

Final datasheet

CoolSiC™ 1200 V SiC Trench MOSFET

Features

- $V_{DS} = 1200\text{ V}$ at $T_{vj} = -55...175^{\circ}\text{C}$
- $I_{DC} = 55\text{ A}$ at $T_C = 25^{\circ}\text{C}$
- $R_{DS(on)} = 40\text{ m}\Omega$ at $V_{GS} = 20\text{ V}$, $T_{vj} = 25^{\circ}\text{C}$
- New performance-optimized chip technology (Gen1p) with improved $R_{DS(on)}$ * A FOM
- Increased recommended turn-on voltage ($V_{GS(on)} = 20\text{ V}$) for lower $R_{DS(on)}$
- 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
- .XT die attach technology for best in class thermal performance
- Sense pin for optimized switching performance
- Suitable for HV creepage requirements

Potential applications

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

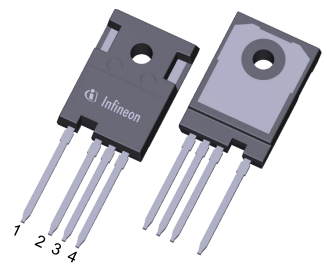
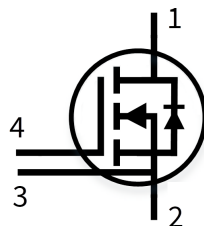
Product validation

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

Description

Pin definition:

- 1 – drain
- 2 – source
- 3 – Kelvin sense contact
- 4 – gate



Type	Package	Marking
AIMZHN120R040M1T	PG-TO247-4-STD-NN6.7	A12M1N040



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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	$R_{th(j-c)}$			0.43	0.56	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}	$V_{GS} = 20\text{ V}$	$T_c = 25\text{ °C}$	55	A
			$T_c = 100\text{ °C}$	39	
Peak drain current, t_p limited by $T_{vj(max)}$	I_{DM}	$V_{GS} = 20\text{ V}$		140	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}	$I_D = 15\text{ A}$, $V_{DD} = 50\text{ V}$, $L = 2.41\text{ mH}$		269	mJ
Power dissipation, limited by $T_{vj(max)}$	P_{tot}		$T_c = 25\text{ °C}$	268	W
			$T_c = 100\text{ °C}$	134	

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	$R_{DS(on)}$	$I_D = 20 \text{ A}$	$T_{vj} = 25 \text{ °C}$, $V_{GS(on)} = 20 \text{ V}$		40	50	mΩ
			$T_{vj} = 100 \text{ °C}$, $V_{GS(on)} = 20 \text{ V}$		56		
			$T_{vj} = 175 \text{ °C}$, $V_{GS(on)} = 20 \text{ V}$		80		
			$T_{vj} = 25 \text{ °C}$, $V_{GS(on)} = 18 \text{ V}$		44		
Gate-source threshold voltage	$V_{GS(th)}$	$I_D = 6.4 \text{ mA}$, $V_{DS} = V_{GS}$ (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}	$V_{DS} = 1200 \text{ V}$, $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		0.3	19	μA
			$T_{vj} = 175 \text{ °C}$		50		
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}	$I_D = 20 \text{ A}$, $V_{DS} = 20 \text{ V}$			12		S
Short-circuit withstand time ¹⁾	t_{SC}	$V_{DD} \leq 800 \text{ V}$, $V_{DS,peak} \leq 1200 \text{ V}$, $T_{vj(start)} = 25 \text{ °C}$, $R_{G,ext} = 2 \text{ } \Omega$	$V_{GS(on)} = 20 \text{ V}$		1.5		μs
			$V_{GS(on)} = 18 \text{ V}$		2		
			$V_{GS(on)} = 15 \text{ V}$		2.5		
Internal gate resistance	$R_{G,int}$	$f = 1 \text{ MHz}$, $V_{AC} = 25 \text{ mV}$			3.7		Ω
Input capacitance	C_{iss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			1264		pF
Output capacitance	C_{oss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			63		pF
Reverse transfer capacitance	C_{rss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			3.6		pF
C_{oss} stored energy	E_{oss}	$V_{DD} = 800 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$			40		μJ
Total gate charge	Q_G	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, turn-on pulse			43		nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, turn-on pulse			12		nC
Gate-to-drain charge	Q_{GD}	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, turn-on pulse			7		nC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \text{ } \Omega$, $R_{GS(off)} = 2 \text{ } \Omega$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ °C}$		10		ns
			$T_{vj} = 175 \text{ °C}$		10		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time	t_r	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	7		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	10		
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	20		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	22		
Fall time	t_f	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	8		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	8		
Turn-on energy	E_{on}	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	112		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	181		
Turn-off energy	E_{off}	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	56		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	64		
Total switching energy	E_{tot}	$V_{DD} = 800 \text{ V}$, $I_D = 20 \text{ A}$, $V_{GS} = 0/20 \text{ V}$, $R_{GS(on)} = 2 \Omega$, $R_{GS(off)} = 2 \Omega$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	168		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	245		
Virtual junction temperature	T_{vj}		-55		175	$^\circ\text{C}$

1) verified by the design/characterization

Note: Dynamic test circuit see Fig. F.

3 Body diode (MOSFET)

Table 5 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Drain-source voltage	V_{DSS}	$T_{vj} = -55...175 \text{ }^\circ\text{C}$	1200	V
Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$	I_{SDC}	$V_{GS} = 0 \text{ V}$	$T_c = 25 \text{ }^\circ\text{C}$	A
			$T_c = 100 \text{ }^\circ\text{C}$	
Peak reverse drain current, t_p limited by $T_{vj(max)}$	I_{SM}	$V_{GS} = 0 \text{ V}$	45	A

Table 6 Characteristic values

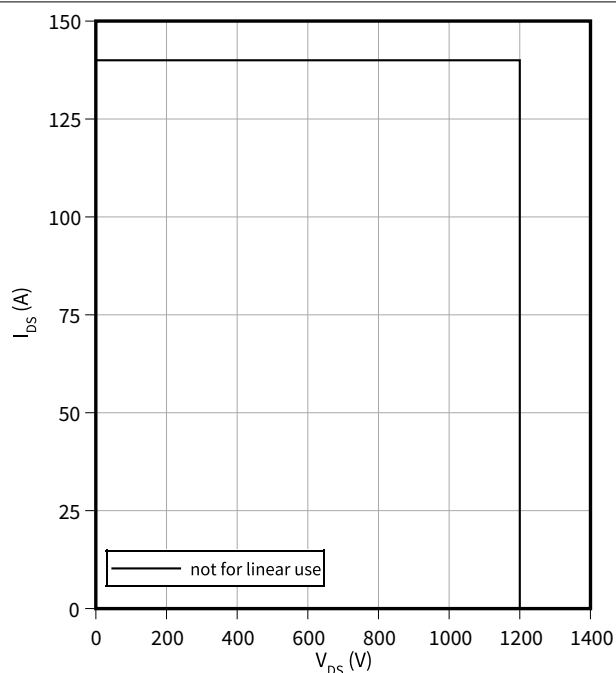
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source reverse voltage	V_{SD}	$I_{SD} = 20 \text{ A}$, $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		3.9	5	V
			$T_{vj} = 100 \text{ °C}$		3.8		
			$T_{vj} = 175 \text{ °C}$		3.7		
MOSFET forward recovery charge	Q_{fr}	$V_{DD} = 800 \text{ V}$, $I_{SD} = 20 \text{ A}$, $V_{GS} = 0 \text{ V}$, $di_{SD}/dt = 3000 \text{ A}/\mu\text{s}$, Q_{fr} includes also Q_C	$T_{vj} = 25 \text{ °C}$		135		nC
			$T_{vj} = 175 \text{ °C}$		350		
MOSFET peak forward recovery current	I_{frm}	$V_{DD} = 800 \text{ V}$, $I_{SD} = 20 \text{ A}$, $V_{GS} = 0 \text{ V}$, $di_{SD}/dt = 3000 \text{ A}/\mu\text{s}$, Q_{fr} includes also Q_C	$T_{vj} = 25 \text{ °C}$		9		A
			$T_{vj} = 175 \text{ °C}$		17		
Virtual junction temperature	T_{vj}			-55		175	°C

4 Characteristics diagrams

Reverse bias safe operating area (RBSOA)

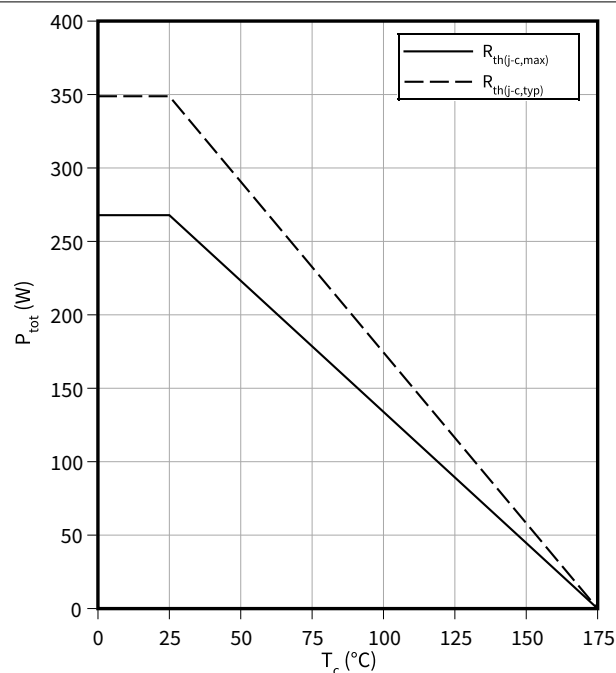
$$I_{DS} = f(V_{DS})$$

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



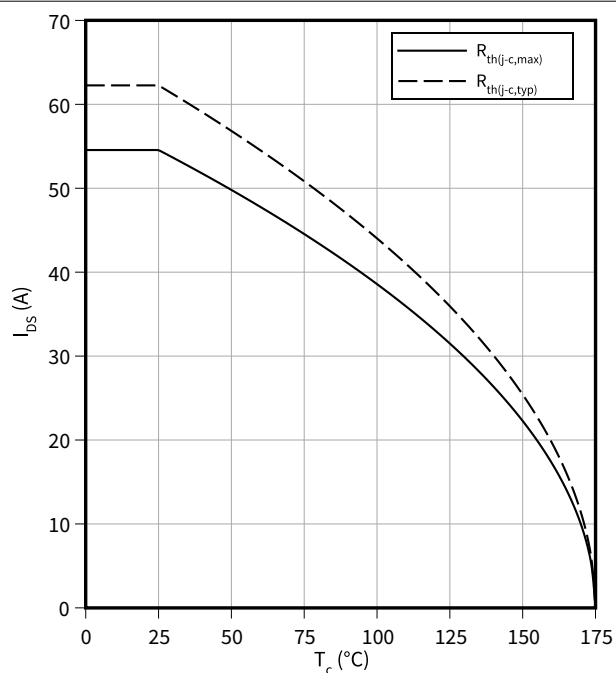
Power dissipation as a function of case temperature

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



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

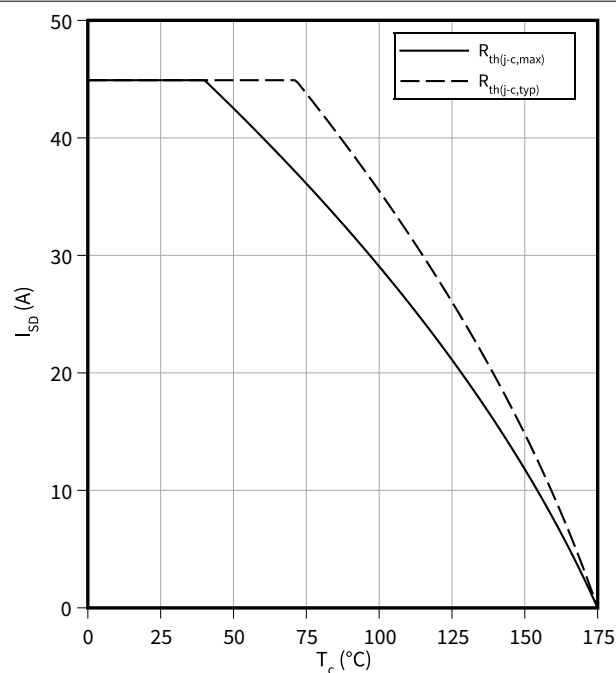
$$I_{DS} = f(T_c)$$



Maximum source to drain current as a function of case temperature

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

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

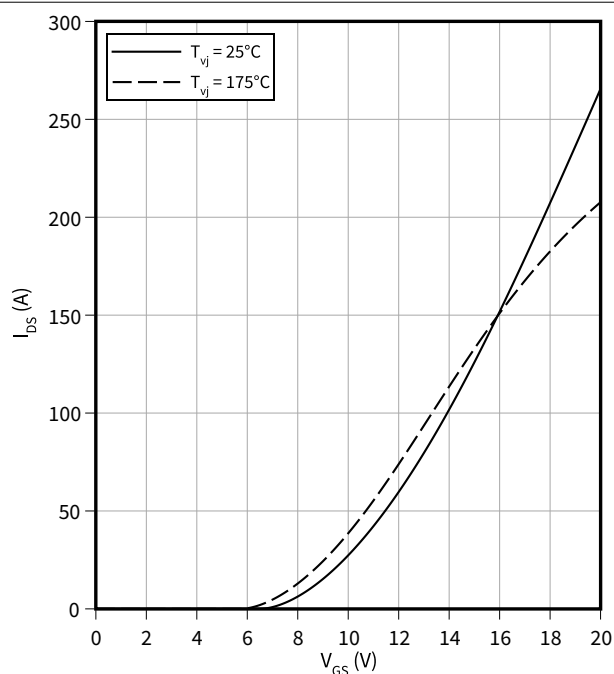


4 Characteristics diagrams

Typical transfer characteristic

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

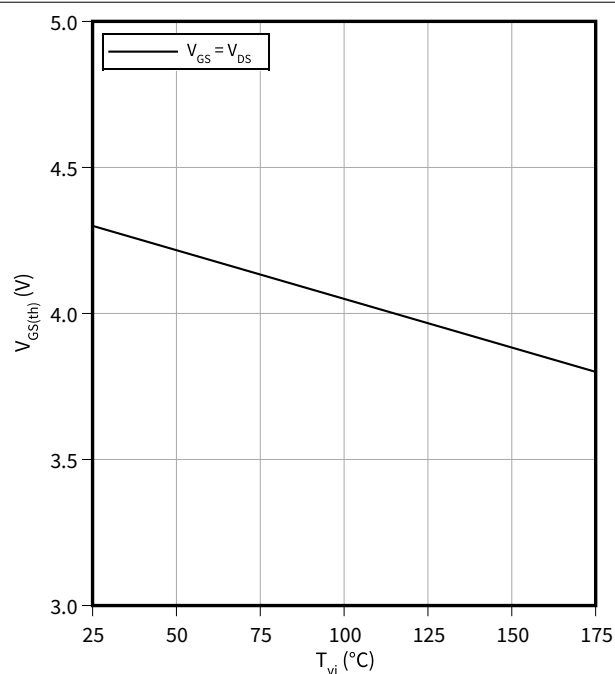
$$V_{DS} = 20 \text{ V}$$



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

$$V_{GS(th)} = f(T_{vj})$$

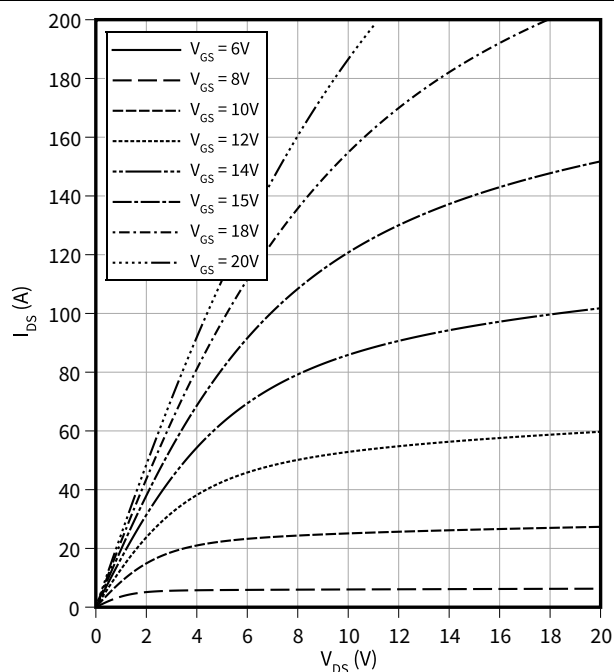
$$I_D = 6.4 \text{ mA}$$



Typical output characteristic, V_{GS} as parameter

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

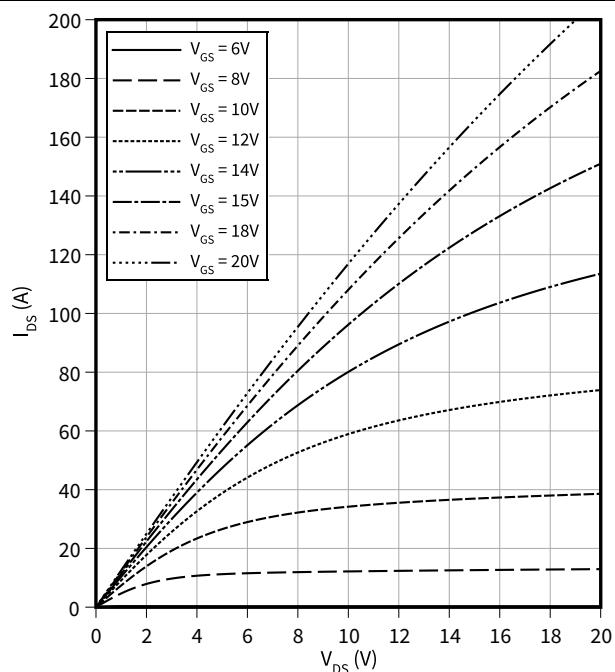
$$T_{vj} = 25^\circ\text{C}$$



Typical output characteristic, V_{GS} as parameter

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

$$T_{vj} = 175^\circ\text{C}$$

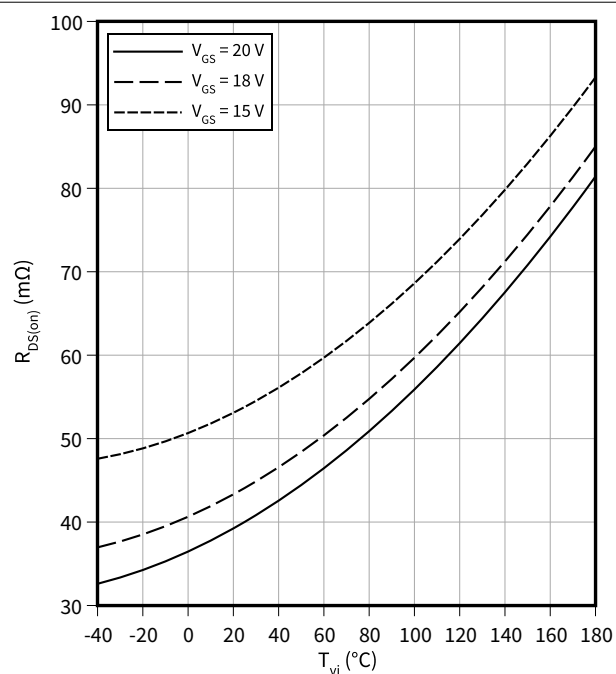


4 Characteristics diagrams

Typical on-state resistance as a function of junction temperature

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

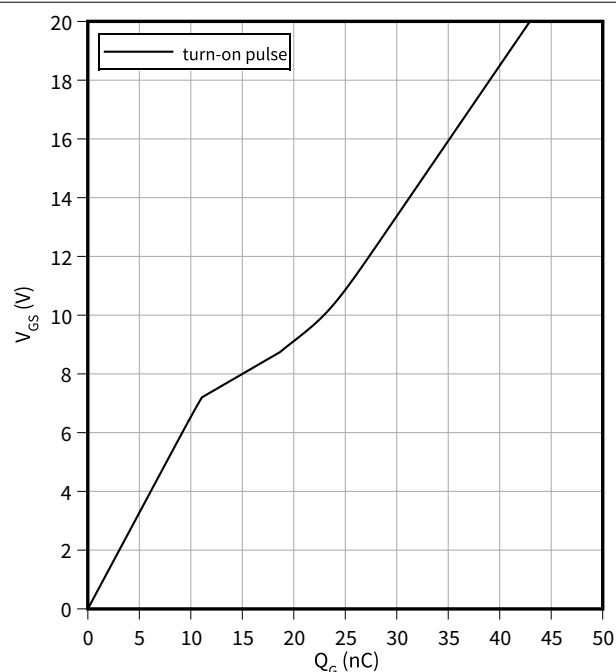
$$I_D = 20 \text{ A}$$



Typical gate charge

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

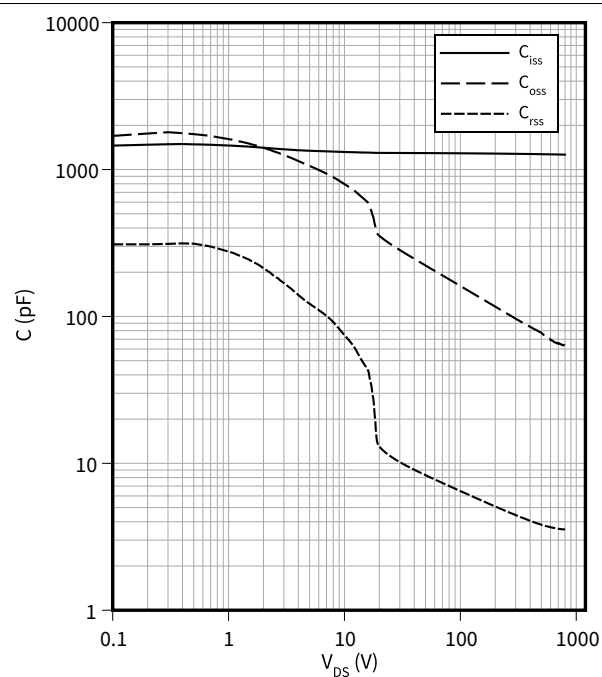
$$I_D = 20 \text{ A}, V_{DS} = 800 \text{ V}$$



Typical capacitance as a function of drain-source voltage

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

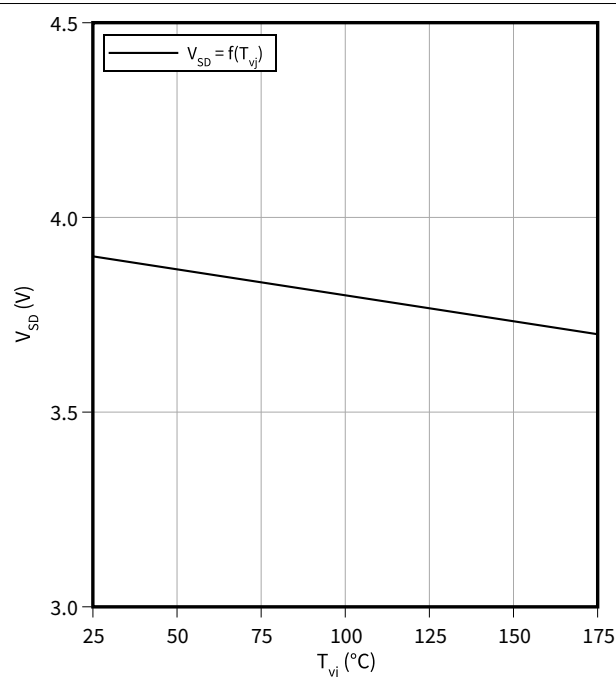
$$f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$$



Typical reverse drain voltage as function of junction temperature

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

$$I_{SD} = 20 \text{ A}, V_{GS} = 0 \text{ V}$$

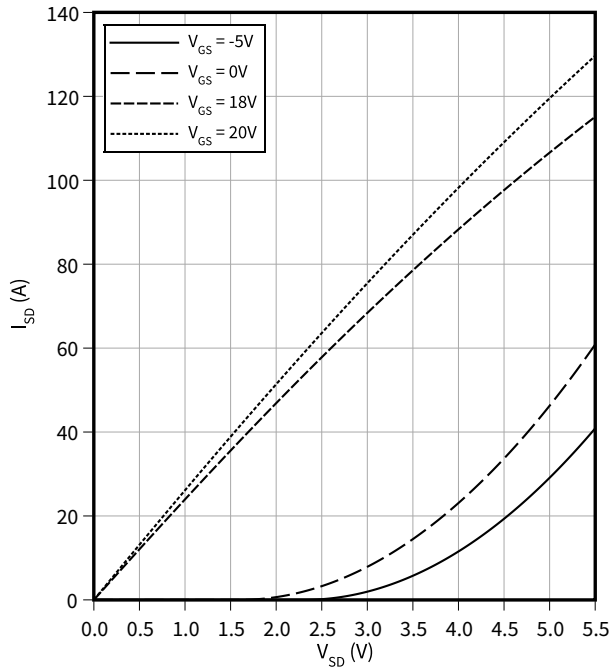


4 Characteristics diagrams

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

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

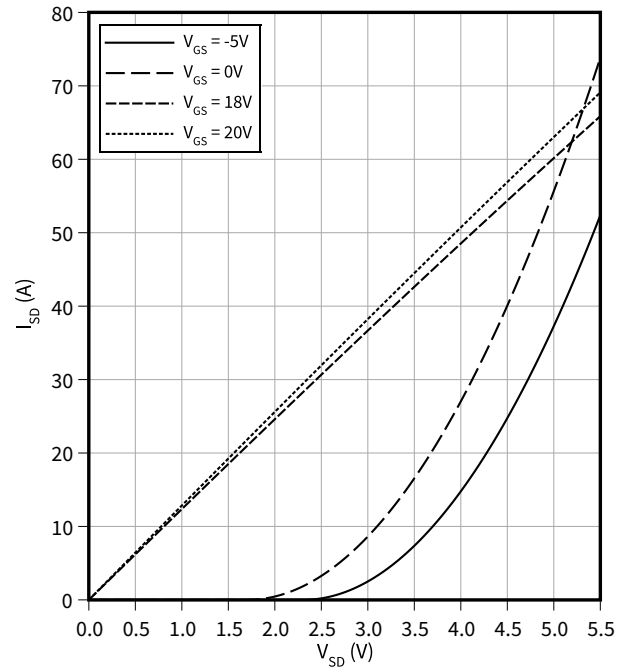
$$T_{vj} = 25\text{ °C}$$



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

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

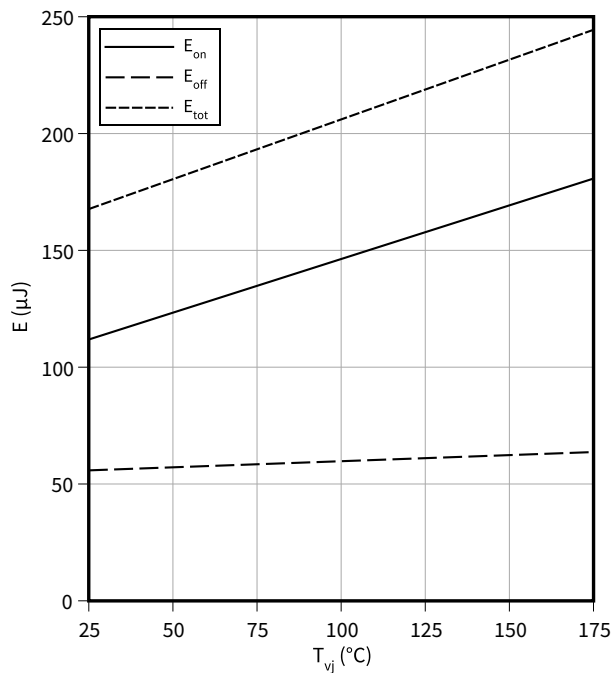
$$T_{vj} = 175\text{ °C}$$



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

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

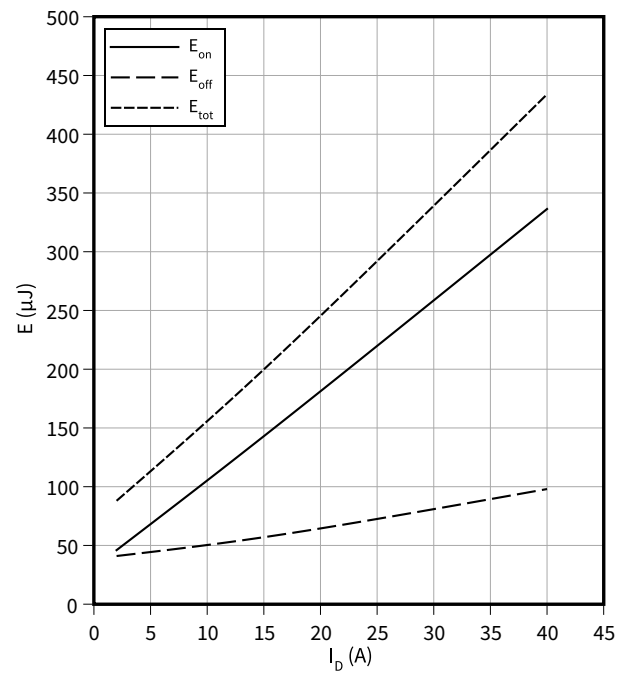
$$V_{GS} = 0/20\text{ V}, I_D = 20\text{ A}, R_{G,ext} = 2\text{ }\Omega, V_{DD} = 800\text{ V}$$



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

$$E = f(I_D)$$

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

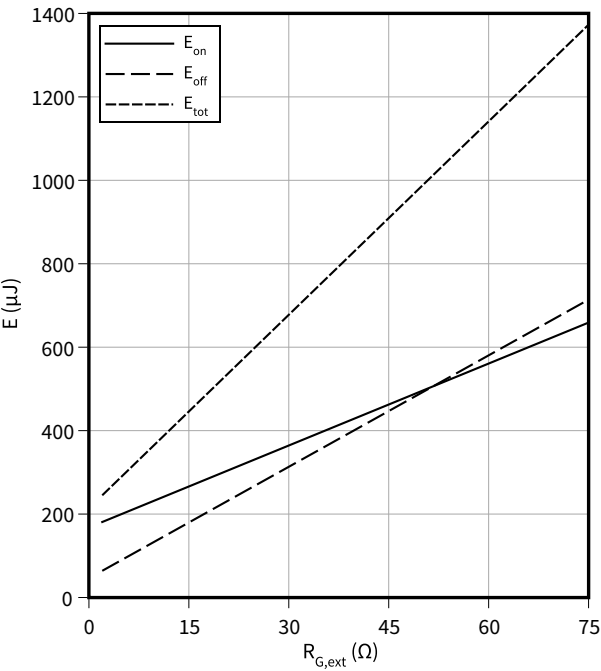


4 Characteristics diagrams

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

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

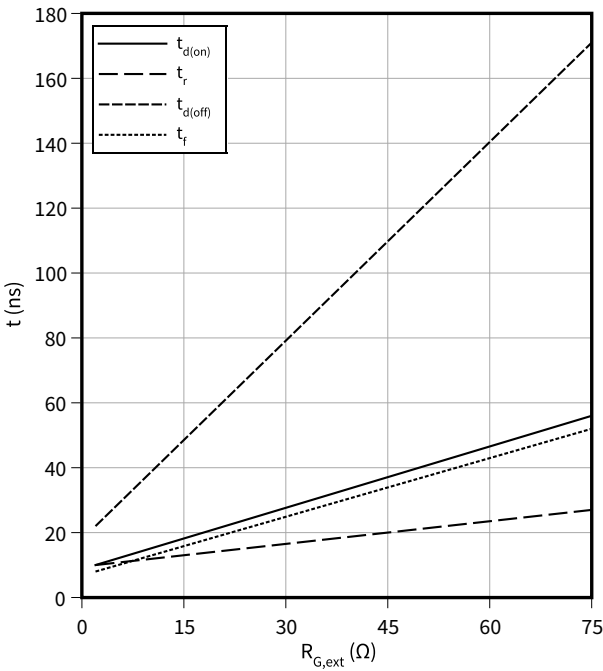
$V_{GS} = 0/20\text{ V}$, $I_D = 20\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{DD} = 800\text{ V}$



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

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

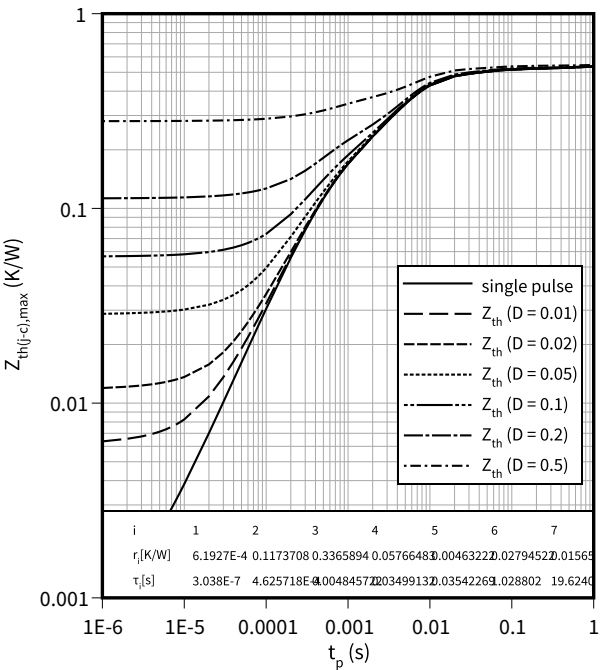
$V_{GS} = 0/20\text{ V}$, $I_D = 20\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{DD} = 800\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

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

$D = t_p/T$



5 Package outlines

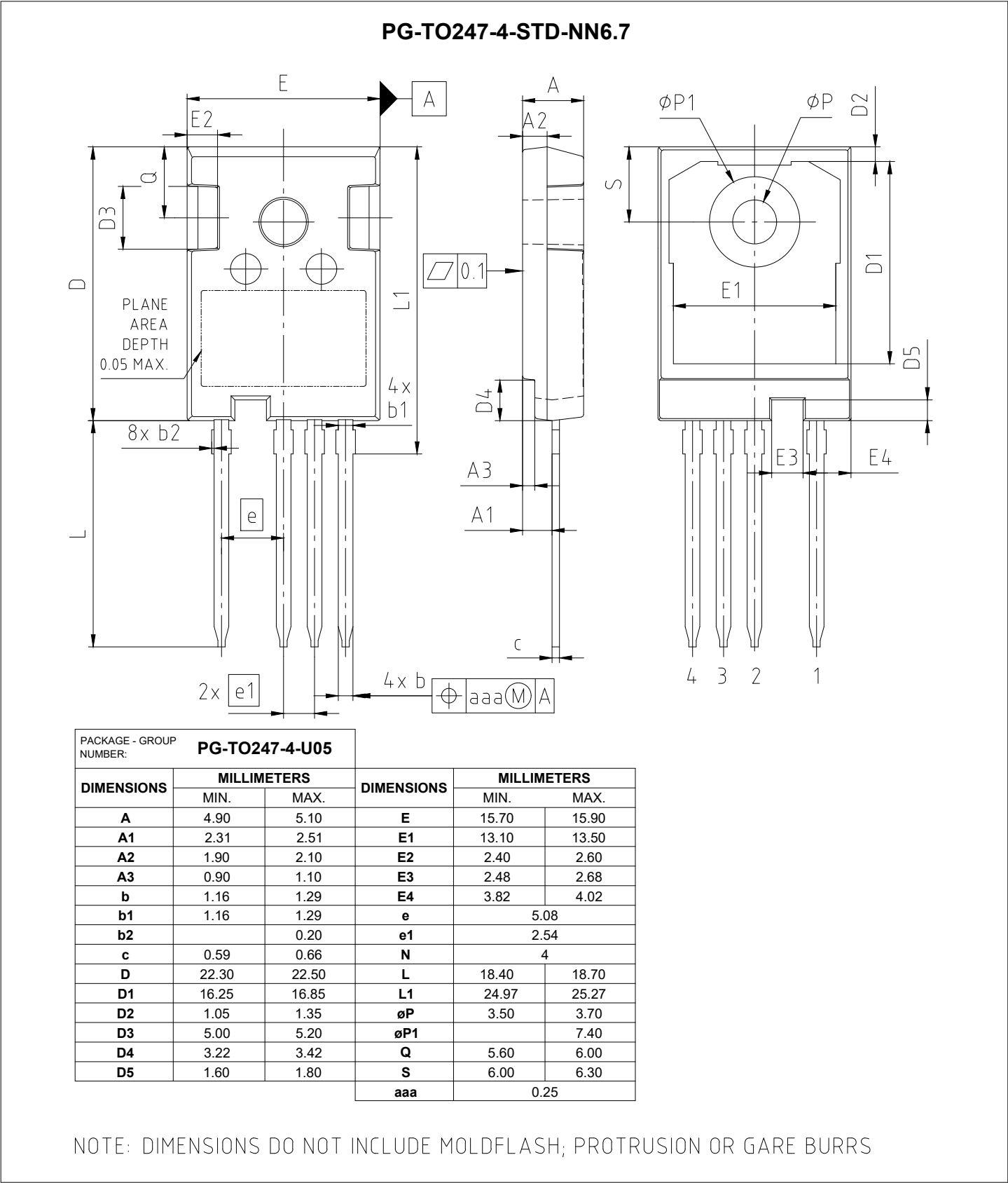


Figure 1

6 Testing conditions

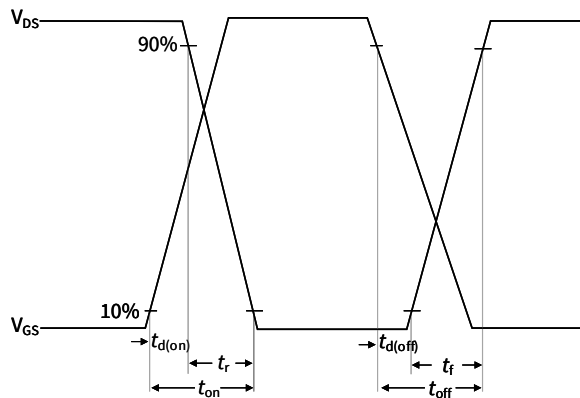


Figure A. Definition of switching times

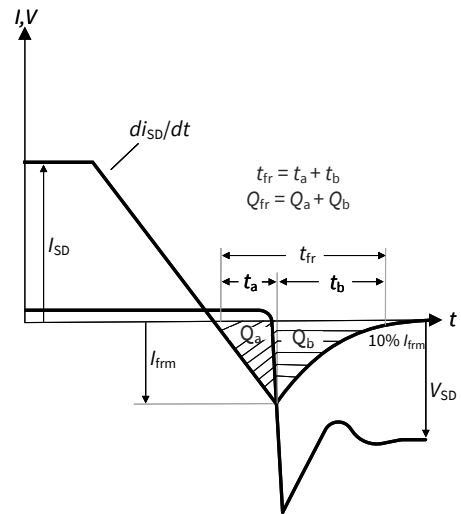


Figure B. Definition of body diode switching characteristics

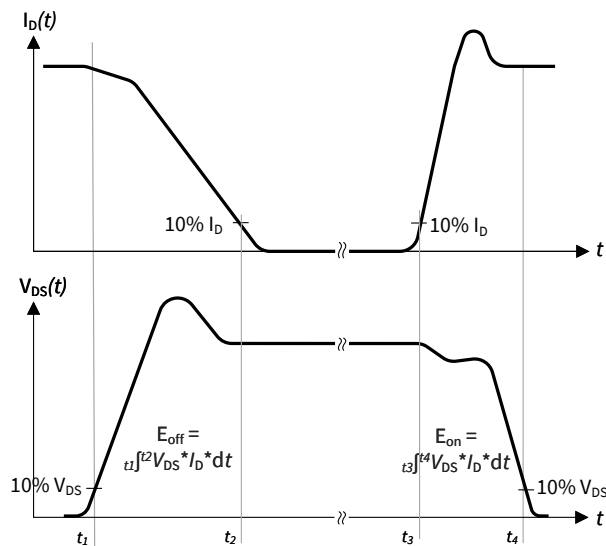


Figure C. Definition of switching losses

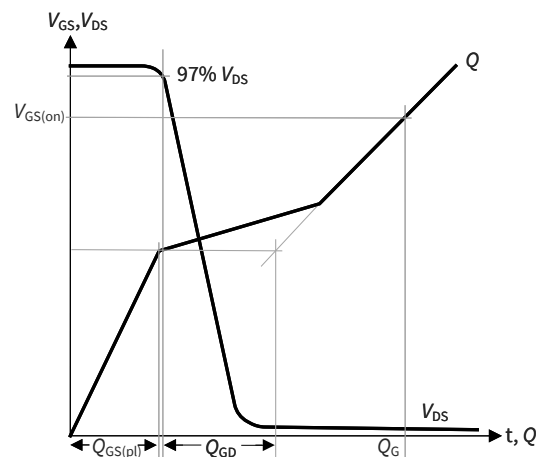


Figure D. Definition of QGD

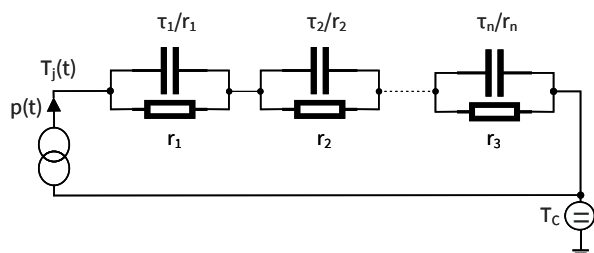


Figure E. Thermal equivalent circuit

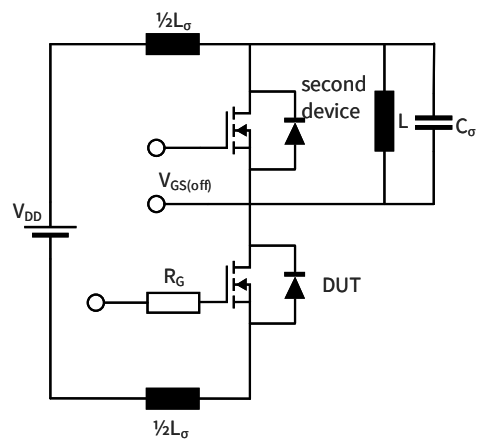


Figure F. Dynamic test circuit

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

Revision history

Document revision	Date of release	Description of changes
0.10	2022-04-19	Target datasheet
0.20	2023-08-03	Preliminary datasheet
1.00	2023-11-30	Final datasheet

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