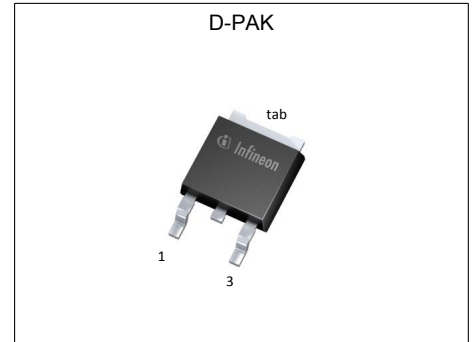


# MOSFET

## OptiMOS™ Power Transistor, -60 V

### Features

- P-Channel
- Very low on-resistance  $R_{DS(on)}$
- 100% avalanche tested
- Normal Level
- Enhancement mode
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

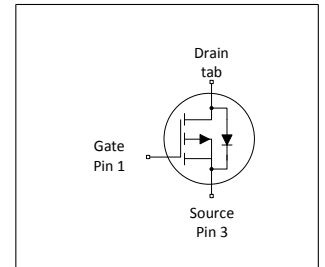


### Product validation

Fully qualified according to JEDEC for Industrial Applications

**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS}$	-60	V
$R_{DS(on),max}$	65	mΩ
$I_D$	-22	A



Type / Ordering Code	Package	Marking	Related Links
IPD650P06NM	PG-TO 252-3	650P06NM	-

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## 1 Maximum ratings

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

**Table 2 Maximum ratings**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current	$I_D$	-	-	-22 -17	A	$V_{GS}=-10\text{ V}$ , $T_C=25\text{ °C}$ $V_{GS}=-10\text{ V}$ , $T_C=100\text{ °C}$
Pulsed drain current <sup>1)</sup>	$I_{D,pulse}$	-	-	-88	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse <sup>2)</sup>	$E_{AS}$	-	-	329	mJ	$I_D=-22\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Gate source voltage	$V_{GS}$	-20	-	20	V	-
Power dissipation	$P_{tot}$	-	-	83	W	$T_C=25\text{ °C}$
Operating and storage temperature	$T_j$ , $T_{stg}$	-55	-	175	°C	IEC climatic category; DIN IEC 68-1: 55/175/56

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case, bottom	$R_{thJC}$	-	-	1.8	°C/W	-
Device on PCB, 6 cm <sup>2</sup> cooling area <sup>3)</sup>	$R_{thJA}$	-	-	75	°C/W	-

## 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	$V_{(BR)DSS}$	-60	-	-	V	$V_{GS}=0\text{ V}$ , $I_D=-250\text{ }\mu\text{A}$
Gate threshold voltage	$V_{GS(th)}$	-2.1	-3	-4	V	$V_{DS}=V_{GS}$ , $I_D=-1040\text{ }\mu\text{A}$
Zero gate voltage drain current	$I_{DSS}$	-	-0.1 -10	-1 -100	$\mu\text{A}$	$V_{DS}=-60\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$ $V_{DS}=-60\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ °C}$
Gate-source leakage current	$I_{GSS}$	-	-10	-100	nA	$V_{GS}=-20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	52	65	m $\Omega$	$V_{GS}=-10\text{ V}$ , $I_D=-22\text{ A}$
Gate resistance	$R_G$	-	5	-	$\Omega$	-
Transconductance	$g_{fs}$	-	21	-	S	$ V_{DS} \geq 2 I_D /R_{DS(on)max}$ , $I_D=-22\text{ A}$

<sup>1)</sup> See Diagram 3 for more detailed information

<sup>2)</sup> See Diagram 13 for more detailed information

<sup>3)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70  $\mu\text{m}$  thick) copper area for drain connection. PCB is vertical in still air.

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	1600	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=-30\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	220	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=-30\text{ V}$ , $f=1\text{ MHz}$
Reverse transfer capacitance	$C_{riss}$	-	54	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=-30\text{ V}$ , $f=1\text{ MHz}$
Turn-on delay time	$t_{d(on)}$	-	12	-	ns	$V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-11\text{ A}$ , $R_{G,ext}=1.6\ \Omega$
Rise time	$t_r$	-	14	-	ns	$V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-11\text{ A}$ , $R_{G,ext}=1.6\ \Omega$
Turn-off delay time	$t_{d(off)}$	-	33	-	ns	$V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-11\text{ A}$ , $R_{G,ext}=1.6\ \Omega$
Fall time	$t_f$	-	12	-	ns	$V_{DD}=-30\text{ V}$ , $V_{GS}=-10\text{ V}$ , $I_D=-11\text{ A}$ , $R_{G,ext}=1.6\ \Omega$

**Table 6 Gate charge characteristics<sup>1)</sup>**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	-9	-	nC	$V_{DD}=-30\text{ V}$ , $I_D=-22\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$
Gate charge at threshold	$Q_{g(th)}$	-	-5	-	nC	$V_{DD}=-30\text{ V}$ , $I_D=-22\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	-15	-	nC	$V_{DD}=-30\text{ V}$ , $I_D=-22\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$
Switching charge	$Q_{sw}$	-	-19	-	nC	$V_{DD}=-30\text{ V}$ , $I_D=-22\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$
Gate charge total	$Q_g$	-	-39	-	nC	$V_{DD}=-30\text{ V}$ , $I_D=-22\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	-5.5	-	V	$V_{DD}=-30\text{ V}$ , $I_D=-22\text{ A}$ , $V_{GS}=0\text{ to }-10\text{ V}$
Output charge	$Q_{oss}$	-	-28	-	nC	$V_{DD}=-30\text{ V}$ , $V_{GS}=0\text{ V}$

**Table 7 Reverse diode**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	$I_S$	-	-	-22	A	$T_C=25\text{ }^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$	-	-	-88	A	$T_C=25\text{ }^\circ\text{C}$
Diode forward voltage	$V_{SD}$	-	-0.9	-1.2	V	$V_{GS}=0\text{ V}$ , $I_F=-22\text{ A}$ , $T_J=25\text{ }^\circ\text{C}$
Reverse recovery time	$t_{rr}$	-	39	-	ns	$V_R=-30\text{ V}$ , $I_F=-22\text{ A}$ , $di_F/dt=-100\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{rr}$	-	-83	-	nC	$V_R=-30\text{ V}$ , $I_F=-22\text{ A}$ , $di_F/dt=-100\text{ A}/\mu\text{s}$

<sup>1)</sup> See diagram ,Gate charge waveforms, for gate charge parameter definition

### 4 Electrical characteristics diagrams

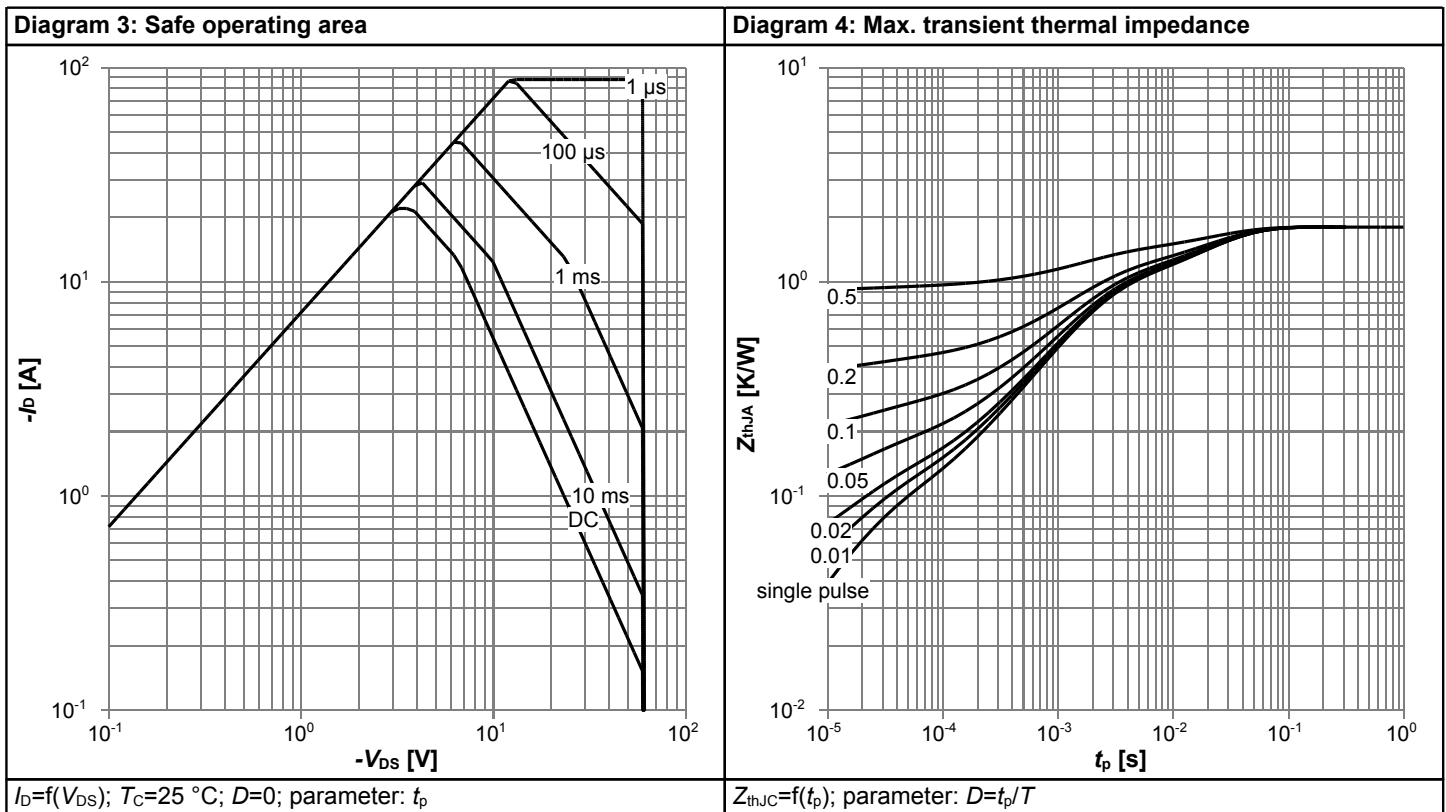
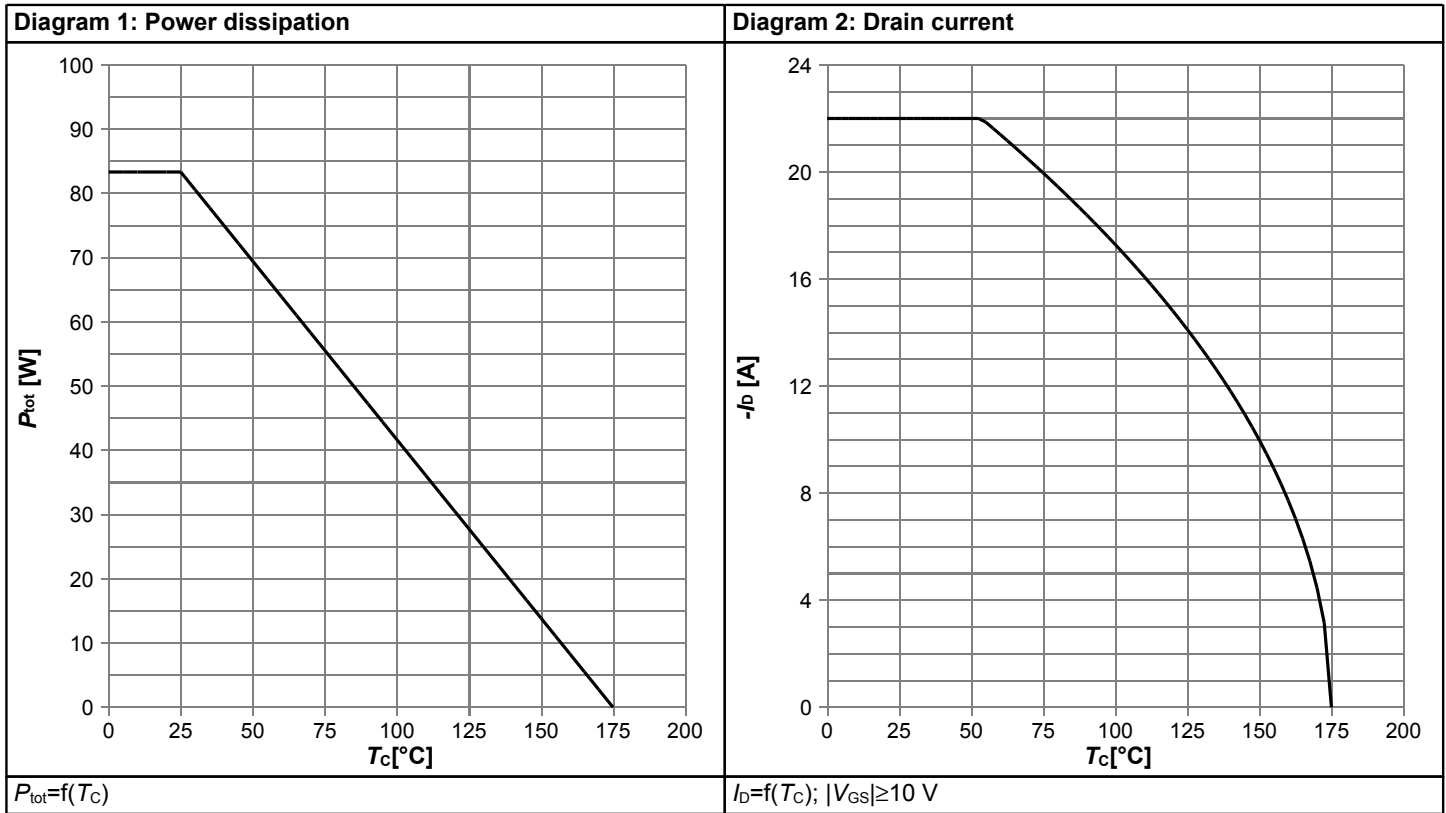
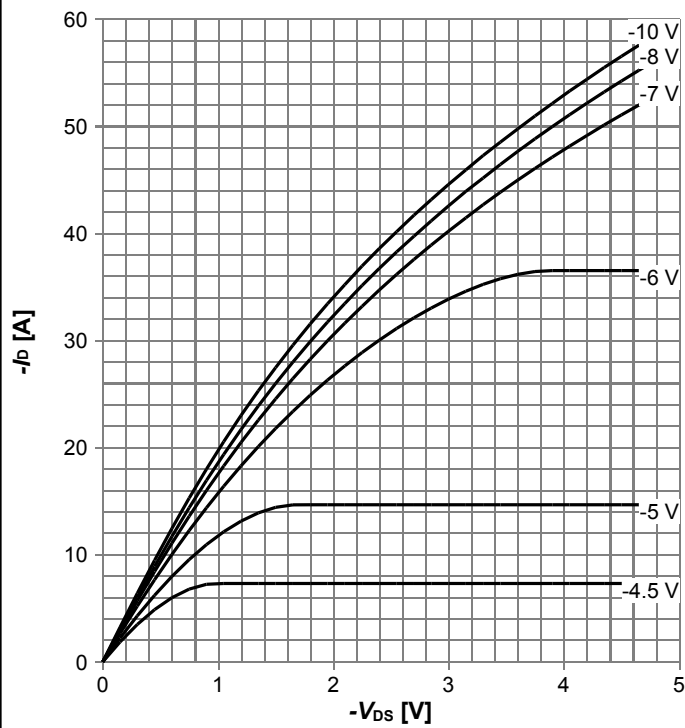
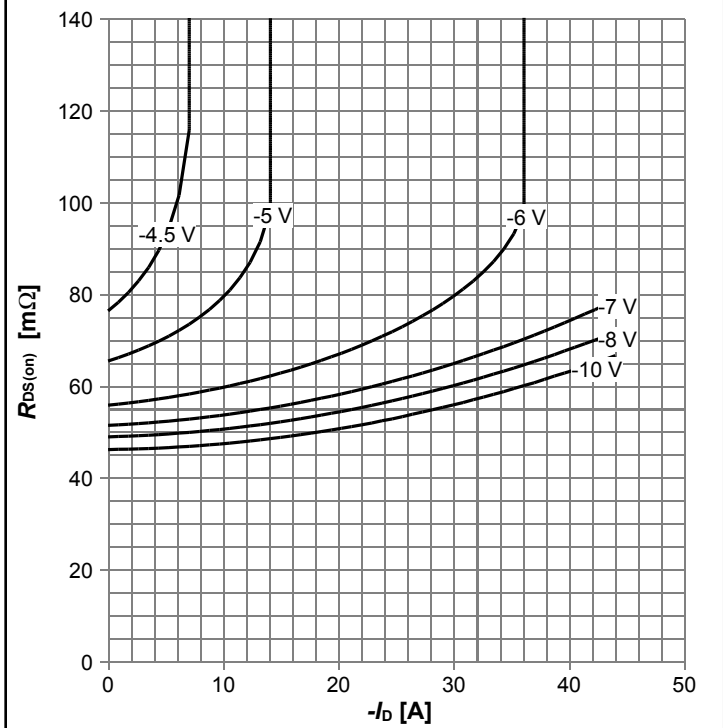


Diagram 5: Typ. output characteristics



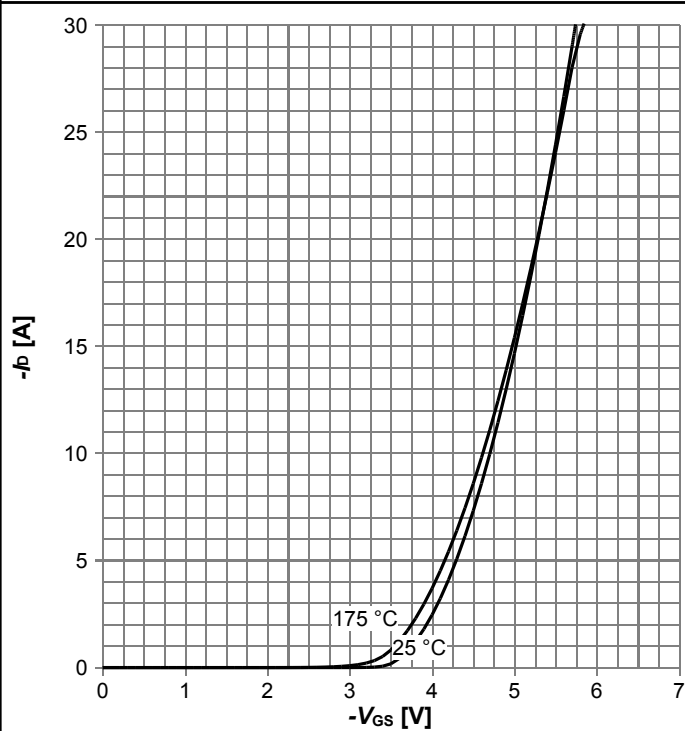
$I_D=f(V_{DS})$ ,  $T_j=25\text{ }^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



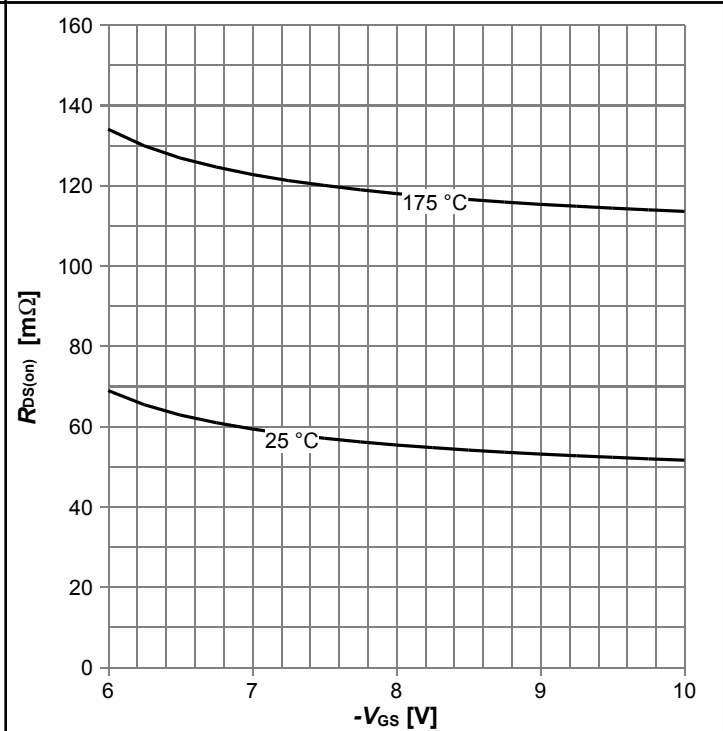
$R_{DS(on)}=f(I_D)$ ,  $T_j=25\text{ }^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



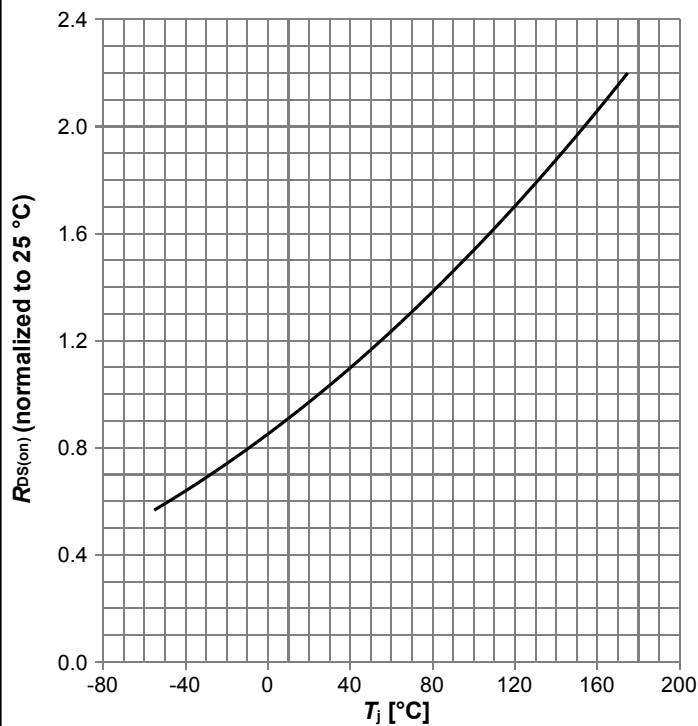
$I_D=f(V_{GS})$ ,  $|V_{DS}|>2|I_D|R_{DS(on)max}$ ; parameter:  $T_j$

Diagram 8: Typ. drain-source on resistance



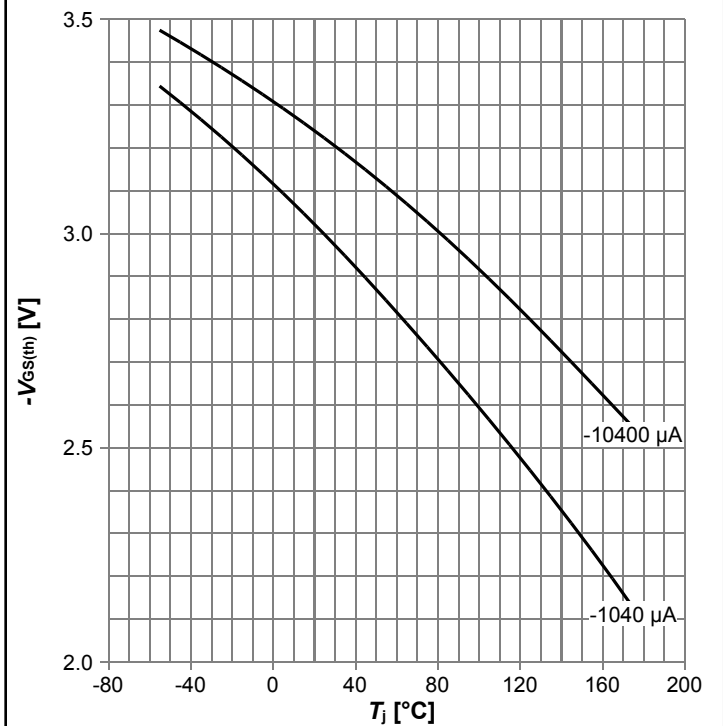
$R_{DS(on)}=f(V_{GS})$ ,  $I_D=-22\text{ A}$ ; parameter:  $T_j$

Diagram 9: Normalized drain-source on resistance



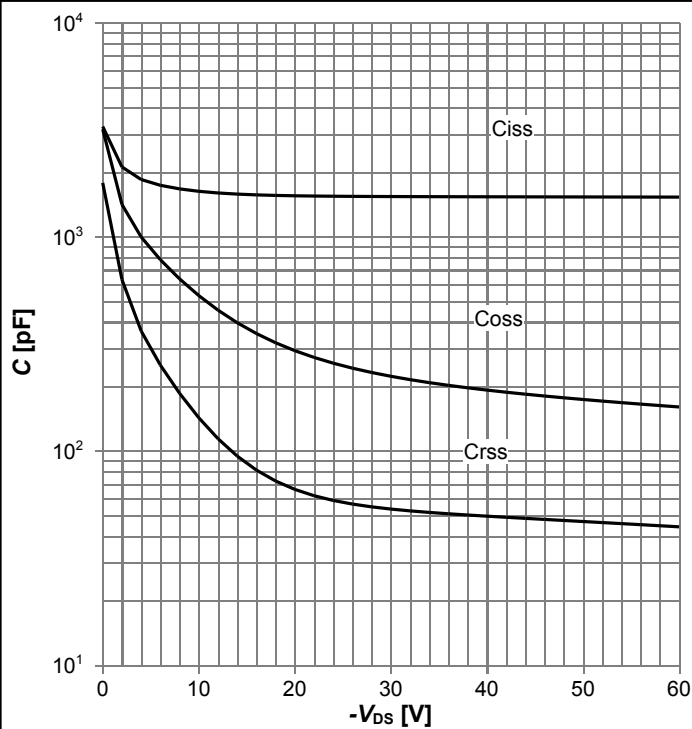
$R_{DS(on)}=f(T_j)$ ,  $I_D=-22$  A,  $V_{GS}=-10$  V

Diagram 10: Typ. gate threshold voltage



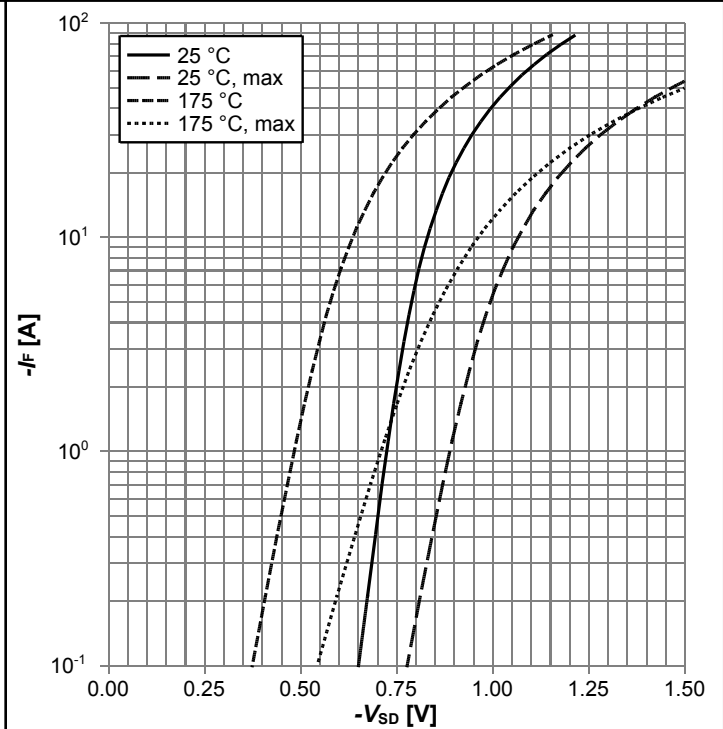
$V_{GS(th)}=f(T_j)$ ,  $V_{GS}=V_{DS}$ ; parameter:  $I_D$

Diagram 11: Typ. capacitances



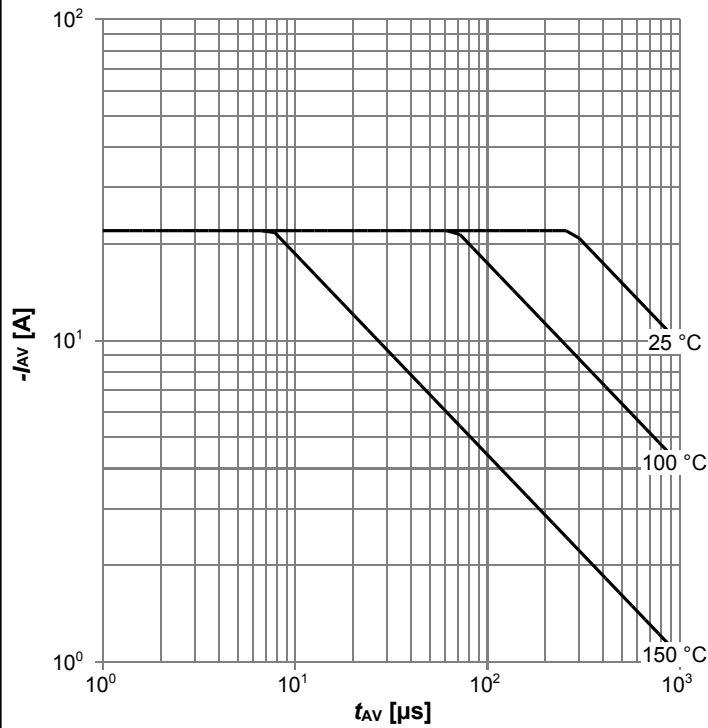
$C=f(V_{DS})$ ;  $V_{GS}=0$  V;  $f=1$  MHz

Diagram 12: Forward characteristics of reverse diode



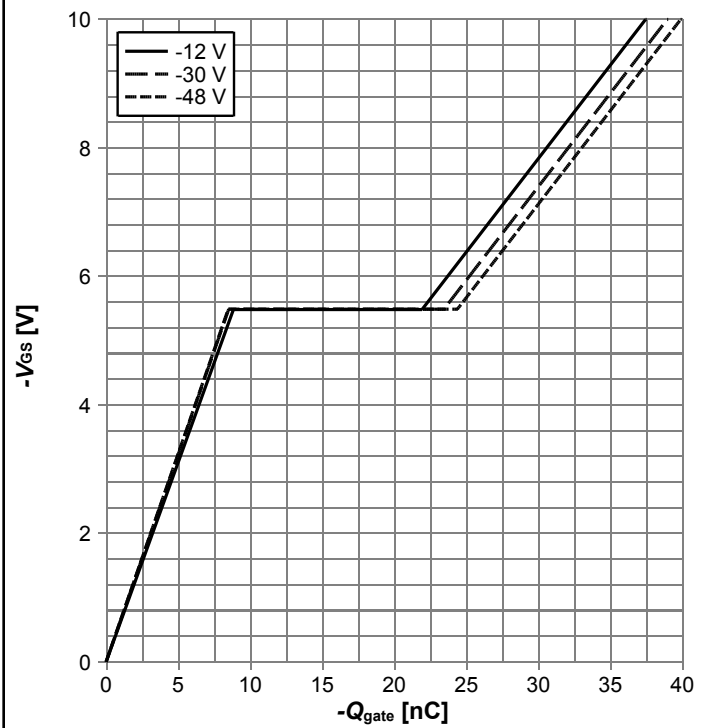
$I_F=f(V_{SD})$ ; parameter:  $T_j$

Diagram 13: Avalanche characteristics



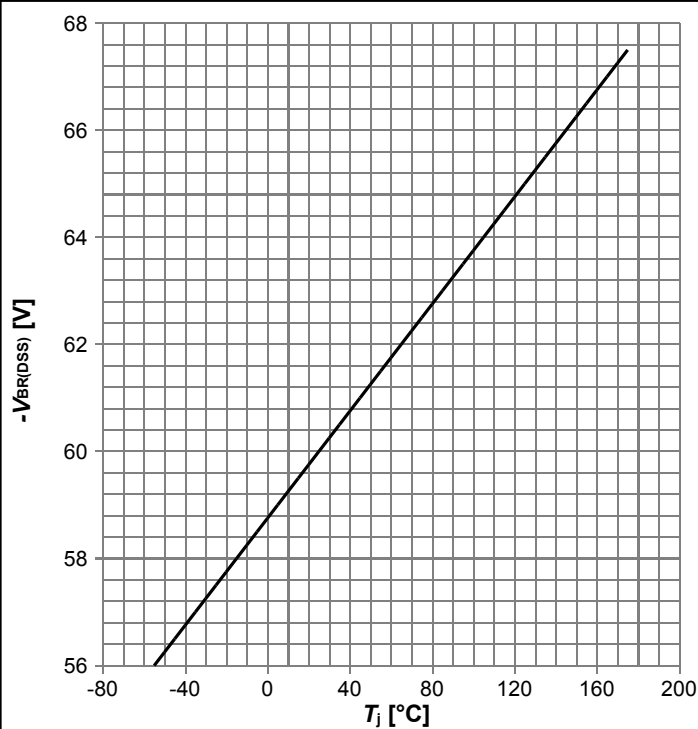
$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$ ; parameter:  $T_{j,start}$

Diagram 14: Typ. gate charge



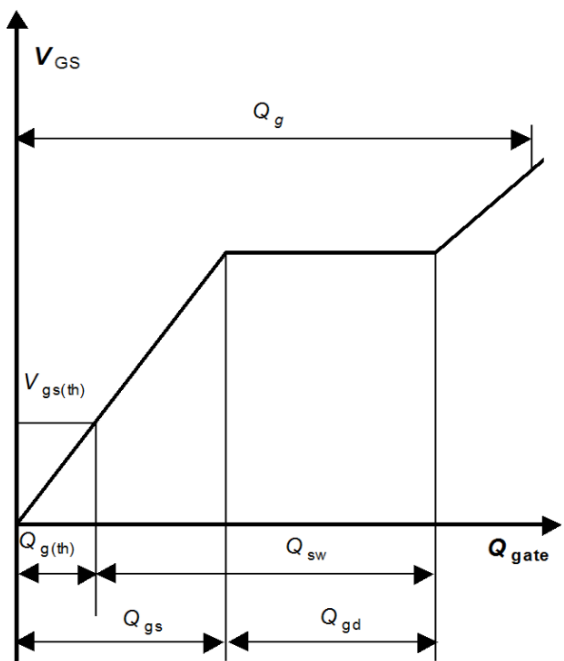
$V_{GS}=f(Q_{gate}), I_D=-22 \text{ A pulsed}, T_j=25 \text{ °C}$ ; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage



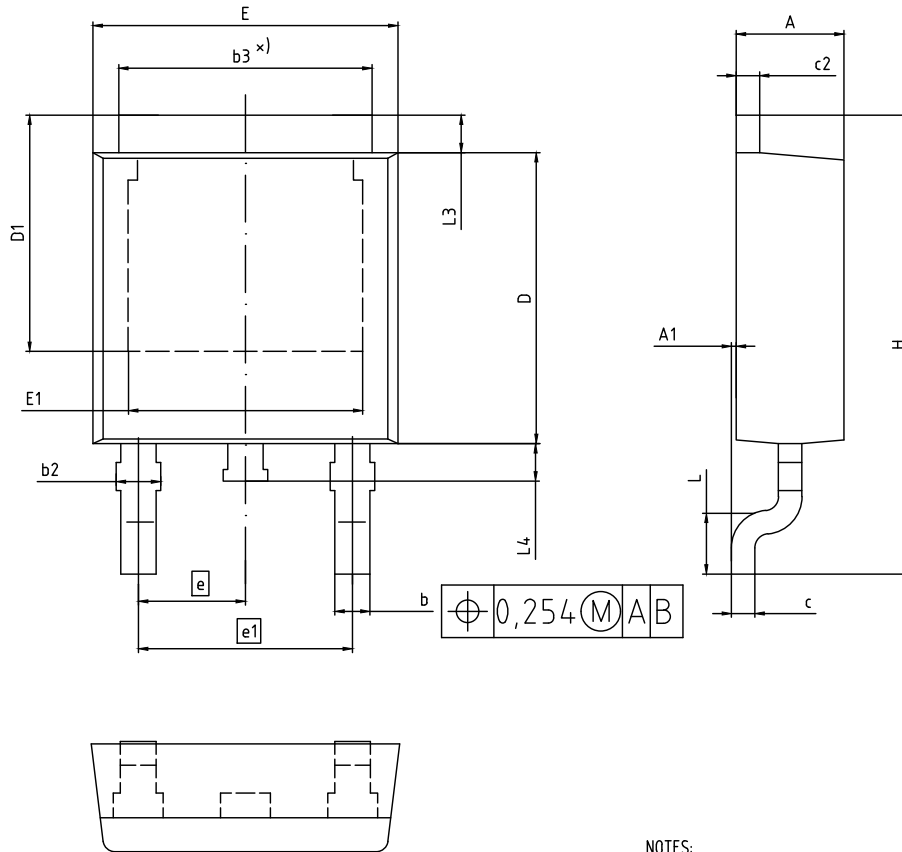
$V_{BR(DSS)}=f(T_j); I_D=-250 \mu\text{A}$

Diagram Gate charge waveforms





## 5 Package Outlines



NOTES:

1. INDUSTRIAL QUALITY GRADE
2. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.16	2.41	0.085	0.095
A1	0.00	0.15	0.000	0.006
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b3	4.95	5.50	0.195	0.217
c	0.46	0.61	0.018	0.024
c2	0.40	0.98	0.016	0.039
D	5.97	6.22	0.235	0.245
D1	5.02	5.84	0.198	0.230
E	6.35	6.73	0.250	0.265
E1	4.32	5.21	0.185	0.205
e	2.29 (BSC)		0.090 (BSC)	
e1	4.57 (BSC)		0.180 (BSC)	
N	3		3	
H	9.40	10.48	0.370	0.413
L	1.18	1.78	0.046	0.070
L3	0.89	1.27	0.035	0.050
L4	0.51	1.02	0.020	0.040

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Figure 1 Outline PG-TO 252-3, dimensions in mm/inches

## Revision History

IPD650P06NM

**Revision: 2019-04-02, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2019-04-02	Release of final version

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