

# DATA SHEET

## **PHC20306**

Complementary enhancement  
mode MOS transistor

Objective specification  
File under Discrete Semiconductors, SC13b

1998 Feb 18

# Complementary enhancement mode MOS transistor

PHC20306

## FEATURES

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

## APPLICATIONS

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

## DESCRIPTION

One N-channel and one P-channel enhancement mode MOS transistor in an 8-pin SOT96-1 (SO8) plastic package.

**CAUTION**

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

## PINNING - SOT96-1 (SO8)

| PIN | SYMBOL         | DESCRIPTION |
|-----|----------------|-------------|
| 1   | s <sub>1</sub> | source 1    |
| 2   | g <sub>1</sub> | gate 1      |
| 3   | s <sub>2</sub> | source 2    |
| 4   | g <sub>2</sub> | gate 2      |
| 5   | d <sub>2</sub> | drain 2     |
| 6   | d <sub>2</sub> | drain 2     |
| 7   | d <sub>1</sub> | drain 1     |
| 8   | d <sub>1</sub> | drain 1     |

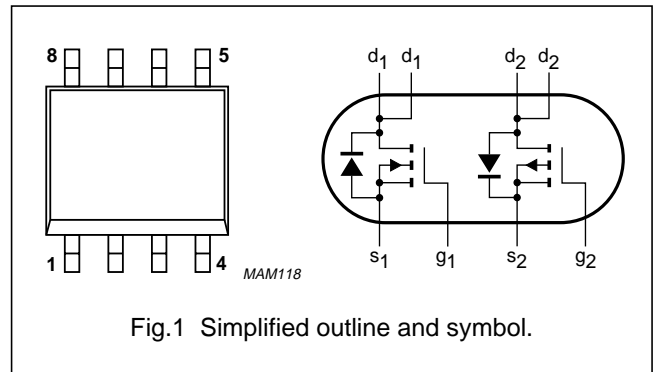


Fig.1 Simplified outline and symbol.

## QUICK REFERENCE DATA

| SYMBOL             | PARAMETER                          | CONDITIONS   | MIN. | MAX. | UNIT |
|--------------------|------------------------------------|--|------|------|------|
| <b>Per channel</b> |                                    |  |      |      |      |
| V <sub>DS</sub>    | drain-source voltage (DC)          |  |      |      |      |
|                    | N-channel                          |  | –    | 30   | V    |
|                    | P-channel                          |  | –    | –30  | V    |
| V <sub>SD</sub>    | source-drain diode forward voltage |  |      |      |      |
|                    | N-channel                          | V <sub>GD</sub> = 0; I <sub>S</sub> = 1.25 A               | –    | 1    | V    |
|                    | P-channel                          | V <sub>GD</sub> = 0; I <sub>S</sub> = –1.25 A              | –    | –1.3 | V    |
| V <sub>GSO</sub>   | gate-source voltage (DC)           | open drain   | –    | ±20  | V    |
| V <sub>GStH</sub>  | gate-source threshold voltage      |  |      |      | V    |
|                    | N-channel                          | V <sub>DS</sub> = V <sub>GS</sub> ; I <sub>D</sub> = 1 mA  | 1    | –    | V    |
|                    | P-channel                          | V <sub>DS</sub> = V <sub>GS</sub> ; I <sub>D</sub> = –1 mA | –1   | –    | V    |
| I <sub>D</sub>     | drain current (DC)                 | T <sub>s</sub> = 80 °C                                     |      |      |      |
|                    | N-channel                          |  | –    | 8.2  | A    |
|                    | P-channel                          |  | –    | –5.6 | A    |
| R <sub>DSon</sub>  | drain-source on-state resistance   |  |      |      |      |
|                    | N-channel                          | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 4 A               | –    | 30   | mΩ   |
|                    | P-channel                          | V <sub>GS</sub> = –10 V; I <sub>D</sub> = –2.8 A           | –    | 65   | mΩ   |
| P <sub>tot</sub>   | total power dissipation            | T <sub>s</sub> = 80 °C                                     | –    | 3.5  | W    |

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## LIMITING VALUES

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

| SYMBOL                    | PARAMETER                      | CONDITIONS                       | MIN. | MAX.  | UNIT |
|---------------------------|--------------------------------|----------------------------------|------|-------|------|
| <b>Per channel</b>        |                                |                                  |      |       |      |
| V <sub>DS</sub>           | drain-source voltage (DC)      |                                  |      |       |      |
|                           | N-channel                      |                                  | –    | 30    | V    |
|                           | P-channel                      |                                  | –    | –30   | V    |
| V <sub>GSO</sub>          | gate-source voltage (DC)       | open drain                       | –    | ±20   | V    |
| I <sub>D</sub>            | drain current (DC)             | T <sub>s</sub> = 80 °C; note 1   |      |       |      |
|                           | N-channel                      |                                  | –    | 8.2   | A    |
|                           | P-channel                      |                                  | –    | –5.6  | A    |
| I <sub>DM</sub>           | peak drain current             | note 2                           |      |       |      |
|                           | N-channel                      |                                  | –    | 33    | A    |
|                           | P-channel                      |                                  | –    | –22.5 | A    |
| P <sub>tot</sub>          | total power dissipation        | T <sub>s</sub> = 80 °C; note 3   | –    | 3.5   | W    |
|                           |                                | T <sub>amb</sub> = 25 °C; note 4 | –    | 2.6   | W    |
|                           |                                | T <sub>amb</sub> = 25 °C; note 5 | –    | 1.1   | W    |
|                           |                                | T <sub>amb</sub> = 25 °C; note 6 | –    | 1.5   | W    |
| T <sub>stg</sub>          | storage temperature            |                                  | –55  | +150  | °C   |
| T <sub>j</sub>            | operating junction temperature |                                  | –55  | +150  | °C   |
| <b>Source-drain diode</b> |                                |                                  |      |       |      |
| I <sub>S</sub>            | source current (DC)            | T <sub>s</sub> = 80 °C           |      |       |      |
|                           | N-channel                      |                                  | –    | 3.5   | A    |
|                           | P-channel                      |                                  | –    | –2.7  | A    |
| I <sub>SM</sub>           | peak pulsed source current     | note 2                           |      |       |      |
|                           | N-channel                      |                                  | –    | 14    | A    |
|                           | P-channel                      |                                  | –    | –10.8 | A    |

## Notes

1. T<sub>s</sub> is the temperature at the soldering point of the drain lead.
2. Pulse width and duty cycle limited by maximum junction temperature.
3. Maximum permissible dissipation per MOS transistor. Both devices may be loaded up to 3.5 W at the same time.
4. Maximum permissible dissipation per MOS transistor. Device mounted on a printed-circuit board with an R<sub>th a-tp</sub> (ambient to tie-point) of 27.5 K/W.
5. Maximum permissible dissipation per MOS transistor. Device mounted on a printed-circuit board with an R<sub>th a-tp</sub> (ambient to tie-point) of 90 K/W.
6. Maximum permissible dissipation if only one MOS transistor dissipates. Device mounted on a printed-circuit board with an R<sub>th a-tp</sub> (ambient to tie-point) of 90 K/W.

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## THERMAL CHARACTERISTICS

| SYMBOL        | PARAMETER   | VALUE | UNIT |
|---------------|---|-------|------|
| $R_{th\ j-s}$ | thermal resistance from junction to soldering point | 20    | K/W  |

## CHARACTERISTICS

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

| SYMBOL             | PARAMETER                        | CONDITIONS   | MIN. | TYP. | MAX.      | UNIT       |
|--------------------|----------------------------------|--|------|------|-----------|------------|
| <b>Per channel</b> |                                  |  |      |      |           |            |
| $V_{(BR)DSS}$      | drain-source breakdown voltage   |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = 0; I_D = 10\ \mu\text{A}$                                    | 30   | –    | –         | V          |
|                    | P-channel                        | $V_{GS} = 0; I_D = -10\ \mu\text{A}$                                   | -30  | –    | –         | V          |
| $V_{GSth}$         | gate-source threshold voltage    |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = V_{DS}; I_D = 1\ \text{mA}$                                  | 1    | –    | –         | V          |
|                    | P-channel                        | $V_{GS} = V_{DS}; I_D = -1\ \text{mA}$                                 | -1   | –    | –         | V          |
| $I_{DSS}$          | drain-source leakage current     |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = 0; V_{DS} = 24\ \text{V}$                                    | –    | –    | 100       | nA         |
|                    | P-channel                        | $V_{GS} = 0; V_{DS} = -24\ \text{V}$                                   | –    | –    | -100      | nA         |
| $I_{GSS}$          | gate leakage current             | $V_{GS} = \pm 20\ \text{V}; V_{DS} = 0$                                |      |      |           |            |
|                    | N-channel                        |  | –    | –    | $\pm 100$ | nA         |
|                    | P-channel                        |  | –    | –    | $\pm 100$ | nA         |
| $R_{DSon}$         | drain-source on-state resistance |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = 4.5\ \text{V}; I_D = 2\ \text{A}$                            | –    | –    | 45        | m $\Omega$ |
|                    |                                  | $V_{GS} = 10\ \text{V}; I_D = 4\ \text{A}$                             | –    | –    | 30        | m $\Omega$ |
|                    | P-channel                        | $V_{GS} = -4.5\ \text{V}; I_D = -1.4\ \text{A}$                        | –    | –    | 100       | m $\Omega$ |
|                    |                                  | $V_{GS} = -10\ \text{V}; I_D = -2.8\ \text{A}$                         | –    | –    | 65        | m $\Omega$ |
| $C_{iss}$          | input capacitance                |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = 0; V_{DS} = 24\ \text{V}; f = 1\ \text{MHz}$                 | –    | 700  | 850       | pF         |
|                    | P-channel                        | $V_{GS} = 0; V_{DS} = -24\ \text{V}; f = 1\ \text{MHz}$                | –    | tbF  | tbF       | pF         |
| $C_{oss}$          | output capacitance               |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = 0; V_{DS} = 24\ \text{V}; f = 1\ \text{MHz}$                 | –    | 260  | 320       | pF         |
|                    | P-channel                        | $V_{GS} = 0; V_{DS} = -24\ \text{V}; f = 1\ \text{MHz}$                | –    | tbF  | tbF       | pF         |
| $C_{rss}$          | reverse transfer capacitance     |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = 0; V_{DS} = 24\ \text{V}; f = 1\ \text{MHz}$                 | –    | 110  | 135       | pF         |
|                    | P-channel                        | $V_{GS} = 0; V_{DS} = -24\ \text{V}; f = 1\ \text{MHz}$                | –    | tbF  | tbF       | pF         |
| $Q_G$              | total gate charge                |  |      |      |           |            |
|                    | N-channel                        | $V_{GS} = 10\ \text{V}; V_{DD} = 15\ \text{V}; I_D = 4\ \text{A}$      | –    | 16   | 30        | nC         |
|                    | P-channel                        | $V_{GS} = -10\ \text{V}; V_{DD} = -15\ \text{V}; I_D = -2.8\ \text{A}$ | –    | tbF  | tbF       | nC         |
| $Q_{GS}$           | gate-source charge               |  |      |      |           |            |
|                    | N-channel                        | $V_{DD} = 15\ \text{V}; I_D = 4\ \text{A}$                             | –    | 2    | –         | nC         |
|                    | P-channel                        | $V_{DD} = -15\ \text{V}; I_D = -2.8\ \text{A}$                         | –    | tbF  | –         | nC         |

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| SYMBOL                    | PARAMETER                             | CONDITIONS  | MIN. | TYP. | MAX. | UNIT |
|---------------------------|---------------------------------------|---|------|------|------|------|
| Q <sub>GD</sub>           | gate-drain charge                     |   |      |      |      |      |
|                           | N-channel                             | V <sub>DD</sub> = 15 V; I <sub>D</sub> = 4 A  | –    | 6.5  | –    | nC   |
|                           | P-channel                             | V <sub>DD</sub> = –15 V; I <sub>D</sub> = –2.8 A  | –    | tbf  | –    | nC   |
| <b>Switching times</b>    |                                       |   |      |      |      |      |
| t <sub>d(on)</sub>        | turn-on delay time                    |   |      |      |      |      |
|                           | N-channel                             | V <sub>GS</sub> = 0 to 10 V; V <sub>DD</sub> = 20 V;<br>I <sub>D</sub> = 1 A; R <sub>gen</sub> = 6 Ω    | –    | 8    | –    | ns   |
|                           | P-channel                             | V <sub>GS</sub> = 0 to –10 V; V <sub>DD</sub> = –20 V;<br>I <sub>D</sub> = –1 A; R <sub>gen</sub> = 6 Ω | –    | tbf  | –    | ns   |
| t <sub>r</sub>            | rise time                             |   |      |      |      |      |
|                           | N-channel                             | V <sub>GS</sub> = 10 to 0 V; V <sub>DD</sub> = 20 V;<br>I <sub>D</sub> = 1 A; R <sub>gen</sub> = 6 Ω    | –    | 21   | –    | ns   |
|                           | P-channel                             | V <sub>GS</sub> = 0 to –10 V; V <sub>DD</sub> = –20 V;<br>I <sub>D</sub> = –1 A; R <sub>gen</sub> = 6 Ω | –    | tbf  | –    | ns   |
| t <sub>on</sub>           | turn-on switching time                |   |      |      |      |      |
|                           | N-channel                             | V <sub>GS</sub> = 0 to 10 V; V <sub>DD</sub> = 20 V;<br>I <sub>D</sub> = 1 A; R <sub>gen</sub> = 6 Ω    | –    | 17   | 25   | ns   |
|                           | P-channel                             | V <sub>GS</sub> = 0 to –10 V; V <sub>DD</sub> = –20 V;<br>I <sub>D</sub> = –1 A; R <sub>gen</sub> = 6 Ω | –    | tbf  | tbf  | ns   |
| t <sub>d(off)</sub>       | turn-off delay time                   |   |      |      |      |      |
|                           | N-channel                             | V <sub>GS</sub> = 10 to 0 V; V <sub>DD</sub> = 20 V;<br>I <sub>D</sub> = 1 A; R <sub>gen</sub> = 6 Ω    | –    | 19   | –    | ns   |
|                           | P-channel                             | V <sub>GS</sub> = –10 to 0 V; V <sub>DD</sub> = –20 V;<br>I <sub>D</sub> = –1 A; R <sub>gen</sub> = 6 Ω | –    | tbf  | –    | ns   |
| t <sub>f</sub>            | fall time                             |   |      |      |      |      |
|                           | N-channel                             | V <sub>GS</sub> = 0 to 10 V; V <sub>DD</sub> = 20 V;<br>I <sub>D</sub> = 1 A; R <sub>gen</sub> = 6 Ω    | –    | 9    | –    | ns   |
|                           | P-channel                             | V <sub>GS</sub> = –10 to 0 V; V <sub>DD</sub> = –20 V;<br>I <sub>D</sub> = –1 A; R <sub>gen</sub> = 6 Ω | –    | tbf  | –    | ns   |
| t <sub>off</sub>          | turn-off switching time               |   |      |      |      |      |
|                           | N-channel                             | V <sub>GS</sub> = 10 to 0 V; V <sub>DD</sub> = 20 V;<br>I <sub>D</sub> = 1 A; R <sub>gen</sub> = 6 Ω    | –    | 40   | 60   | ns   |
|                           | P-channel                             | V <sub>GS</sub> = –10 to 0 V; V <sub>DD</sub> = –20 V;<br>I <sub>D</sub> = –1 A; R <sub>gen</sub> = 6 Ω | –    | tbf  | tbf  | ns   |
| <b>Source-drain diode</b> |                                       |   |      |      |      |      |
| V <sub>SD</sub>           | source-drain diode forward<br>voltage |   |      |      |      |      |
|                           | N-channel                             | V <sub>GD</sub> = 0; I <sub>S</sub> = 1.25 A  | –    | –    | 1    | V    |
|                           | P-channel                             | V <sub>GD</sub> = 0; I <sub>S</sub> = –1.25 A   | –    | –    | –1.3 | V    |
| t <sub>rr</sub>           | reverse recovery time                 |   |      |      |      |      |
|                           | N-channel                             | I <sub>S</sub> = 1.25 A; di/dt = –100 A/μs  | –    | 45   | –    | ns   |
|                           | P-channel                             | I <sub>S</sub> = –1.25 A; di/dt = 100 A/μs  | –    | tbf  | –    | ns   |

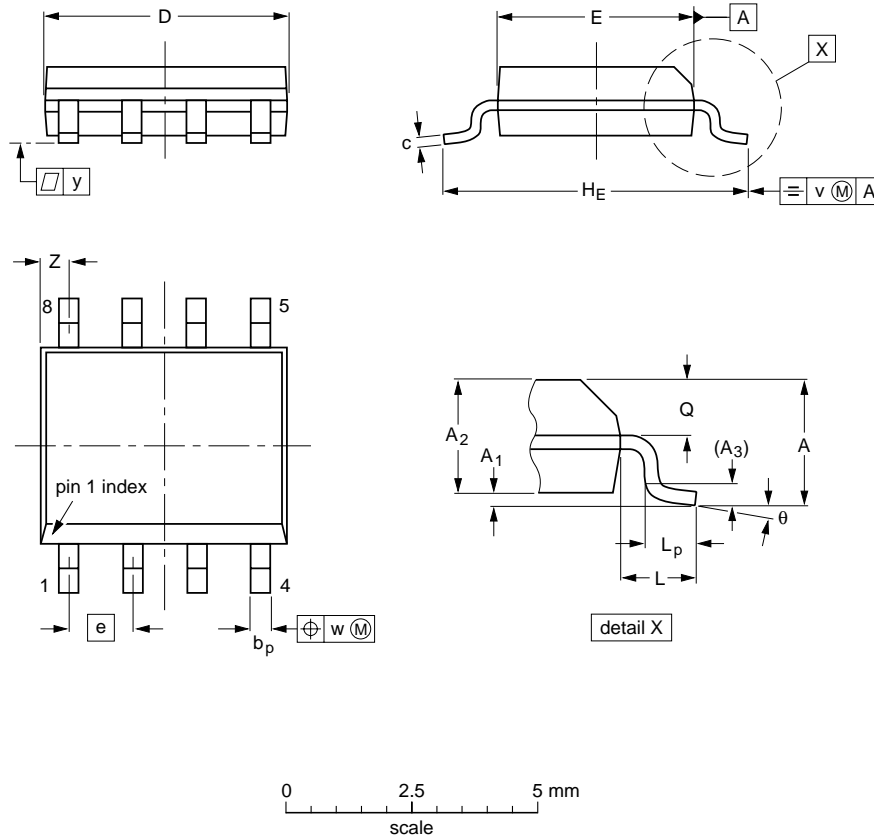
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PACKAGE OUTLINE

S08: 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 <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c                | D <sup>(1)</sup> | E <sup>(2)</sup> | e     | H <sub>E</sub> | L     | L <sub>p</sub> | Q              | v    | w    | y     | Z <sup>(1)</sup> | θ        |
|--------|--------|----------------|----------------|----------------|----------------|------------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm     | 1.75   | 0.25<br>0.10   | 1.45<br>1.25   | 0.25           | 0.49<br>0.36   | 0.25<br>0.19     | 5.0<br>4.8       | 4.0<br>3.8       | 1.27  | 6.2<br>5.8     | 1.05  | 1.0<br>0.4     | 0.7<br>0.6     | 0.25 | 0.25 | 0.1   | 0.7<br>0.3       | 8°<br>0° |
| inches | 0.069  | 0.010<br>0.004 | 0.057<br>0.049 | 0.01           | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.20<br>0.19     | 0.16<br>0.15     | 0.050 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.024 | 0.01 | 0.01 | 0.004 | 0.028<br>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<br>97-05-22 |

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## DEFINITIONS

| <b>Data Sheet Status</b>  |   |
|---|---|
| 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.                                |
| <b>Limiting values</b>  |   |
| 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. |   |
| <b>Application information</b>  |   |
| Where application information is given, it is advisory and does not form part of the specification.   |   |

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