

# MOSFET

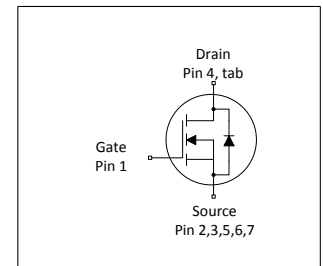
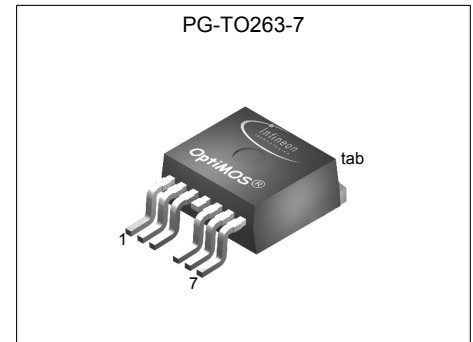
## StrongIRFET™2 Power-Transistor

### 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

Fully qualified according to JEDEC for Industrial Applications



**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS}$	40	V
$R_{DS(on),max}$	1.35	m $\Omega$
$I_D$	232	A
$Q_{oss}$	117	nC
$Q_G (0V..10V)$	106	nC



RoHS

Type / Ordering Code	Package	Marking	Related Links
IPF013N04NF2S	PG-TO263-7	013N04NS	-

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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 <sup>1)</sup>	$I_D$	-	-	232 178 40	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 <sup>3)</sup>	$I_{D,pulse}$	-	-	928	A	$T_A=25\text{ °C}$
Avalanche energy, single pulse <sup>4)</sup>	$E_{AS}$	-	-	283	mJ	$I_D=100\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Gate source voltage	$V_{GS}$	-20	-	20	V	-
Power dissipation	$P_{tot}$	-	-	188 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	$R_{thJC}$	-	-	0.8	°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	$V_{(BR)DSS}$	40	-	-	V	$V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	2.1	2.8	3.4	V	$V_{DS}=V_{GS}$ , $I_D=126\text{ }\mu\text{A}$
Zero gate voltage drain current	$I_{DSS}$	-	0.1 10	1 100	$\mu\text{A}$	$V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$ $V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=125\text{ °C}$
Gate-source leakage current	$I_{GSS}$	-	10	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	1.08 1.24	1.35 1.8	$\text{m}\Omega$	$V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ $V_{GS}=6\text{ V}$ , $I_D=50\text{ A}$
Gate resistance	$R_G$	-	2.0	-	$\Omega$	-
Transconductance <sup>1)</sup>	$g_{fs}$	195	-	-	S	$ V_{DS} \geq 2 I_D R_{DS(on)max}$ , $I_D=100\text{ A}$

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	7500	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	2760	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$
Reverse transfer capacitance	$C_{rss}$	-	145	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$
Turn-on delay time	$t_{d(on)}$	-	20	-	ns	$V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Rise time	$t_r$	-	42	-	ns	$V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Turn-off delay time	$t_{d(off)}$	-	47	-	ns	$V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$
Fall time	$t_f$	-	20	-	ns	$V_{DD}=20\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ , $R_{G,ext}=1.6\text{ }\Omega$

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	32	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge at threshold	$Q_{g(th)}$	-	21	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	20	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Switching charge	$Q_{sw}$	-	31	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total <sup>1)</sup>	$Q_g$	-	106	159	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	4.3	-	V	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total, sync. FET	$Q_{g(sync)}$	-	94	-	nC	$V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }10\text{ V}$
Output charge	$Q_{oss}$	-	117	-	nC	$V_{DS}=20\text{ V}$ , $V_{GS}=0\text{ V}$

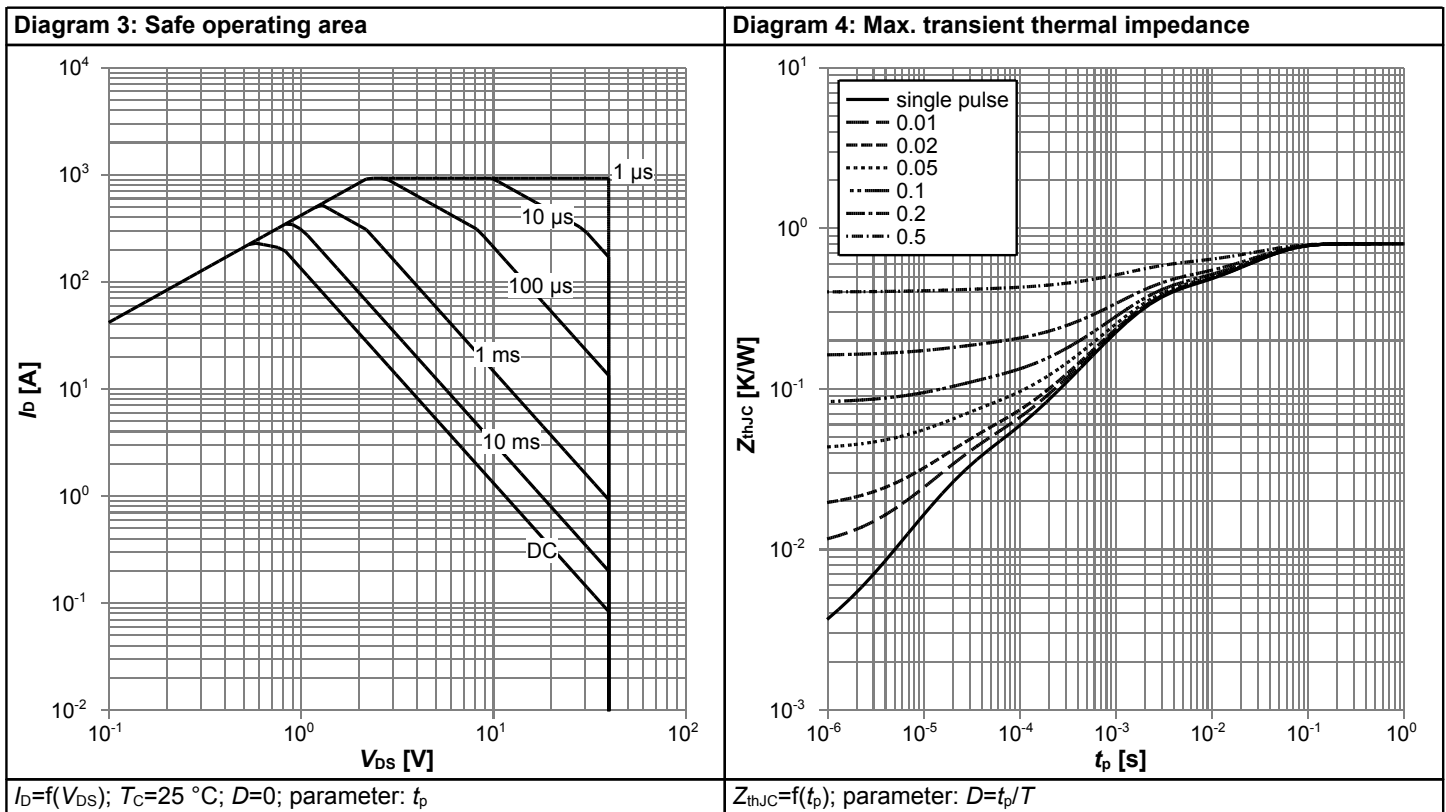
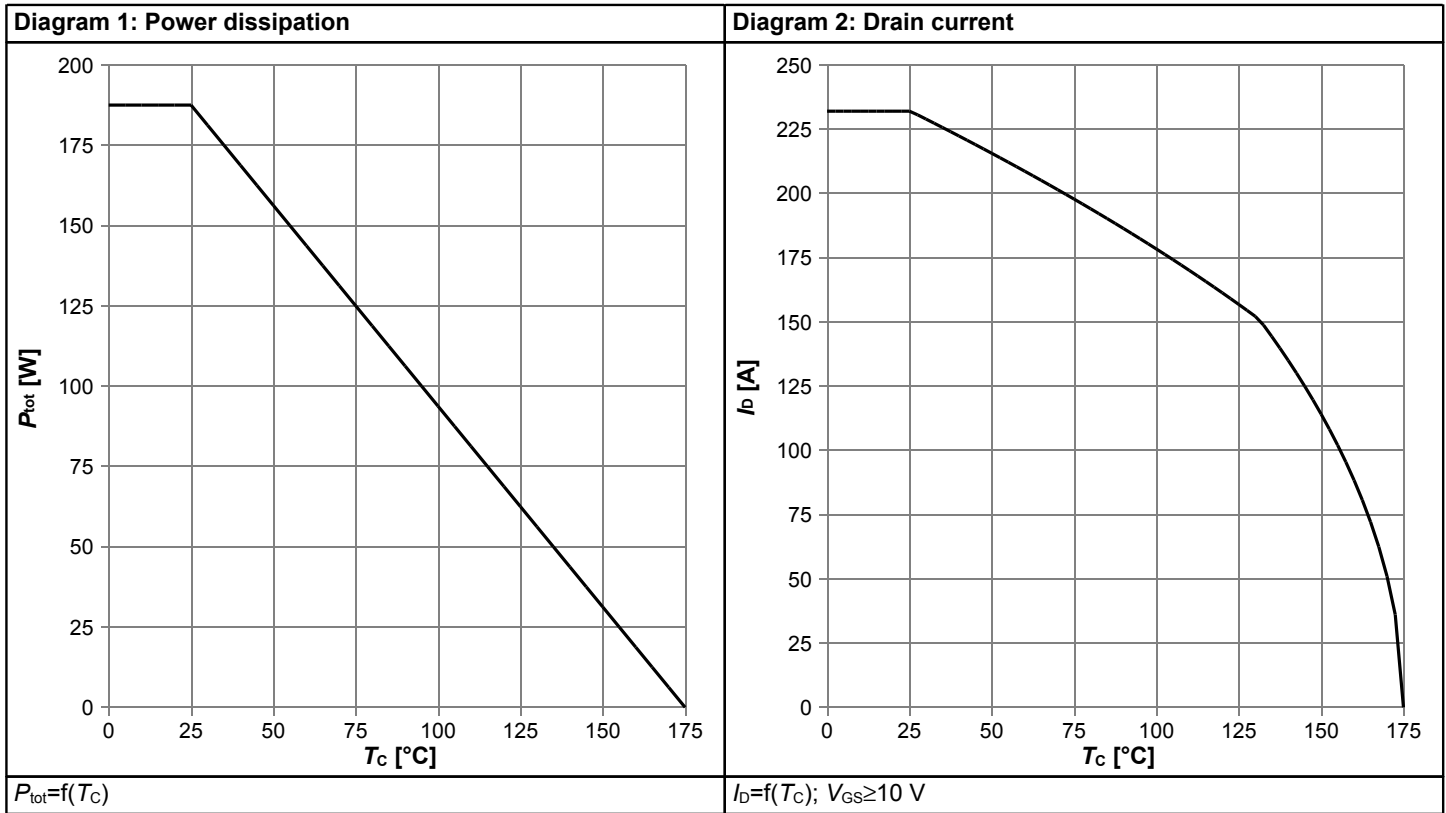
<sup>1)</sup> Defined by design. Not subject to production test.

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

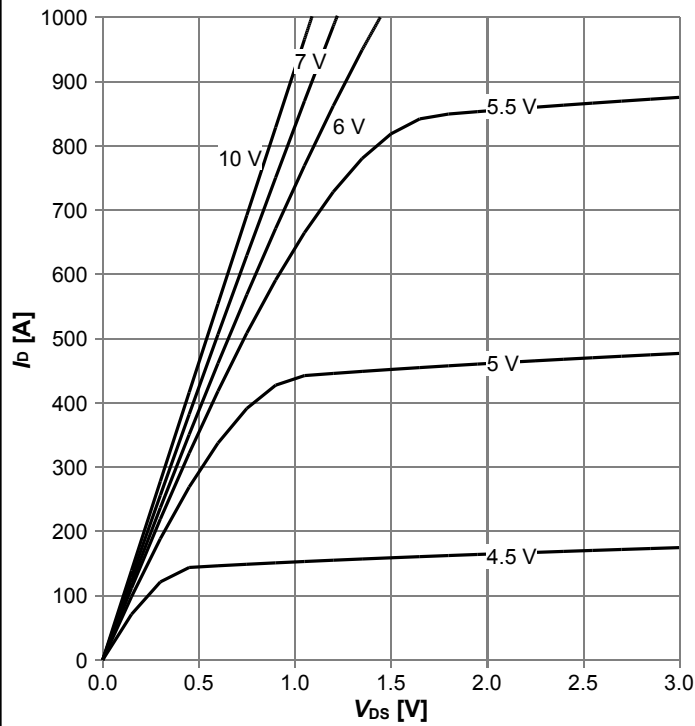
**Table 7 Reverse diode**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	$I_S$	-	-	169	A	$T_C=25\text{ °C}$
Diode pulse current	$I_{S,pulse}$	-	-	928	A	$T_C=25\text{ °C}$
Diode forward voltage	$V_{SD}$	-	0.85	1	V	$V_{GS}=0\text{ V}, I_F=100\text{ A}, T_j=25\text{ °C}$
Reverse recovery time	$t_{rr}$	-	37	-	ns	$V_R=20\text{ V}, I_F=100\text{ A}, di_F/dt=500\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{rr}$	-	174	-	nC	$V_R=20\text{ V}, I_F=100\text{ A}, di_F/dt=500\text{ A}/\mu\text{s}$

**4 Electrical characteristics diagrams**

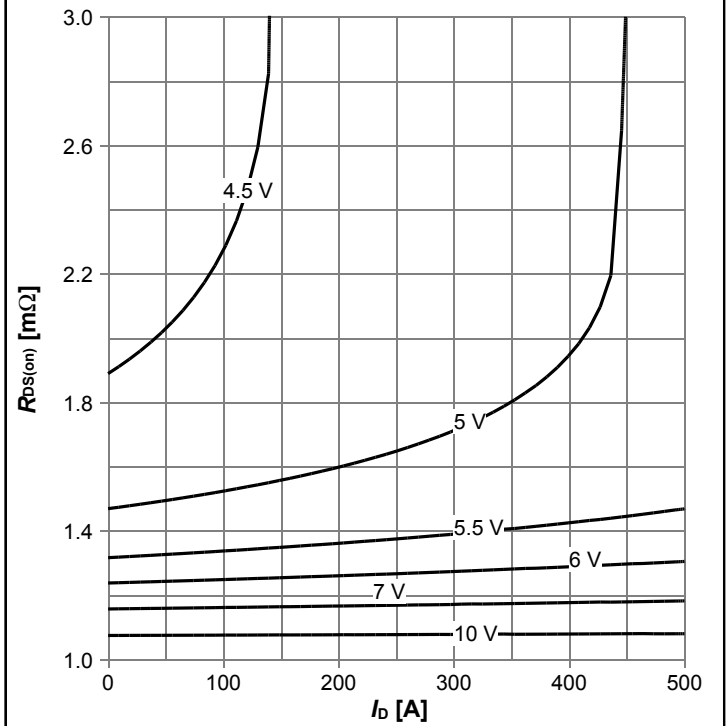


**Diagram 5: Typ. output characteristics**



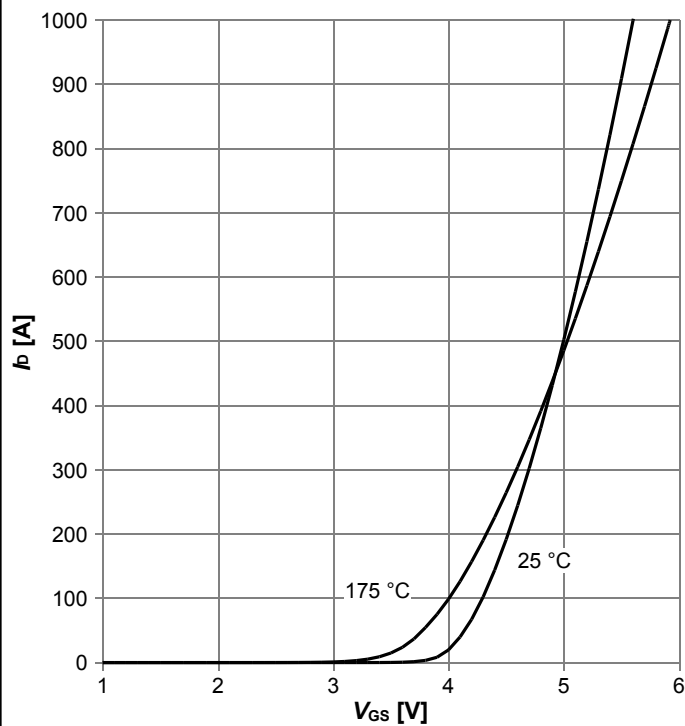
$I_D=f(V_{DS}), T_j=25\text{ °C};$  parameter:  $V_{GS}$

**Diagram 6: Typ. drain-source on resistance**



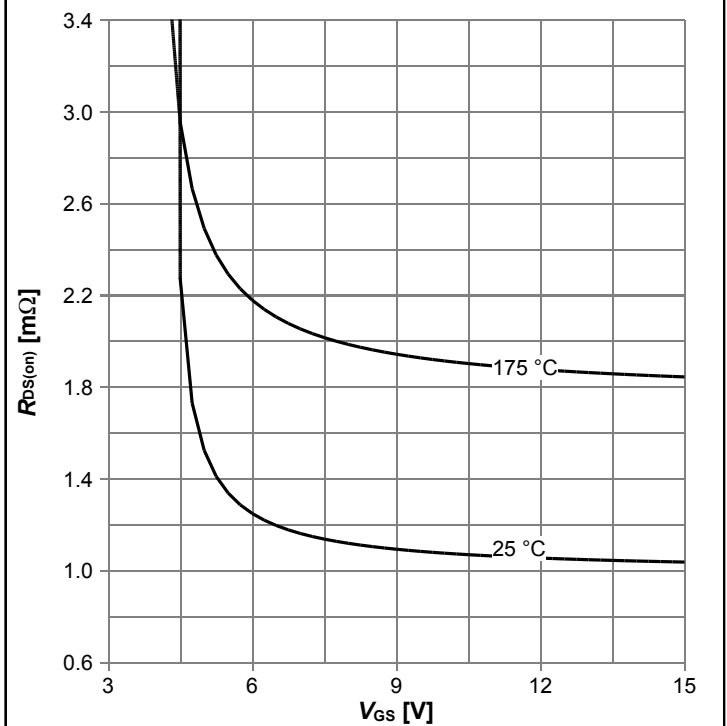
$R_{DS(on)}=f(I_D), T_j=25\text{ °C};$  parameter:  $V_{GS}$

**Diagram 7: Typ. transfer characteristics**



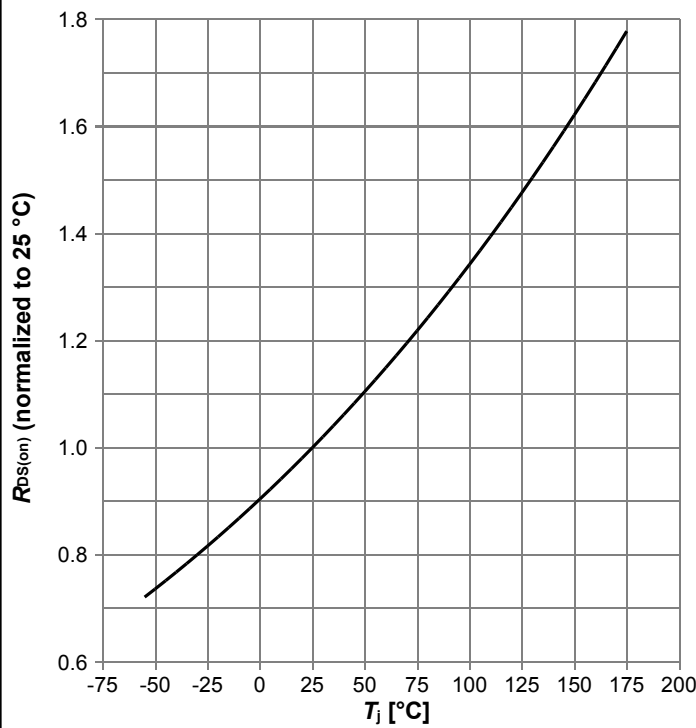
$I_D=f(V_{GS}), |V_{DS}|>2|I_D|R_{DS(on)max};$  parameter:  $T_j$

**Diagram 8: Typ. drain-source on resistance**



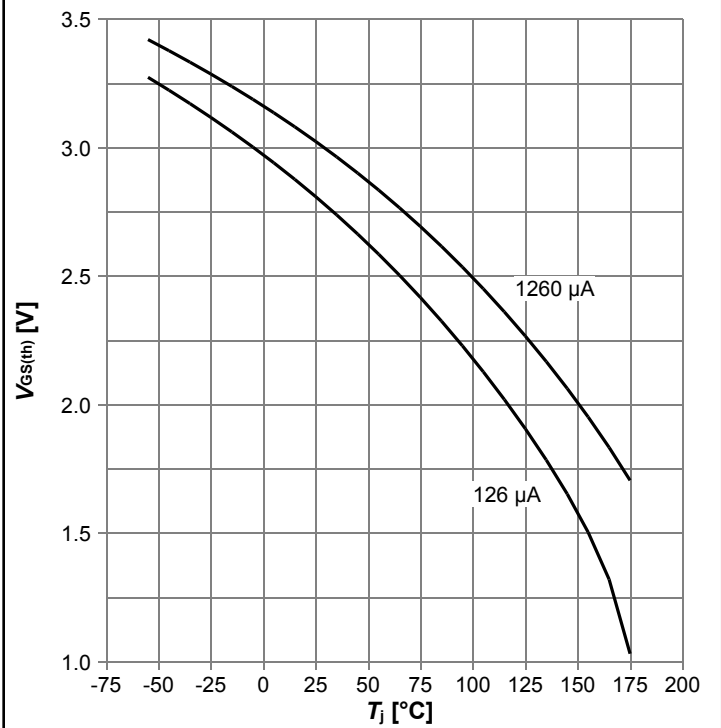
$R_{DS(on)}=f(V_{GS}), I_D=100\text{ A};$  parameter:  $T_j$

**Diagram 9: Normalized drain-source on resistance**



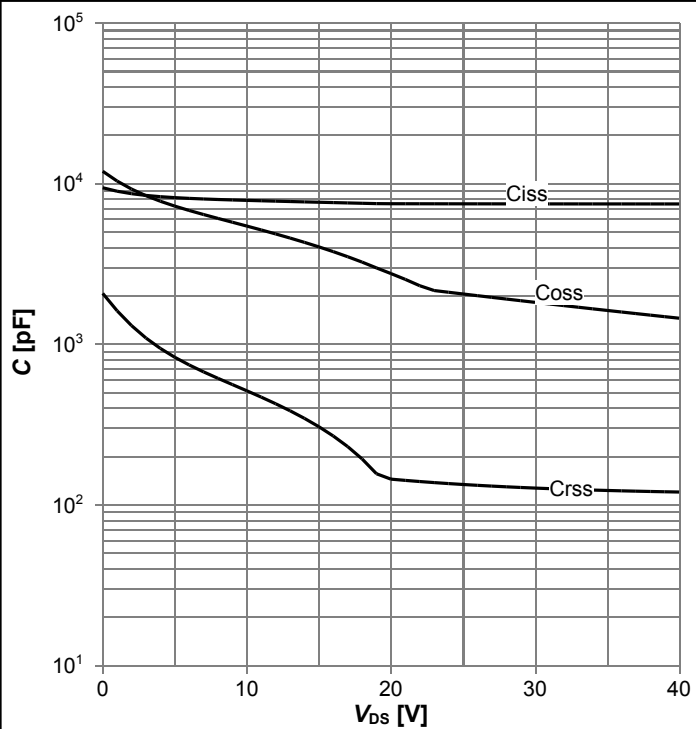
$R_{DS(on)}=f(T_j)$ ,  $I_D=100\text{ A}$ ,  $V_{GS}=10\text{ V}$

**Diagram 10: Typ. gate threshold voltage**



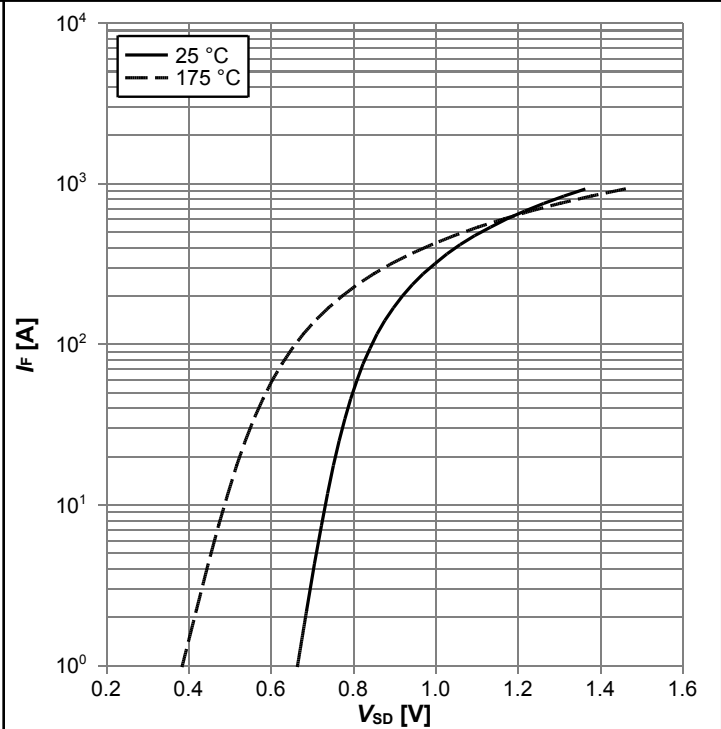
$V_{GS(th)}=f(T_j)$ ,  $V_{GS}=V_{DS}$ ; parameter:  $I_D$

**Diagram 11: Typ. capacitances**



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

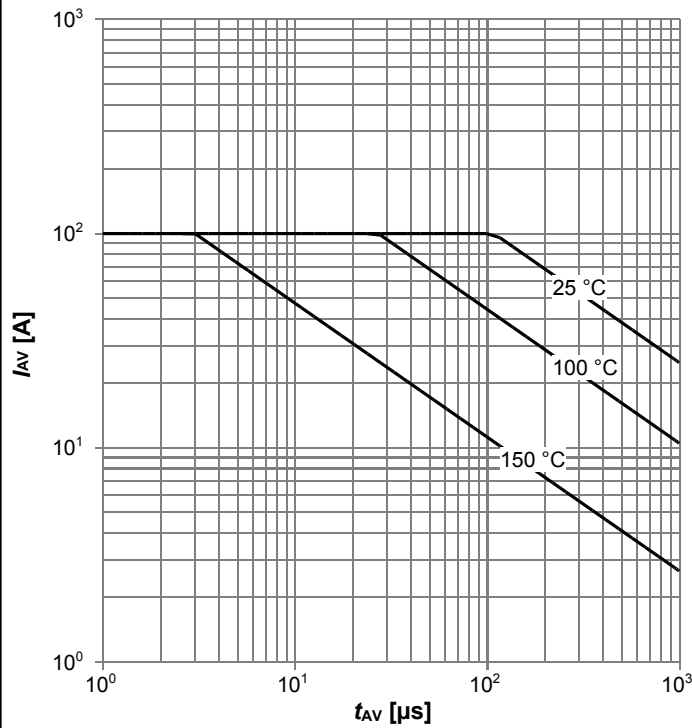
**Diagram 12: Typ. forward characteristics of reverse diode**



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

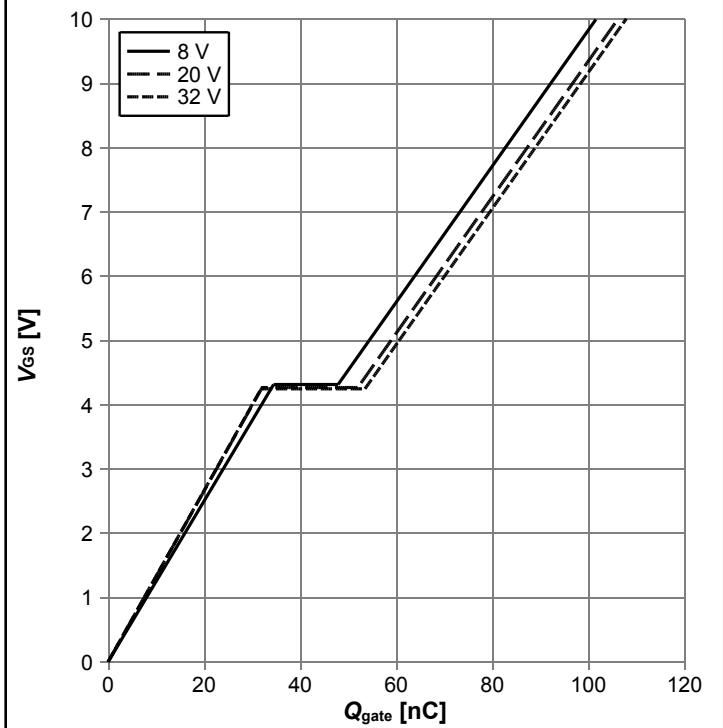


**Diagram 13: Avalanche characteristics**



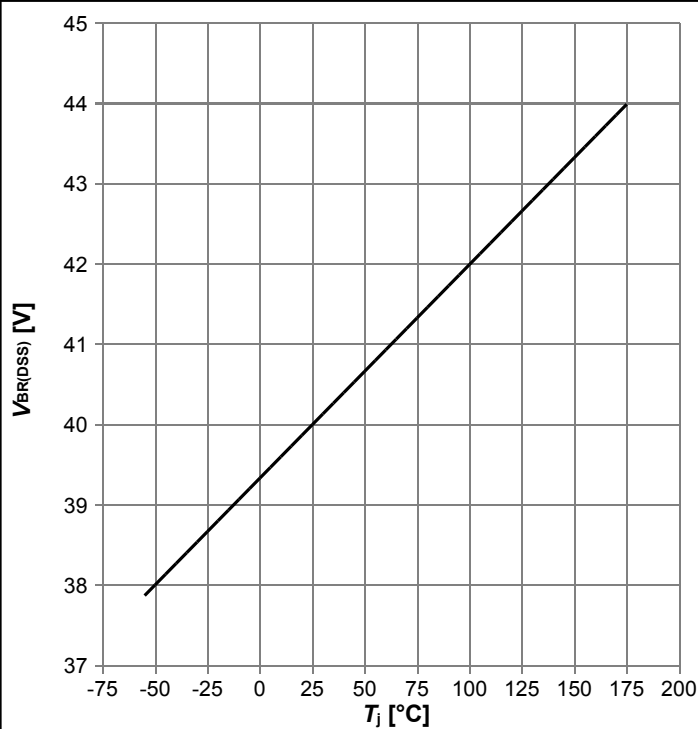
$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$ ; parameter:  $T_{j,start}$

**Diagram 14: Typ. gate charge**



$V_{GS}=f(Q_{gate}), I_D=100$  A pulsed,  $T_j=25$  °C; parameter:  $V_{DD}$

**Diagram 15: Drain-source breakdown voltage**

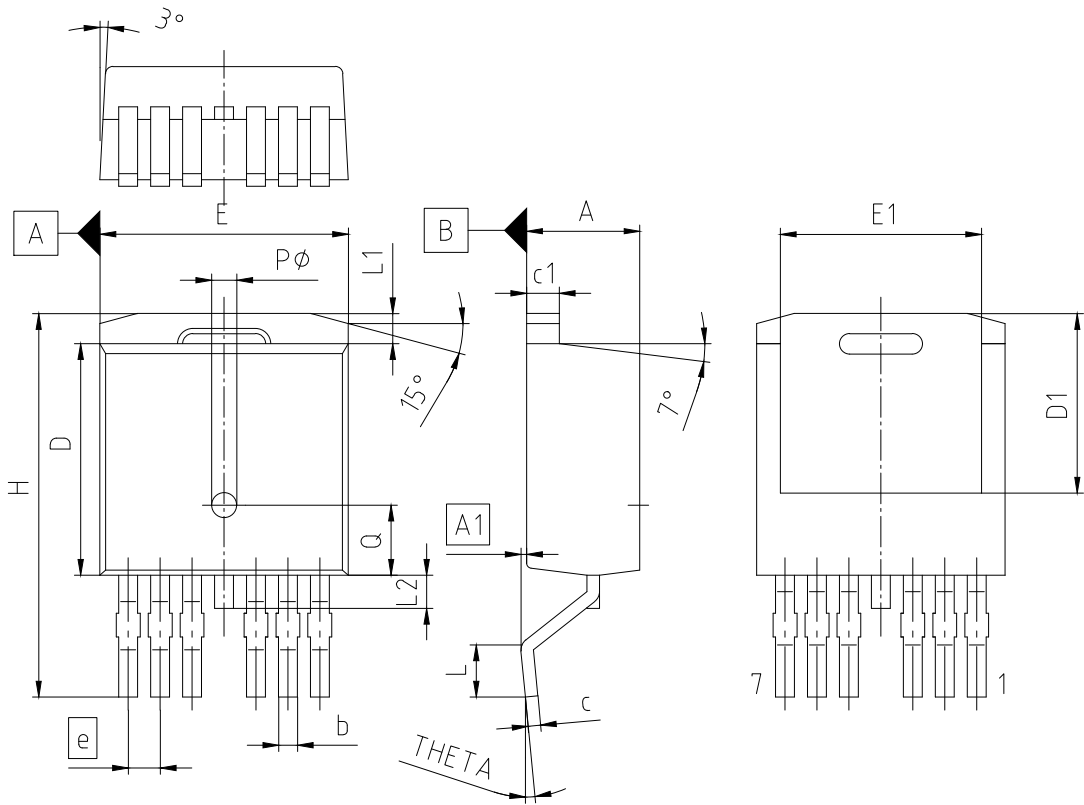


$V_{BR(DSS)}=f(T_j); I_D=1$  mA

**Diagram Gate charge waveforms**



**5 Package Outlines**



PACKAGE - GROUP NUMBER: <b>PG-TO263-7-U02</b>		
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
<b>A</b>	4.30	4.70
<b>A1</b>	0.00	0.25
<b>b</b>	0.65	0.85
<b>c</b>	0.45	0.60
<b>c1</b>	1.25	1.40
<b>D</b>	9.00	9.40
<b>D1</b>	6.86	7.42
<b>E</b>	9.68	10.08
<b>E1</b>	7.70	8.30
<b>e</b>	1.27	
<b>N</b>	7	
<b>H</b>	14.61	15.88
<b>L</b>	1.78	2.79
<b>L1</b>	0.00	1.60
<b>L2</b>	0.00	1.78
<b>THETA</b>	0° - 8°	
<b>PØ</b>	0.90	1.10
<b>Q</b>	2.78	

**Figure 1 Outline PG-TO263-7, dimensions in mm**

## Revision History

IPF013N04NF2S

**Revision: 2022-10-11, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2022-10-11	Release of final version

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