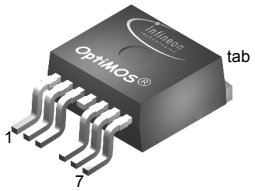
MOSFET

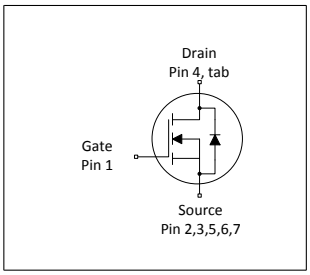
OptiMOS™ 6 Power-Transistor, 135 V

PG-TO263-7



Features

- N-channel, normal level
- Very low on-resistance $R_{DS(on)}$
- Excellent gate charge x $R_{DS(on)}$ product (FOM)
- Very low reverse recovery charge (Q_{rr})
- 100% avalanche tested
- 175°C operating temperature
- Optimized for motor drives and battery powered applications
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21
- MSL 1 classified according to J-STD-020



Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS}	135	V
$R_{DS(on),max}$	2.1	mΩ
I_D	250	A
Q_{oss}	275	nC
Q_G	160	nC
Q_{rr} (500 A/µs)	168	nC

Type / Ordering Code	Package	Marking	Related Links
IPF021N13NM6	PG-TO263-7	021N13N6	-

Table of Contents

1 Maximum ratings

at T_A=25 °C, unless otherwise specified

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current[1]	I_D	- - - -	- - - -	250 191 191 29	A	V_{GS}=10 V, T_C=25 °C V_{GS}=10 V, T_C=100 °C V_{GS}=8 V, T_C=100 °C V_{GS}=10 V, T_A=25 °C, R_{THJA}=40 °C/W[2]
Pulsed drain current[3]	$I_{D,pulse}$	-	-	1000	A	T_C=25 °C
Avalanche current, single pulse[4]	I_{AS}	-	-	100	A	T_C=25 °C
Avalanche energy, single pulse[4]	E_{AS}	-	-	874	mJ	I_D=66 A, R_{GS}=25 Ω
Gate source voltage	V_{GS}	-20	-	20	V	-
Power dissipation	P_{tot}	- -	- -	395 3.8	W	T_C=25 °C T_A=25 °C, R_{THJA}=40 °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}	-	-	0.4	°C/W	-
Thermal resistance, junction - ambient, 6 cm² cooling area[2]	R_{thJA}	-	-	40	°C/W	-
Thermal resistance, junction - ambient, minimal footprint	R_{thJA}	-	-	62	°C/W	-

[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.

3 Electrical characteristics

at T_j=25 °C, unless otherwise specified

Table 4 Static characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	135	-	-	V	V_{GS}=0 V, I_D=1 mA
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5	V	V_{DS}=V_{GS}, I_D=276 µA
Zero gate voltage drain current	I_{DSS}	- -	1 10	10 100	µA	V_{DS}=108 V, V_{GS}=0 V, T_j=25 °C V_{DS}=108 V, V_{GS}=0 V, T_j=125 °C
Gate-source leakage current	I_{GSS}	-	10	100	nA	V_{GS}=20 V, V_{DS}=0 V
Drain-source on-state resistance	$R_{DS(on)}$	- - -	1.8 1.9 2.0	2.05 2.1 2.4	mΩ	V_{GS}=15 V, I_D=100 A V_{GS}=10 V, I_D=100 A V_{GS}=8 V, I_D=50 A
Gate resistance[1)]	R_G	-	1.1	1.7	Ω	-
Transconductance[1)]	g_{fs}	115	230	-	S	$\|V_{DS}\|\geq 2\|I_D\|R_{DS(on)max}$, I_D=100 A

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance[1)]	C_{iss}	-	11000	14000	pF	V_{GS}=0 V, V_{DS}=68 V, f=1 MHz
Output capacitance[1)]	C_{oss}	-	2200	2900	pF	V_{GS}=0 V, V_{DS}=68 V, f=1 MHz
Reverse transfer capacitance[1)]	C_{rss}	-	28	49	pF	V_{GS}=0 V, V_{DS}=68 V, f=1 MHz
Turn-on delay time	$t_{d(on)}$	-	25	-	ns	V_{DD}=68 V, V_{GS}=10 V, I_D=50 A, $R_{G,ext}$=1.6 Ω
Rise time	t_r	-	21	-	ns	V_{DD}=68 V, V_{GS}=10 V, I_D=50 A, $R_{G,ext}$=1.6 Ω
Turn-off delay time	$t_{d(off)}$	-	56	-	ns	V_{DD}=68 V, V_{GS}=10 V, I_D=50 A, $R_{G,ext}$=1.6 Ω
Fall time	t_f	-	25	-	ns	V_{DD}=68 V, V_{GS}=10 V, I_D=50 A, $R_{G,ext}$=1.6 Ω

Table 6 Gate charge characteristics[2)]

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge[1)]	Q_{gs}	-	48	62	nC	V_{DD}=68 V, I_D=50 A, V_{GS}=0 to 10 V
Gate charge at threshold	$Q_{g(th)}$	-	33	-	nC	V_{DD}=68 V, I_D=50 A, V_{GS}=0 to 10 V
Gate to drain charge[1)]	Q_{gd}	-	30	45	nC	V_{DD}=68 V, I_D=50 A, V_{GS}=0 to 10 V
Switching charge	Q_{sw}	-	45	-	nC	V_{DD}=68 V, I_D=50 A, V_{GS}=0 to 10 V
Gate charge total[1)]	Q_g	-	160	208	nC	V_{DD}=68 V, I_D=50 A, V_{GS}=0 to 10 V
Gate plateau voltage	$V_{plateau}$	-	4.4	-	V	V_{DD}=68 V, I_D=50 A, V_{GS}=0 to 10 V
Gate charge total, sync. FET	$Q_{g(sync)}$	-	146	-	nC	V_{DS}=0.1 V, V_{GS}=0 to 10 V
Output charge[1)]	Q_{oss}	-	275	358	nC	V_{DS}=68 V, V_{GS}=0 V

[1)] Defined by design. Not subject to production test.
[2)] See ″Gate charge waveforms″ for parameter definition

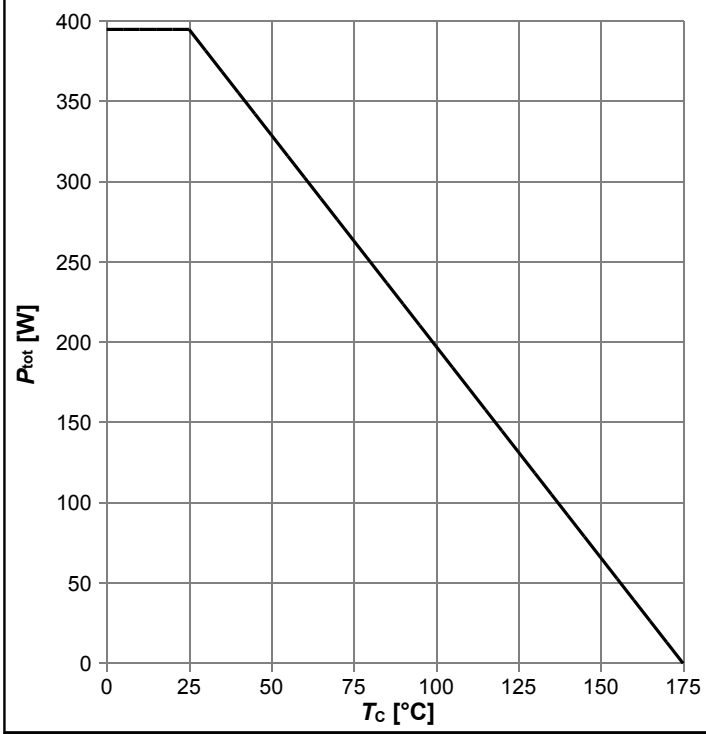
Table 7 Reverse diode

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	I_S	-	-	224	A	T_C=25 °C
Diode pulse current	$I_{S,pulse}$	-	-	1000	A	T_C=25 °C
Diode forward voltage	V_{SD}	-	0.86	1	V	V_{GS}=0 V, I_F=100 A, T_j=25 °C
Reverse recovery time[1)]	t_{rr}	-	38	76	ns	V_R=68 V, I_F=50 A, di_F/dt=500 A/µs
Reverse recovery charge[1)]	Q_{rr}	-	168	336	nC	V_R=68 V, I_F=50 A, di_F/dt=500 A/µs

[1)] Defined by design. Not subject to production test.

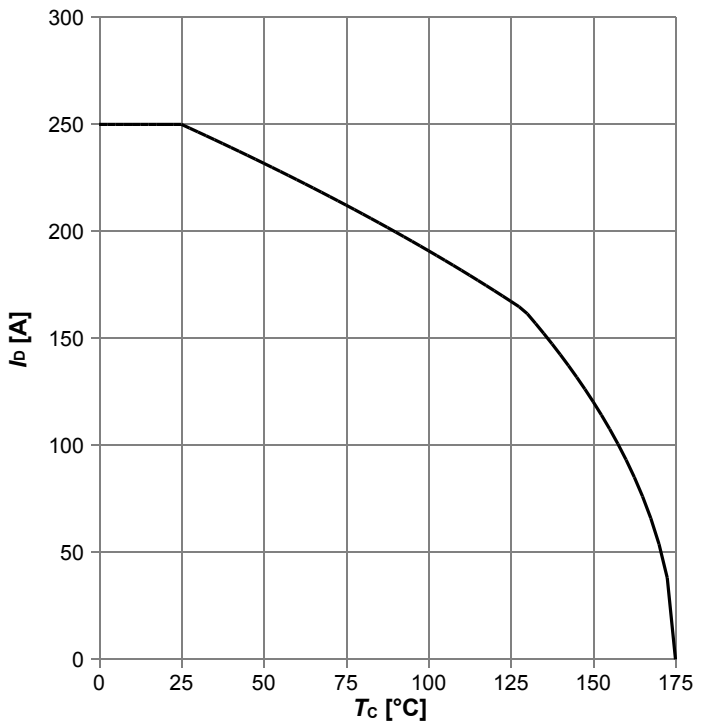
4 Electrical characteristics diagrams

Diagram 1: Power dissipation



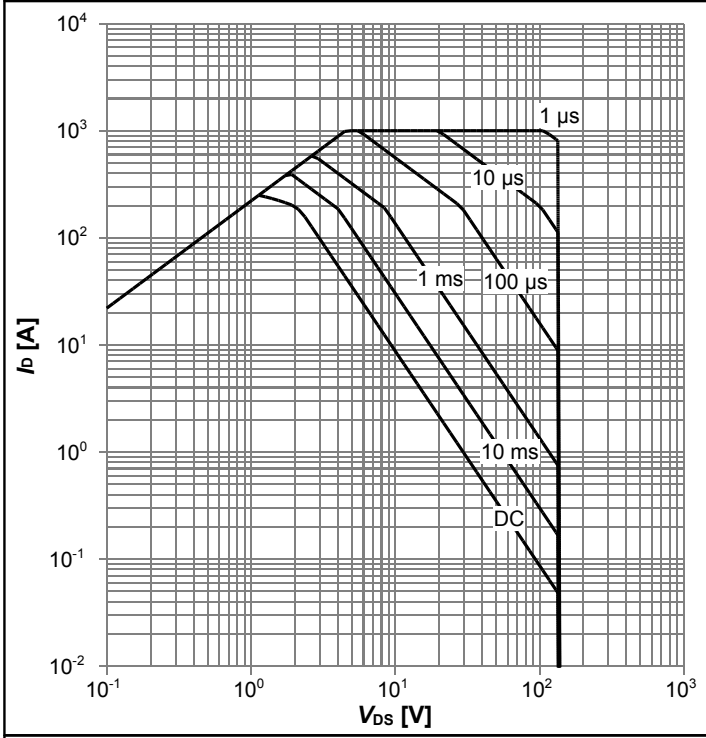
$P_{tot}=f(T_C)$

Diagram 2: Drain current



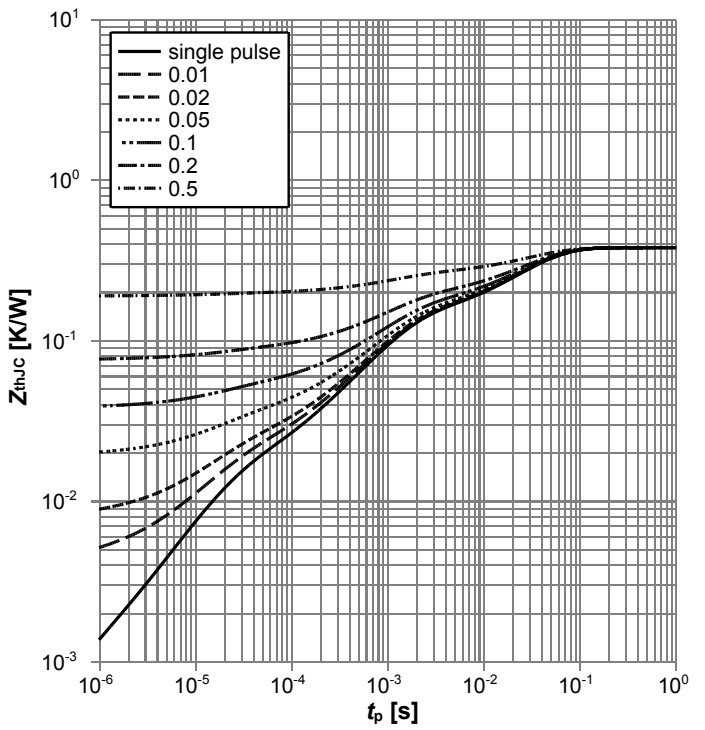
$I_D=f(T_C)$; $V_{GS}\geq 10$ V

Diagram 3: Safe operating area



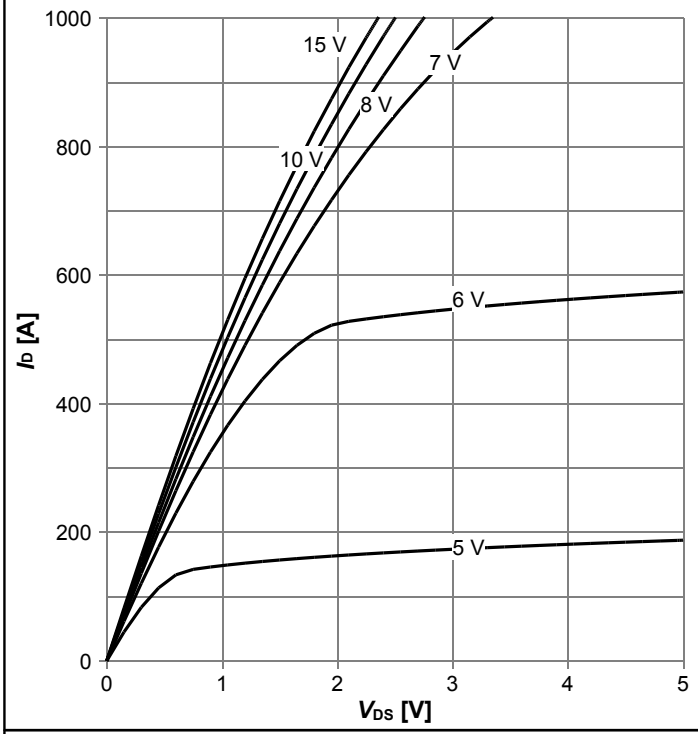
$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$; parameter: t_p

Diagram 4: Max. transient thermal impedance



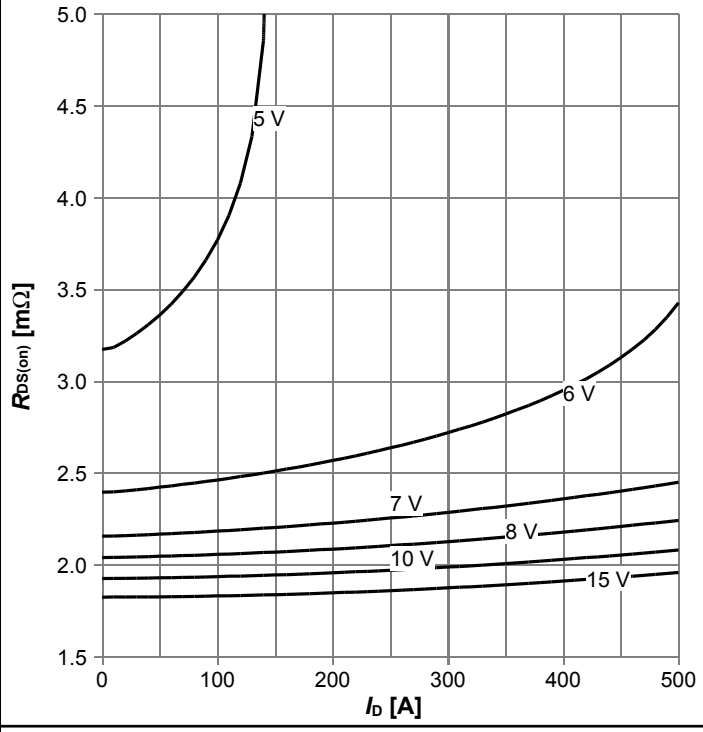
$Z_{thJC}=f(t_p)$; parameter: $D=t_p/T$

Diagram 5: Typ. output characteristics



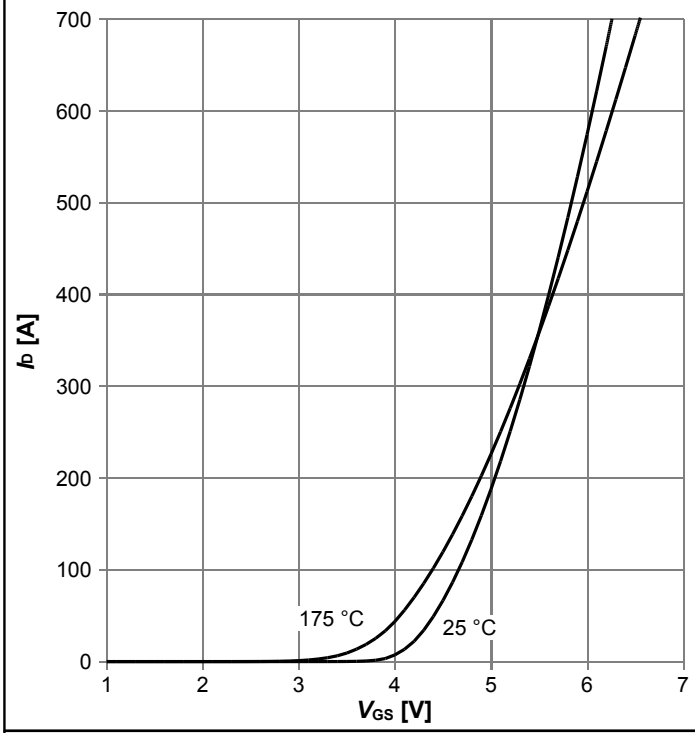
$I_D=f(V_{DS})$, $T_j=25$ °C; parameter: V_{GS}

Diagram 6: Typ. drain-source on resistance



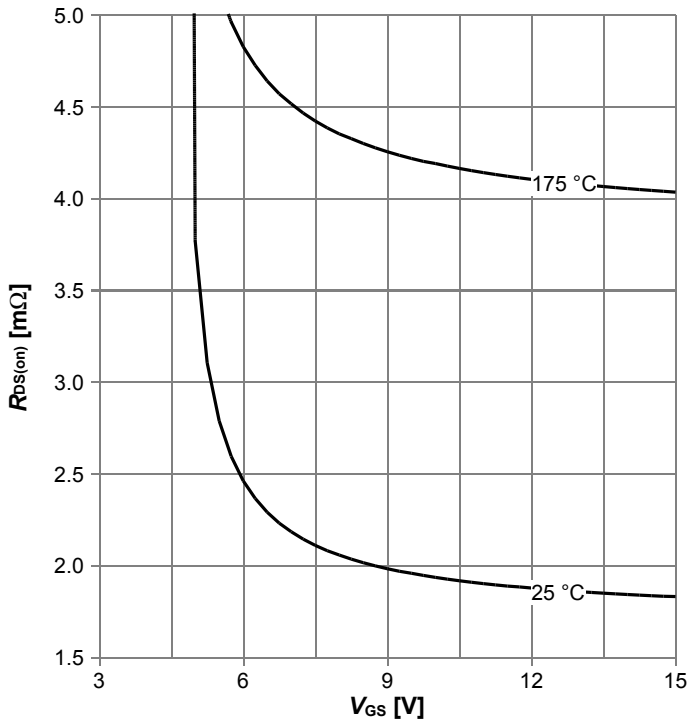
$R_{DS(on)}=f(I_D)$, $T_j=25$ °C; parameter: V_{GS}

Diagram 7: Typ. transfer characteristics



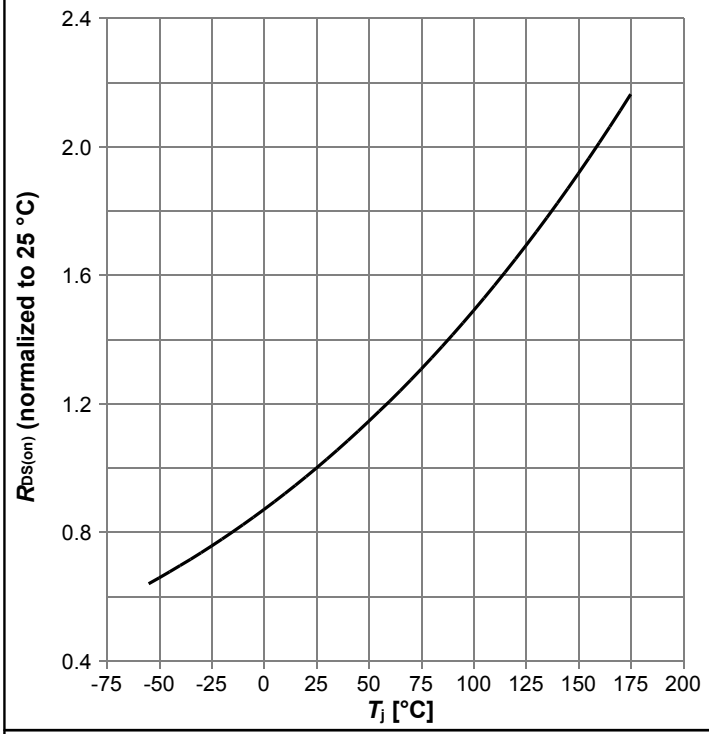
$I_D=f(V_{GS})$, $|V_{DS}|>2|I_D|R_{DS(on)max}$; parameter: T_j

Diagram 8: Typ. drain-source on resistance



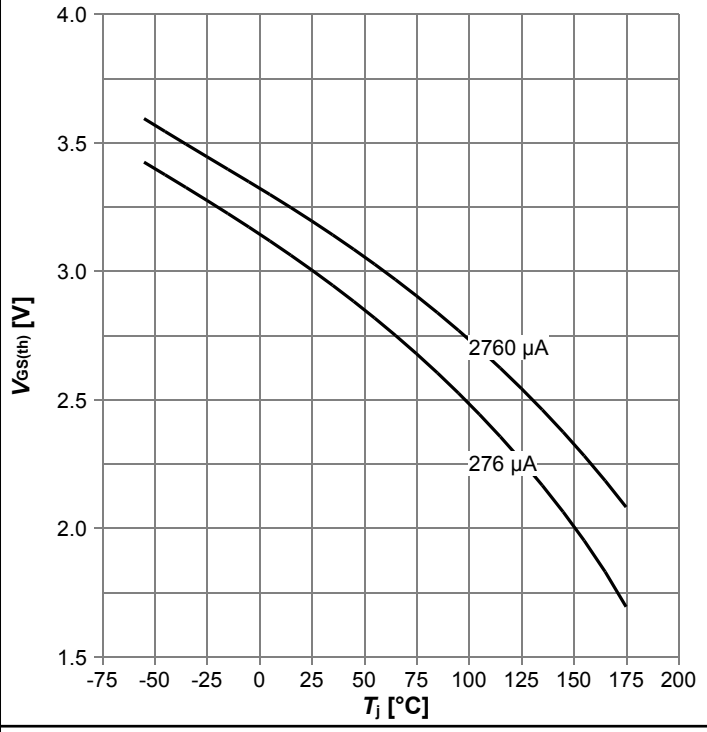
$R_{DS(on)}=f(V_{GS})$, $I_D=100$ A; parameter: T_j

Diagram 9: Normalized drain-source on resistance



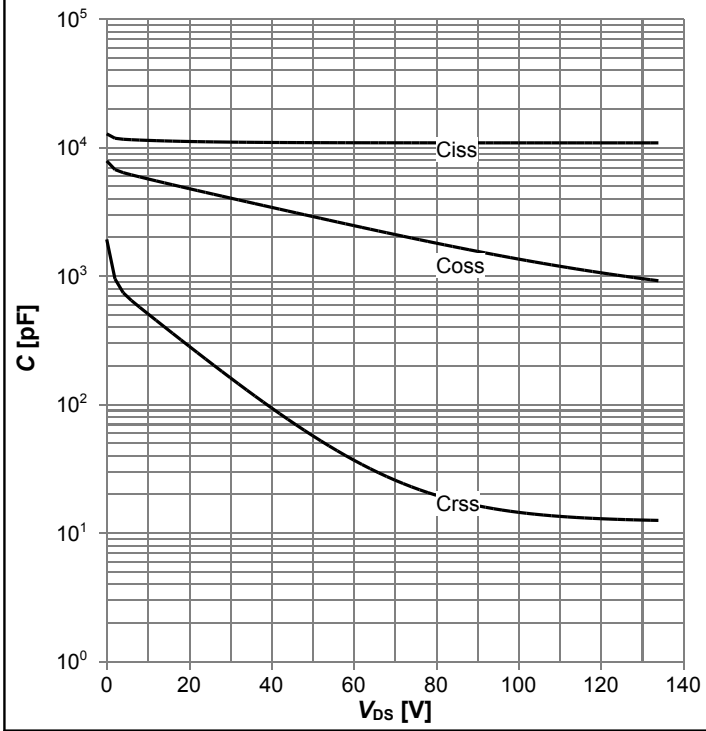
$R_{DS(on)}$=f(T_j), I_D=100 A, V_{GS}=10 V

Diagram 10: Typ. gate threshold voltage



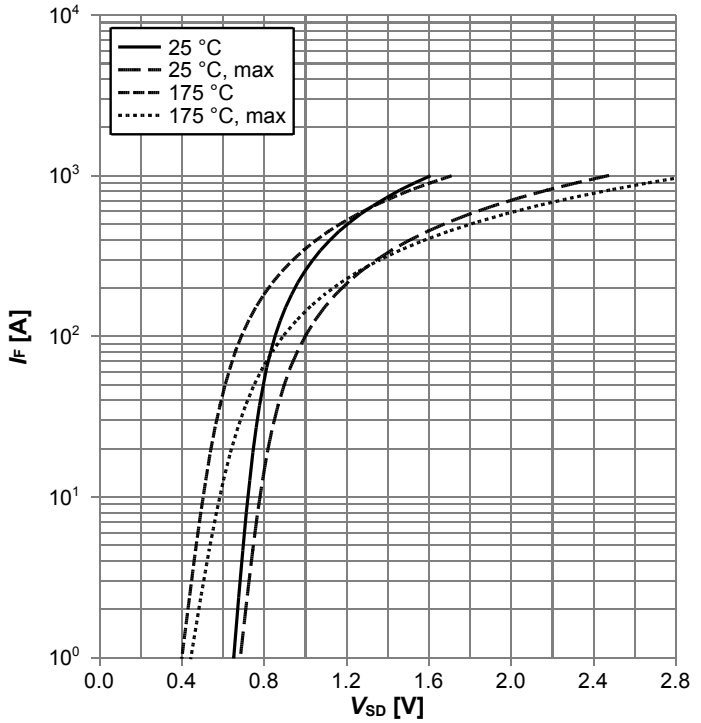
$V_{GS(th}$=f(T_j), V_{GS}=V_{DS}; parameter: I_D

Diagram 11: Typ. capacitances



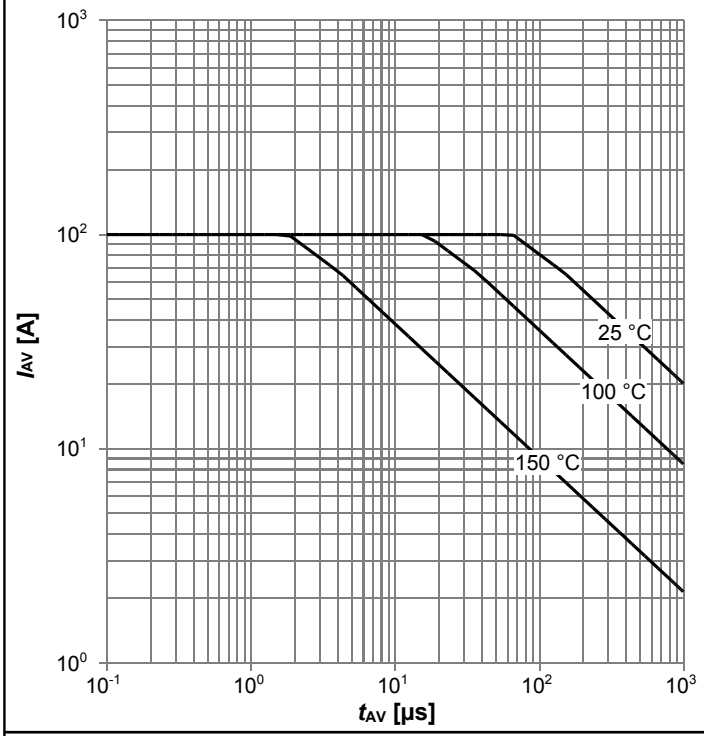
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz

Diagram 12: Forward characteristics of reverse diode



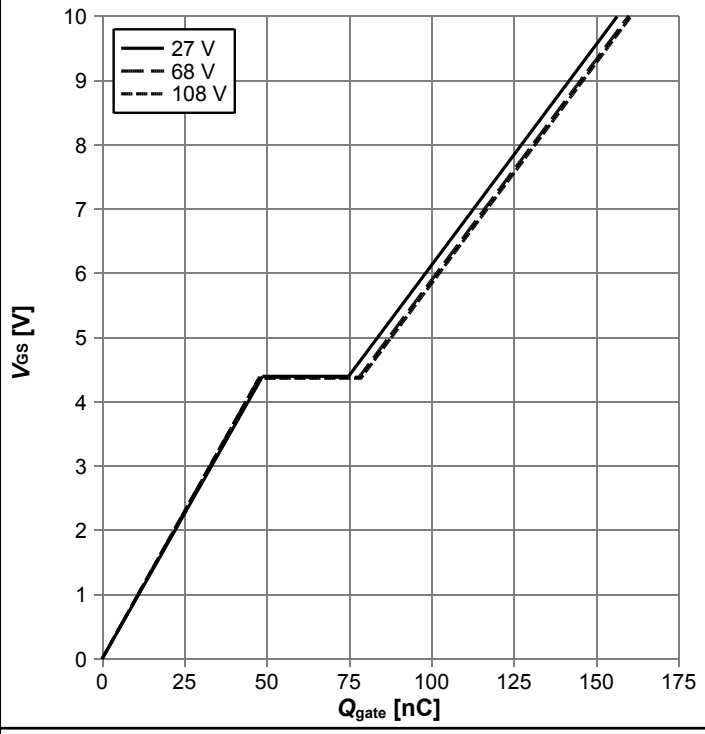
I_F=f(V_{SD}); parameter: T_j

Diagram 13: Avalanche characteristics



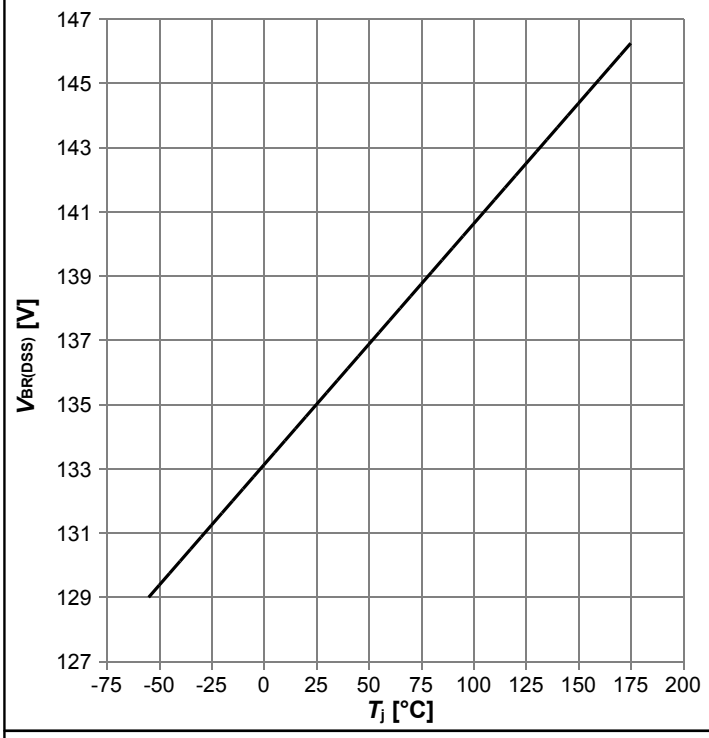
I_{AS}=f(t_{AV}); R_{GS}=25 Ω; parameter: $T_{j,start}$

Diagram 14: Typ. gate charge



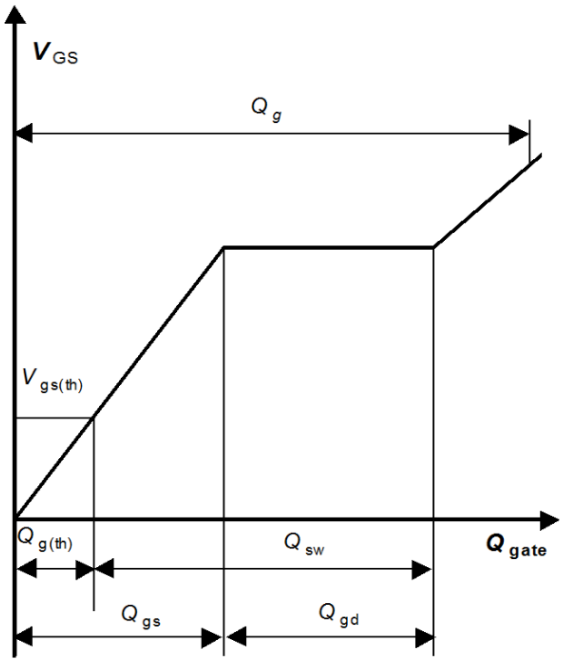
V_{GS}=f(Q_{gate}), I_D=50 A pulsed, T_j=25 °C; parameter: V_{DD}

Diagram 15: Drain-source breakdown voltage

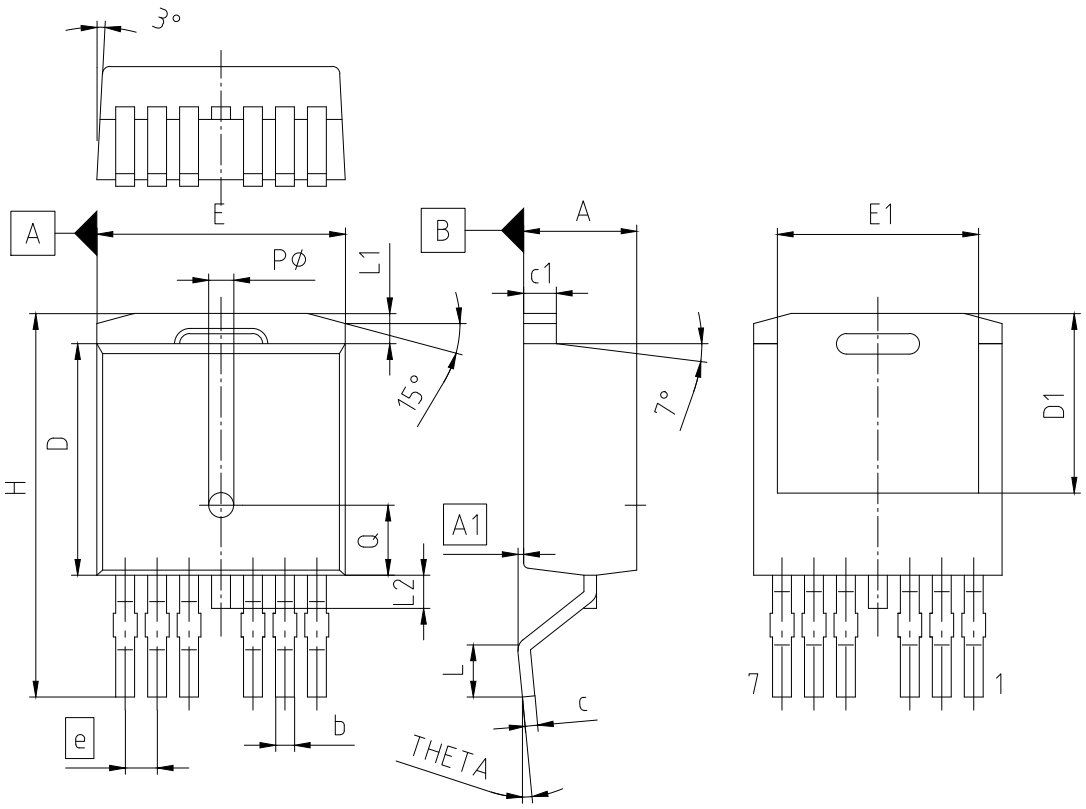


$V_{BR(DSS)}$=f(T_j); I_D=1 mA

Diagram Gate charge waveforms



5 Package Outlines



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

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

Revision History

IPF021N13NM6

Revision: 2023-10-16, Rev. 2.0

Previous Revision		
Revision	Date	Subjects (major changes since last revision)
2.0	2023-10-16	Release of final version

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