

DATA SHEET

PHN405

4 N-channel 60 mΩ FET array
enhancement mode MOS
transistors

Product specification
Supersedes data of 1997 Jun 19
File under Discrete Semiconductors, SC13

1998 Mar 17

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PHN405

FEATURES

- High-speed switching
- No secondary breakdown
- Very low on-state resistance
- Current monitoring.

APPLICATIONS

- Motor and actuator driver
- Power management
- Synchronized rectification.

DESCRIPTION

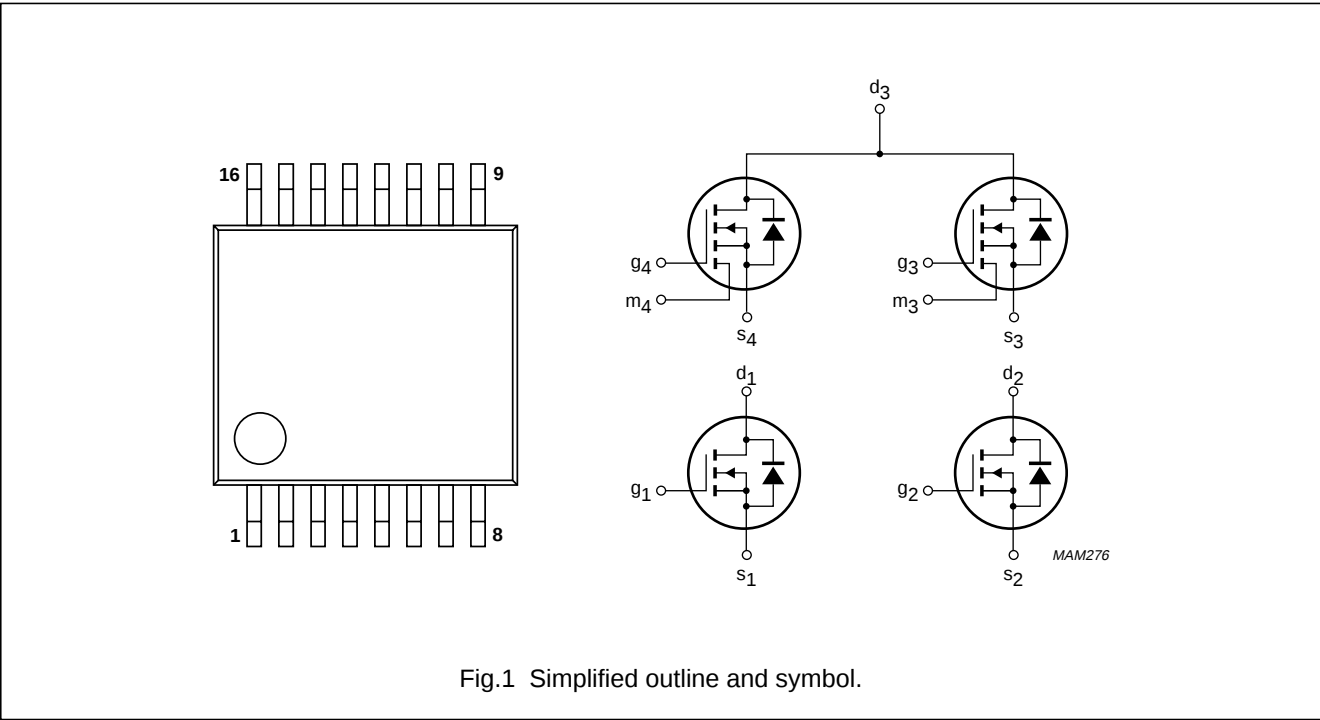
Four enhancement mode MOS transistors in a 16-pin plastic SOT338-1 (SSOP16) package. Two transistors feature current monitoring (sense FETs).

PINNING - SOT338-1 (SSOP16)

PIN	SYMBOL	DESCRIPTION
1 and 4	d ₁	drain 1
2	s ₁	source 1
3	g ₁	gate 1
5 and 8	d ₂	drain 2
6	s ₂	source 2
7	g ₂	gate 2
9	g ₃	gate 3
10	s ₃	source 3
11 and 15	d ₃	drain 3
12	m ₃	current monitor 3
13	g ₄	gate 4
14	s ₄	source 4
16	m ₄	current monitor 4

CAUTION

The device is supplied in an antistatic package.
The gate-source input must be protected against static discharge during transport or handling.



4 N-channel 60 mΩ FET array enhancement mode MOS transistors

PHN405

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DS}	drain-source voltage (DC)		–	30	V
V_{GS}	gate-source voltage (DC)		–	±20	V
V_{GSth}	gate-source threshold voltage	$I_D = 1 \text{ mA}$; $V_{DS} = V_{GS}$	1	2.8	V
I_D	drain current (DC)	$T_s = 80 \text{ °C}$	–	3.7	A
R_{DSon}	drain-source on-state resistance	$I_D = 2 \text{ A}$; $V_{GS} = 10 \text{ V}$	–	60	mΩ
P_{tot}	total power dissipation	$T_s = 80 \text{ °C}$	–	1.4	W

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

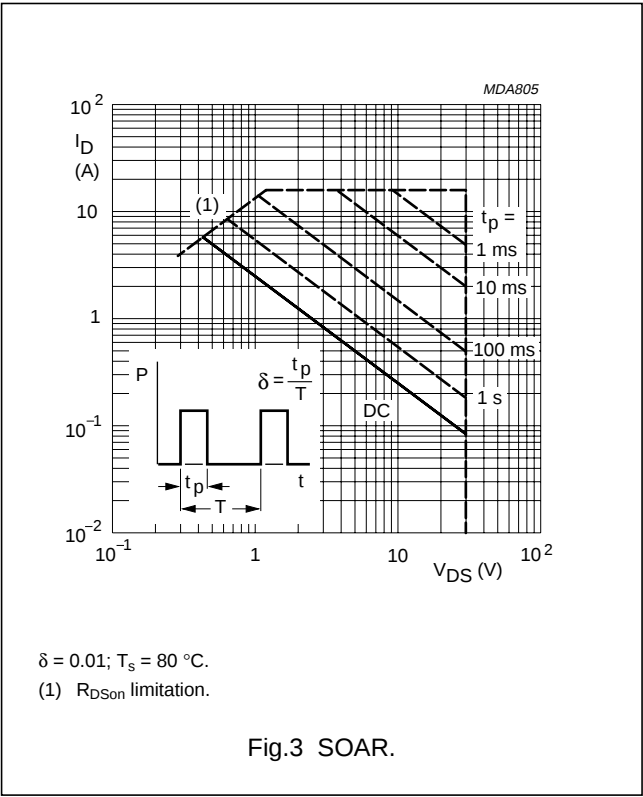
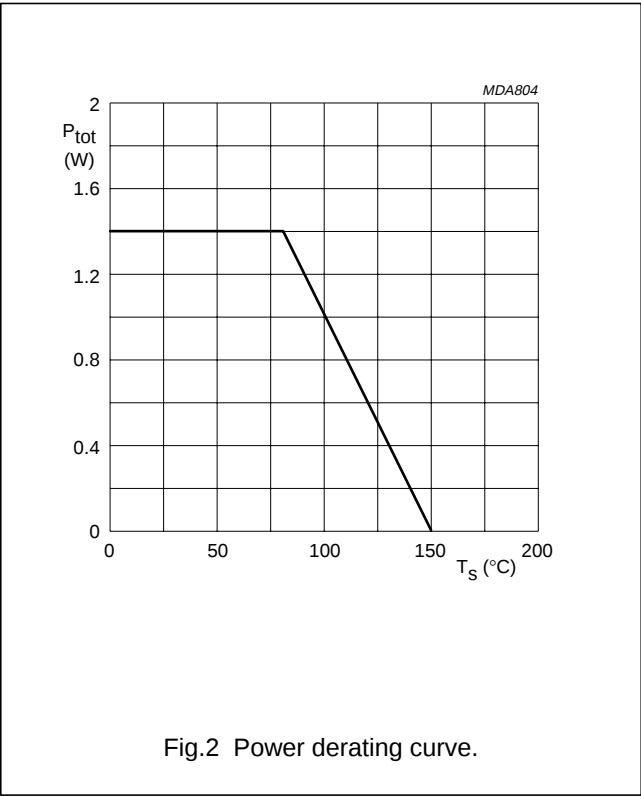
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
Per FET					
V_{DS}	drain-source voltage (DC)		–	30	V
V_{GS}	gate-source voltage (DC)		–	±20	V
I_D	drain current (DC)	$T_s = 80 \text{ °C}$; note 1	–	3.7	A
I_{DM}	peak drain current	note 2	–	14.8	A
P_{tot}	total power dissipation	$T_s = 80 \text{ °C}$; note 3	–	1.4	W
		$T_s = 80 \text{ °C}$; note 4	–	1.25	W
		$T_s = 80 \text{ °C}$; note 5	–	1.09	W
T_{stg}	storage temperature		–55	+150	°C
T_j	operating junction temperature		–55	+150	°C
Current monitor					
I_M	monitor current (DC)	$T_s = 80 \text{ °C}$	–	50	mA
I_{MM}	peak monitor current	note 2	–	220	mA
Source-drain diode					
I_S	source current (DC)	$T_s = 80 \text{ °C}$	–	1.4	A
I_{SM}	peak source current	note 2	–	5.6	A

Notes

- T_s is the temperature at the soldering point of the drain lead.
- Pulse width and duty cycle limited by maximum junction temperature.
- When only one FET dissipates.
- When either FETs 1 and 3 or 2 and 4 dissipate an equal amount of power.
- When all four FETs dissipate an equal amount of power.

4 N-channel 60 mΩ FET array
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PHN405



THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
Per FET				
$R_{th\ j-s}$	thermal resistance from junction to soldering point	note 1	50	K/W
		note 2	56	K/W
		note 3	64	K/W

Notes

1. When only one FET dissipates.
2. When either FETs 1 and 3 or 2 and 4 dissipate an equal amount of power.
3. When all four FETs dissipate an equal amount of power.

4 N-channel 60 mΩ FET array enhancement mode MOS transistors

PHN405

CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Per FET						
$V_{(BR)DSS}$	drain-source breakdown voltage	$V_{GS} = 0$; $I_D = 10\text{ }\mu\text{A}$	30	–	–	V
V_{GSth}	gate-source threshold voltage	$V_{GS} = V_{DS}$; $I_D = 1\text{ mA}$	1	–	2.8	V
I_{DSS}	drain-source leakage current	$V_{GS} = 0$; $V_{DS} = 24\text{ V}$	–	–	100	nA
I_{GSS}	gate leakage current	$V_{GS} = \pm 20\text{ V}$; $V_{DS} = 0$	–	–	± 100	nA
R_{DSon}	drain-source on-state resistance	$V_{GS} = 4.5\text{ V}$; $I_D = 1\text{ A}$	–	–	120	mΩ
		$V_{GS} = 10\text{ V}$; $I_D = 2\text{ A}$	–	–	60	mΩ
C_{iss}	input capacitance	$V_{GS} = 0$; $V_{DS} = 24\text{ V}$; $f = 1\text{ MHz}$	–	230	–	pF
C_{oss}	output capacitance	$V_{GS} = 0$; $V_{DS} = 24\text{ V}$; $f = 1\text{ MHz}$	–	90	–	pF
C_{rss}	reverse transfer capacitance	$V_{GS} = 0$; $V_{DS} = 24\text{ V}$; $f = 1\text{ MHz}$	–	50	–	pF
Q_G	total gate charge	$V_{GS} = 10\text{ V}$; $V_{DD} = 15\text{ V}$; $I_D = 1\text{ A}$	–	7.1	10	nC
Q_{GS}	gate-source charge	$V_{DD} = 15\text{ V}$; $I_D = 1\text{ A}$;	–	0.5	–	nC
Q_{GD}	gate-drain charge	$V_{DD} = 15\text{ V}$; $I_D = 1\text{ A}$;	–	2.4	–	nC
Switching times						
$t_{d(on)}$	turn-on delay time	$V_{GS} = 0\text{ to }10\text{ V}$; $V_{DD} = 20\text{ V}$; $I_D = 1\text{ A}$; $R_{gen} = 6\text{ }\Omega$	–	3.5	–	ns
t_f	fall time	$V_{GS} = 0\text{ to }10\text{ V}$; $V_{DD} = 20\text{ V}$; $I_D = 1\text{ A}$; $R_{gen} = 6\text{ }\Omega$	–	3.5	–	ns
t_{on}	turn-on switching time	$V_{GS} = 0\text{ to }10\text{ V}$; $V_{DD} = 20\text{ V}$; $I_D = 1\text{ A}$; $R_{gen} = 6\text{ }\Omega$	–	7	10	ns
$t_{d(off)}$	turn-off delay time	$V_{GS} = 10\text{ to }0\text{ V}$; $V_{DD} = 20\text{ V}$; $I_D = 1\text{ A}$; $R_{gen} = 6\text{ }\Omega$	–	12	–	ns
t_r	rise time	$V_{GS} = 10\text{ to }0\text{ V}$; $V_{DD} = 20\text{ V}$; $I_D = 1\text{ A}$; $R_{gen} = 6\text{ }\Omega$	–	8	–	ns
t_{off}	turn-off switching time	$V_{GS} = 10\text{ to }0\text{ V}$; $V_{DD} = 20\text{ V}$; $I_D = 1\text{ A}$; $R_{gen} = 6\text{ }\Omega$	–	20	30	ns
Current monitor						
R_{DMon}	on-state drain-monitor resistance	$V_{GM} = 10\text{ V}$; $I_D = 25\text{ mA}$; $I_S = 0$	–	–	4	Ω
		$V_{GM} = 4.5\text{ V}$; $I_D = 12\text{ mA}$; $I_S = 0$	–	–	8	Ω
I_S/I_M	source to monitor current ratio	$V_{GS} = 10\text{ V}$; $I_D = 2\text{ A}$; $V_{MS} = 0$	–	66.7	–	
C_{Moss}	output capacitance of monitor cells	$V_{GM} = V_{MS} = 0$; $V_{DS} = 24\text{ V}$; $f = 1\text{ MHz}$	–	1.35	–	pF
Source-drain diode						
V_{SD}	source-drain diode forward voltage	$V_{GD} = 0$; $I_S = 1.25\text{ A}$	–	–	1	V
t_{rr}	reverse recovery time	$I_S = 1.25\text{ A}$; $di/dt = -100\text{ A}/\mu\text{s}$	–	25	–	ns

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PHN405

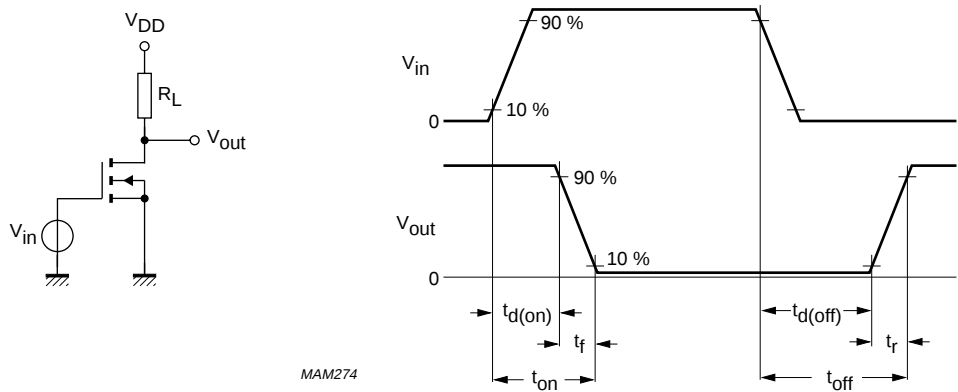


Fig.4 Switching times test circuit with input and output waveforms.

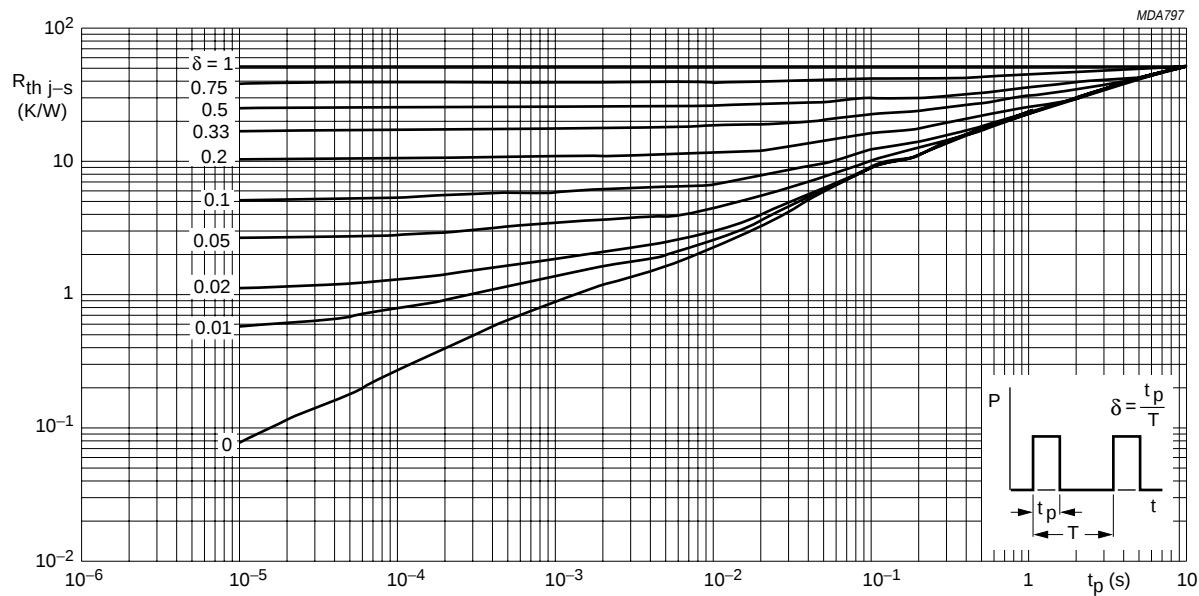
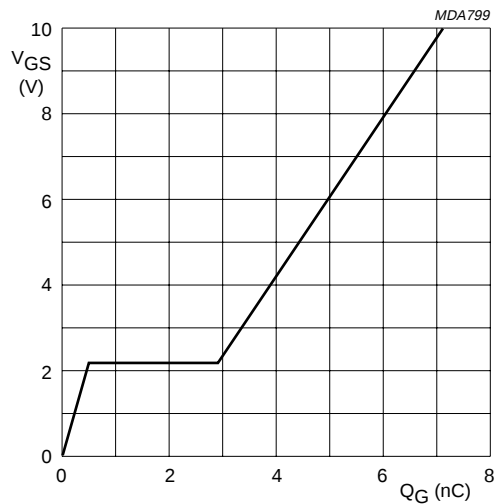


Fig.5 Transient thermal resistance from junction to soldering point as a function of pulse time; typical values.

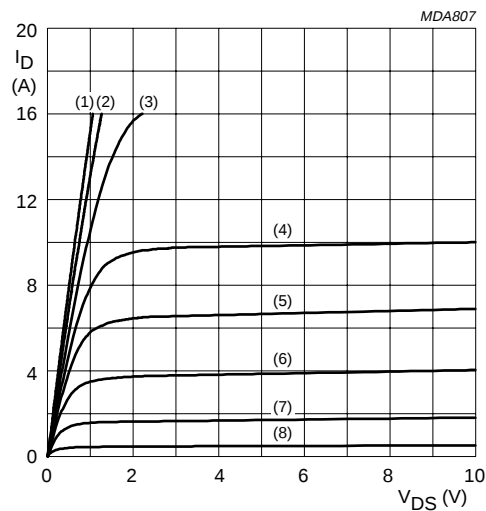
4 N-channel 60 mΩ FET array
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PHN405



$V_{DD} = 15\text{ V}$; $I_D = 1\text{ A}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

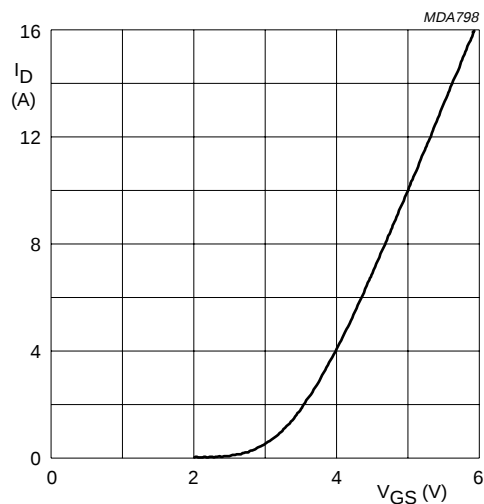
Fig.6 Gate-source voltage as a function of total gate charge; typical values.



$T_{amb} = 25\text{ }^\circ\text{C}$; $t_p = 80\text{ }\mu\text{s}$; $\delta = 0$.

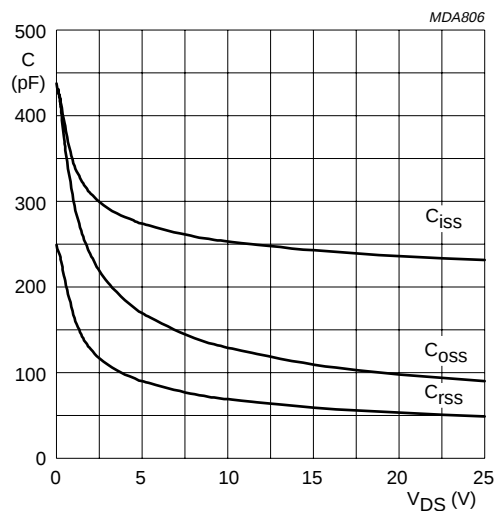
- | | |
|-------------------------------|-------------------------------|
| (1) $V_{GS} = 10\text{ V}$. | (5) $V_{GS} = 4.5\text{ V}$. |
| (2) $V_{GS} = 7.5\text{ V}$. | (6) $V_{GS} = 4\text{ V}$. |
| (3) $V_{GS} = 6\text{ V}$. | (7) $V_{GS} = 3.5\text{ V}$. |
| (4) $V_{GS} = 5\text{ V}$. | (8) $V_{GS} = 3\text{ V}$. |

Fig.7 Output characteristics; typical values.



$V_{DS} = 10\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$; $t_p = 80\text{ }\mu\text{s}$; $\delta = 0$.

Fig.8 Transfer characteristic; typical values.

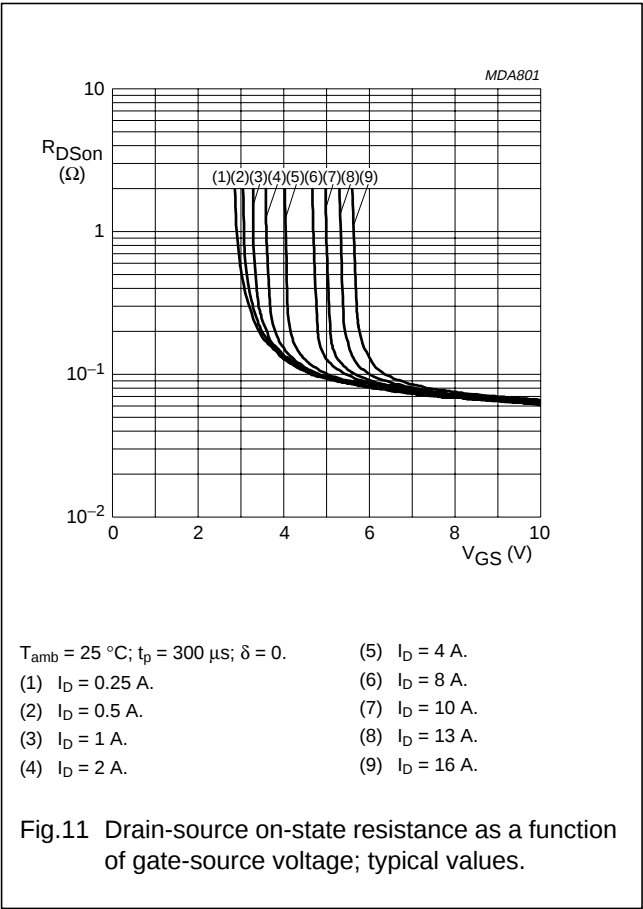
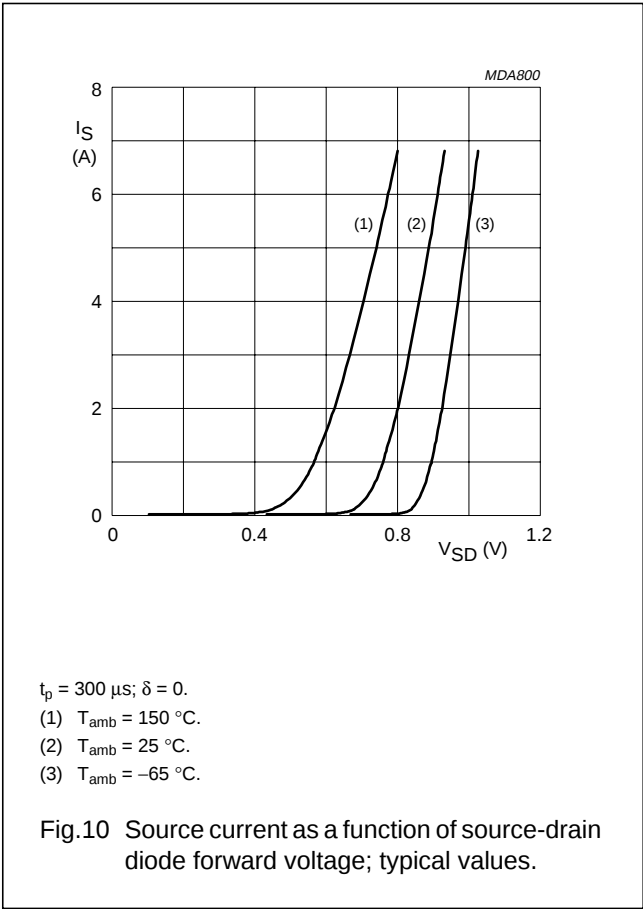


$V_{GS} = 0$; $f = 1\text{ MHz}$; $T_j = 25\text{ }^\circ\text{C}$.

Fig.9 Capacitance as a function of drain-source voltage; typical values.

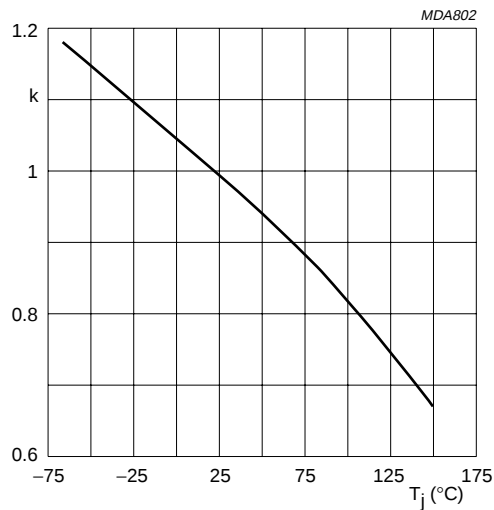
4 N-channel 60 mΩ FET array
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PHN405



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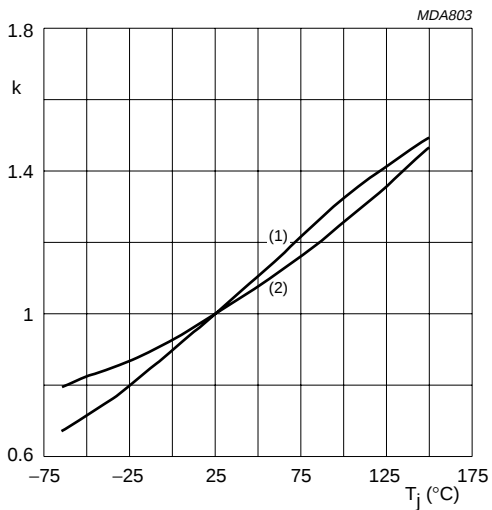
PHN405



$$k = \frac{V_{GSth} \text{ at } T_j}{V_{GSth} \text{ at } 25^\circ\text{C}}$$

V_{GSth} at $V_{DS} = V_{GS}$; $I_D = 1 \text{ mA}$.

Fig.12 Temperature coefficient of gate-source threshold voltage as a function of junction temperature; typical values.



$$k = \frac{R_{DSon} \text{ at } T_j}{R_{DSon} \text{ at } 25^\circ\text{C}}$$

R_{DSon} at:
(1) $V_{GS} = 10 \text{ V}$; $I_D = 2 \text{ A}$.
(2) $V_{GS} = 4.5 \text{ V}$; $I_D = 1 \text{ A}$.

Fig.13 Temperature coefficient of drain-source on-resistance as a function of junction temperature; typical values.

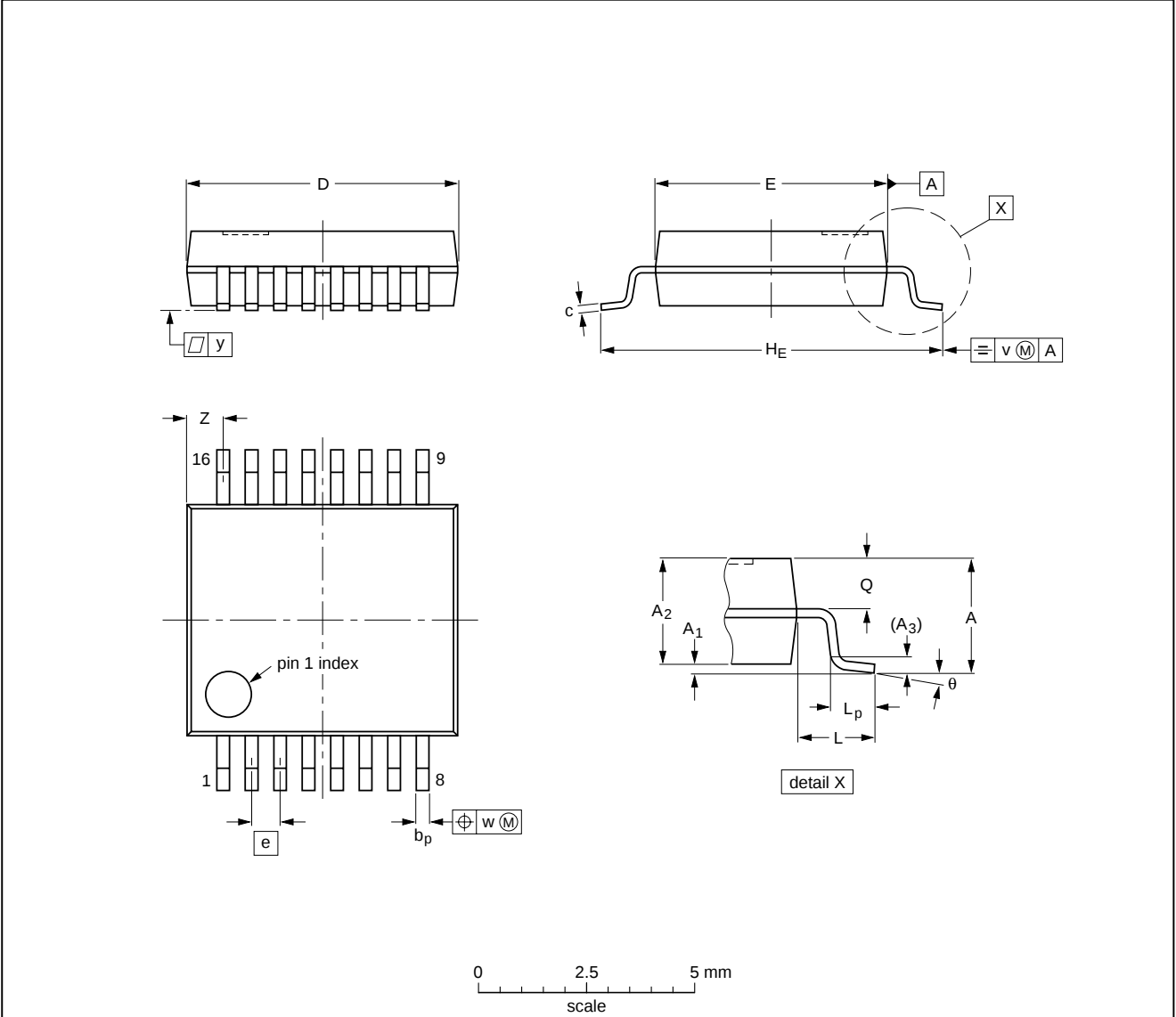
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PHN405

PACKAGE OUTLINE

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.00 0.55	8° 0°

Note

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT338-1		MO-150AC				94-01-14 95-02-04

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PHN405**DEFINITIONS**

Data Sheet Status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). 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.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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