

MOSFET

OptiMOS™ 6 Power-Transistor, 135 V

Features

- N-channel, normal level
- Very low on-resistance  $R_{DS(on)}$
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Very low reverse recovery charge ( $Q_{rr}$ )
- 100% avalanche tested
- 175°C operating temperature
- Optimized for motor drives and battery powered applications
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21
- MSL 1 classified according to J-STD-020

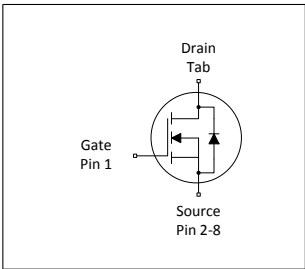
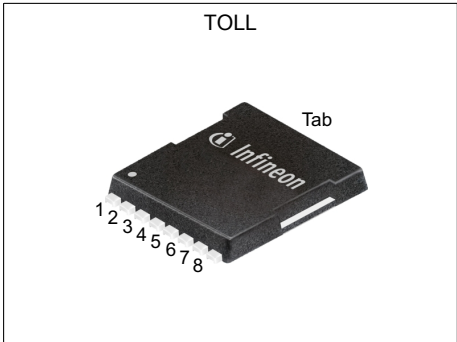
Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS}$	135	V
$R_{DS(on),max}$	2.0	mΩ
$I_D$	297	A
$Q_{oss}$	274	nC
$Q_G$	159	nC
$Q_{rr}$ (500 A/μs)	154	nC

Type / Ordering Code	Package	Marking	Related Links
IPT020N13NM6	PG-HSOF-8	020N13N6	-



RoHS

**Table of Contents**

Description ..... 1

Maximum ratings ..... 3

Thermal characteristics ..... 3

Electrical characteristics ..... 4

Electrical characteristics diagrams ..... 6

Package Outlines ..... 10

Revision History ..... 11

Trademarks ..... 11

Disclaimer ..... 11

## 1 Maximum ratings

at  $T_A=25\text{ °C}$ , unless otherwise specified

**Table 2 Maximum ratings**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current <sup>1)</sup>	$I_D$	-	-	297 210 196 29	A	$V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$ $V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$ $V_{GS}=8\text{ V}$ , $T_C=100\text{ °C}$ $V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}^{2)}$
Pulsed drain current <sup>3)</sup>	$I_{D,pulse}$	-	-	1188	A	$T_C=25\text{ °C}$
Avalanche current, single pulse <sup>4)</sup>	$I_{AS}$	-	-	142	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse <sup>4)</sup>	$E_{AS}$	-	-	832	mJ	$I_D=69\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Gate source voltage	$V_{GS}$	-20	-	20	V	-
Power dissipation	$P_{tot}$	-	-	395 3.8	W	$T_C=25\text{ °C}$ $T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}^{2)}$
Operating and storage temperature	$T_j, T_{stg}$	-55	-	175	°C	-

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.4	°C/W	-
Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>2)</sup>	$R_{thJA}$	-	-	40	°C/W	-
Thermal resistance, junction - ambient, minimal footprint	$R_{thJA}$	-	-	62	°C/W	-

<sup>1)</sup> Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature as specified. For other case temperatures please refer to Diagram 2. De-rating will be required based on the actual environmental conditions.

<sup>2)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

<sup>3)</sup> See Diagram 3 for more detailed information.

<sup>4)</sup> See Diagram 13 for more detailed information.

### 3 Electrical characteristics

at  $T_j=25\text{ °C}$ , unless otherwise specified

**Table 4 Static characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	135	-	-	V	$V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5	V	$V_{DS}=V_{GS}$ , $I_D=275\text{ }\mu\text{A}$
Zero gate voltage drain current	$I_{DSS}$	-	1 10	10 100	$\mu\text{A}$	$V_{DS}=108\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$ $V_{DS}=108\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ °C}$
Gate-source leakage current	$I_{GSS}$	-	10	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	1.6 1.7 1.8	1.95 2.0 2.3	m $\Omega$	$V_{GS}=15\text{ V}$ , $I_D=142\text{ A}$ $V_{GS}=10\text{ V}$ , $I_D=142\text{ A}$ $V_{GS}=8\text{ V}$ , $I_D=71\text{ A}$
Gate resistance <sup>1)</sup>	$R_G$	-	1.1	1.7	$\Omega$	-
Transconductance <sup>1)</sup>	$g_{fs}$	140	280	-	S	$ V_{DS} \geq 2 I_D /R_{DS(on)max}$ , $I_D=142\text{ A}$

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance <sup>1)</sup>	$C_{iss}$	-	11000	14000	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=68\text{ V}$ , $f=1\text{ MHz}$
Output capacitance <sup>1)</sup>	$C_{oss}$	-	2200	2900	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=68\text{ V}$ , $f=1\text{ MHz}$
Reverse transfer capacitance <sup>1)</sup>	$C_{rss}$	-	28	49	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=68\text{ V}$ , $f=1\text{ MHz}$
Turn-on delay time	$t_{d(on)}$	-	21	-	ns	$V_{DD}=68\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=71\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Rise time	$t_r$	-	17	-	ns	$V_{DD}=68\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=71\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Turn-off delay time	$t_{d(off)}$	-	48	-	ns	$V_{DD}=68\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=71\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Fall time	$t_f$	-	22	-	ns	$V_{DD}=68\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=71\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$

**Table 6 Gate charge characteristics<sup>2)</sup>**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge <sup>1)</sup>	$Q_{gs}$	-	49	64	nC	$V_{DD}=68\text{ V}$ , $I_D=71\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge at threshold	$Q_{g(th)}$	-	33	-	nC	$V_{DD}=68\text{ V}$ , $I_D=71\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge <sup>1)</sup>	$Q_{gd}$	-	30	45	nC	$V_{DD}=68\text{ V}$ , $I_D=71\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Switching charge	$Q_{sw}$	-	47	-	nC	$V_{DD}=68\text{ V}$ , $I_D=71\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total <sup>1)</sup>	$Q_g$	-	159	207	nC	$V_{DD}=68\text{ V}$ , $I_D=71\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	4.5	-	V	$V_{DD}=68\text{ V}$ , $I_D=71\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total, sync. FET	$Q_{g(sync)}$	-	145	-	nC	$V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }10\text{ V}$
Output charge <sup>1)</sup>	$Q_{oss}$	-	274	356	nC	$V_{DS}=68\text{ V}$ , $V_{GS}=0\text{ V}$

<sup>1)</sup> Defined by design. Not subject to production test.

<sup>2)</sup> See "Gate charge waveforms" for parameter definition

**Table 7 Reverse diode**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	$I_S$	-	-	297	A	$T_C=25\text{ °C}$
Diode pulse current	$I_{S,pulse}$	-	-	1188	A	$T_C=25\text{ °C}$
Diode forward voltage	$V_{SD}$	-	0.87	1	V	$V_{GS}=0\text{ V}$ , $I_F=142\text{ A}$ , $T_J=25\text{ °C}$
Reverse recovery time <sup>1)</sup>	$t_{rr}$	-	36	72	ns	$V_R=68\text{ V}$ , $I_F=71\text{ A}$ , $di_F/dt=500\text{ A/}\mu\text{s}$
Reverse recovery charge <sup>1)</sup>	$Q_{rr}$	-	154	308	nC	$V_R=68\text{ V}$ , $I_F=71\text{ A}$ , $di_F/dt=500\text{ A/}\mu\text{s}$

<sup>1)</sup> Defined by design. Not subject to production test.

## 4 Electrical characteristics diagrams

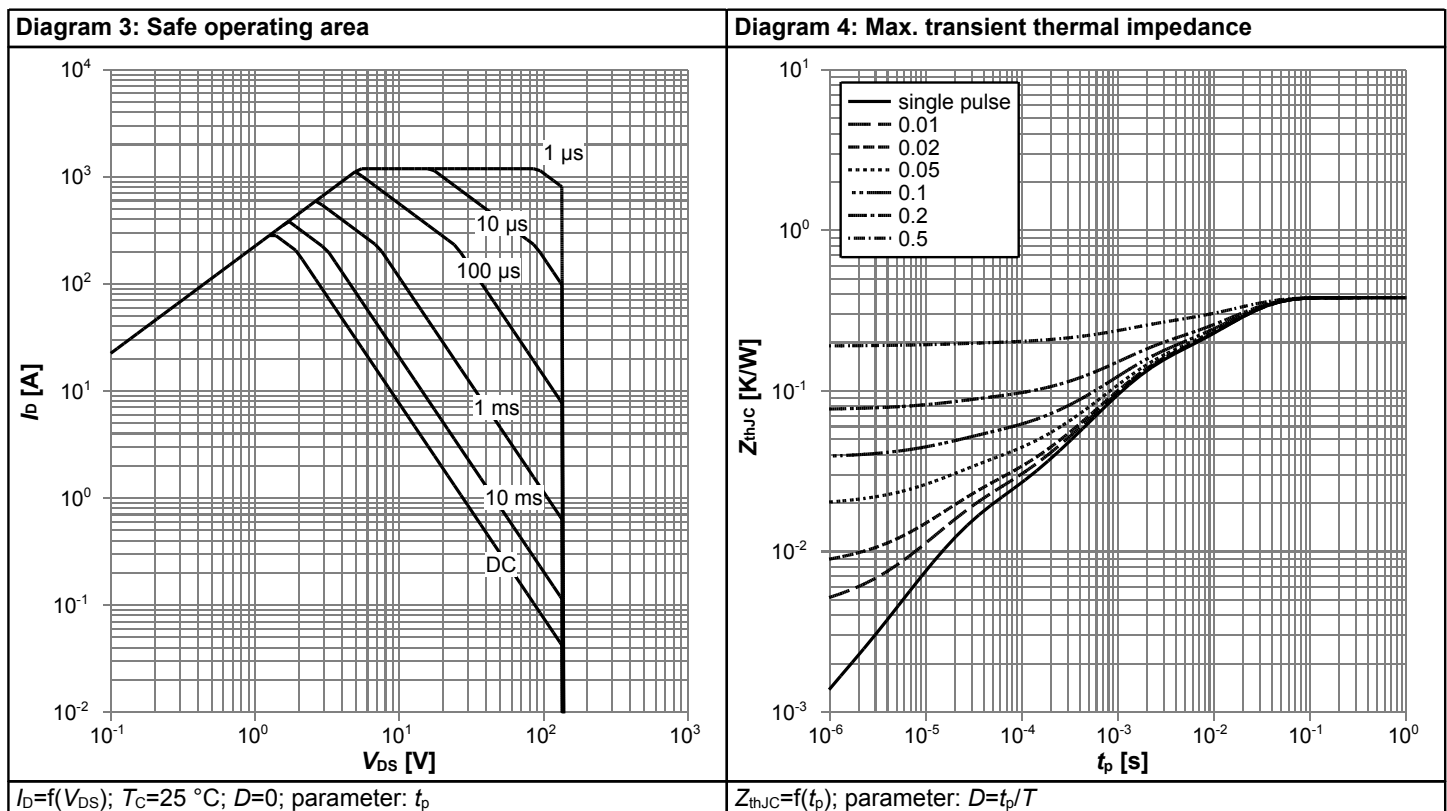
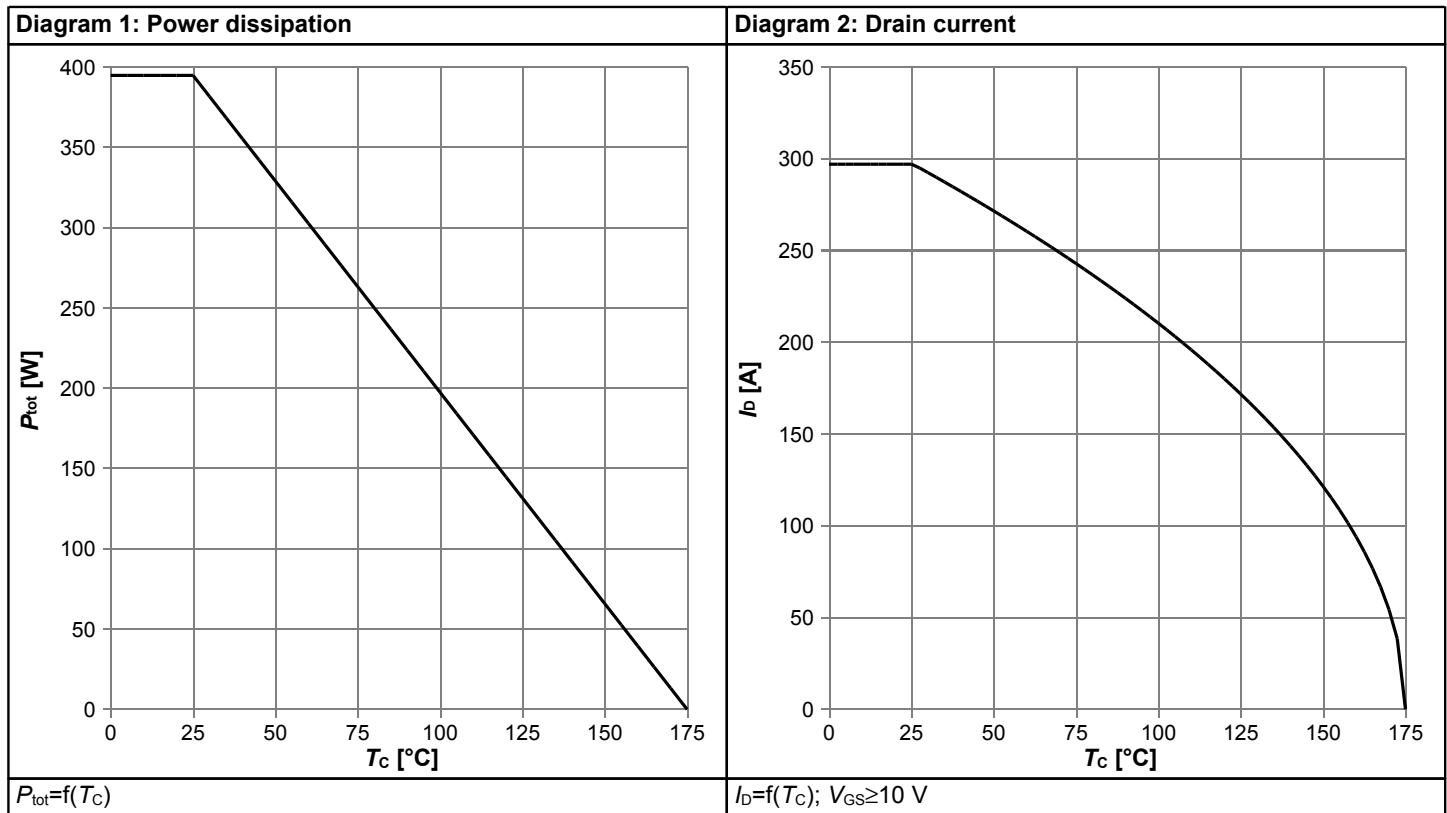
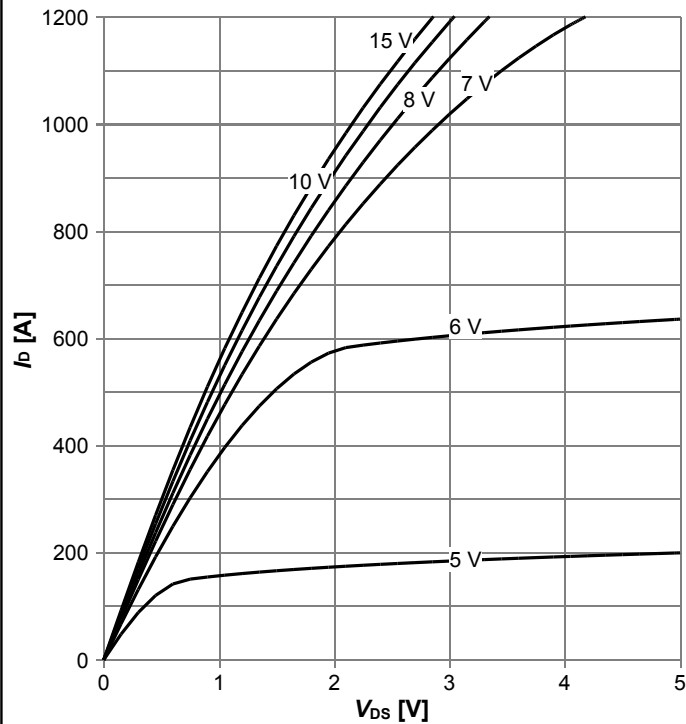
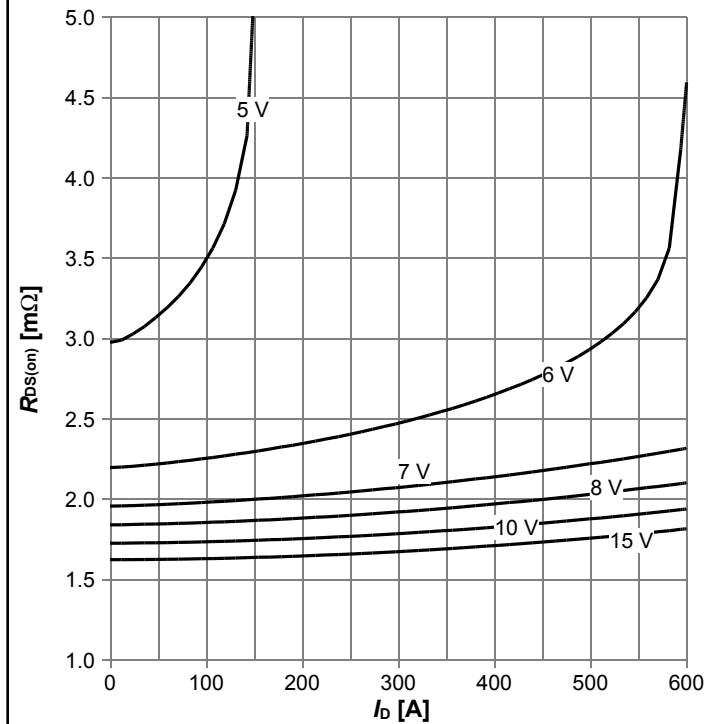


Diagram 5: Typ. output characteristics



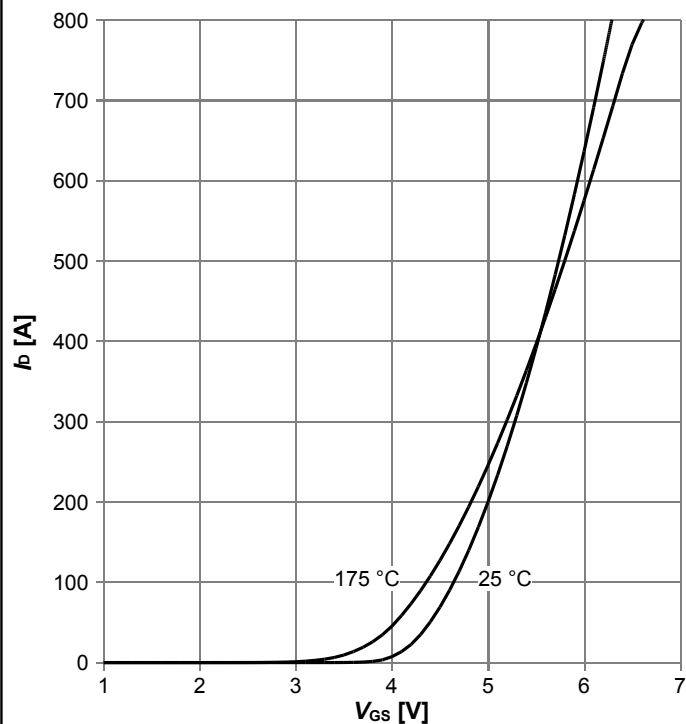
$I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



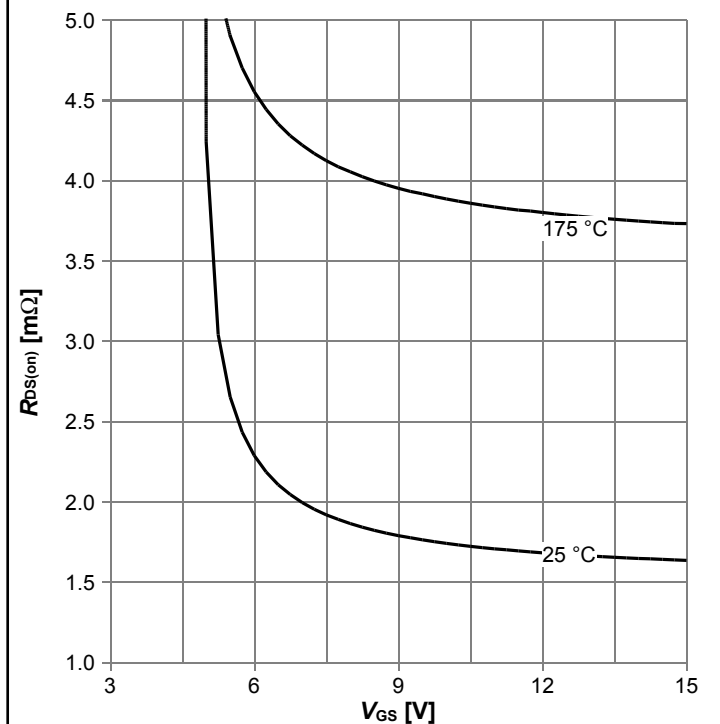
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



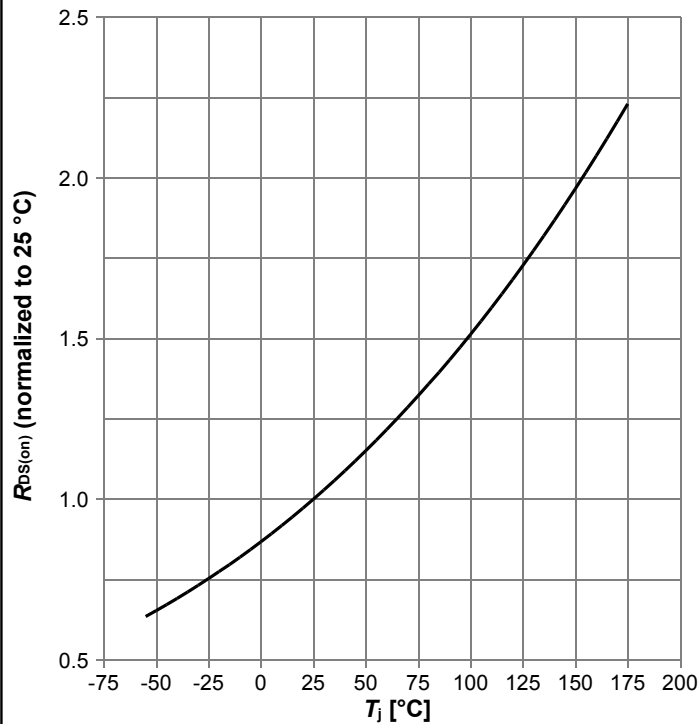
$I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)max}$ ; parameter:  $T_j$

Diagram 8: Typ. drain-source on resistance



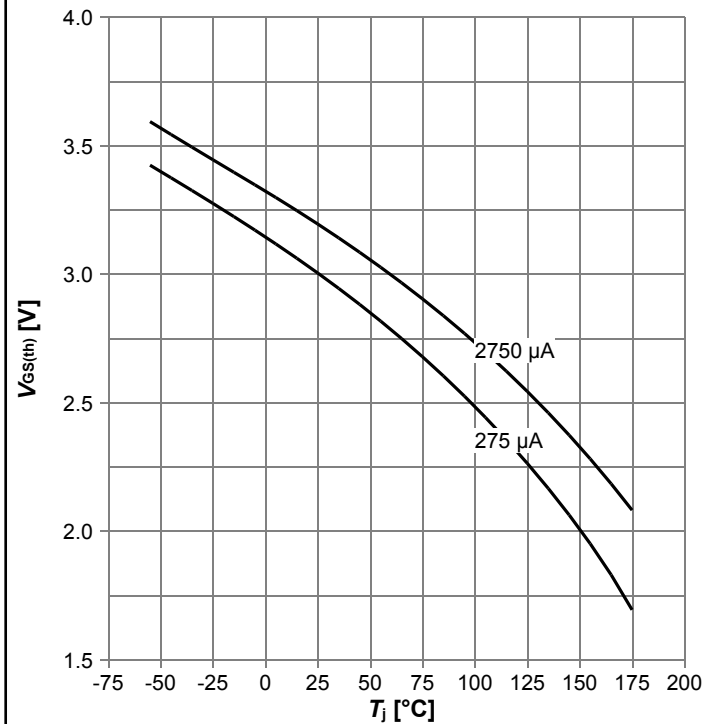
$R_{DS(on)} = f(V_{GS})$ ,  $I_D = 142\text{ A}$ ; parameter:  $T_j$

Diagram 9: Normalized drain-source on resistance



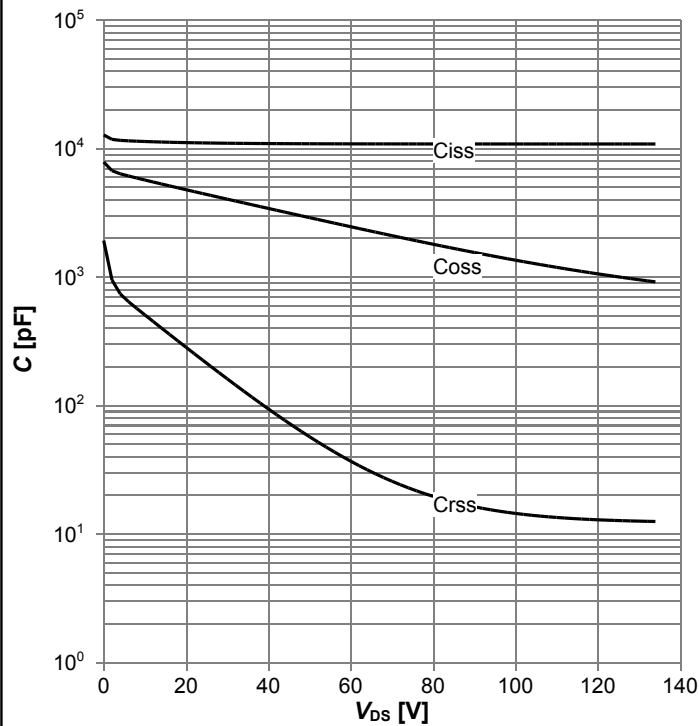
$R_{DS(on)} = f(T_j)$ ,  $I_D = 142 \text{ A}$ ,  $V_{GS} = 10 \text{ V}$

Diagram 10: Typ. gate threshold voltage



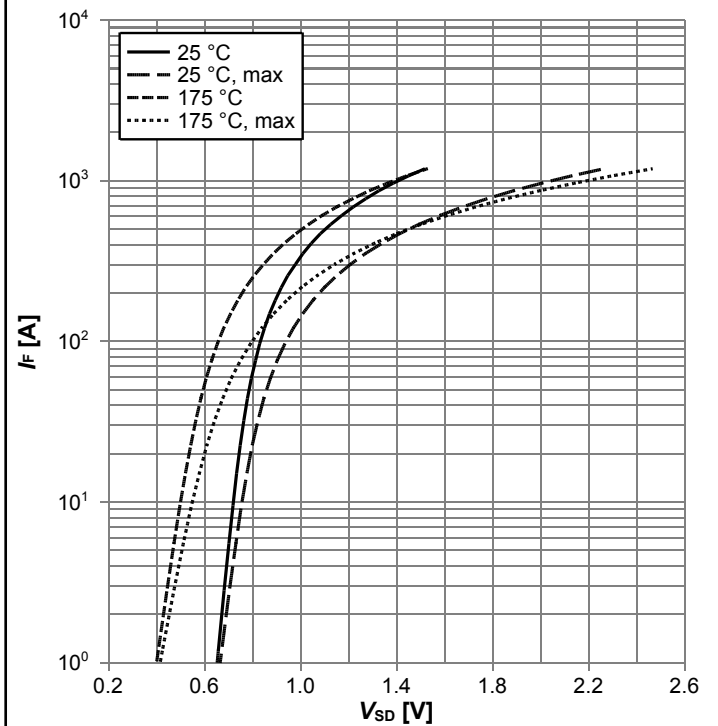
$V_{GS(th)} = f(T_j)$ ,  $V_{GS} = V_{DS}$ ; parameter:  $I_D$

Diagram 11: Typ. capacitances



$C = f(V_{DS})$ ;  $V_{GS} = 0 \text{ V}$ ;  $f = 1 \text{ MHz}$

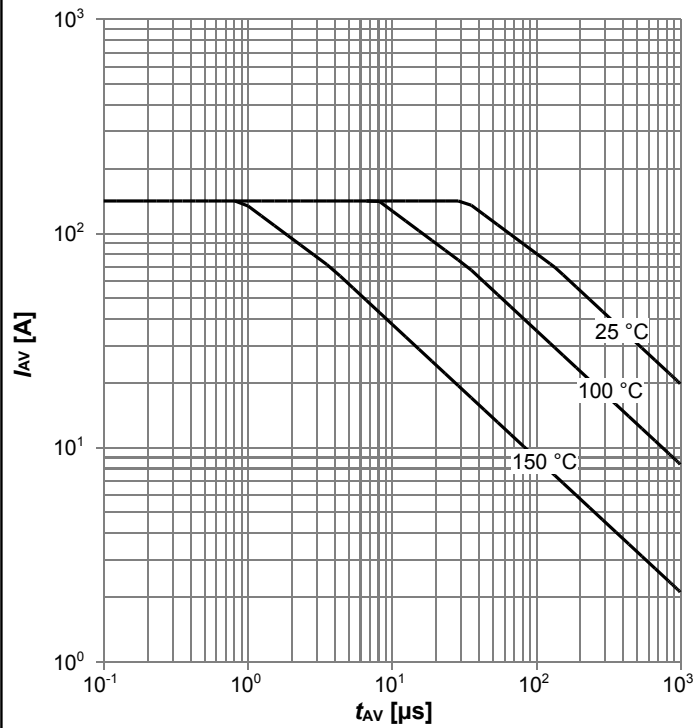
Diagram 12: Forward characteristics of reverse diode



$I_F = f(V_{SD})$ ; parameter:  $T_j$

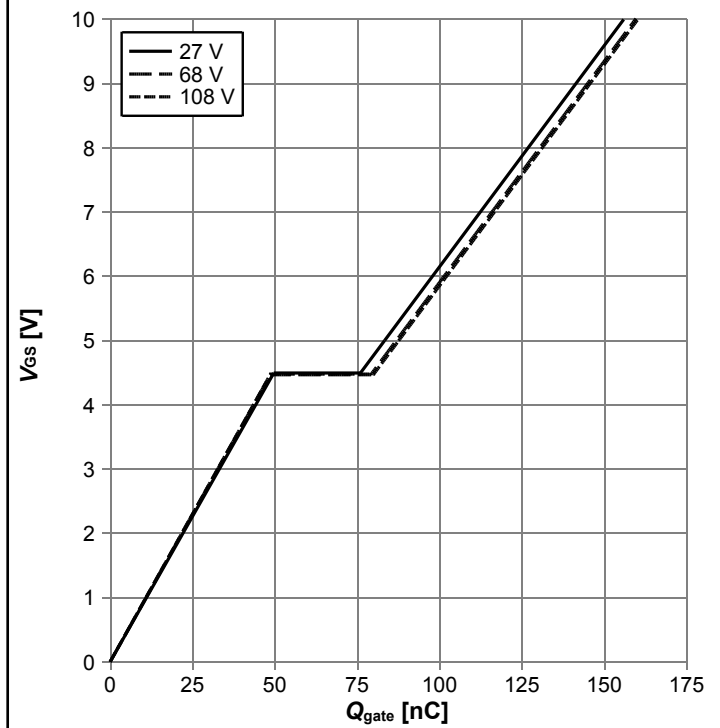


Diagram 13: Avalanche characteristics



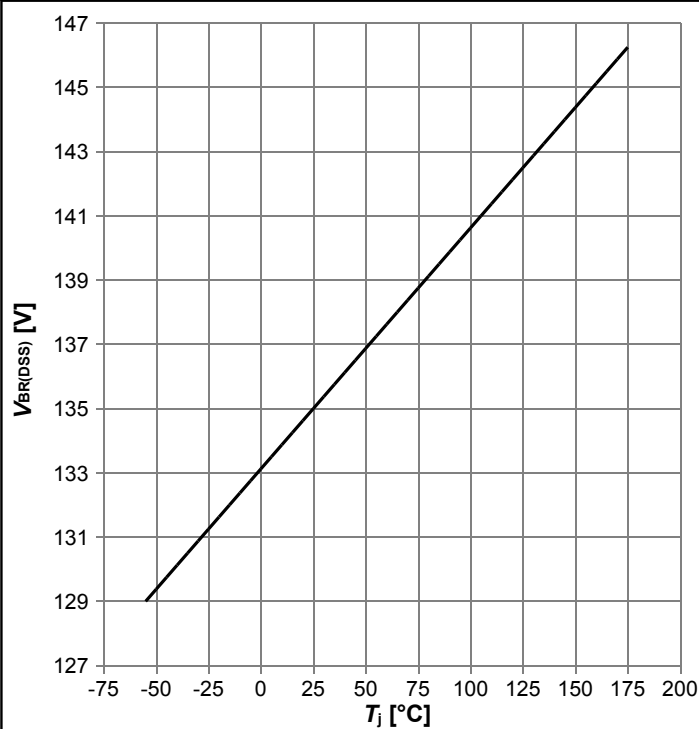
$I_{AS}=f(t_{AV})$ ;  $R_{GS}=25 \Omega$ ; parameter:  $T_{j,start}$

Diagram 14: Typ. gate charge



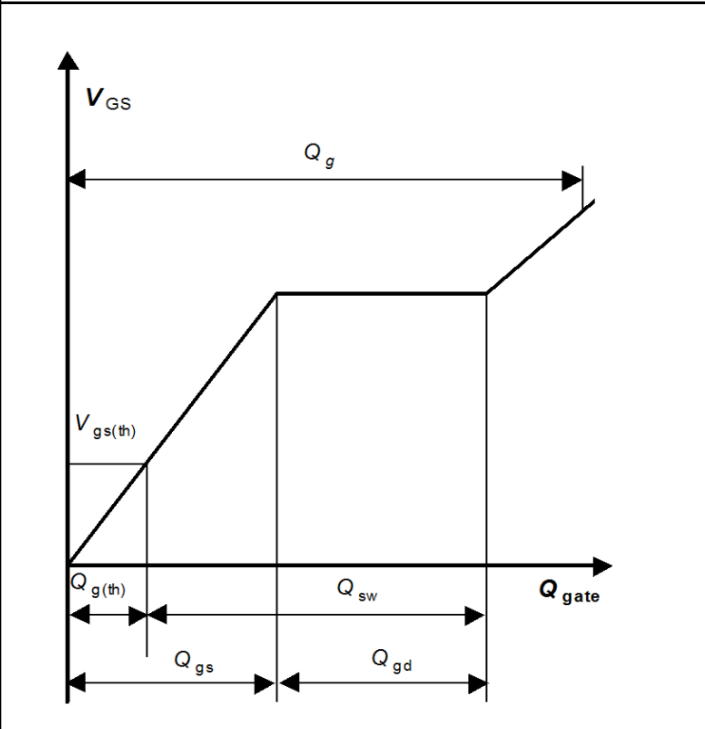
$V_{GS}=f(Q_{gate})$ ,  $I_D=71$  A pulsed,  $T_j=25$  °C; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage



$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1$  mA

Diagram Gate charge waveforms



## 5 Package Outlines

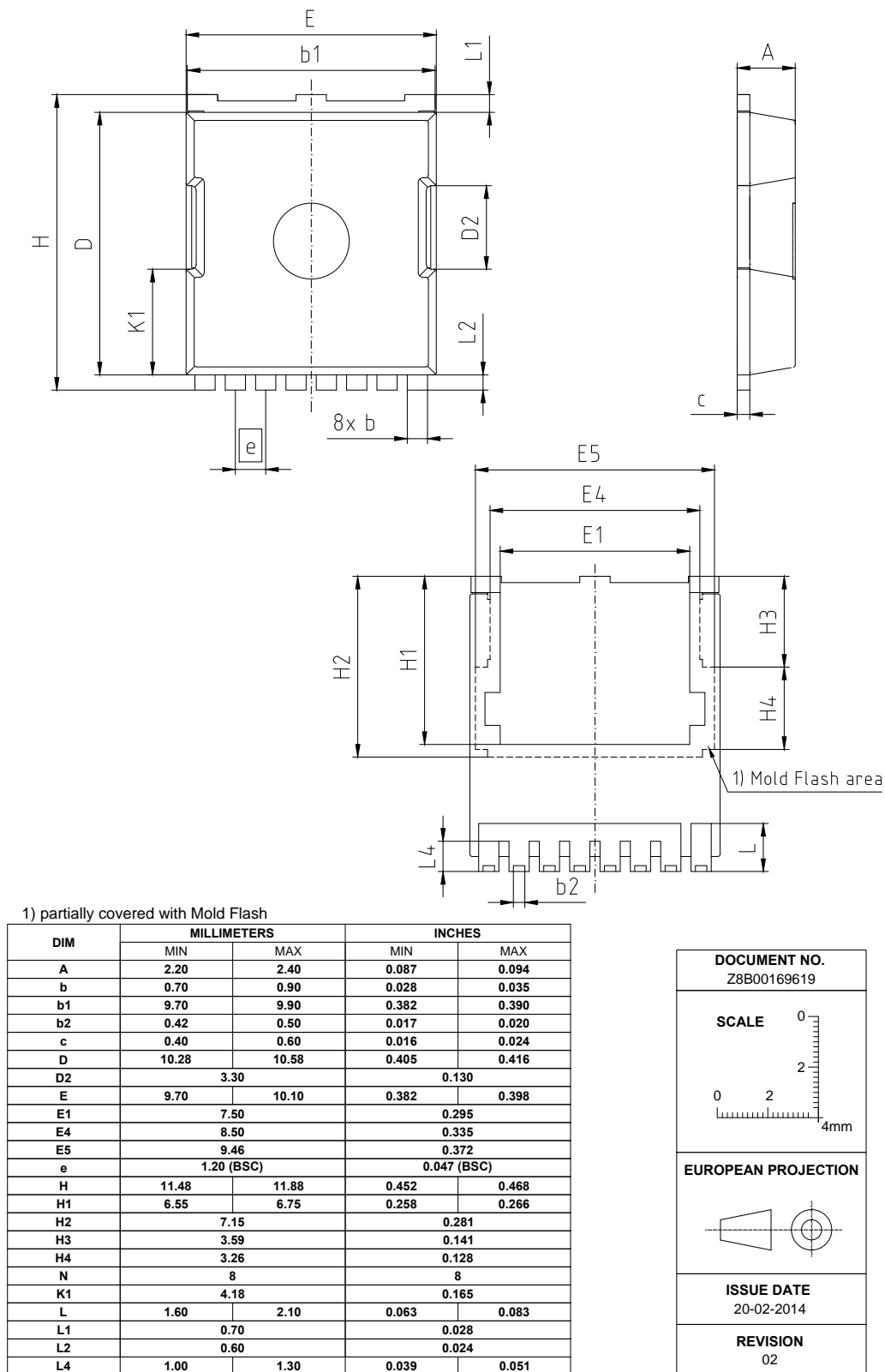


Figure 1 Outline PG-HSOF-8, dimensions in mm/inches

## Revision History

IPT020N13NM6

**Revision: 2023-10-16, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2023-10-16	Release of final version

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