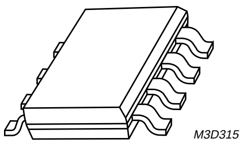


Si9956DY

N-channel enhancement mode field-effect transistor

Rev. 01 — 16 July 2001 **Product data**

1. Description

Dual N-channel enhancement mode field-effect transistor in a plastic package using TrenchMOS™[1] technology.

Product availability:

Si9956DY in SOT96-1 (SO8).

2. Features

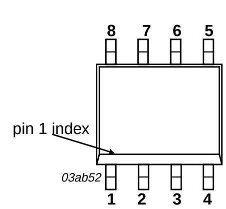
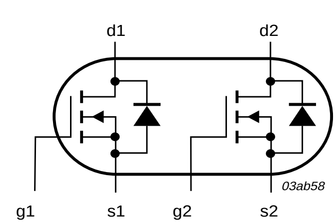
- Low on-state resistance
- Fast switching
- TrenchMOS™ technology.

3. Applications

- DC to DC convertors
- DC motor control
- Lithium-ion battery applications
- Notebook PC
- Portable equipment applications.

4. Pinning information

Table 1: Pinning - SOT96-1, simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	source 1 (s_1)		
2	gate 1 (g_1)		
3	source 2 (s_2)		
4	gate 2 (g_2)		
5,6	drain 2 (d_2)		
7,8	drain 1 (d_1)	**SOT96-1 (SO8)**	

1. TrenchMOS is a trademark of Royal Philips Electronics.

5. Quick reference data

Table 2: Quick reference data

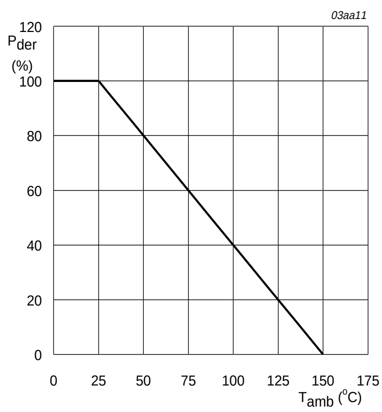
Symbol	Parameter	Conditions	Typ	Max	Unit
V_{DS}	drain-source voltage (DC)	T_j = 25 to 150 °C	–	20	V
I_D	drain current (DC)	T_{amb} = 25 °C; pulsed; $t_p \leq 10$ s	–	3.5	A
P_{tot}	total power dissipation	T_{amb} = 25 °C; pulsed; $t_p \leq 10$ s	–	2	W
T_j	junction temperature		–	150	°C
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 2.2 A	55	100	mΩ
		V_{GS} = 4.5 V; I_D = 1 A	70	200	mΩ

6. Limiting values

Table 3: Limiting values

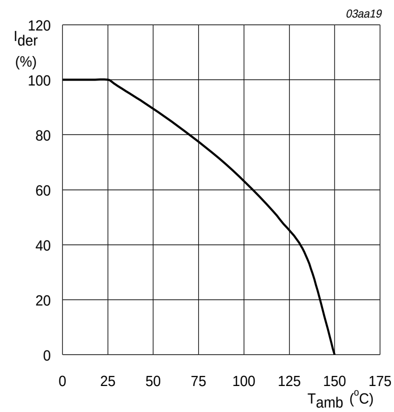
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage (DC)	T_j = 25 to 150 °C	–	20	V
V_{GS}	gate-source voltage (DC)		–	±20	V
I_D	drain current (DC)	T_{amb} = 25 °C; pulsed; $t_p \leq 10$ s; Figure 2 and 3	–	3.5	A
		T_{amb} = 70 °C; pulsed; $t_p \leq 10$ s; Figure 2	–	2.8	A
I_{DM}	peak drain current	T_{amb} = 25 °C; pulsed; $t_p \leq 10$ µs; Figure 3	–	14	A
P_{tot}	total power dissipation	T_{amb} = 25 °C; pulsed; $t_p \leq 10$ s; Figure 1	–	2	W
		T_{amb} = 70 °C; pulsed; $t_p \leq 10$ s; Figure 1	–	1.3	W
T_{stg}	storage temperature		–55	+150	°C
T_j	operating junction temperature		–55	+150	°C
Source-drain diode					
I_S	source (diode forward) current (DC)	T_{amb} = 25 °C	–	1.3	A



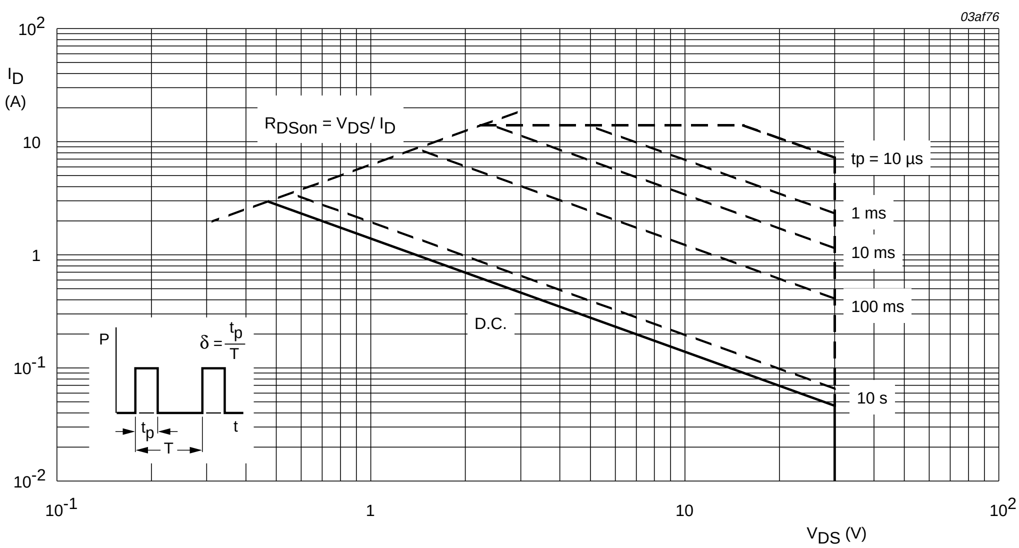
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ C)}} \times 100\%$$

Fig 1. Normalized total power dissipation as a function of mounting base temperature.



$$I_{der} = \frac{I_D}{I_{D(25^\circ C)}} \times 100\%$$

Fig 2. Normalized continuous drain current as a function of mounting base temperature.



T_{amb} = 25 °C; I_{DM} is single pulse.

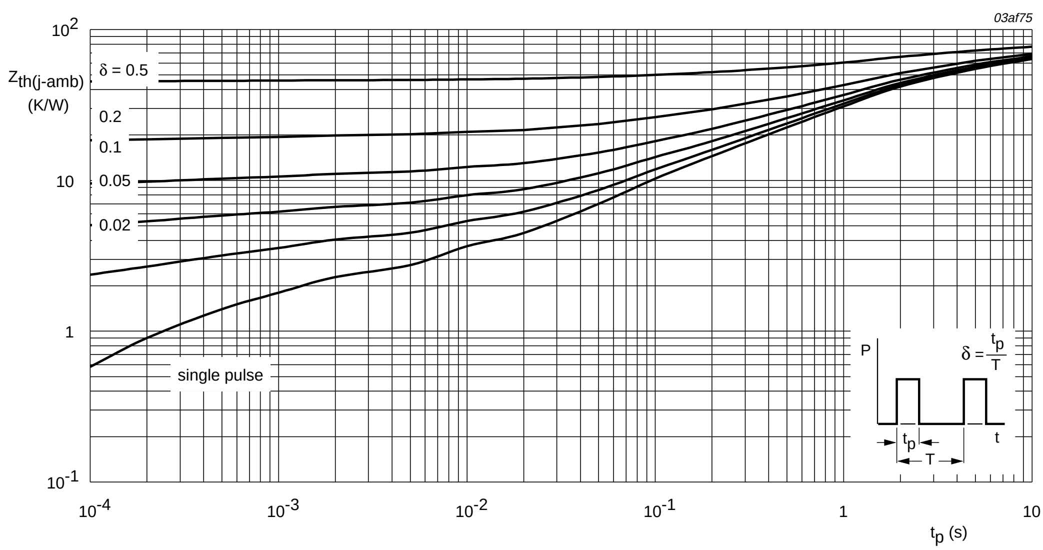
Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage.

7. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Value	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	mounted on a printed circuit board; $t_p \leq 10$ s; minimum footprint; Figure 4	62.5	K/W

7.1 Transient thermal impedance



$T_{amb} = 25$ °C

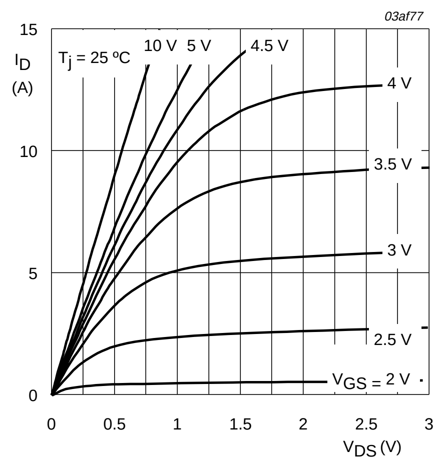
Fig 4. Transient thermal impedance from junction to ambient as a function of pulse duration.

8. Characteristics

Table 5: Characteristics

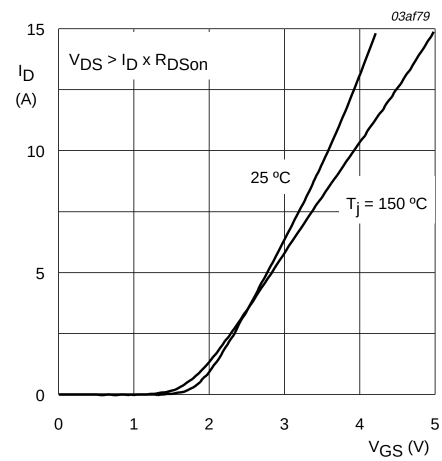
T_j = 25 °C unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{GS(th)}$	gate-source threshold voltage	I_D = 250 μA; V_{DS} = V_{GS}	1	–	–	V
I_{DSS}	drain-source leakage current	V_{DS} = 16 V; V_{GS} = 0 V				
		T_j = 25 °C	–	–	2	μA
		T_j = 55 °C	–	–	25	μA
I_{GSS}	gate-source leakage current	V_{GS} = ±20 V; V_{DS} = 0 V	–	–	100	nA
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 2.2 A; Figure 7 and 8	–	55	100	mΩ
		V_{GS} = 4.5 V; I_D = 1 A; Figure 7 and 8	–	70	200	mΩ
Dynamic characteristics						
g_{fs}	forward transconductance	V_{DS} = 15 V; I_D = 3.5 A	–	5.7	–	S
$Q_{g(tot)}$	total gate charge	I_D = 1.8 A; V_{DS} = 10 V; V_{GS} = 10 V; Figure 13	–	8	30	nC
Q_{gs}	gate-source charge		–	0.8	–	nC
Q_{gd}	gate-drain (Miller) charge		–	1.7	–	nC
$t_{d(on)}$	turn-on delay time	V_{DD} = 10 V; R_D = 10 Ω; V_{GS} = 10 V; R_G = 6 Ω	–	6	20	ns
t_r	turn-on rise time		–	8	20	ns
$t_{d(off)}$	turn-off delay time		–	14	90	ns
t_f	turn-off fall time		–	8	50	ns
Source-drain (reverse) diode						
V_{SD}	source-drain (diode forward) voltage	I_S = 2.3A; V_{GS} = 0 V; Figure 12	–	0.75	1.2	V
t_{rr}	reverse recovery time	I_S = 1.7 A; dI_S/dt = –100 A/μs; V_{GS} = 0 V	–	50	100	ns



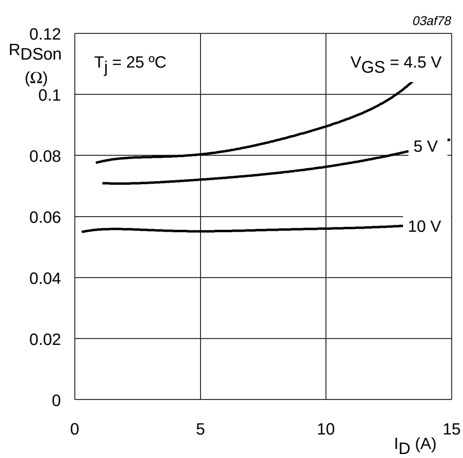
T_j = 25 °C

Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values.



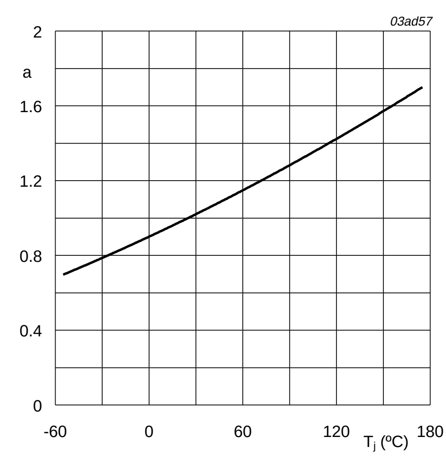
T_j = 25 °C and 150 °C; $V_{DS} > I_D \times R_{DSon}$

Fig 6. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



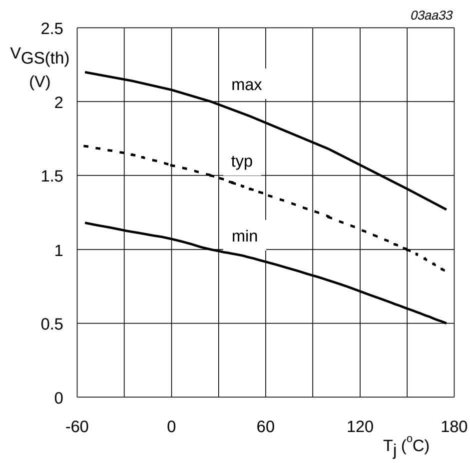
T_j = 25 °C

Fig 7. Drain-source on-state resistance as a function of drain current; typical values.



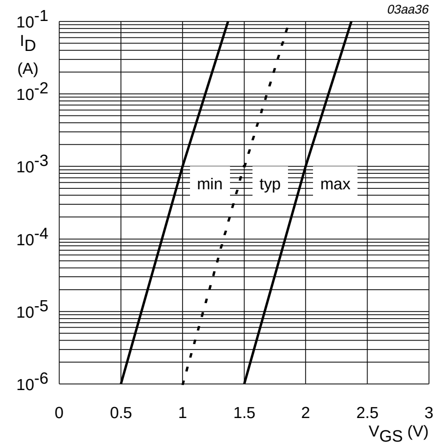
$$a = \frac{R_{DSon}}{R_{DSon(25^{\circ}C)}}$$

Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature.



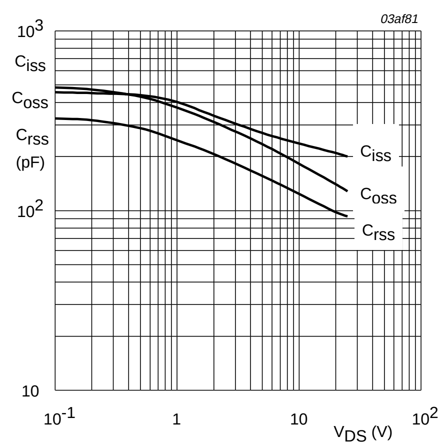
I_D = 250 µA; $V_{DS} = V_{GS}$

Fig 9. Gate-source threshold voltage as a function of junction temperature.



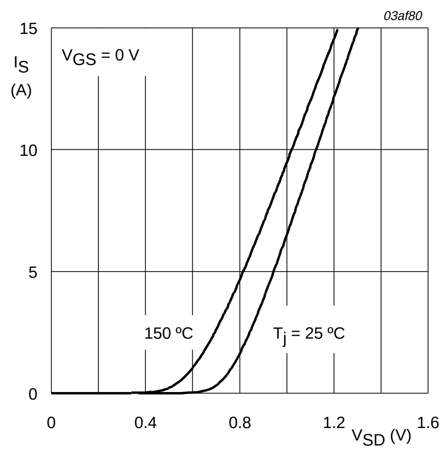
T_j = 25 °C; V_{DS} = 5 V

Fig 10. Sub-threshold drain current as a function of gate-source voltage.



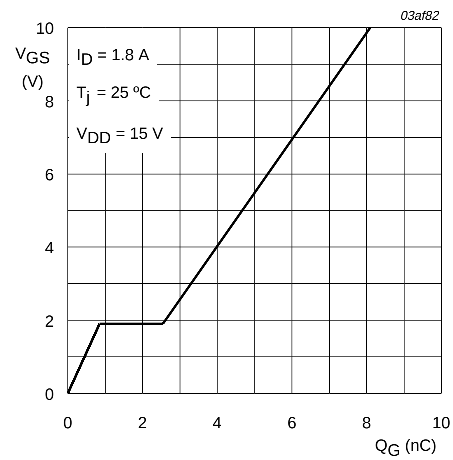
V_{GS} = 0 V; f = 1 MHz

Fig 11. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



T_j = 25 °C and 150 °C; V_{GS} = 0 V

Fig 12. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.

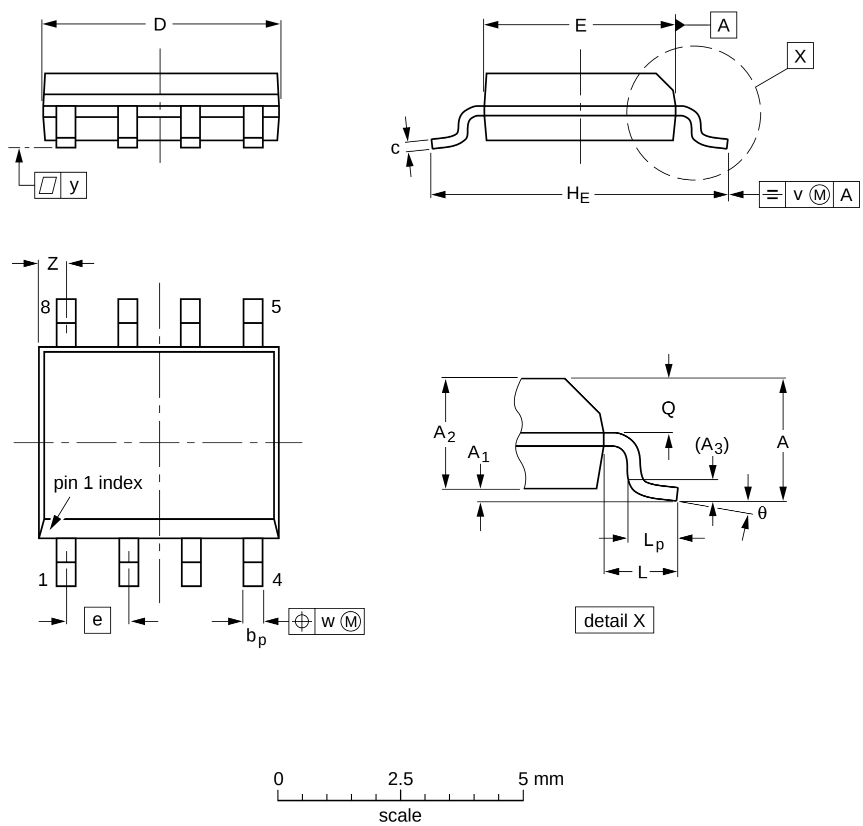


I_D = 1.8 A; V_{DD} = 15 V

Fig 13. Gate-source voltage as a function of gate charge; typical values.

9. Package outline

SO8: plastic small outline package; 8 leads; body width 3.9 mm **SOT96-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D(1)	E(2)	e	H_E	L	L_p	Q	v	w	y	Z(1)	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT96-1	076E03S	MS-012AA				~~95-02-04~~ 97-05-22

Fig 14. SOT96-1 (SO8).

10. Revision history

Table 6: Revision history

Rev	Date	CPCN	Description
01	20010716	-	Product specification; initial version

11. Data sheet status

Data sheet status [1]	Product status [2]	Definition
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A.

[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.

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Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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