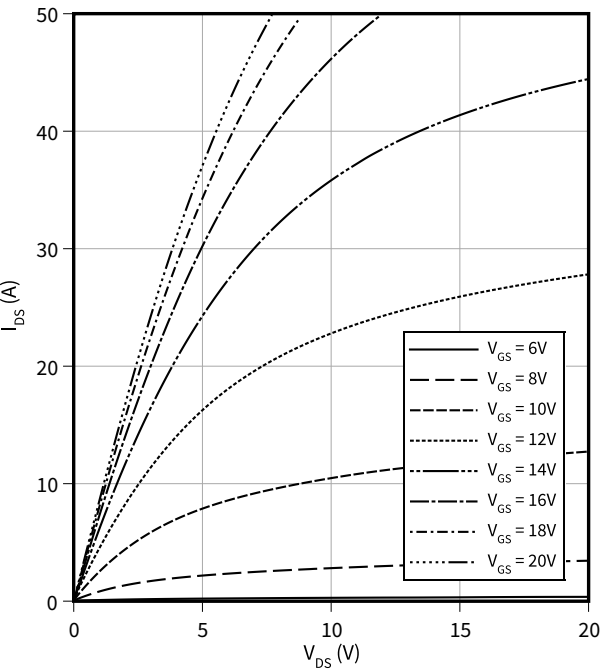
Typical gate-source threshold voltage as a function of junction temperature

$V_{GS(th)} = f(T_{vj})$
 $I_D = 2.2\text{ mA}$



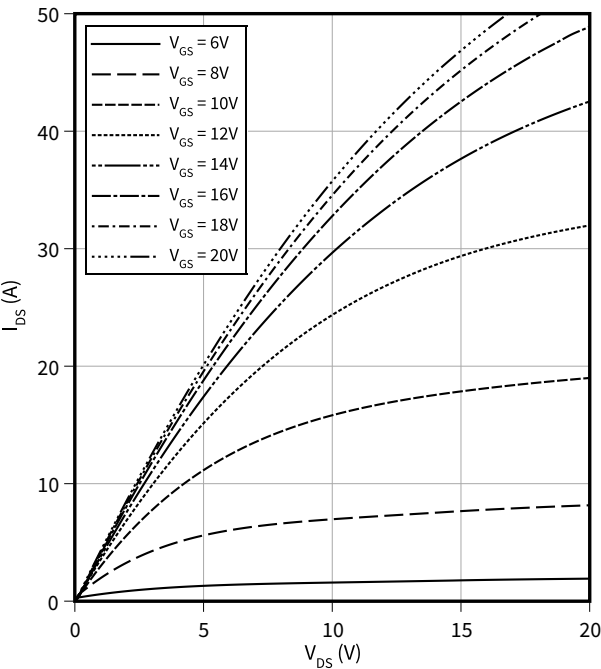
Typical output characteristic, V_{GS} as parameter

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



Typical output characteristic, V_{GS} as parameter

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

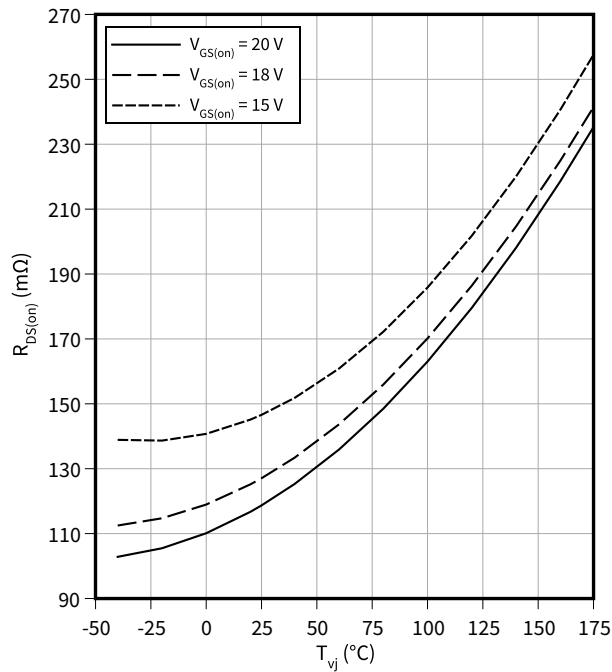


4 Characteristics diagrams

Typical on-state resistance as a function of junction temperature

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

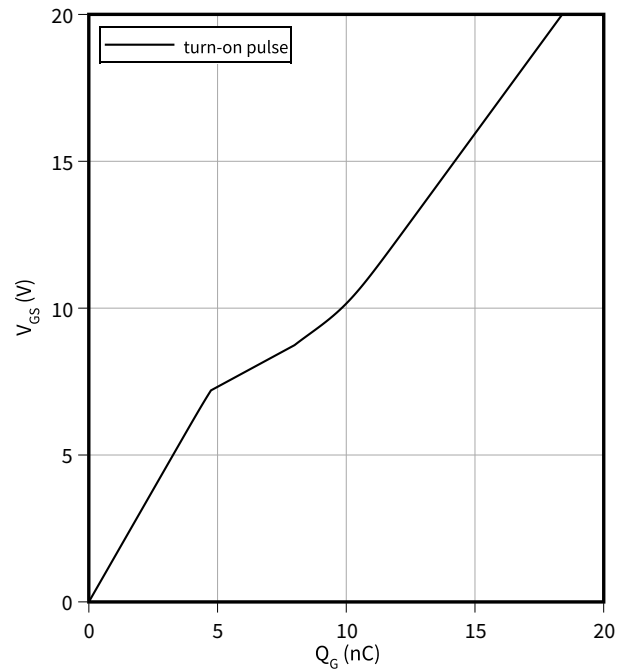
$$I_D = 7 \text{ A}$$



Typical gate charge

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

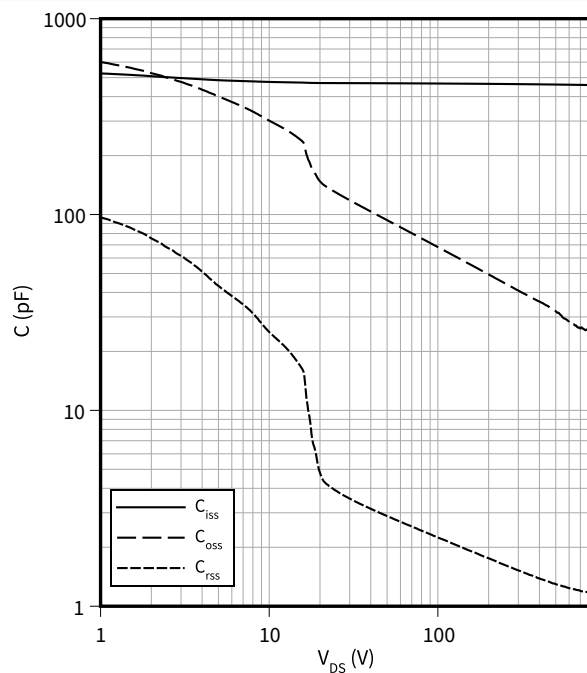
$$I_D = 7 \text{ A}, V_{DS} = 800 \text{ V}$$



Typical capacitance as a function of drain-source voltage

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

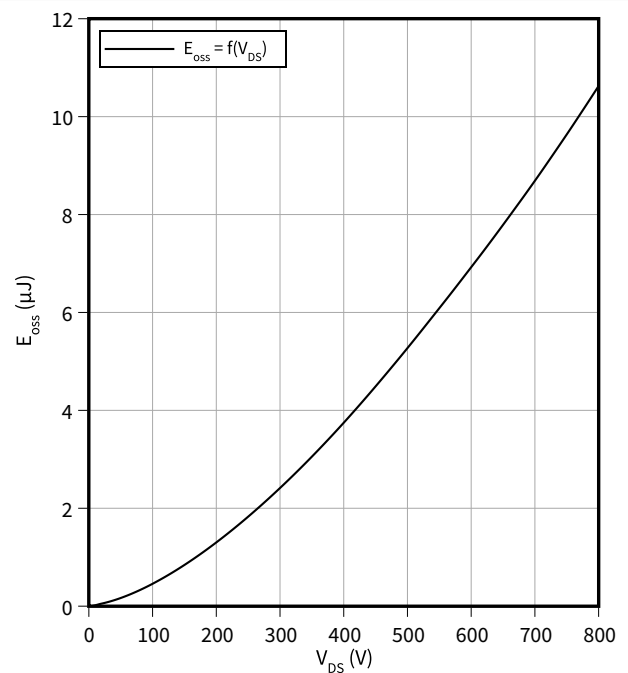
$$f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$$



Typical C_{oss} stored energy

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

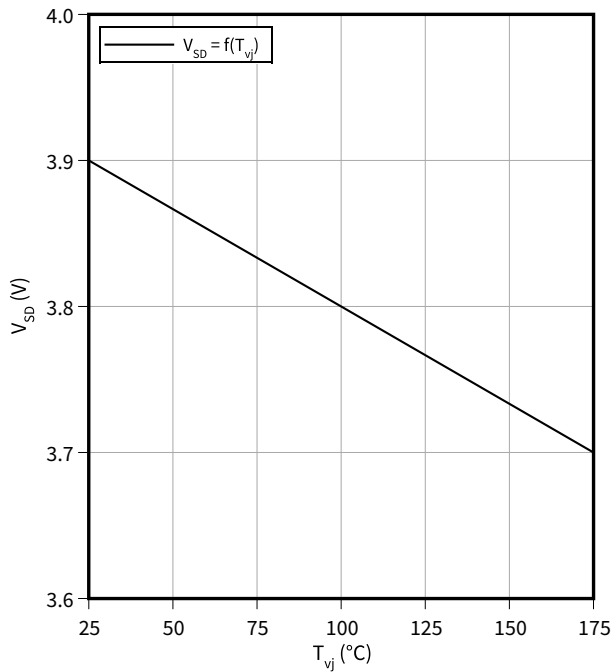
$$f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$$



4 Characteristics diagrams

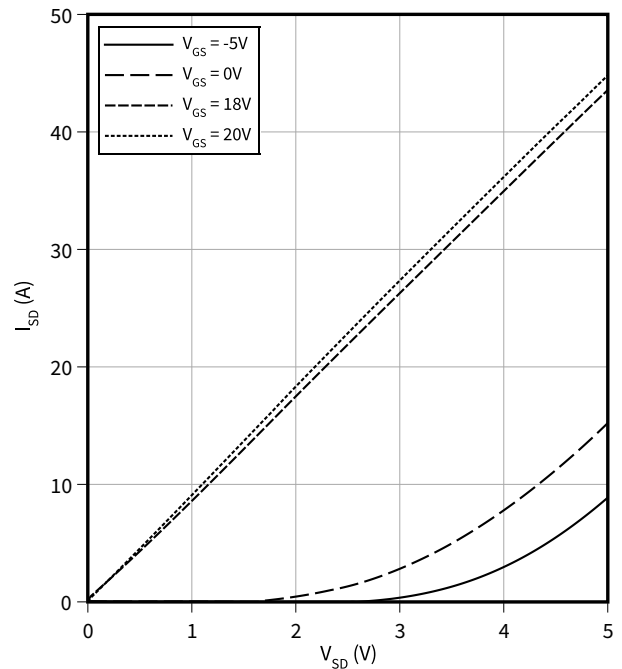
Typical reverse drain voltage as function of junction temperature

$V_{SD} = f(T_{vj})$
 $I_{SD} = 7 \text{ A}$, $V_{GS} = 0 \text{ V}$



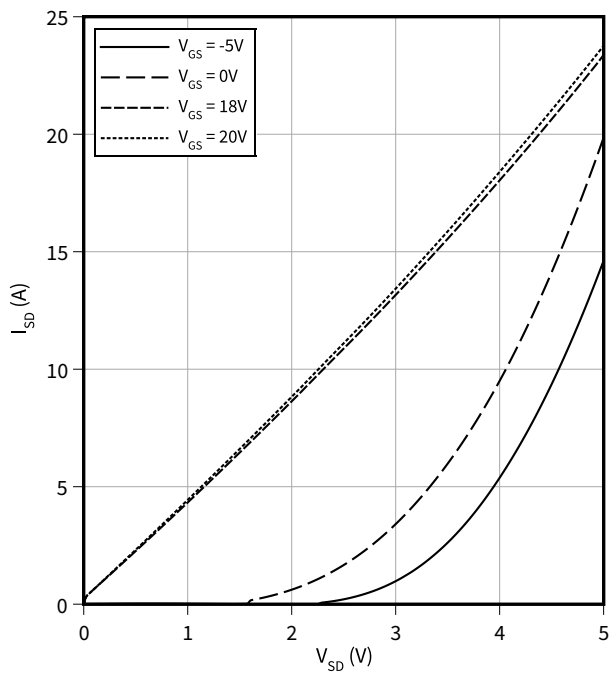
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

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



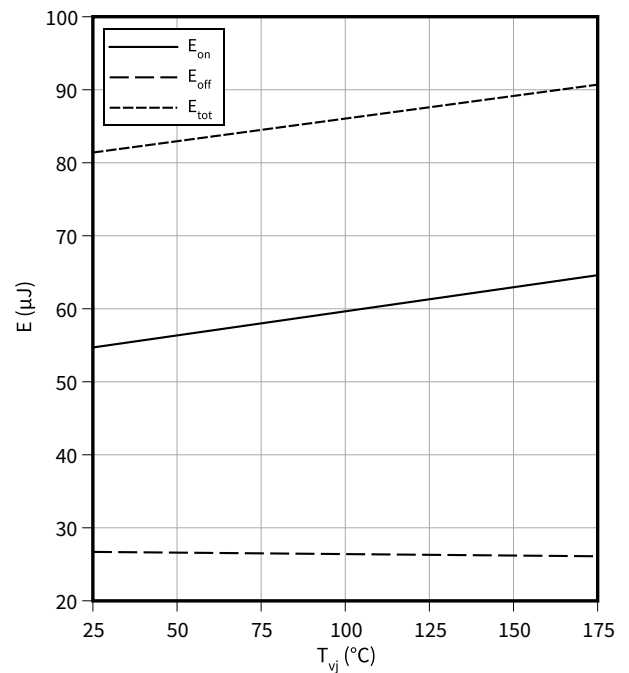
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

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



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

$E = f(T_{vj})$
 $V_{GS} = 0/20 \text{ V}$, $I_D = 7 \text{ A}$, $R_{G,ext} = 5 \text{ } \Omega$, $V_{DD} = 800 \text{ V}$

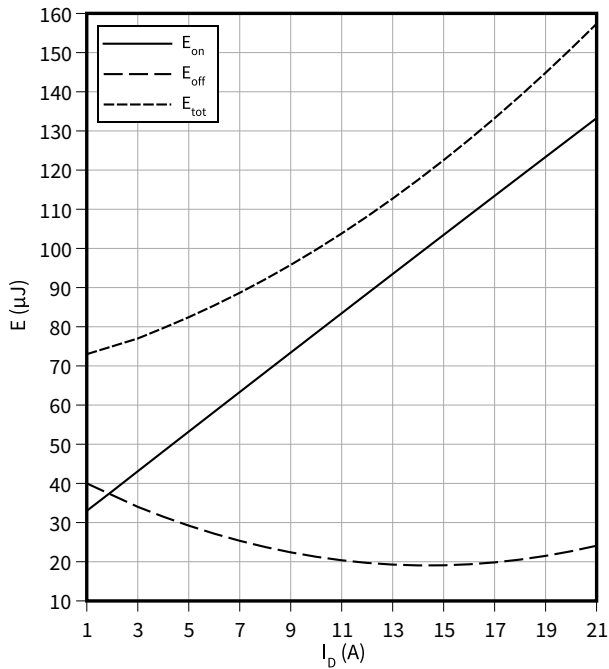


4 Characteristics diagrams

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

$$E = f(I_D)$$

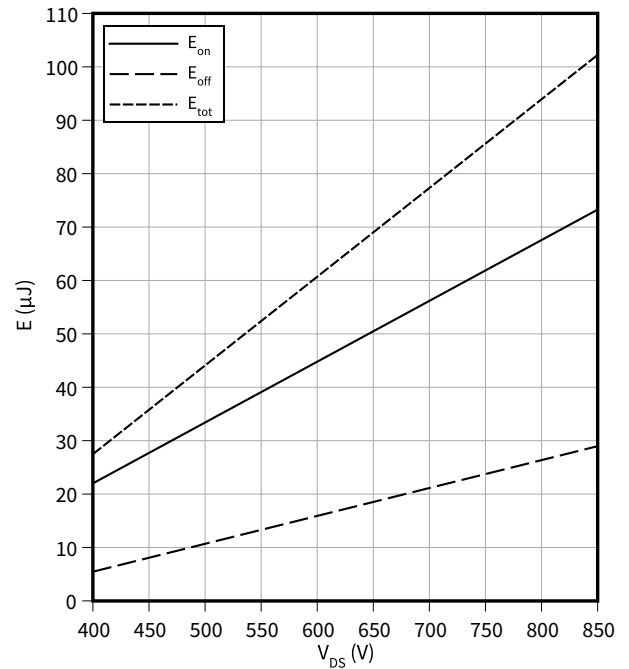
$V_{GS} = 0/20$ V, $T_{vj} = 175$ °C, $R_{G,ext} = 5$ Ω , $V_{DD} = 800$ V



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

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

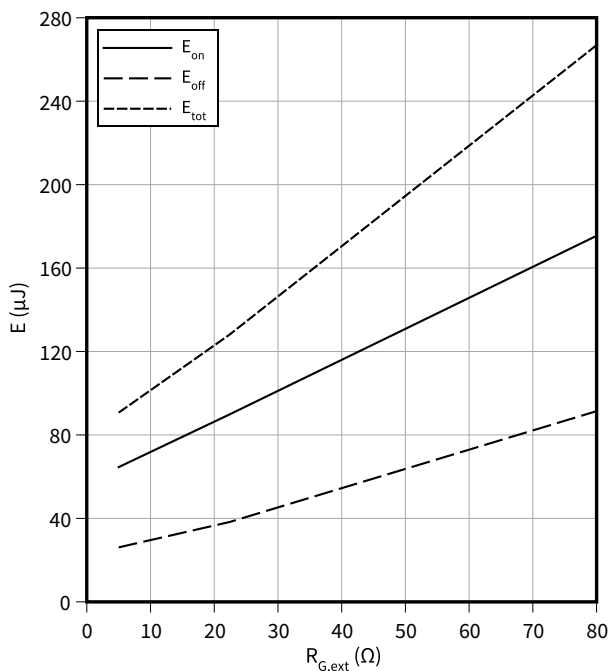
$V_{GS} = 0/20$ V, $I_D = 7$ A, $T_{vj} = 175$ °C, $R_{G,ext} = 5$ Ω



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

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

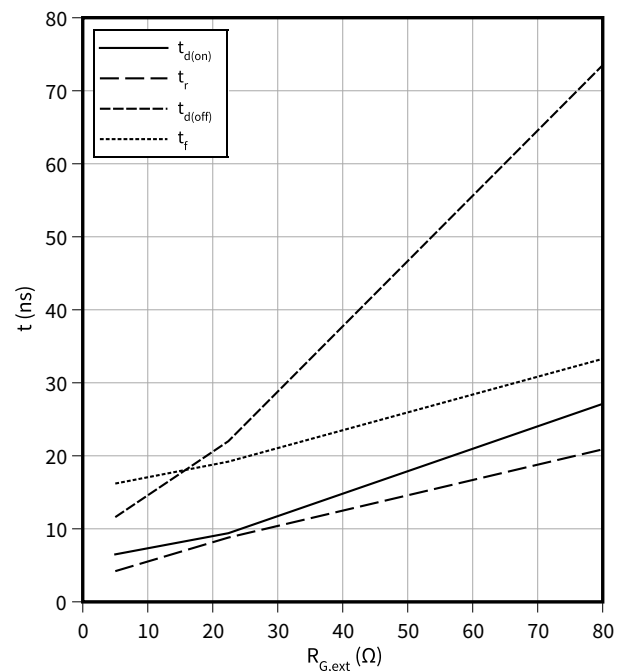
$V_{GS} = 0/20$ V, $I_D = 7$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



Typical switching times as a function of gate resistance

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

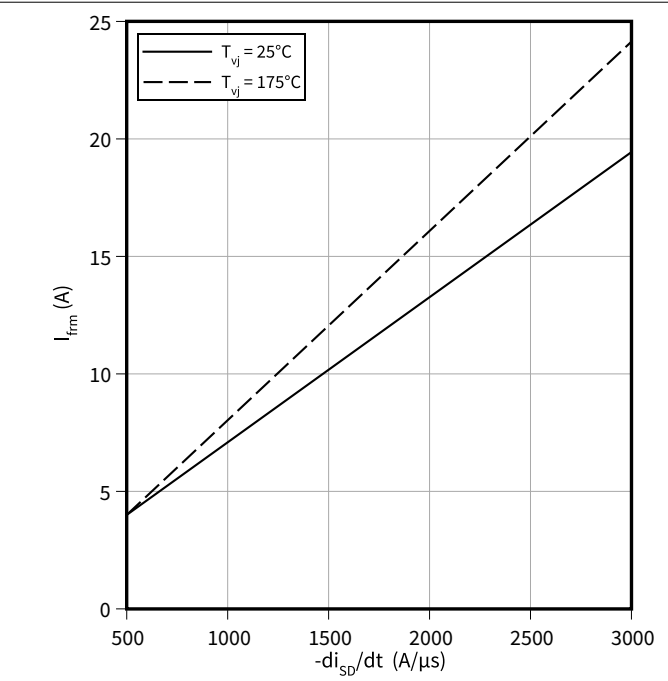
$V_{GS} = 0/20$ V, $I_D = 7$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



4 Characteristics diagrams

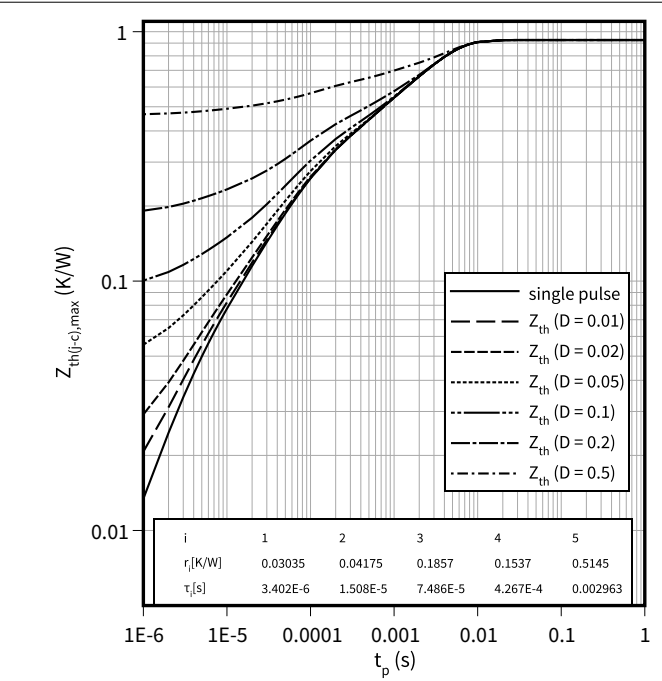
Typical MOSFET peak forward recovery current as a function of reverse drain current slope

$I_{frm} = f(-di_{SD}/dt)$
 $V_{GS} = 0/20\text{ V}, I_{SD} = 7\text{ A}, V_{DD} = 800\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

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



5 Package outlines

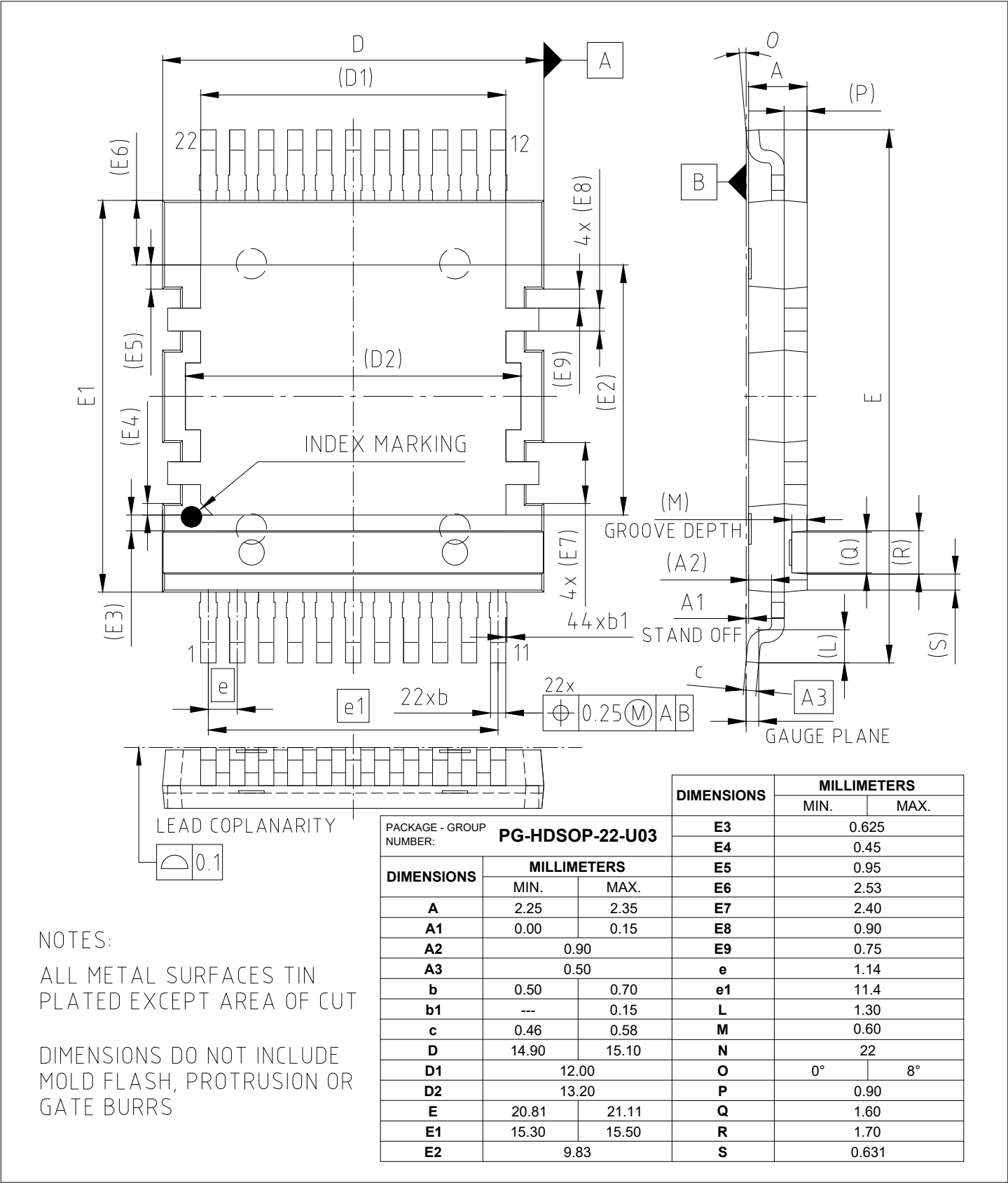


Figure 1

6 Testing conditions

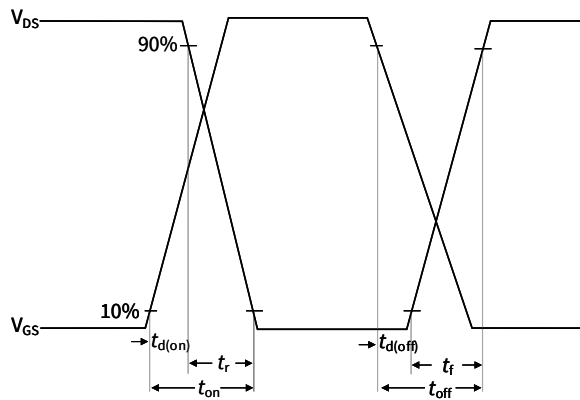


Figure A. Definition of switching times

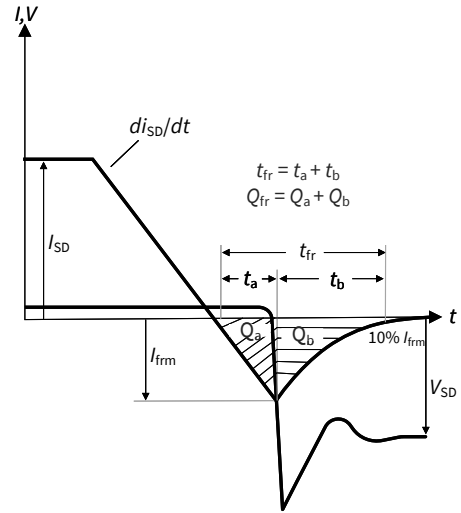


Figure B. Definition of body diode switching characteristics

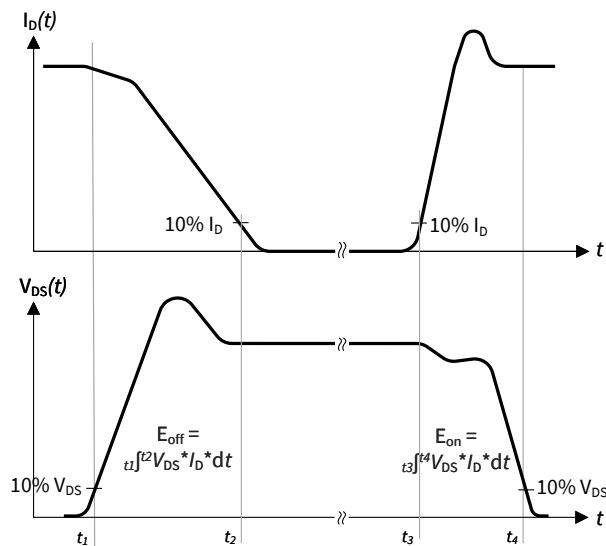


Figure C. Definition of switching losses

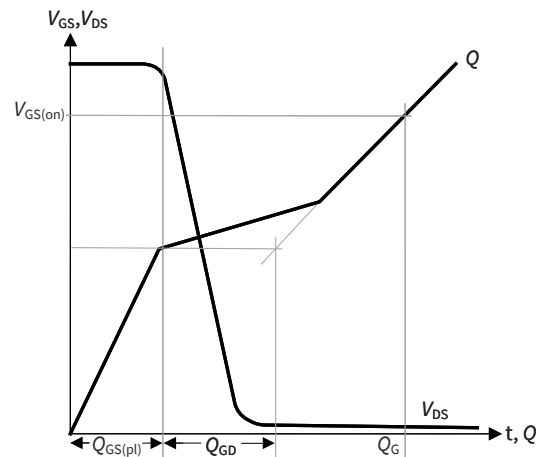


Figure D. Definition of QGD

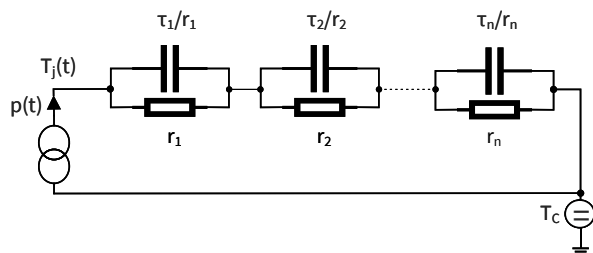


Figure E. Thermal equivalent circuit

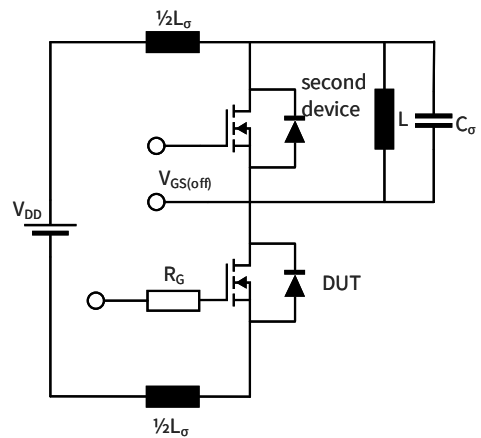


Figure F. Dynamic test circuit

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



Revision history

Revision history

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

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