

MOSFET

StrongIRFET™2 Power-Transistor, 60 V

Features

- Optimized for wide range of applications
- N-channel, normal level
- 100% avalanche tested
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

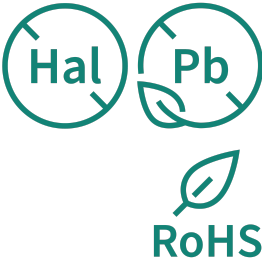
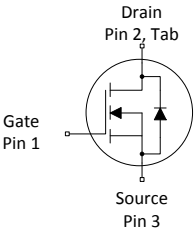
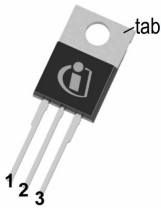
Product validation

Qualified according to JEDEC Standard

Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS}	60	V
$R_{DS(on),max}$	4.0	mΩ
I_D	109	A
Q_{oss}	46	nC
$Q_G(0V..10V)$	45	nC

PG-TO220-3



Type/Ordering Code	Package	Marking	Related Links
IPP040N06NF2S	PG-TO220-3	040N06NS	-



Table of Contents

Description 1

Maximum ratings 3

Thermal characteristics 4

Electrical characteristics 5

Electrical characteristics diagrams 7

Package Outlines 11

Revision History 12

Trademarks 12

Disclaimer 12

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 ¹⁾	I_D	-	-	109 84 22	A	$V_{GS}=10\text{ V}$, $T_C=25\text{ °C}$ $V_{GS}=10\text{ V}$, $T_C=100\text{ °C}$ $V_{GS}=10\text{ V}$, $T_A=25\text{ °C}$, $R_{thJA}=40\text{ °C/W}$ ²⁾
Pulsed drain current ³⁾	$I_{D,pulse}$	-	-	436	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse ⁴⁾	E_{AS}	-	-	94	mJ	$I_D=60\text{ A}$, $R_{GS}=25\text{ }\Omega$
Gate source voltage	V_{GS}	-20	-	20	V	-
Power dissipation	P_{tot}	-	-	107 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	-

¹⁾ 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.

²⁾ Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

³⁾ See Diagram 3 for more detailed information

⁴⁾ See Diagram 13 for more detailed information

2 Thermal characteristics

Table 3 Thermal characteristics

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	1.4	°C/W	-
Thermal resistance, junction - ambient, 6 cm ² cooling area ⁵⁾	R_{thJA}	-	-	40	°C/W	-
Thermal resistance, junction - ambient, minimal footprint	R_{thJA}	-	-	62	°C/W	-

⁵⁾ Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

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	$V_{GS}=0\text{ V}$, $I_D=1\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	2.1	2.8	3.3	V	$V_{DS}=V_{GS}$, $I_D=52\text{ }\mu\text{A}$
Zero gate voltage drain current	I_{DSS}	-	0.5 10	1 100	μA	$V_{DS}=60\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$ $V_{DS}=60\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=125\text{ °C}$
Gate-source leakage current	I_{GSS}	-	10	100	nA	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$
Drain-source on-state resistance ⁶⁾	$R_{DS(on)}$	-	3.5 4.6	4.0 6.4	m Ω	$V_{GS}=10\text{ V}$, $I_D=60\text{ A}$ $V_{GS}=6\text{ V}$, $I_D=30\text{ A}$
Gate resistance	R_G	-	3.2	-	Ω	-
Transconductance ⁷⁾	g_{fs}	55	-	-	S	$ V_{DS} \geq 2 I_D R_{DS(on)max}$, $I_D=60\text{ A}$

⁶⁾ $R_{DS(on)}$ is specified at a distance of 1.8 mm distance to the package body; mounting at a larger distance increases the overall package resistance of approximately 0.04 mOhm/mm per leg.

⁷⁾ Defined by design. Not subject to production test.

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	3000	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=30\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	670	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=30\text{ V}$, $f=1\text{ MHz}$
Reverse transfer capacitance	C_{rss}	-	43	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=30\text{ V}$, $f=1\text{ MHz}$
Turn-on delay time	$t_{d(on)}$	-	26	-	ns	$V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=60\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$
Rise time	t_r	-	23	-	ns	$V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=60\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$
Turn-off delay time	$t_{d(off)}$	-	45	-	ns	$V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=60\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$
Fall time	t_f	-	13	-	ns	$V_{DD}=30\text{ V}$, $V_{GS}=10\text{ V}$, $I_D=60\text{ A}$, $R_{G,ext}=1.6\text{ }\Omega$

Table 6 Gate charge characteristics ⁸⁾

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	14	-	nC	$V_{DD}=30\text{ V}$, $I_D=60\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate charge at threshold	$Q_{g(th)}$	-	8.5	-	nC	$V_{DD}=30\text{ V}$, $I_D=60\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	Q_{gd}	-	8.8	-	nC	$V_{DD}=30\text{ V}$, $I_D=60\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$

Table 6 Gate charge characteristics ⁸⁾

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Switching charge	Q_{sw}	-	15	-	nC	$V_{DD}=30\text{ V}$, $I_D=60\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total ⁹⁾	Q_g	-	45	68	nC	$V_{DD}=30\text{ V}$, $I_D=60\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	4.7	-	V	$V_{DD}=30\text{ V}$, $I_D=60\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total, sync. FET	$Q_{g(sync)}$	-	41	-	nC	$V_{DS}=0.1\text{ V}$, $V_{GS}=0\text{ to }10\text{ V}$
Output charge	Q_{oss}	-	46	-	nC	$V_{DS}=30\text{ V}$, $V_{GS}=0\text{ V}$

⁸⁾ See "Gate charge waveforms" for parameter definition

⁹⁾ Defined by design. Not subject to production test.

Table 7 Reverse diode

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	I_S	-	-	86	A	$T_C=25\text{ °C}$
Diode pulse current	$I_{S,pulse}$	-	-	436	A	$T_C=25\text{ °C}$
Diode forward voltage	V_{SD}	-	0.94	1.1	V	$V_{GS}=0\text{ V}$, $I_F=60\text{ A}$, $T_j=25\text{ °C}$
Reverse recovery time	t_{rr}	-	39	-	ns	$V_R=30\text{ V}$, $I_F=60\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$
Reverse recovery charge	Q_{rr}	-	39	-	nC	$V_R=30\text{ V}$, $I_F=60\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$
Reverse recovery time	t_{rr}	-	25	-	ns	$V_R=30\text{ V}$, $I_F=60\text{ A}$, $di_F/dt=500\text{ A}/\mu\text{s}$
Reverse recovery charge	Q_{rr}	-	97	-	nC	$V_R=30\text{ V}$, $I_F=60\text{ A}$, $di_F/dt=500\text{ A}/\mu\text{s}$

4 Electrical characteristics diagrams

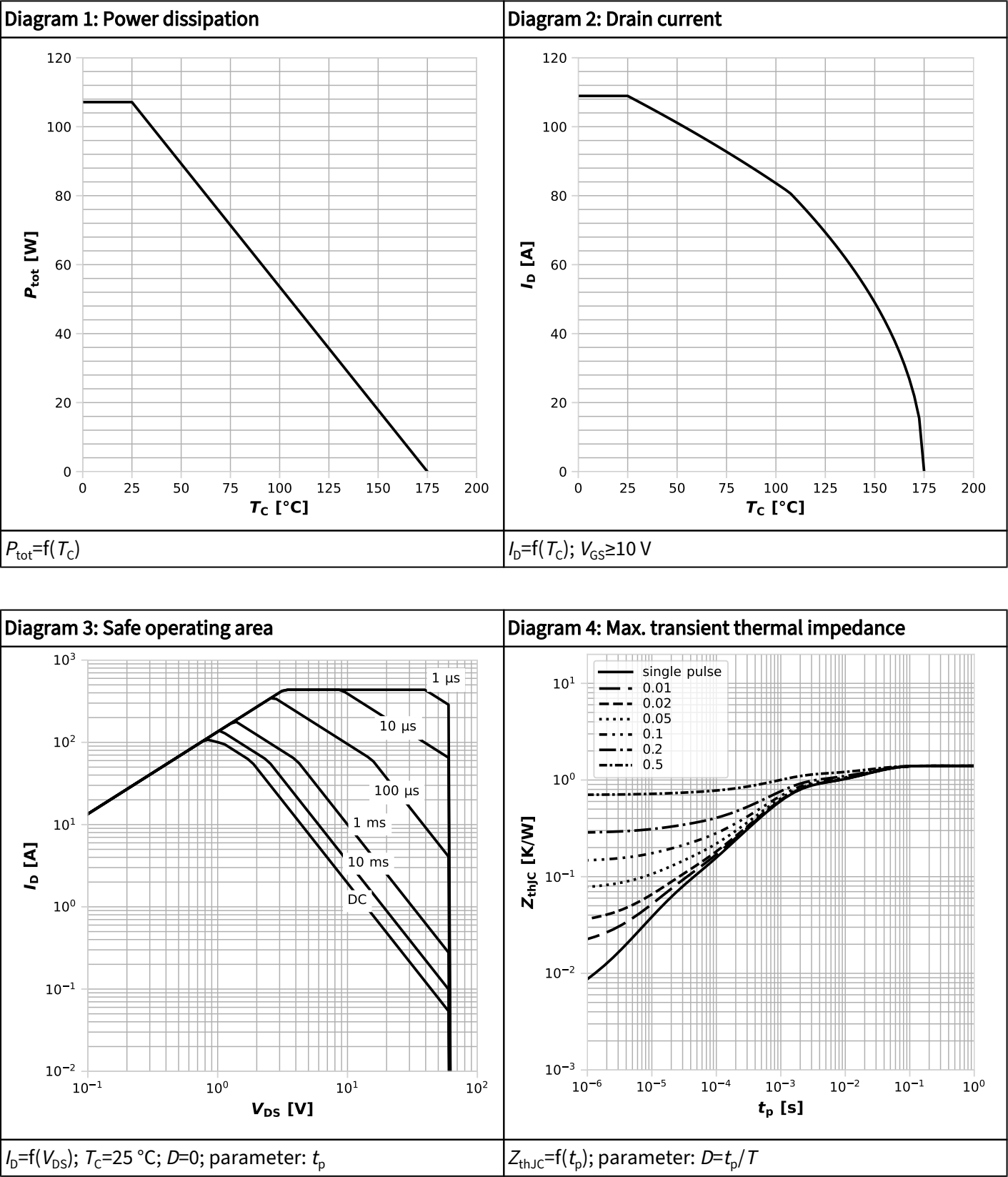
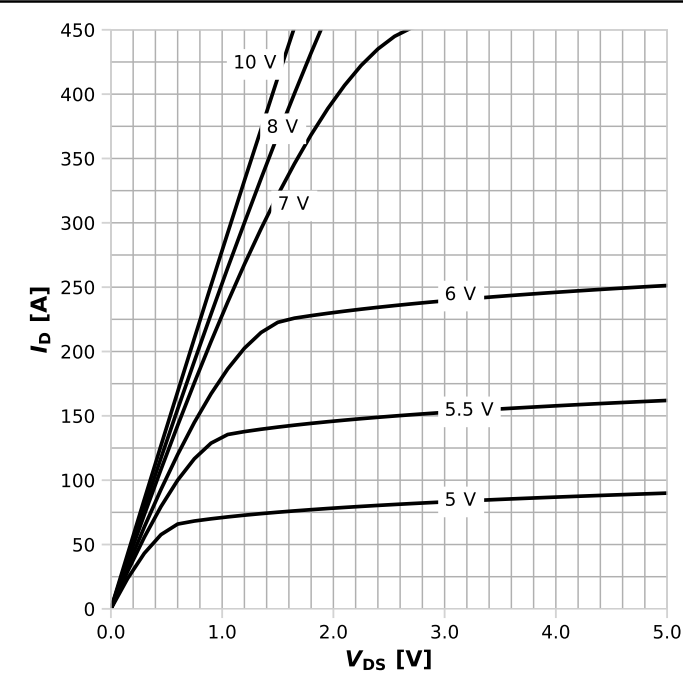


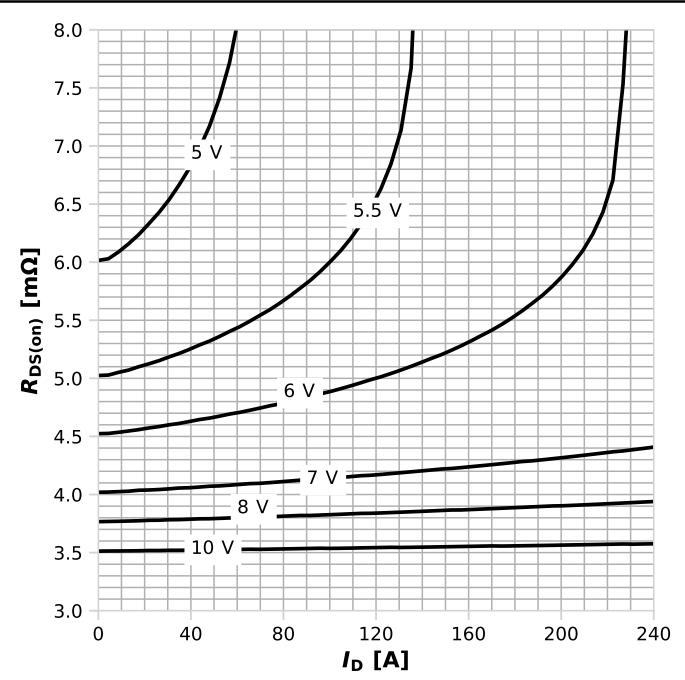


Diagram 5: Typ. output characteristics



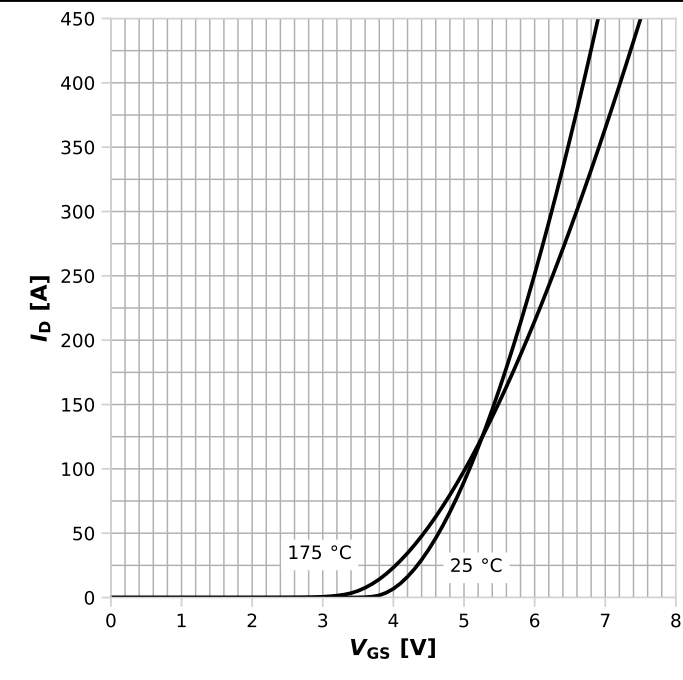
$I_D = f(V_{DS})$, $T_j = 25\text{ }^\circ\text{C}$; parameter: V_{GS}

Diagram 6: Typ. drain-source on resistance



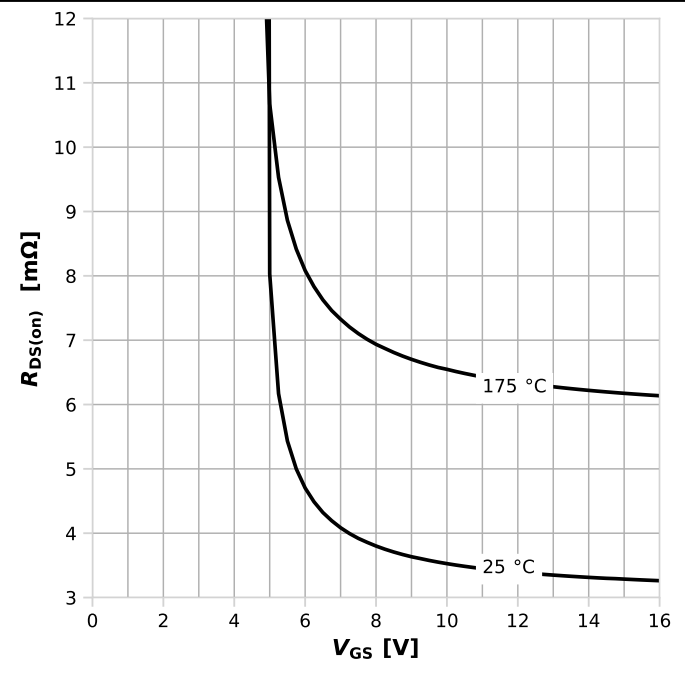
$R_{DS(on)} = f(I_D)$, $T_j = 25\text{ }^\circ\text{C}$; parameter: V_{GS}

Diagram 7: Typ. transfer characteristics



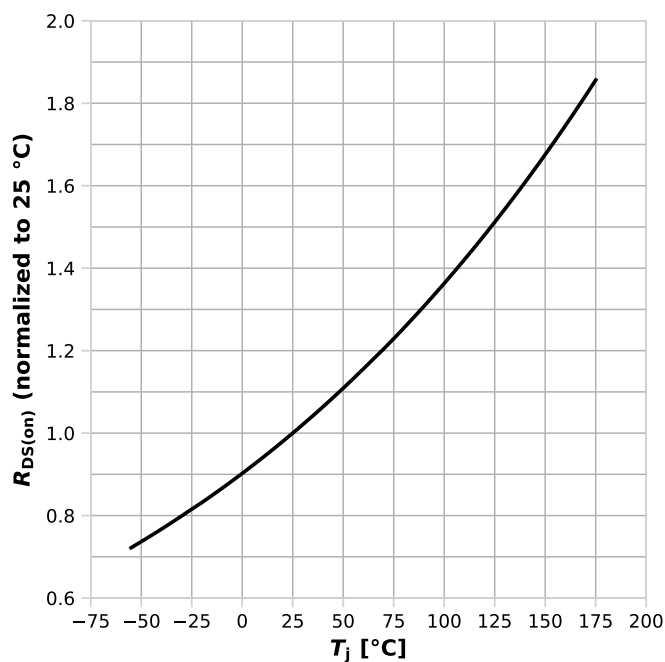
$I_D = f(V_{GS})$, $|V_{DS}| > 2|I_D|R_{DS(on)max}$; parameter: T_j

Diagram 8: Typ. drain-source on resistance



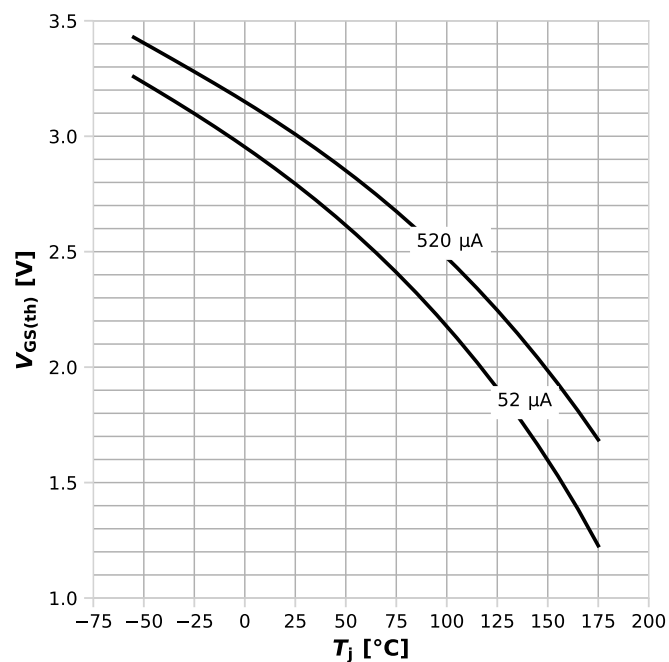
$R_{DS(on)} = f(V_{GS})$, $I_D = 60\text{ A}$; parameter: T_j

Diagram 9: Normalized drain-source on resistance



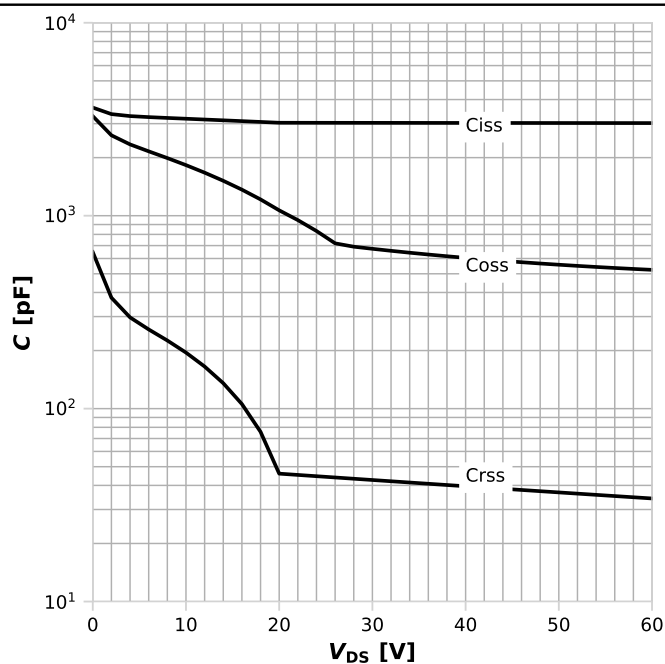
$$R_{DS(on)} = f(T_j), I_D = 60 \text{ A}, V_{GS} = 10 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



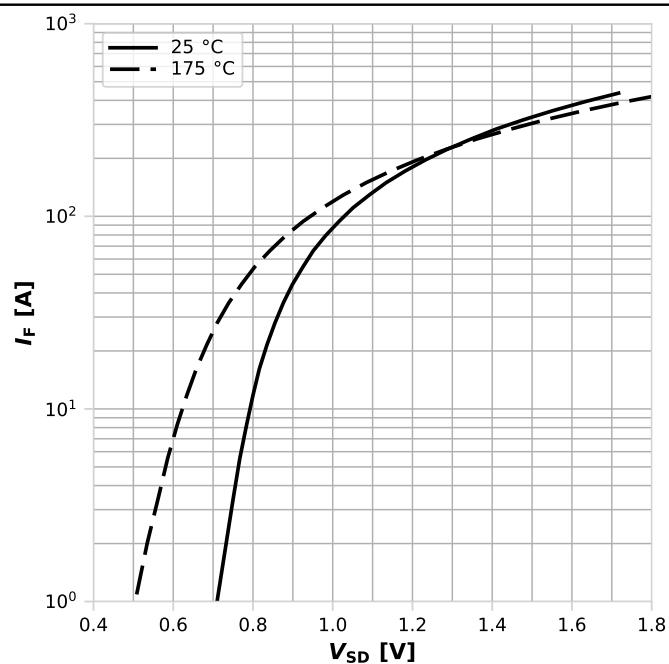
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}; \text{ parameter: } I_D$$

Diagram 11: Typ. capacitances



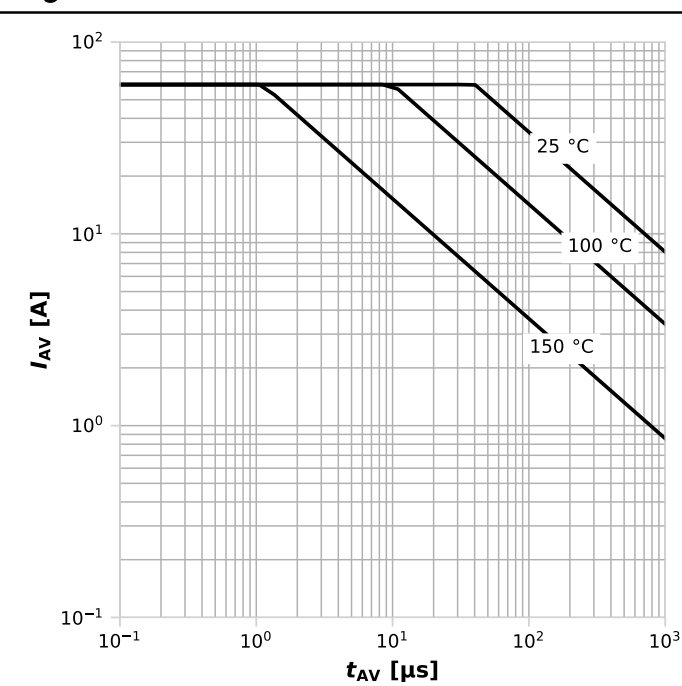
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$

Diagram 12: Forward characteristics of reverse diode



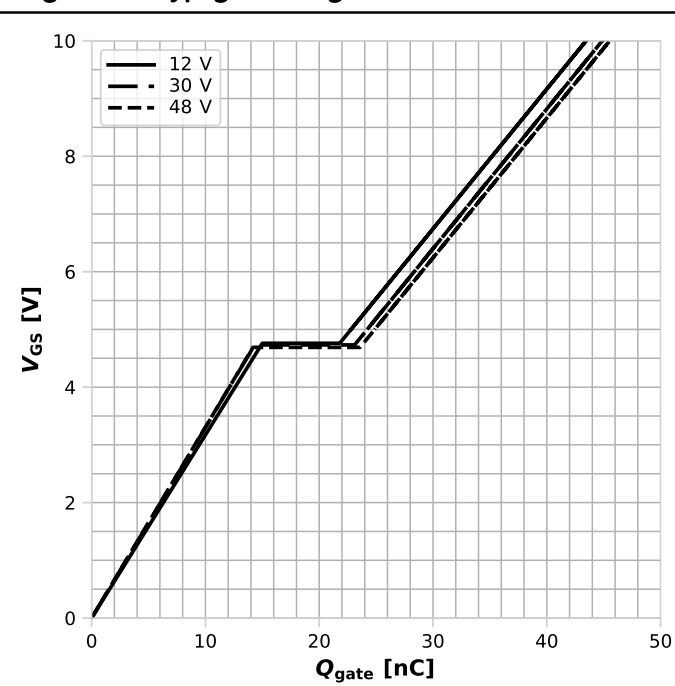
$$I_F = f(V_{SD}); \text{ parameter: } T_j$$

Diagram 13: Avalanche characteristics



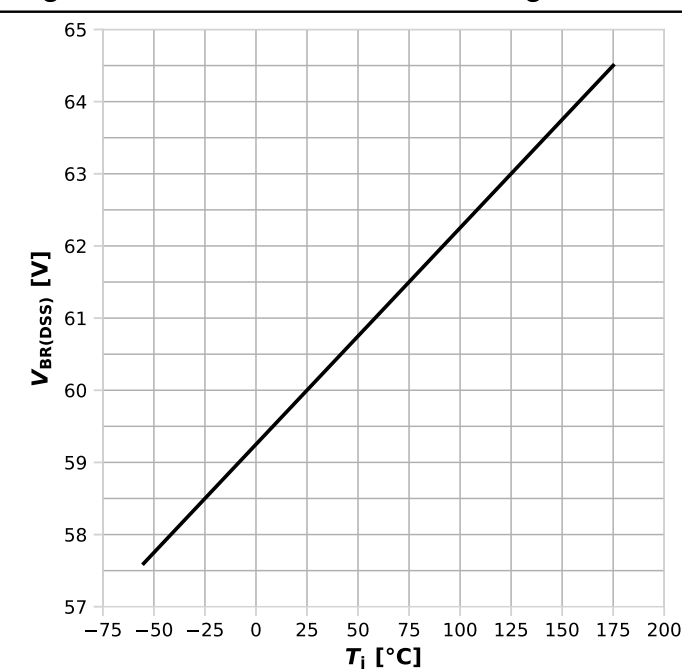
$I_{AS}=f(t_{AV})$; $R_{GS}=25\ \Omega$; parameter: $T_{j,start}$

Diagram 14: Typ. gate charge



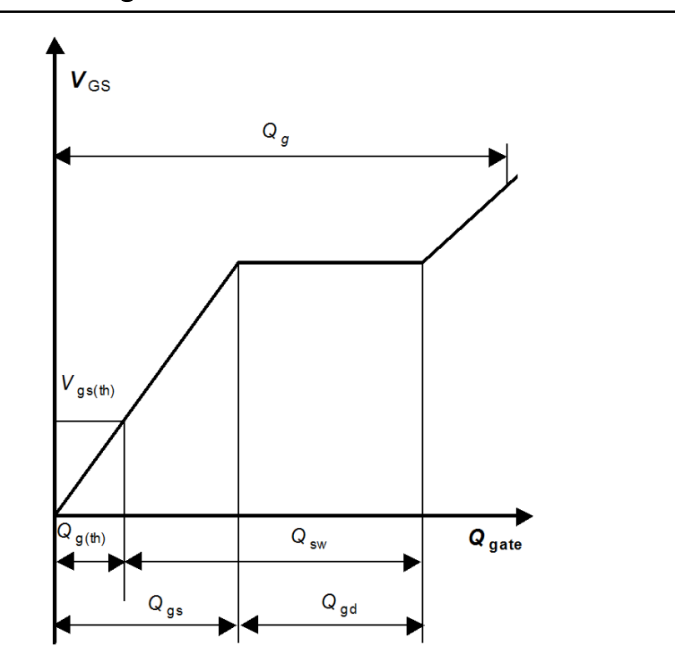
$V_{GS}=f(Q_{gate})$, $I_D=60\text{ A}$ pulsed, $T_j=25\text{ °C}$; parameter: V_{DD}

Diagram 15: Drain-source breakdown voltage



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

Gate charge waveforms



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5 Package Outlines

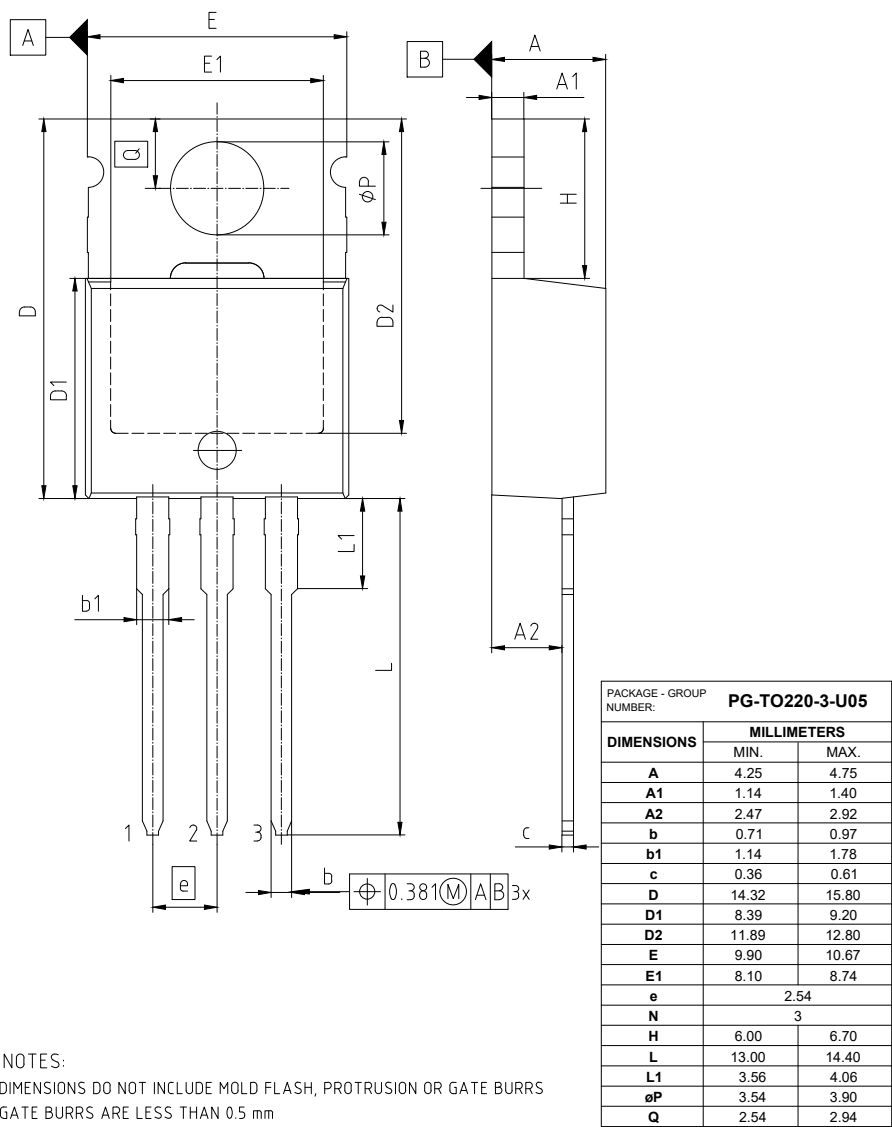


Figure 1 Outline PG-TO220-3, dimensions in mm

Revision History

IPP040N06NF2S

Revision 2024-10-07, Rev. 2.3

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2022-01-18	Release of final version
2.1	2022-02-16	Updated the x-axis scale on diagrams 6 & 15
2.2	2022-05-16	Updated diagram 12 title
2.3	2024-10-07	Added trr and Qrr at diF/dt=100 A/μs

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Infineon Technologies AG

81726 München, Germany

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