

MOSFET

StrongIRFET™2 Power-Transistor, 40 V

Features

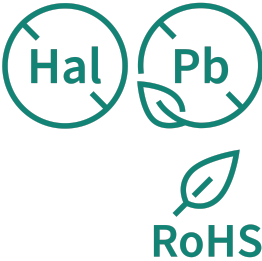
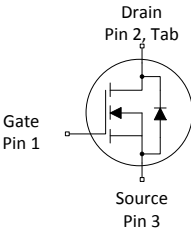
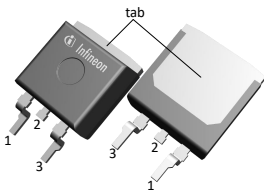
- Optimized for wide range of applications
- N-channel, normal level
- 100% avalanche tested
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

Product validation

Qualified according to JEDEC Standard

Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS}$	40	V
$R_{DS(on),max}$	1.25	mΩ
$I_D$	199	A
$Q_{oss}$	176	nC
$Q_G(0V..10V)$	159	nC



Type/Ordering Code	Package	Marking	Related Links
IPB012N04NF2S	PG-TO263-3	012N04NS	-



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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>	$I_D$	-	-	199 153 41	A	$V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$ $V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$ $V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ , $R_{thJA}=40\text{ °C/W}$ <sup>2)</sup>
Pulsed drain current <sup>3)</sup>	$I_{D,pulse}$	-	-	796	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse <sup>4)</sup>	$E_{AS}$	-	-	637	mJ	$I_D=100\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Gate source voltage	$V_{GS}$	-20	-	20	V	-
Power dissipation	$P_{tot}$	-	-	294 3.8	W	$T_C=25\text{ °C}$ $T_A=25\text{ °C}$ , $R_{thJA}=40\text{ °C/W}$ <sup>2)</sup>
Operating and storage temperature	$T_j, T_{stg}$	-55	-	175	°C	-

<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

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.51	°C/W	-
Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>5)</sup>	$R_{thJA}$	-	-	40	°C/W	-
Thermal resistance, junction - ambient, minimal footprint	$R_{thJA}$	-	-	62	°C/W	-

<sup>5)</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.

### 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	$V_{DS}=V_{GS}$ , $I_D=189\text{ }\mu\text{A}$
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	$R_{DS(on)}$	-	0.82 0.93	1.25 1.40	m $\Omega$	$V_{GS}=10\text{ V}$ , $I_D=100\text{ A}$ $V_{GS}=6\text{ V}$ , $I_D=50\text{ A}$
Gate resistance	$R_G$	-	2.5	-	$\Omega$	-
Transconductance <sup>6)</sup>	$g_{fs}$	225	-	-	S	$ V_{DS} \geq 2 I_D R_{DS(on)max}$ , $I_D=100\text{ A}$

<sup>6)</sup> Defined by design. Not subject to production test.

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	11300	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	4130	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$
Reverse transfer capacitance	$C_{rss}$	-	210	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=20\text{ V}$ , $f=1\text{ MHz}$
Turn-on delay time	$t_{d(on)}$	-	23	-	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	$t_r$	-	50	-	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	$t_{d(off)}$	-	67	-	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	$t_f$	-	31	-	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>7)</sup>**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	47	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge at threshold	$Q_{g(th)}$	-	32	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	30	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Switching charge	$Q_{sw}$	-	45	-	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total <sup>8)</sup>	$Q_g$	-	159	239	nC	$V_{DD}=20\text{ V}$ , $I_D=100\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$

**Table 6 Gate charge characteristics** <sup>7)</sup>

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate plateau voltage	$V_{\text{plateau}}$	-	4.2	-	V	$V_{\text{DD}}=20\text{ V}$ , $I_{\text{D}}=100\text{ A}$ , $V_{\text{GS}}=0\text{ to }10\text{ V}$
Gate charge total, sync. FET	$Q_{\text{g(sync)}}$	-	142	-	nC	$V_{\text{DS}}=0.1\text{ V}$ , $V_{\text{GS}}=0\text{ to }10\text{ V}$
Output charge	$Q_{\text{oss}}$	-	176	-	nC	$V_{\text{DS}}=20\text{ V}$ , $V_{\text{GS}}=0\text{ V}$

<sup>7)</sup> See "Gate charge waveforms" for parameter definition

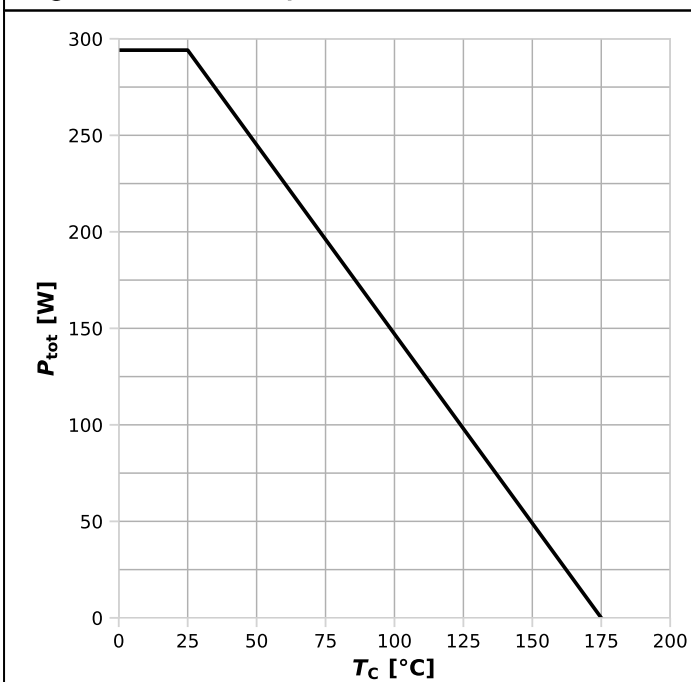
<sup>8)</sup> Defined by design. Not subject to production test.

**Table 7 Reverse diode**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	$I_{\text{S}}$	-	-	162	A	$T_{\text{C}}=25\text{ °C}$
Diode pulse current	$I_{\text{S,pulse}}$	-	-	796	A	$T_{\text{C}}=25\text{ °C}$
Diode forward voltage	$V_{\text{SD}}$	-	0.83	1	V	$V_{\text{GS}}=0\text{ V}$ , $I_{\text{F}}=100\text{ A}$ , $T_{\text{J}}=25\text{ °C}$
Reverse recovery time	$t_{\text{rr}}$	-	55	-	ns	$V_{\text{R}}=20\text{ V}$ , $I_{\text{F}}=100\text{ A}$ , $di_{\text{F}}/dt=100\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{\text{rr}}$	-	65	-	nC	$V_{\text{R}}=20\text{ V}$ , $I_{\text{F}}=100\text{ A}$ , $di_{\text{F}}/dt=100\text{ A}/\mu\text{s}$
Reverse recovery time	$t_{\text{rr}}$	-	44	-	ns	$V_{\text{R}}=20\text{ V}$ , $I_{\text{F}}=100\text{ A}$ , $di_{\text{F}}/dt=500\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{\text{rr}}$	-	230	-	nC	$V_{\text{R}}=20\text{ V}$ , $I_{\text{F}}=100\text{ A}$ , $di_{\text{F}}/dt=500\text{ A}/\mu\text{s}$

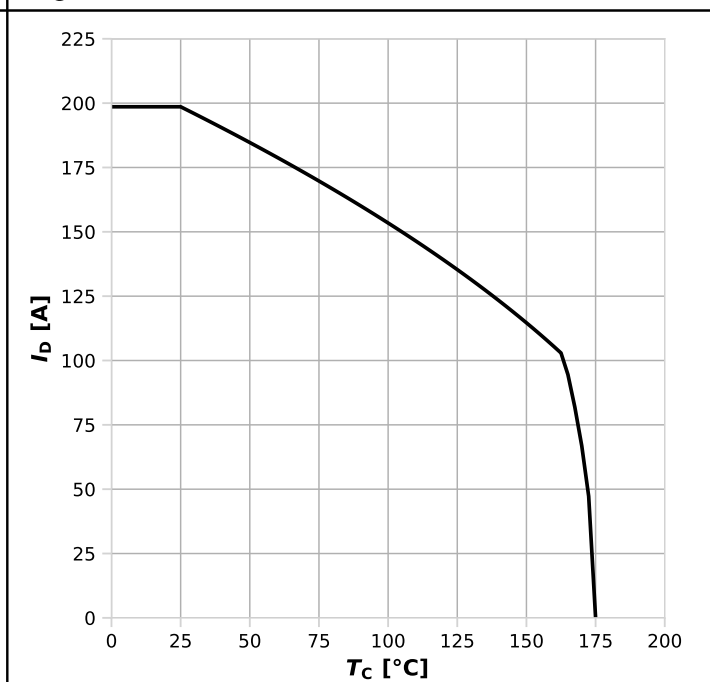
## 4 Electrical characteristics diagrams

Diagram 1: Power dissipation



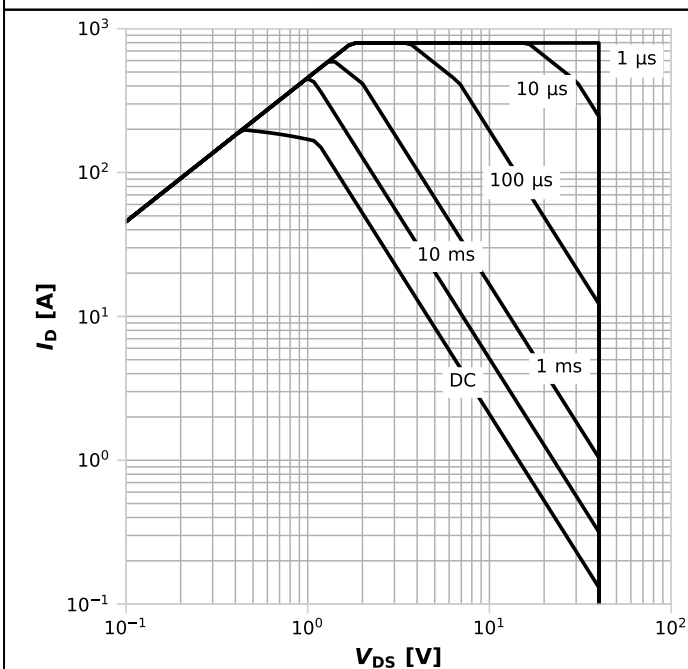
$$P_{tot}=f(T_c)$$

Diagram 2: Drain current



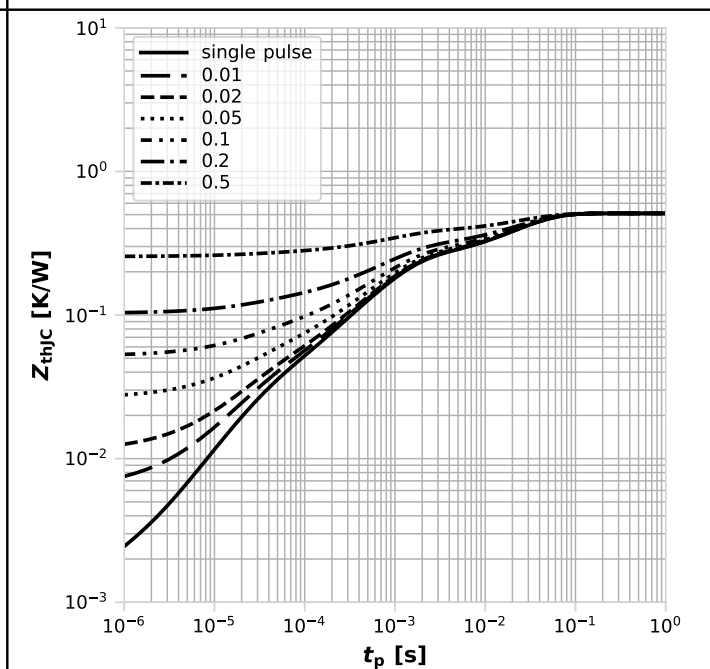
$$I_D=f(T_c); V_{GS}\geq 10\text{ V}$$

Diagram 3: Safe operating area



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

Diagram 4: Max. transient thermal impedance



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

Diagram 5: Typ. output characteristics

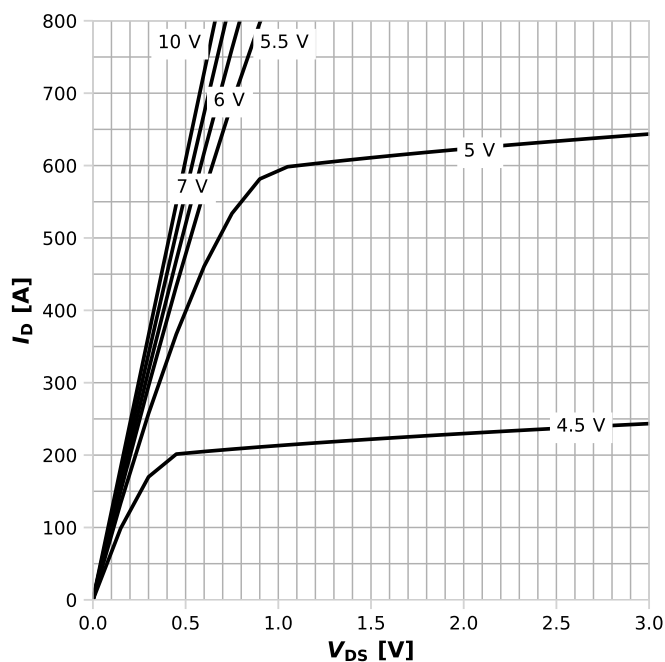

 $I_D = f(V_{DS})$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$ 

Diagram 6: Typ. drain-source on resistance

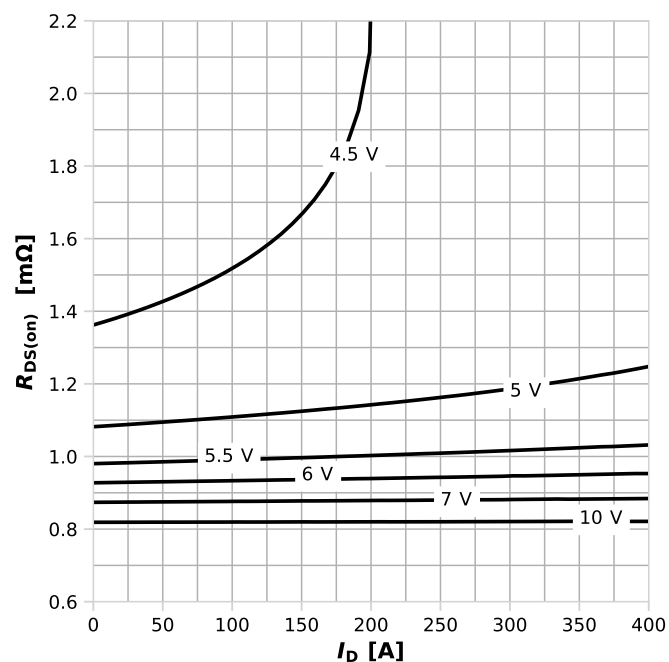

 $R_{DS(on)} = f(I_D)$ ,  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$ 

Diagram 7: Typ. transfer characteristics

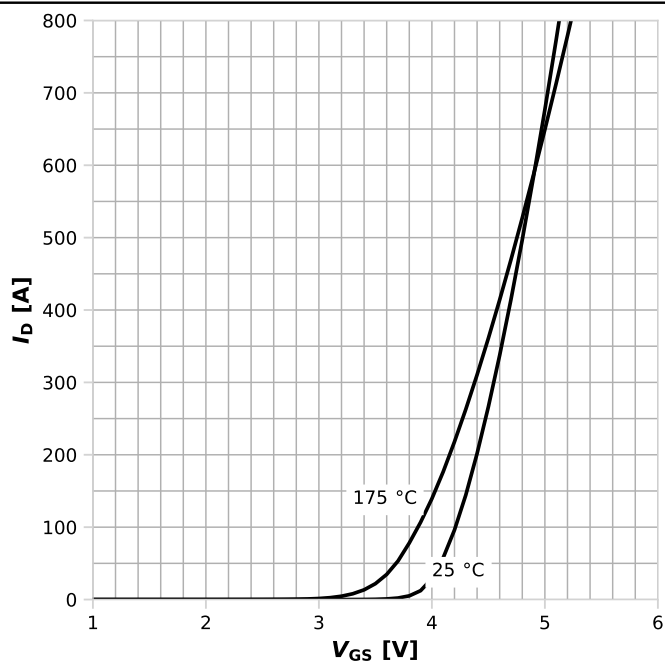

 $I_D = f(V_{GS})$ ,  $|V_{DS}| > 2|I_D|R_{DS(on)max}$ ; parameter:  $T_j$ 

Diagram 8: Typ. drain-source on resistance

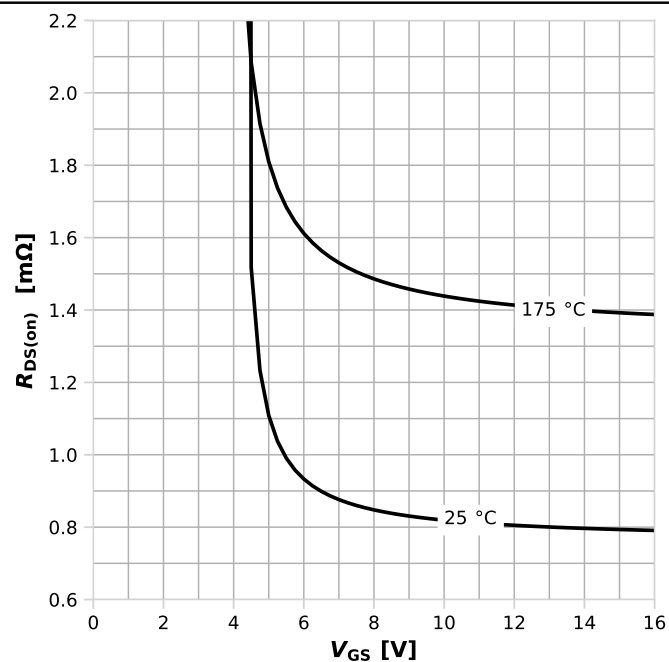
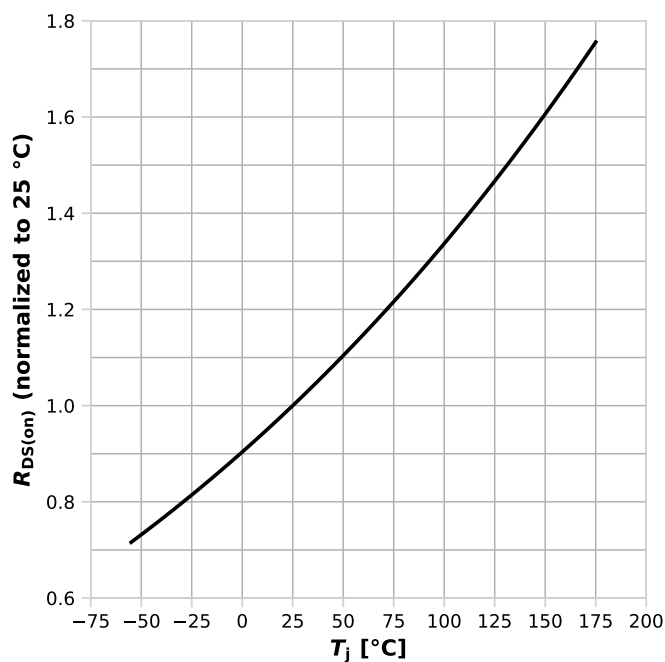

 $R_{DS(on)} = f(V_{GS})$ ,  $I_D = 100\text{ A}$ ; parameter:  $T_j$

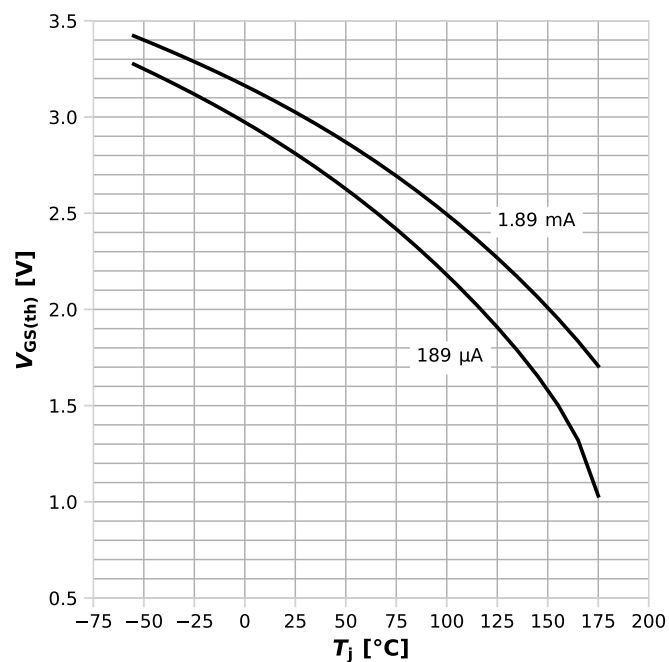


Diagram 9: Normalized drain-source on resistance



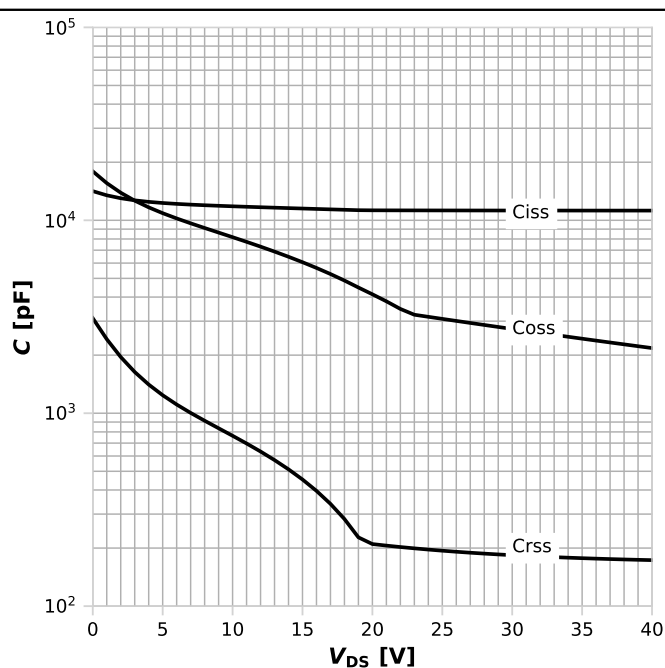
$$R_{DS(on)} = f(T_j), I_D = 100 \text{ A}, V_{GS} = 10 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



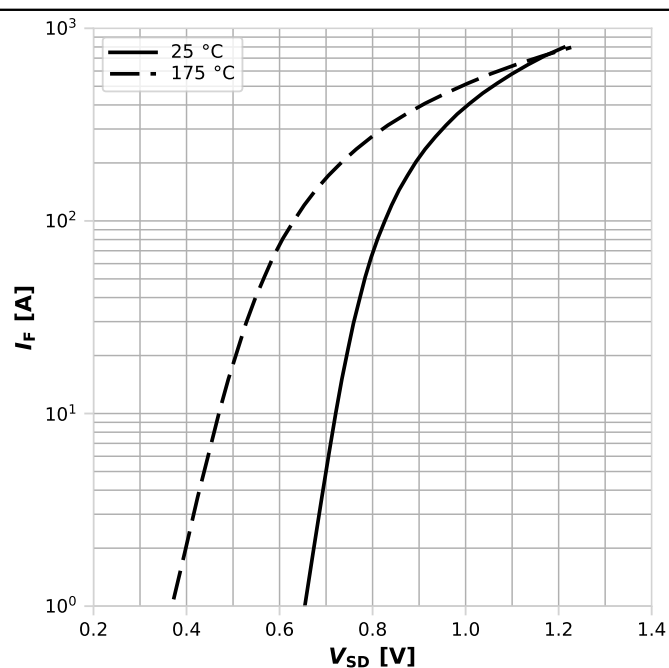
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}; \text{ parameter: } I_D$$

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



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

Diagram 13: Avalanche characteristics

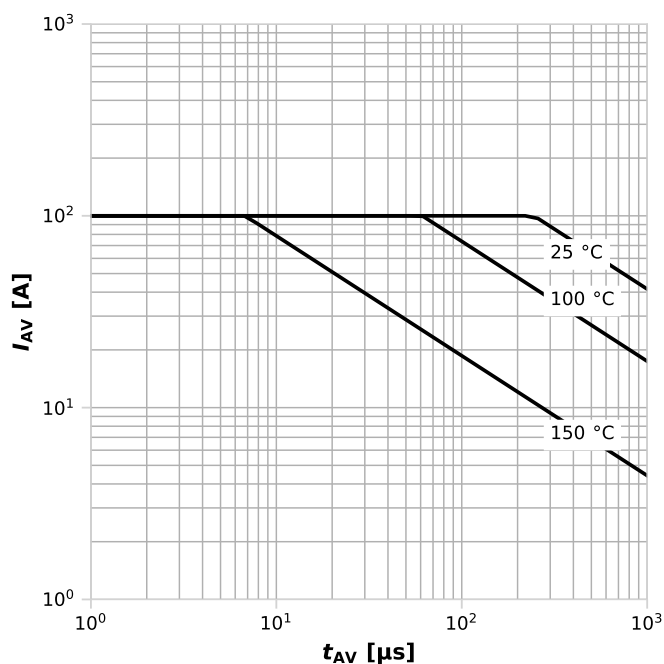

 $I_{AS}=f(t_{AV}); R_{GS}=25\ \Omega; \text{parameter: } T_{j,\text{start}}$ 

Diagram 14: Typ. gate charge

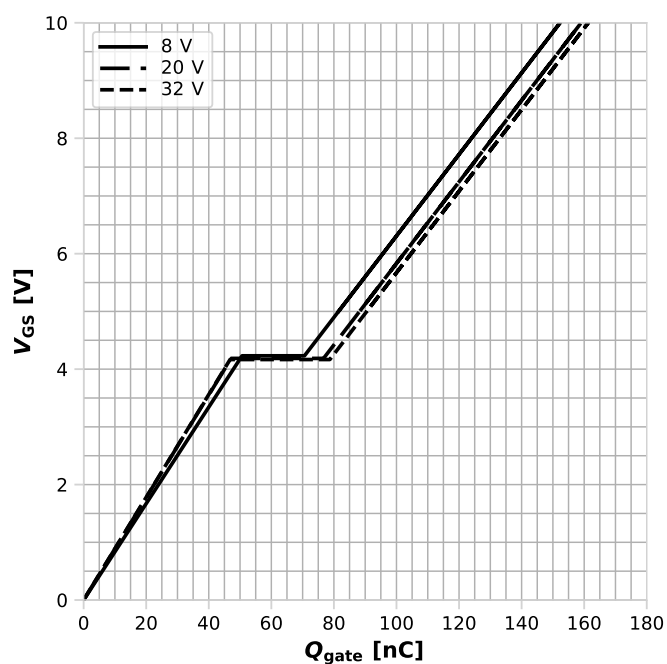
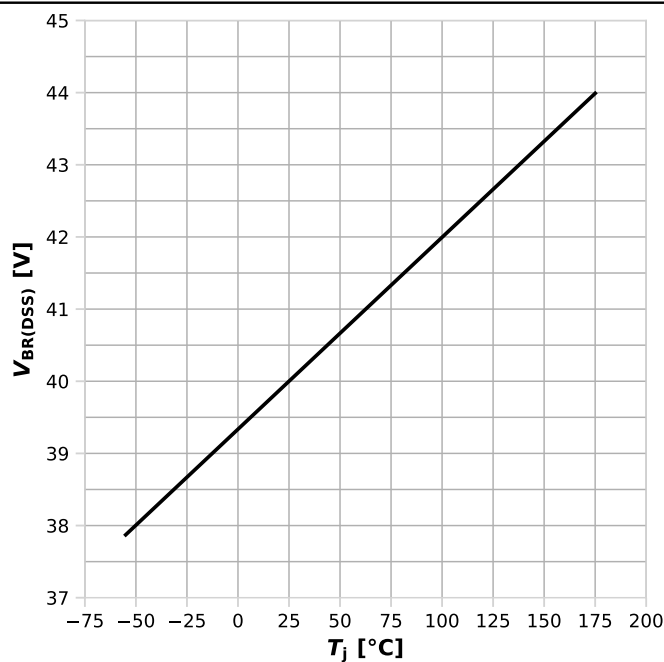
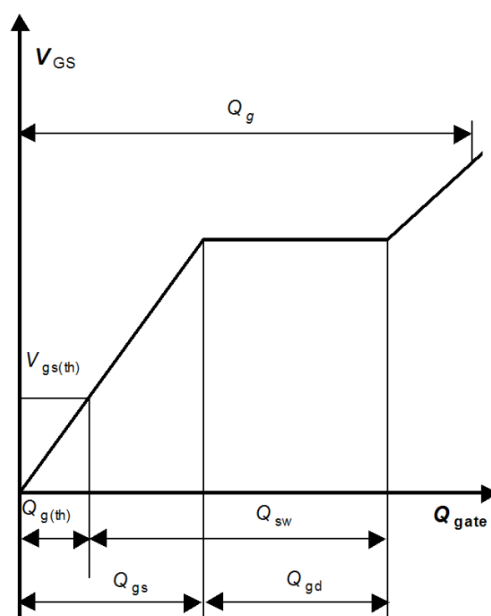

 $V_{GS}=f(Q_{\text{gate}}), I_D=100\ \text{A pulsed}, T_j=25\ ^\circ\text{C}; \text{parameter: } V_{DD}$ 

Diagram 15: Drain-source breakdown voltage

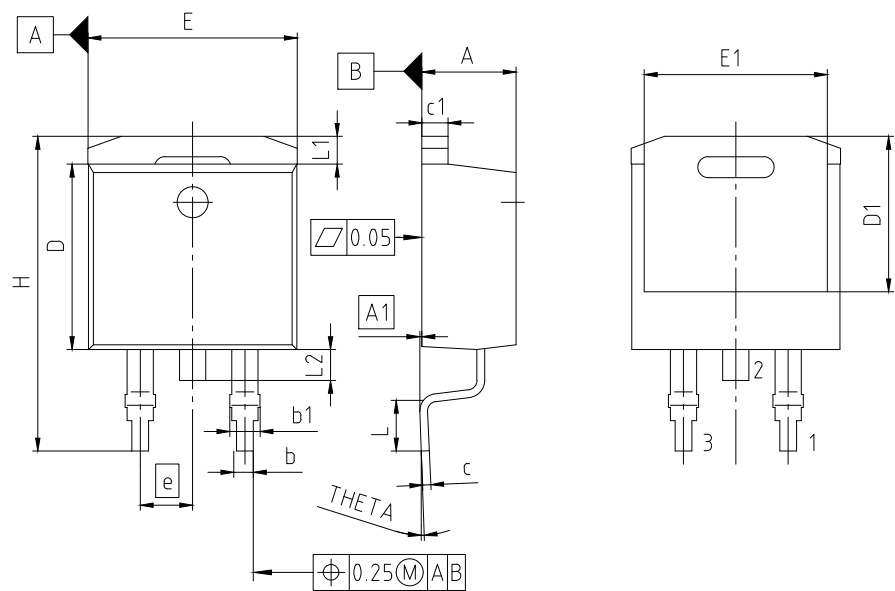

 $V_{BR(DSS)}=f(T_j); I_D=1\ \text{mA}$ 

Gate charge waveforms



-

5 Package Outlines



PACKAGE - GROUP NUMBER: PG-T0263-3-U02		
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.06	4.83
A1	0.00	0.25
b	0.51	1.00
b1	1.07	1.78
c	0.30	0.73
c1	1.14	1.65
D	8.38	9.65
D1	6.60	7.50
E	9.65	10.67
E1	6.22	8.70
e	2.54	
N	3	
H	14.60	15.88
L	1.52	2.60
L1	1.05	1.68
L2	1.35	1.78
THETA	-9.00°	8.00°

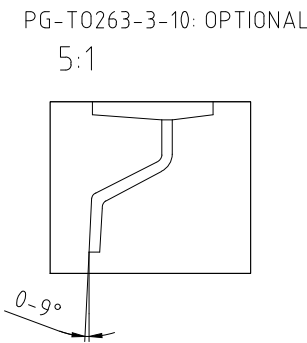


Figure 1 Outline PG-T0263-3, dimensions in mm

## Revision History

IPB012N04NF2S

### Revision 2024-10-07, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2022-10-12	Release of final version
2.1	2024-10-07	Added trr and Qrr at diF/dt=100 A/μs

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