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# MOSFET

## OptiMOS™ Power-Transistor, 60 V

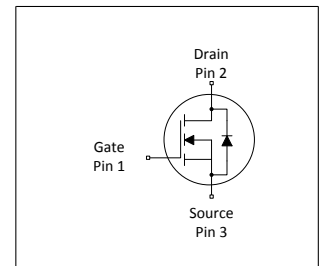
### Features

- Optimized for high performance SMPS, e.g. sync. rec.
- 100% avalanche tested
- Superior thermal resistance
- N-channel
- Qualified according to JEDEC<sup>1)</sup> for target applications
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21



**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS}$	60	V
$R_{DS(on),max}$	6.0	m $\Omega$
$I_D$	45	A
$Q_{OSS}$	32	nC
$Q_G(0V..10V)$	27	nC



Type / Ordering Code	Package	Marking	Related Links
IPA060N06N	PG-TO220-FP	060N06N	-

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

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## 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	$I_D$	-	-	45 38	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>	$I_{D,pulse}$	-	-	180	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse <sup>2)</sup>	$E_{AS}$	-	-	60	mJ	$I_D=45\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Gate source voltage	$V_{GS}$	-20	-	20	V	-
Power dissipation	$P_{tot}$	-	-	33	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	$R_{thJC}$	-	3.4	4.6	K/W	-
Thermal resistance, junction - ambient, Leaded	$R_{thJA}$	-	-	80	K/W	-

## 3 Electrical characteristics

**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	$V_{DS}=V_{GS}$ , $I_D=36\text{ }\mu\text{A}$
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	$R_{DS(on)}$	-	5.2 6.7	6.0 7.5	m $\Omega$	$V_{GS}=10\text{ V}$ , $I_D=45\text{ A}$ $V_{GS}=6\text{ V}$ , $I_D=12\text{ A}$
Gate resistance <sup>3)</sup>	$R_G$	-	1.6	2.4	$\Omega$	-
Transconductance	$g_{fs}$	36	73	-	S	$ V_{DS} >2 I_D R_{DS(on)max}$ , $I_D=45\text{ A}$

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

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

<sup>3)</sup> Defined by design. Not subject to production test

**Table 5 Dynamic characteristics<sup>1)</sup>**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	2000	2500	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=30\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	490	613	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=30\text{ V}$ , $f=1\text{ MHz}$
Reverse transfer capacitance	$C_{rss}$	-	22	44	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=30\text{ V}$ , $f=1\text{ MHz}$
Turn-on delay time	$t_{d(on)}$	-	12	-	ns	$V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=45\text{ A}$ , $R_{G,ext,ext}=3\ \Omega$
Rise time	$t_r$	-	12	-	ns	$V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=45\text{ A}$ , $R_{G,ext,ext}=3\ \Omega$
Turn-off delay time	$t_{d(off)}$	-	20	-	ns	$V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=45\text{ A}$ , $R_{G,ext,ext}=3\ \Omega$
Fall time	$t_f$	-	7	-	ns	$V_{DD}=30\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=45\text{ A}$ , $R_{G,ext,ext}=3\ \Omega$

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	9	-	nC	$V_{DD}=30\text{ V}$ , $I_D=45\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge at threshold	$Q_{g(th)}$	-	5	-	nC	$V_{DD}=30\text{ V}$ , $I_D=45\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge <sup>1)</sup>	$Q_{gd}$	-	5	7	nC	$V_{DD}=30\text{ V}$ , $I_D=45\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Switching charge	$Q_{sw}$	-	9	-	nC	$V_{DD}=30\text{ V}$ , $I_D=45\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total <sup>1)</sup>	$Q_g$	-	27	32	nC	$V_{DD}=30\text{ V}$ , $I_D=45\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	4.8	-	V	$V_{DD}=30\text{ V}$ , $I_D=45\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total, sync. FET	$Q_{g(sync)}$	-	24	-	nC	$V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }10\text{ V}$
Output charge <sup>1)</sup>	$Q_{oss}$	-	32	40	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	$I_S$	-	-	27	A	$T_C=25\text{ °C}$
Diode pulse current	$I_{S,pulse}$	-	-	180	A	$T_C=25\text{ °C}$
Diode forward voltage	$V_{SD}$	-	0.91	1.2	V	$V_{GS}=0\text{ V}$ , $I_F=27\text{ A}$ , $T_J=25\text{ °C}$
Reverse recovery time <sup>1)</sup>	$t_{rr}$	-	32	51	ns	$V_R=30\text{ V}$ , $I_F=27\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{rr}$	-	28	-	nC	$V_R=30\text{ V}$ , $I_F=27\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$

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

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

### 4 Electrical characteristics diagrams

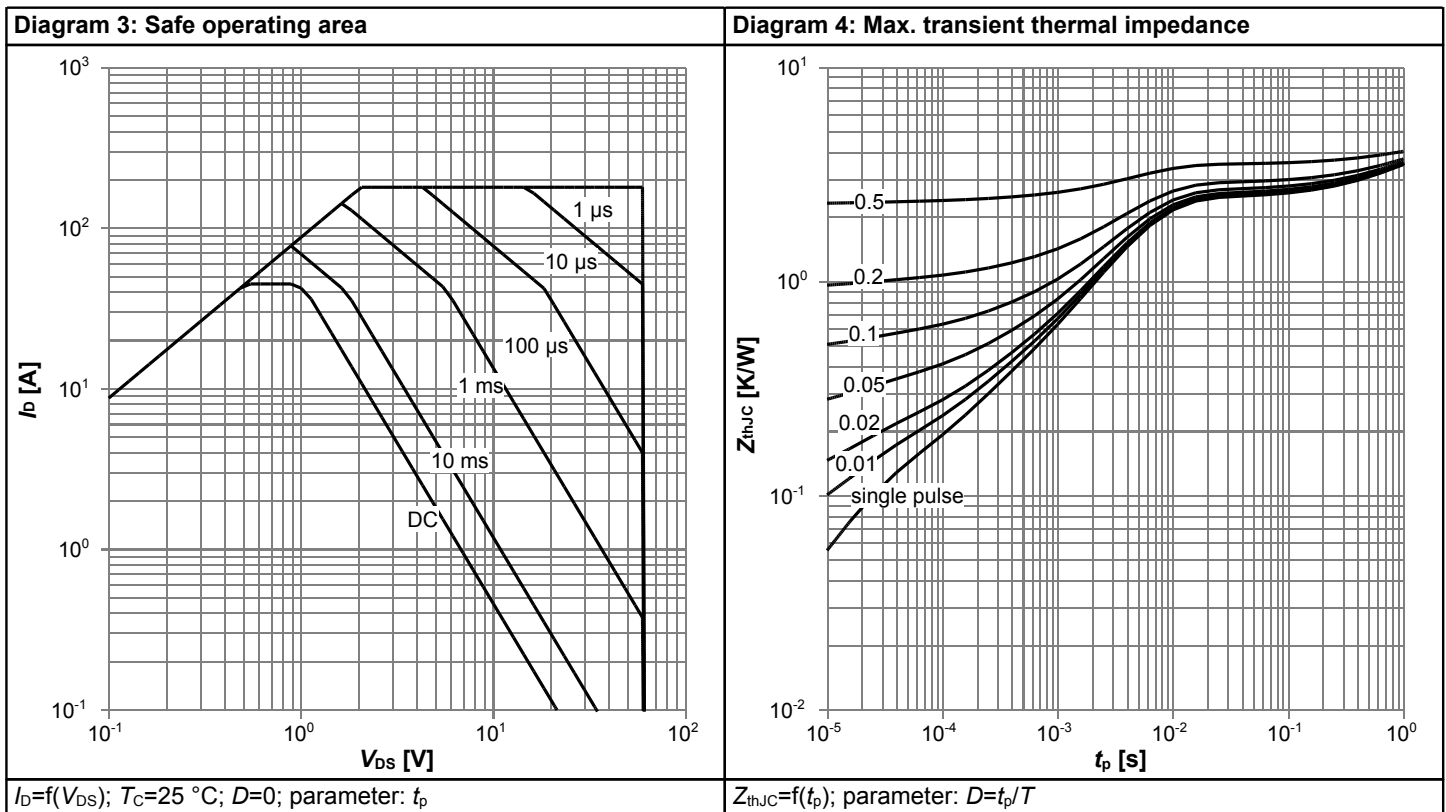
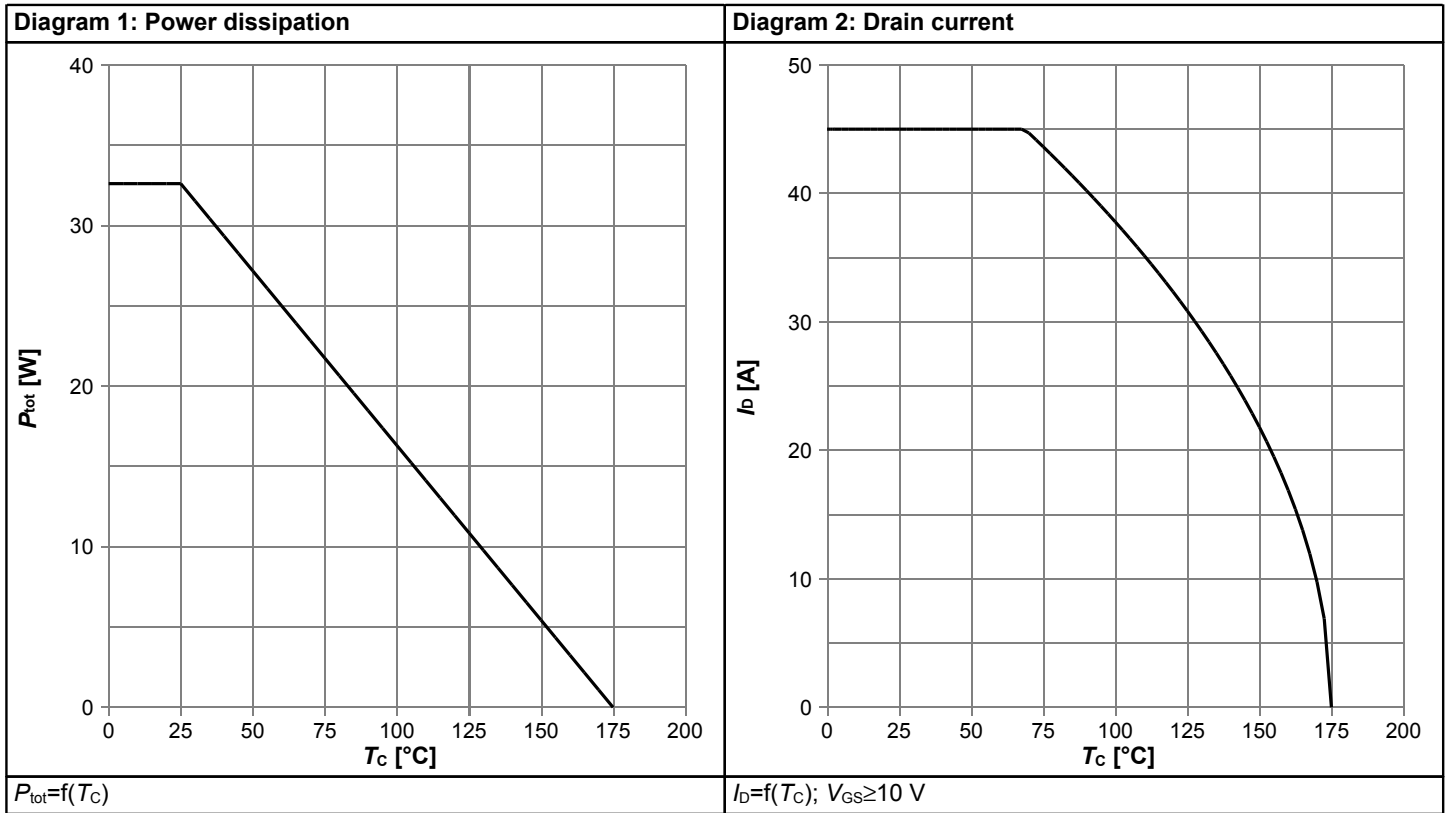
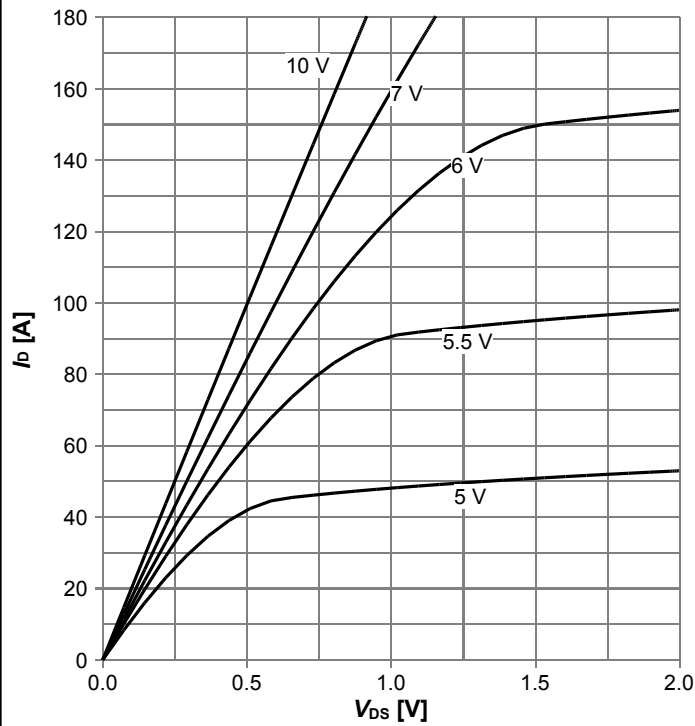
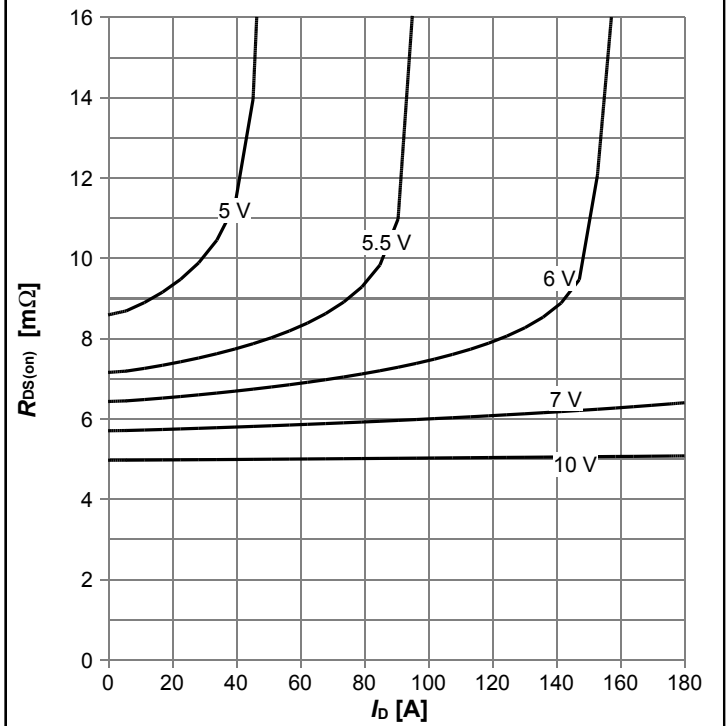


Diagram 5: Typ. output characteristics



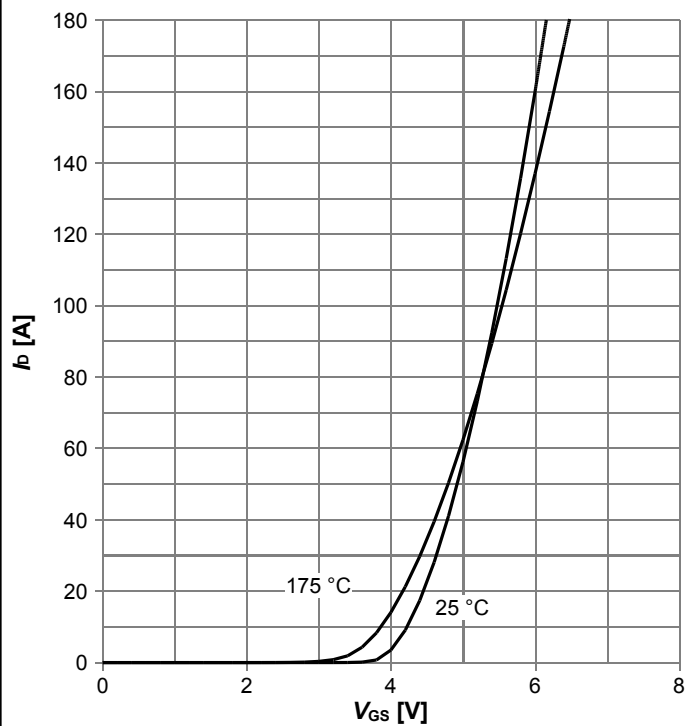
$I_D = f(V_{DS})$ ;  $T_j = 25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. drain-source on resistance



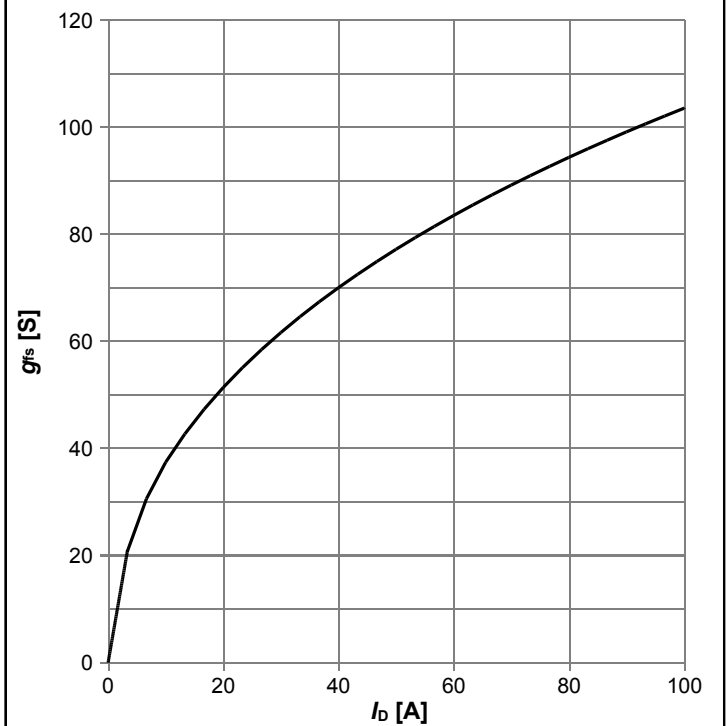
$R_{DS(on)} = f(I_D)$ ;  $T_j = 25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. transfer characteristics



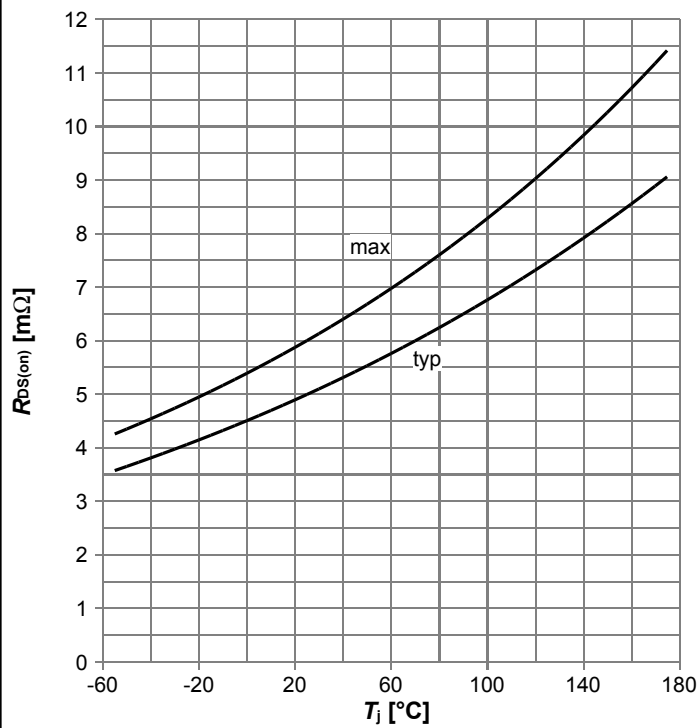
$I_D = f(V_{GS})$ ;  $|V_{DS}| > 2|I_D|R_{DS(on)max}$ ; parameter:  $T_j$

Diagram 8: Typ. forward transconductance



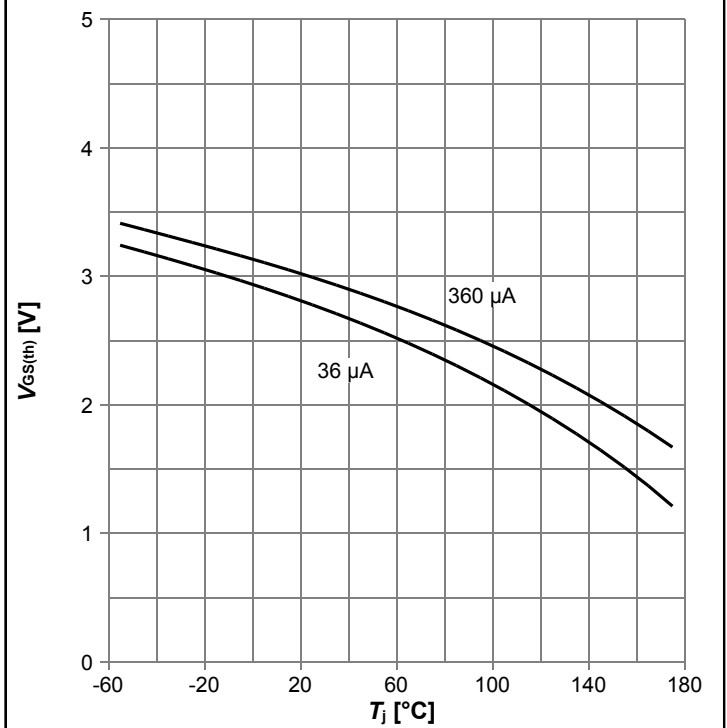
$g_{fs} = f(I_D)$ ;  $T_j = 25\text{ °C}$

Diagram 9: Drain-source on-state resistance



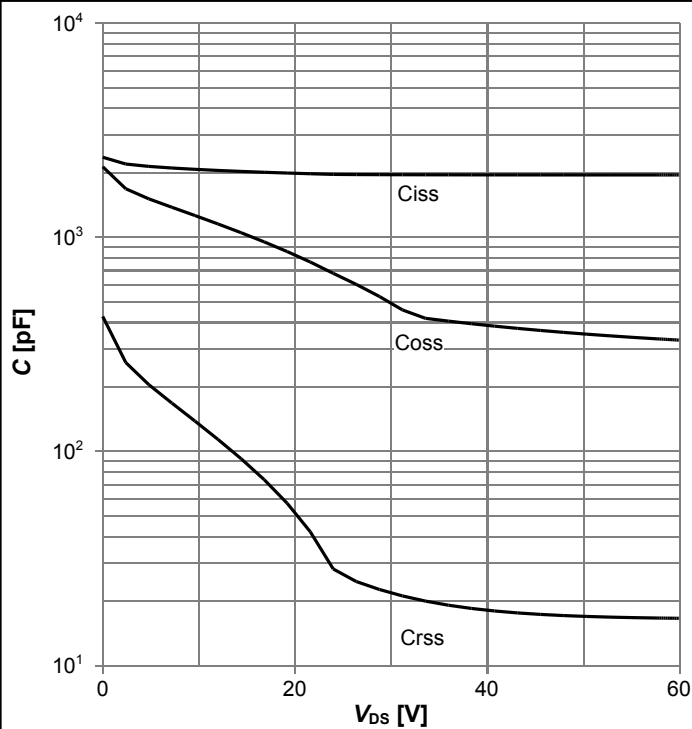
$R_{DS(on)}=f(T_j)$ ;  $I_D=45\text{ A}$ ;  $V_{GS}=10\text{ V}$

Diagram 10: Typ. gate threshold voltage



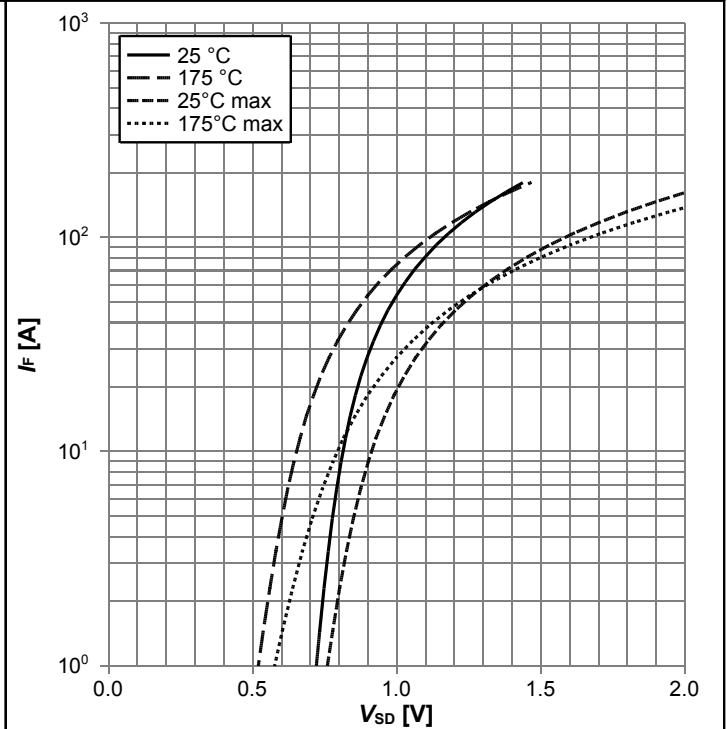
$V_{GS(th)}=f(T_j)$ ;  $V_{GS}=V_{DS}$

Diagram 11: Typ. capacitances



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

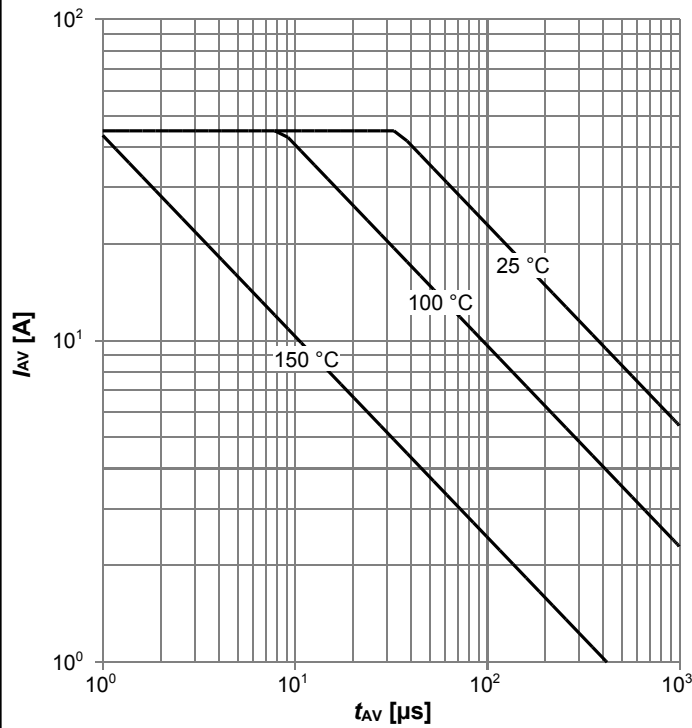
Diagram 12: Forward characteristics of reverse diode



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

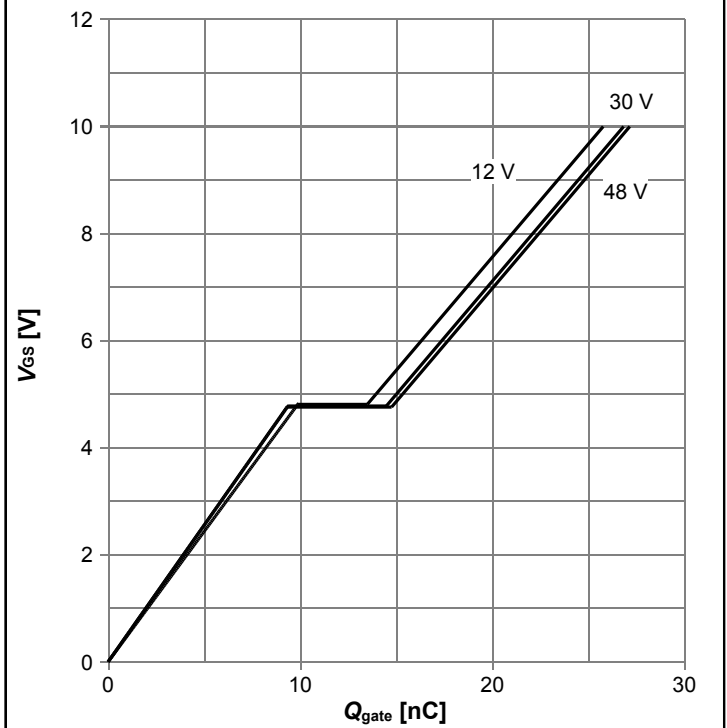


Diagram 13: Avalanche characteristics



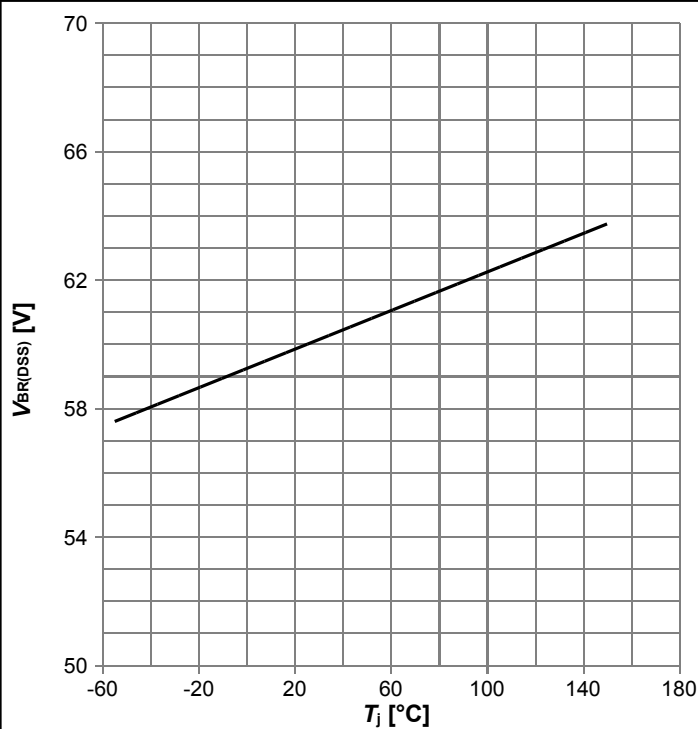
$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$ ; parameter:  $T_{j(start)}$

Diagram 14: Typ. gate charge



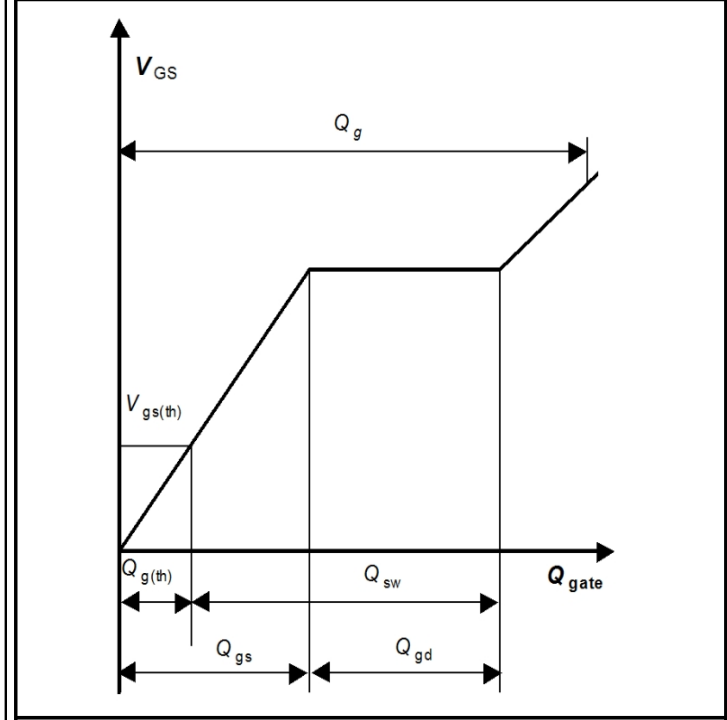
$V_{GS}=f(Q_{gate}); I_D=45 \text{ A pulsed}$ ; parameter:  $V_{DD}$

Diagram 15: Drain-source breakdown voltage

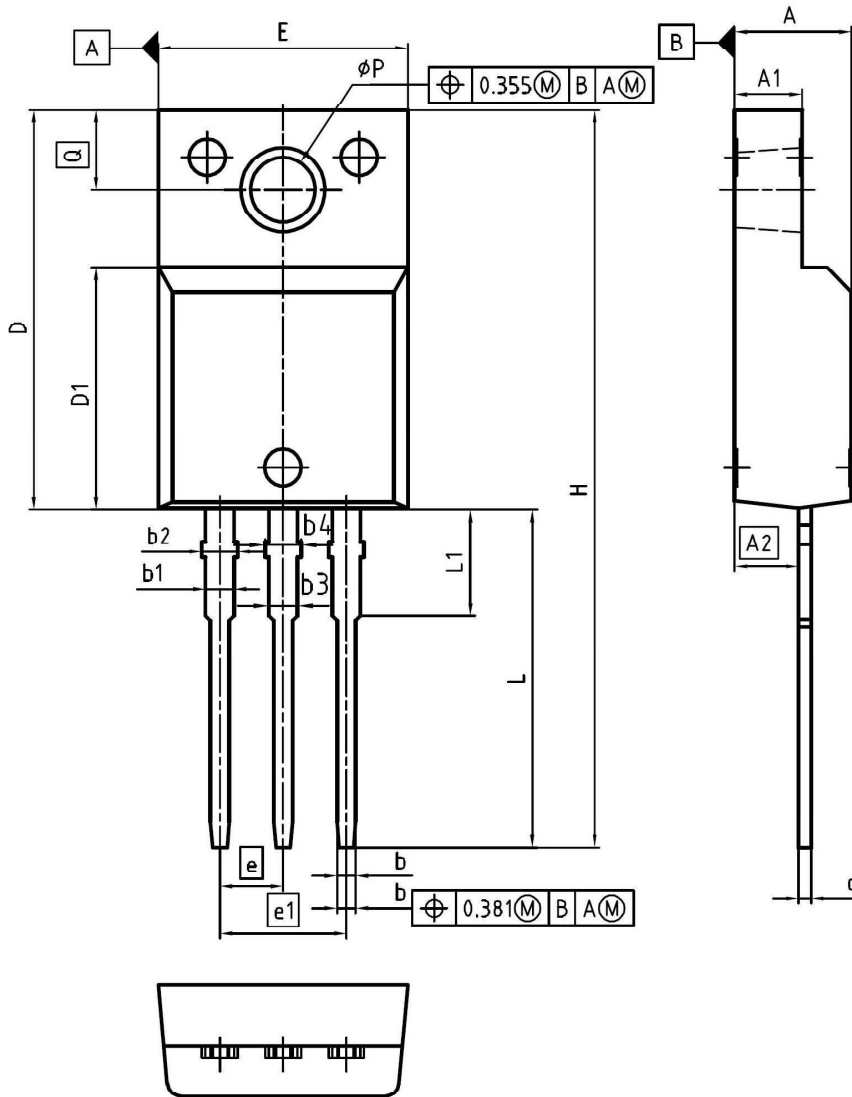


$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Gate charge waveforms



### 5 Package Outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.55	4.85	0.179	0.191
A1	2.55	2.85	0.100	0.112
A2	2.42	2.72	0.095	0.107
b	0.65	0.85	0.026	0.033
b1	0.95	1.33	0.037	0.052
b2	0.95	1.51	0.037	0.059
b3	0.65	1.33	0.026	0.052
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.85	16.15	0.624	0.636
D1	9.53	9.83	0.375	0.387
E	10.35	10.65	0.407	0.419
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H	29.45	29.75	1.159	1.171
L	13.45	13.75	0.530	0.541
L1	3.15	3.45	0.124	0.136
$\phi P$	2.95	3.20	0.116	0.126
Q	3.15	3.50	0.124	0.138

DOCUMENT NO.  
Z8B00003319

SCALE

EUROPEAN PROJECTION

ISSUE DATE  
08-03-2007

REVISION  
03

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

## Revision History

IPA060N06N

**Revision: 2016-08-10, Rev. 2.2**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2014-06-19	Rev.2.1
2.2	2016-08-10	Add Rthja parameter

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**Infineon Technologies AG**  
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