

# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## OptiMOS™

OptiMOS™FD Power-Transistor, 200 V  
IPP120N20NFD

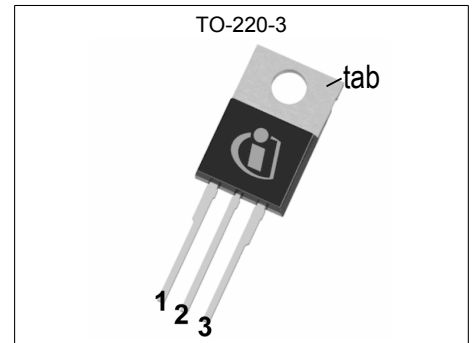
## Data Sheet

Rev. 2.0  
Final

## 1 Description

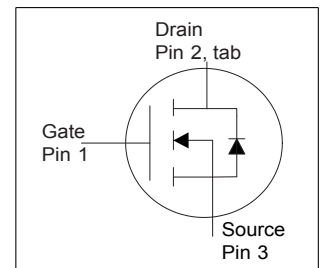
### Features

- N-channel, normal level
- Fast Diode (FD) with reduced  $Q_{rr}$
- Optimized for hard commutation ruggedness
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC <sup>1)</sup> for target application
- Halogen-free according to IEC61249-2-21



**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS}$	200	V
$R_{DS(on),max}$	12	mΩ
$I_D$	84	A



Type / Ordering Code	Package	Marking	Related Links
IPP120N20NFD	PG-TO220-3	120N20NF	-

<sup>1)</sup> J-STD20 and JESD22

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## 2 Maximum ratings

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

**Table 2 Maximum ratings**  
at  $25\text{ °C}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current	$I_D$	-	-	84 60	A	$T_C=25\text{ °C}$ $T_C=100\text{ °C}$
Pulsed drain current <sup>1)</sup>	$I_{D,pulse}$	-	-	336	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	375	mJ	$I_D=67\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Reverse diode peak $dv/dt$	$dv/dt$	-	-	60	kV/ $\mu$ s	$I_D=160\text{ A}$ , $V_{DS}=100\text{ V}$ , $di/dt=1500\text{ A}/\mu\text{s}$ , $T_{j,max}=175\text{ °C}$
Gate source voltage	$V_{GS}$	-20	-	20	V	-
Power dissipation	$P_{tot}$	-	-	300	W	$T_C=25\text{ °C}$
Operating and storage temperature	$T_j$ , $T_{stg}$	-55	-	175	$^{\circ}\text{C}$	IEC climatic category; DIN IEC 68-1: 55/175/56

## 3 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	0.3	0.5	K/W	-
Thermal resistance, junction - ambient, minimal footprint	$R_{thJA}$	-	-	62	K/W	-
Thermal resistance, junction - ambient, $6\text{ cm}^2$ cooling area <sup>2)</sup>	$R_{thJA}$	-	-	40	K/W	-

<sup>1)</sup> See figure 3

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

## 4 Electrical characteristics

**Table 4 Static characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	200	-	-	V	$V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	2	3	4	V	$V_{DS}=V_{GS}$ , $I_D=270\text{ }\mu\text{A}$
Zero gate voltage drain current	$I_{DSS}$	-	0.1 10	1 100	$\mu\text{A}$	$V_{DS}=160\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ }^\circ\text{C}$ $V_{DS}=160\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ }^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$	-	1	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	10.6	12	m $\Omega$	$V_{GS}=10\text{ V}$ , $I_D=84\text{ A}$
Gate resistance	$R_G$	-	2.4	3.6	$\Omega$	-
Transconductance	$g_{fs}$	70	139	-	S	$ V_{DS} >2 I_D R_{DS(on)max}$ , $I_D=84\text{ A}$

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	5000	6650	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	400	532	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Reverse transfer capacitance	$C_{riss}$	-	6	13	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Turn-on delay time	$t_{d(on)}$	-	13	-	ns	$V_{DD}=100\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=42\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Rise time	$t_r$	-	10	-	ns	$V_{DD}=100\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=42\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Turn-off delay time	$t_{d(off)}$	-	24	-	ns	$V_{DD}=100\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=42\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Fall time	$t_f$	-	8	-	ns	$V_{DD}=100\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=42\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	25	-	nC	$V_{DD}=100\text{ V}$ , $I_D=84\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	8	-	nC	$V_{DD}=100\text{ V}$ , $I_D=84\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Switching charge	$Q_{sw}$	-	17	-	nC	$V_{DD}=100\text{ V}$ , $I_D=84\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total	$Q_g$	-	65	87	nC	$V_{DD}=100\text{ V}$ , $I_D=84\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	4.7	-	V	$V_{DD}=100\text{ V}$ , $I_D=84\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Output charge	$Q_{oss}$	-	162	-	nC	$V_{DD}=100\text{ V}$ , $V_{GS}=0\text{ V}$

<sup>1)</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	$I_S$	-	-	84	A	$T_C=25\text{ °C}$
Diode pulse current <sup>1)</sup>	$I_{S,pulse}$	-	-	336	A	$T_C=25\text{ °C}$
Diode hard commutation current <sup>2)</sup>	$I_{S,hard}$	-	-	160	A	$T_C=25\text{ °C}$ , $di_F/dt=1500\text{ A}/\mu\text{s}$
Diode forward voltage	$V_{SD}$	-	1	1.2	V	$V_{GS}=0\text{ V}$ , $I_F=84\text{ A}$ , $T_j=25\text{ °C}$
Reverse recovery time	$t_{rr}$	-	144	288	ns	$V_R=100\text{ V}$ , $I_F=56\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{rr}$	-	629	-	nC	$V_R=100\text{ V}$ , $I_F=56\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$

<sup>1)</sup> Diode pulse current is defined by thermal and/or package limits

<sup>2)</sup> Maximum allowed hard-commutated current through diode at  $di/dt=1500\text{ A}/\mu\text{s}$

## 5 Electrical characteristics diagrams

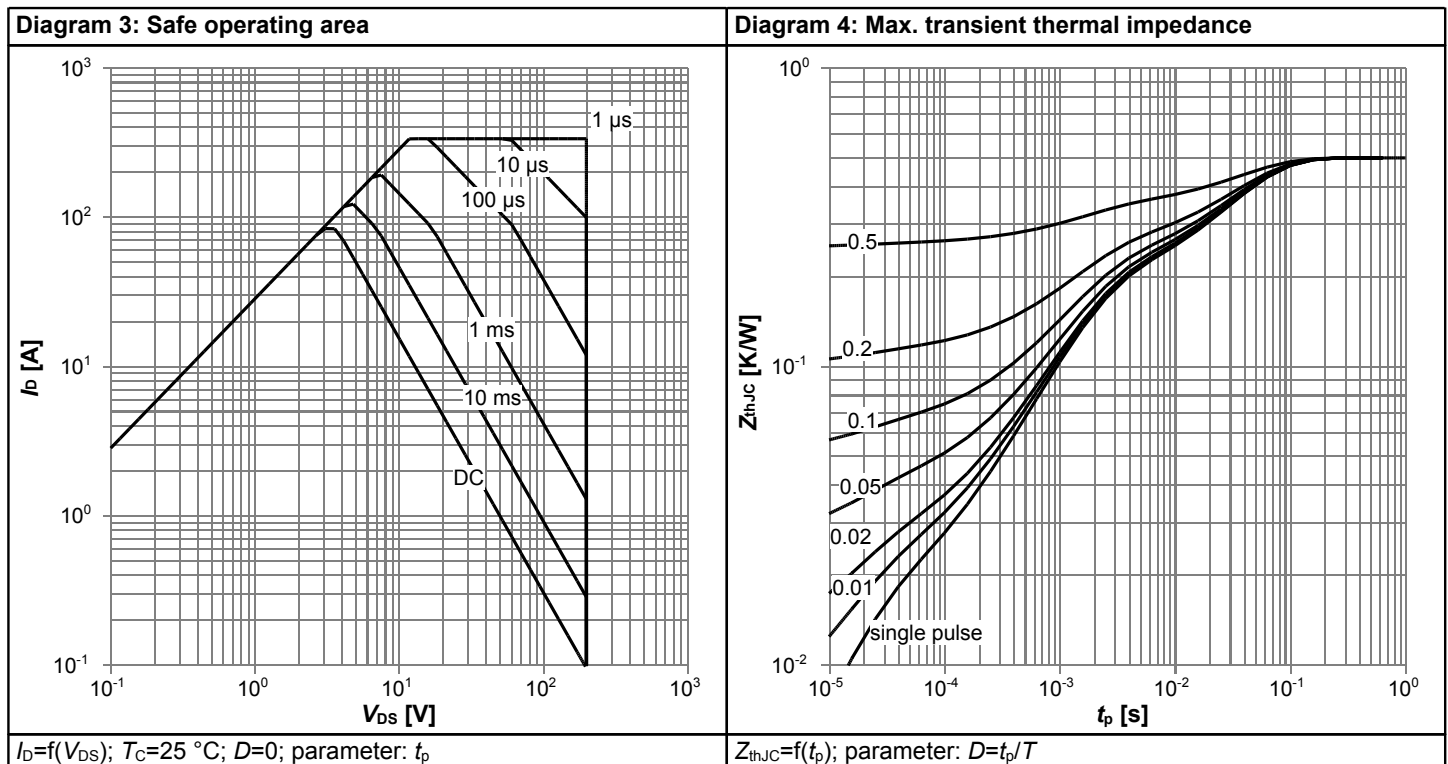
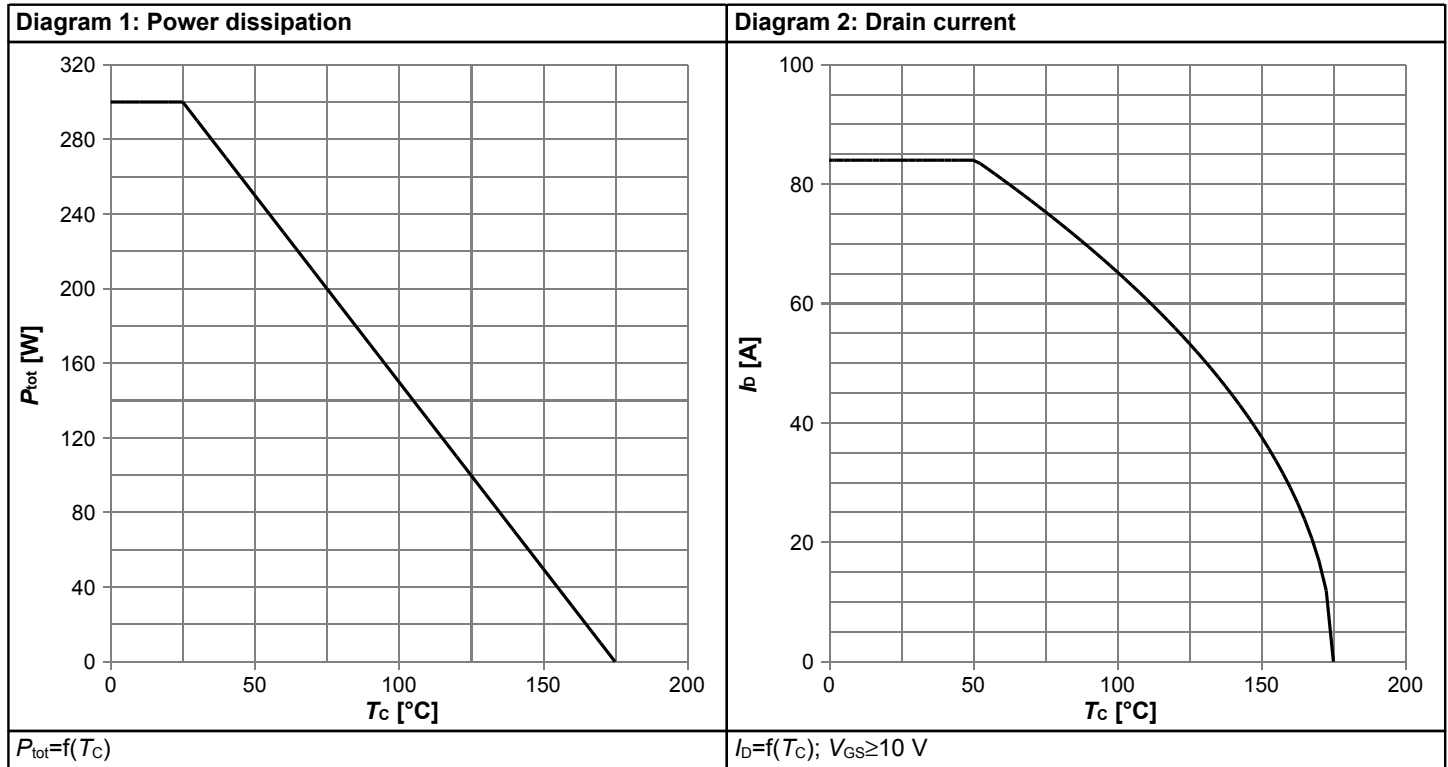
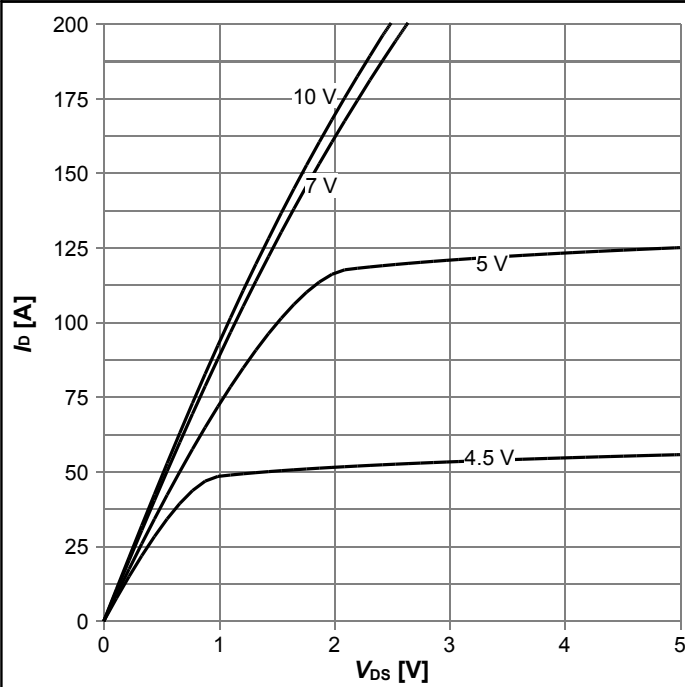
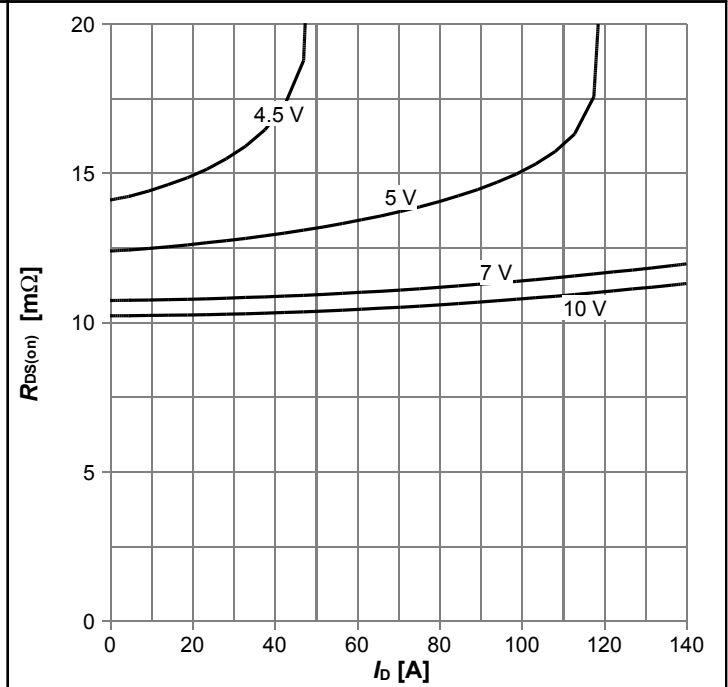


Diagram 5: Typ. output characteristics



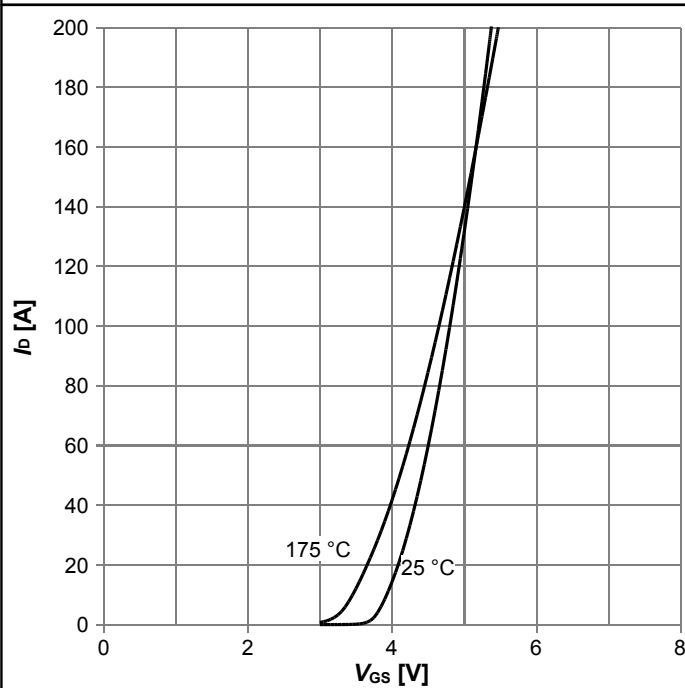
$I_D = f(V_{DS}); T_j = 25\text{ °C};$  parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



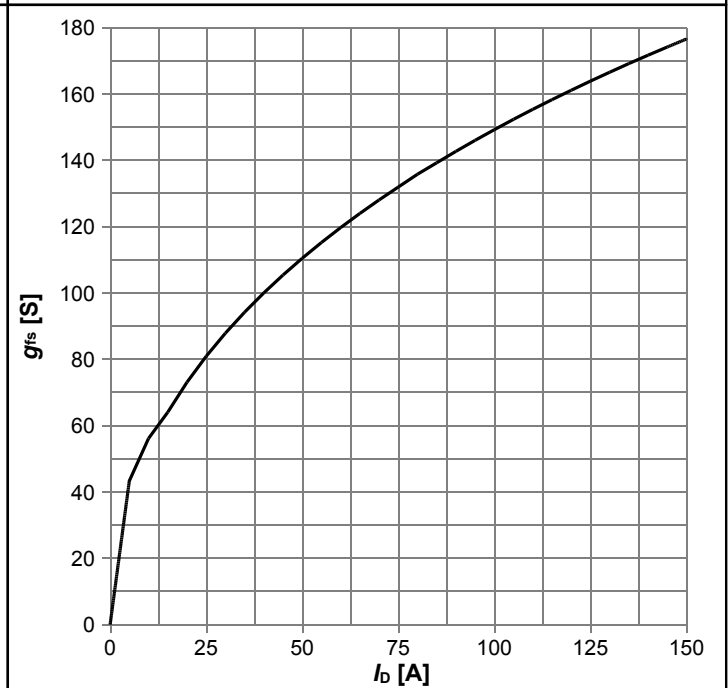
$R_{DS(on)} = f(I_D); T_j = 25\text{ °C};$  parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



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

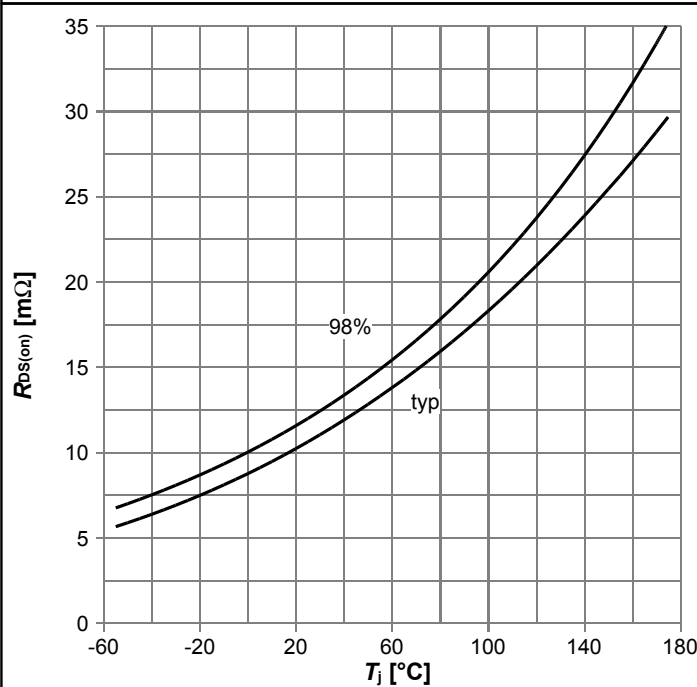
Diagram 8: Typ. forward transconductance



$g_{fs} = f(I_D); T_j = 25\text{ °C}$

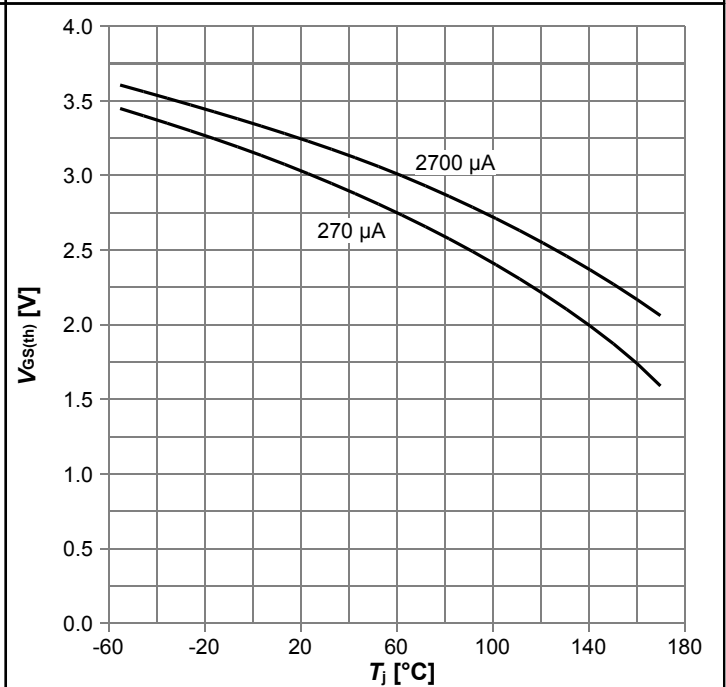


Diagram 9: Drain-source on-state resistance



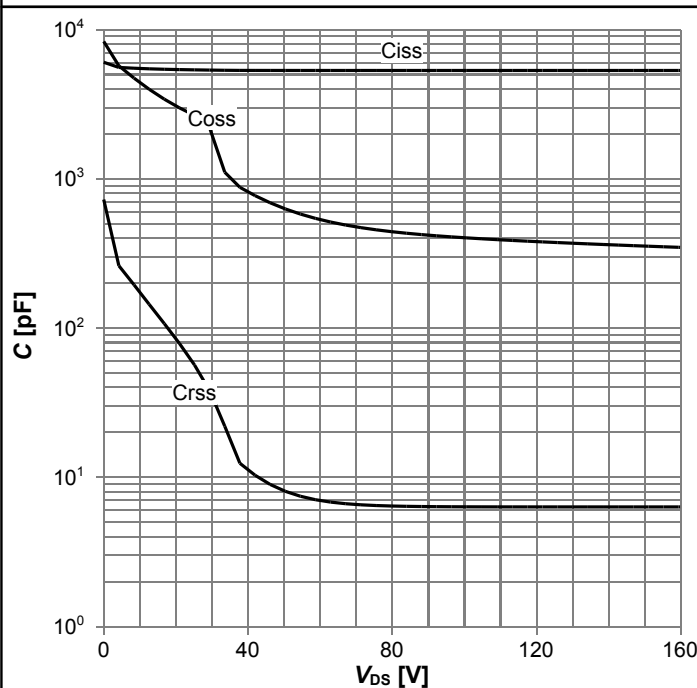
$R_{DS(on)}=f(T_j)$ ;  $I_D=84\text{ A}$ ;  $V_{GS}=10\text{ V}$

Diagram 10: Typ. gate threshold voltage



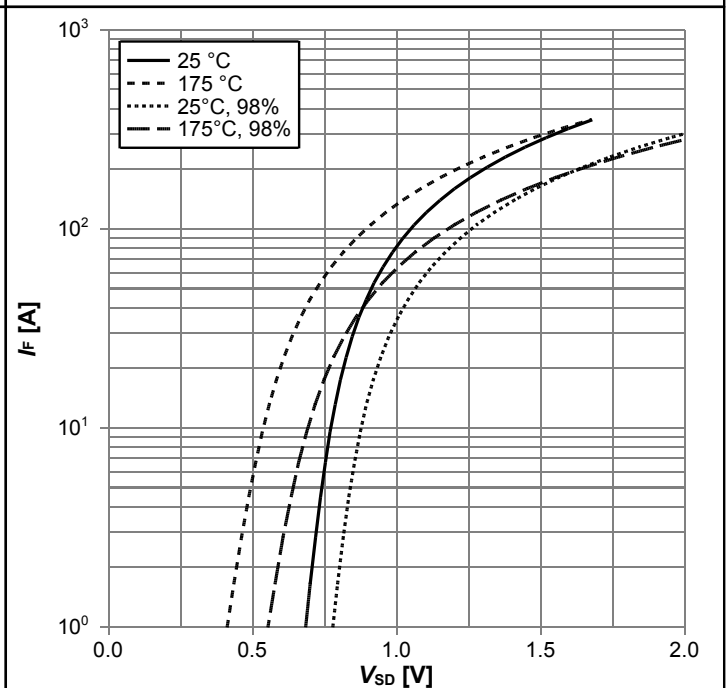
$V_{GS(th)}=f(T_j)$ ;  $V_{GS}=V_{DS}$ ; parameter:  $I_D$

Diagram 11: Typ. capacitances



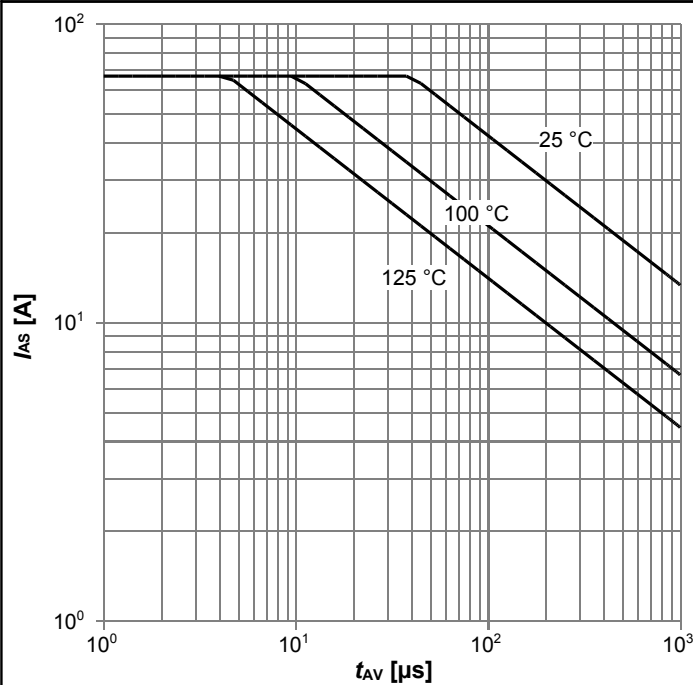
$C=f(V_{DS})$ ;  $V_{GS}=0\text{ V}$ ;  $f=1\text{ MHz}$

Diagram 12: Forward characteristics of reverse diode



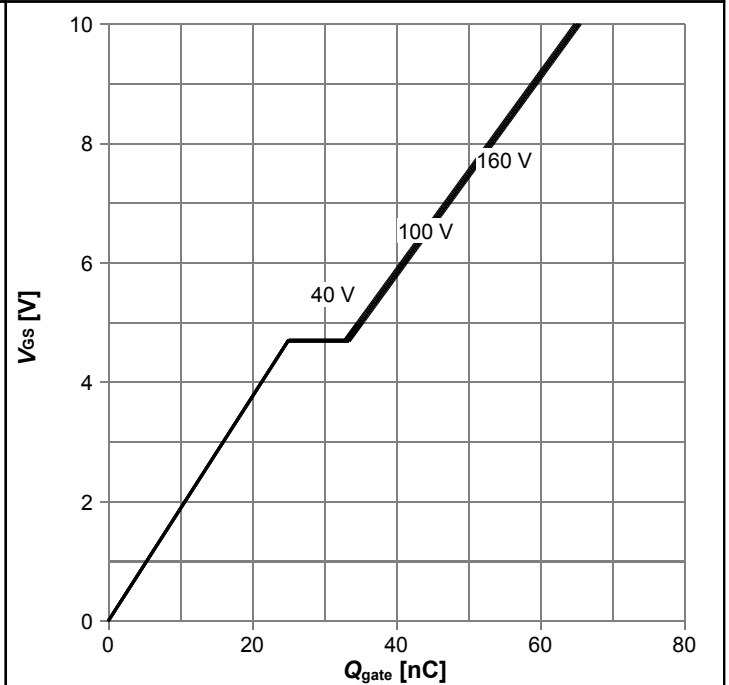
$I_F=f(V_{SD})$ ; parameter:  $T_j$

Diagram 13: Avalanche characteristics



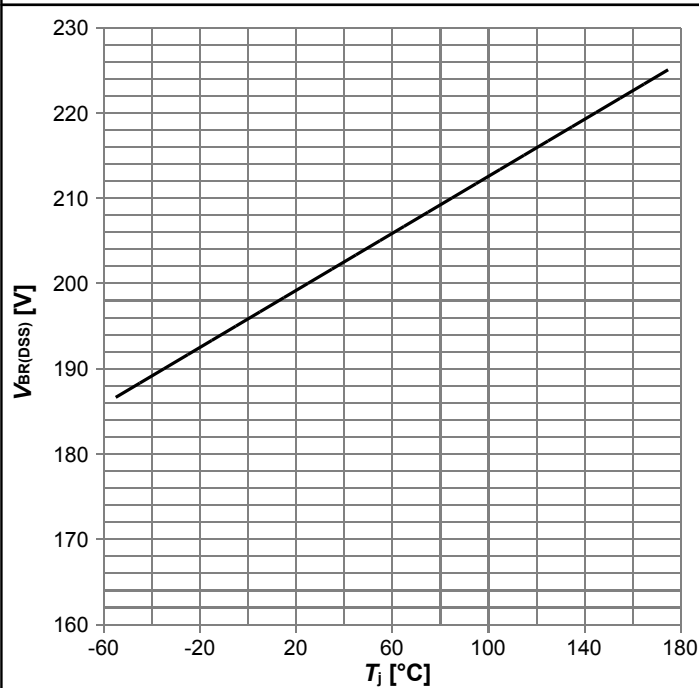
$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$ ; parameter:  $T_{j(start)}$

Diagram 14: Typ. gate charge



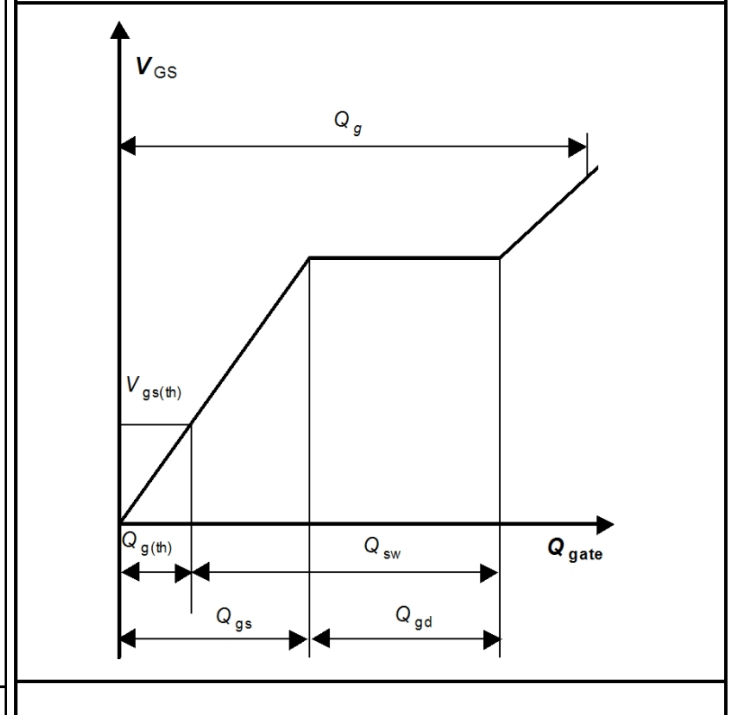
$V_{GS}=f(Q_{gate}); I_D=84$  A pulsed; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage

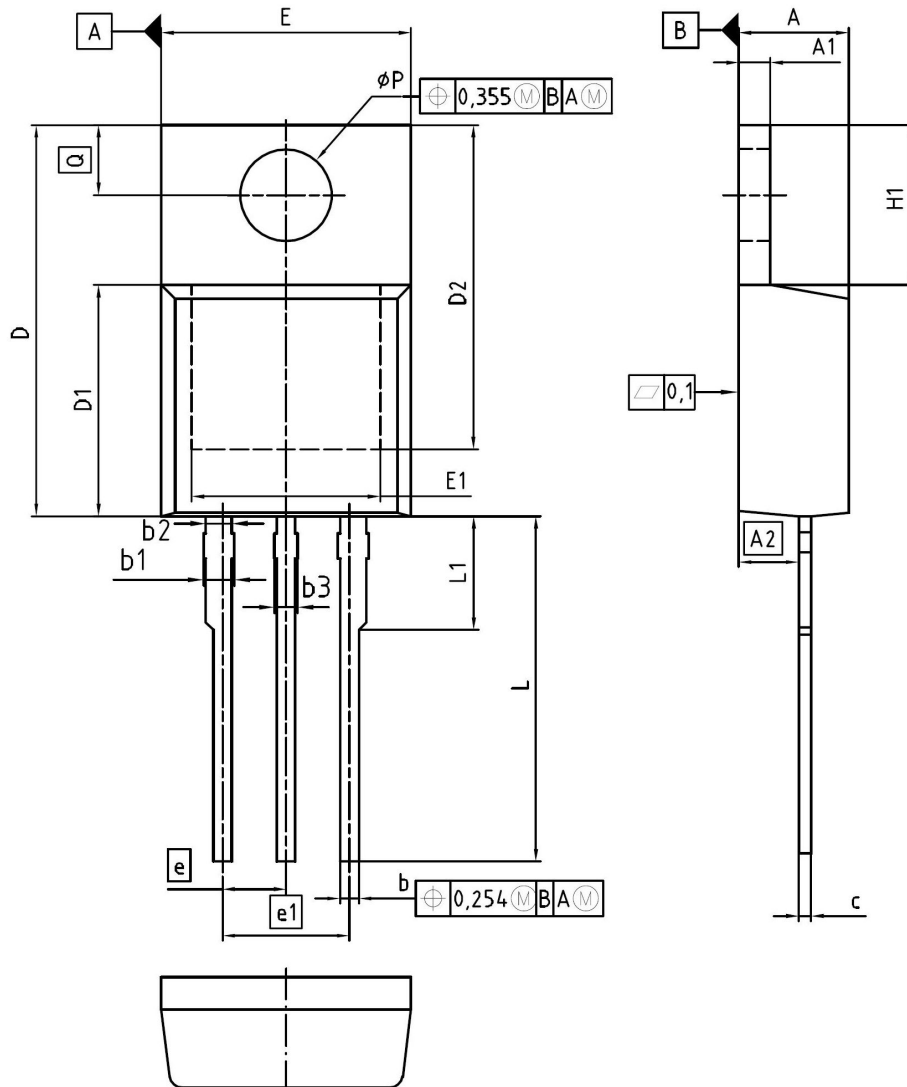


$V_{BR(DSS)}=f(T_j); I_D=1$  mA

Gate charge waveforms



### 6 Package Outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
φP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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REVISION  
06

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

## Revision History

IPP120N20NFD

**Revision: 2014-02-06, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2014-02-06	Release of final version

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