

# DATA SHEET

**74F670**

**4 x 4 register file (3-State)**

Product specification

1990 Jul 12

IC15 Data Handbook

# 4 x 4 register file (3-State)

# 74F670

## FEATURES

- Simultaneous and Independent Read and Write operations
- Expandable to almost any word size and bit length
- 3-State outputs

## DESCRIPTION

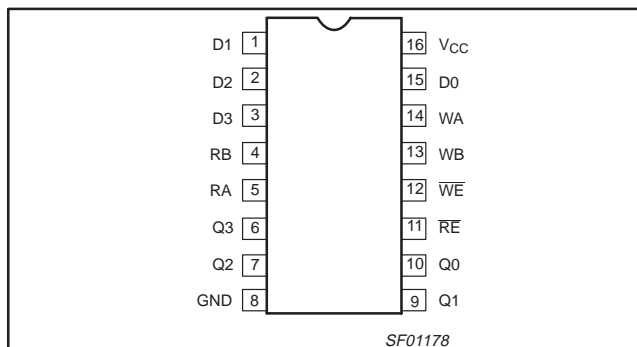
The 74F670 is a 16-bit 3-State Register File organized as 4 words of 4 bits each. Separate Read and Write Address and Enable inputs are available, permitting simultaneous writing into one word location and reading from another location. The 4-bit word to be stored is presented to four data inputs.

The Write address inputs (WA and WB) determine the location of the stored word. The Write Address inputs should only be changed when the Write Enable input ( $\overline{WE}$ ) is High for conventional operation. When the  $\overline{WE}$  is Low, the data is entered into the addressed location.

The addressed location remains transparent to the data while the  $\overline{WE}$  is Low. Data supplied at the inputs will be read out in true (non-inverting) form from the 3-State outputs. Data and address inputs are inhibited when the  $\overline{WE}$  is High. Direct acquisition of data stored in any of the four registers is made possible by individual Read Address inputs (RA, RB). The addressed word appears at the four outputs when the Read Enable ( $\overline{RE}$ ) is Low. Data outputs are in the high impedance "off" state when the  $\overline{RE}$  is High. This permits outputs to be tied together to increase the word capacity to very large numbers.

Up to 128 devices can be stacked to increase the word size to 512 locations by tying the 3-State outputs together. Since the limiting factor for expansion is the output High current, further stacking is possible by tying pullup resistors to the outputs to increase the  $I_{OH}$  current available. Design of the Read Enable signals for the stacked devices must ensure that there is no overlap in the Low levels which cause more than one output to be active at the same time. Parallel expansion to generate n-bit words is accomplished by driving the Enable and address inputs of each device in parallel.

## PIN CONFIGURATION



| TYPE   | TYPICAL PROPAGATION DELAY | TYPICAL SUPPLY CURRENT (TOTAL) |
|--------|---------------------------|--------------------------------|
| 74F670 | 6.5ns                     | 50mA                           |

## ORDERING INFORMATION

| DESCRIPTION        | COMMERCIAL RANGE<br>$V_{CC} = 5V \pm 10\%$ ,<br>$T_{amb} = 0^{\circ}C \text{ to } +70^{\circ}C$ | PKG DWG # |
|--------------------|---|-----------|
| 16-pin plastic DIP | N74F670N  | SOT38-4   |
| 16-pin plastic SOL | N74F670D  | SOT162-1  |

## INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

| PINS            | DESCRIPTION          | 74F(U.L.) HIGH/LOW | LOAD VALUE HIGH/LOW |
|-----------------|----------------------|--------------------|---------------------|
| D0 - D3         | Data inputs          | 1.0/1.0            | 20 $\mu$ A/0.6mA    |
| WA, WB          | Write address inputs | 1.0/1.0            | 20 $\mu$ A/0.6mA    |
| RA, RB          | Read address inputs  | 1.0/1.0            | 20 $\mu$ A/0.6mA    |
| $\overline{WE}$ | Write Enable inputs  | 1.0/1.0            | 20mA/0.6mA          |
| $\overline{RE}$ | Read Enable inputs   | 1.0/1.0            | 20mA/0.6mA          |
| Q0-Q3           | Data output          | 150/40             | 3.0mA/24mA          |

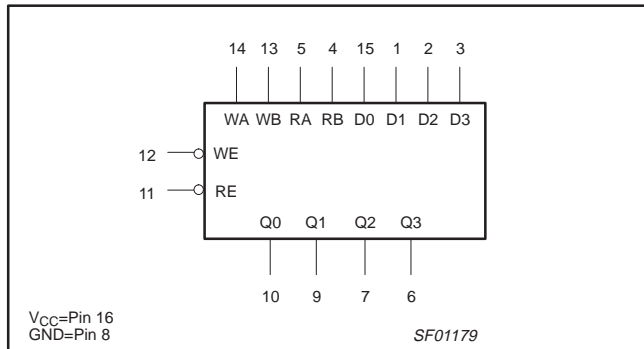
### NOTE:

One (1.0) FAST Unit Load is defined as: 20 $\mu$ A in the High state and 0.6mA in the Low state.

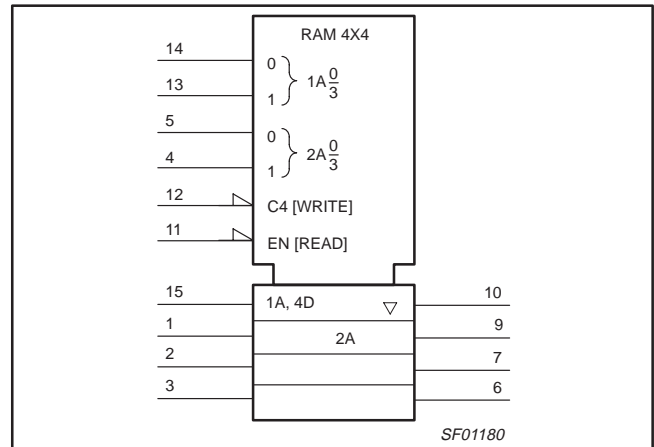
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## LOGIC SYMBOL



## LOGIC SYMBOL (IEEE/IEC)



## WORD SELECT FUNCTION TABLE

| WRITE MODE |    | READ MODE |    | OPERATING MODE |
|------------|----|-----------|----|----------------|
| WB         | WA | RB        | RA | Word Selected  |
| L          | L  | L         | L  | Word 0         |
| L          | H  | L         | H  | Word 1         |
| H          | L  | H         | L  | Word 2         |
| H          | H  | H         | H  | Word 3         |

H = High voltage level  
L = Low voltage level

## WRITE MODE FUNCTION TABLE

| INPUTS |    | INTERNAL LATCHES* | OPERATING MODE |
|--------|----|-------------------|----------------|
| WE     | Dn |                   |                |
| L      | L  | L                 | Write data     |
| L      | H  | H                 |                |
| H      | X  | NC                | Data latched   |

H = High voltage level  
L = Low voltage level  
NC= No change  
X = Don't care  
\* = The write address (WA and WB) to the "internal latches" must be stabled while WE is Low for conventional operation.

## READ MODE FUNCTION TABLE

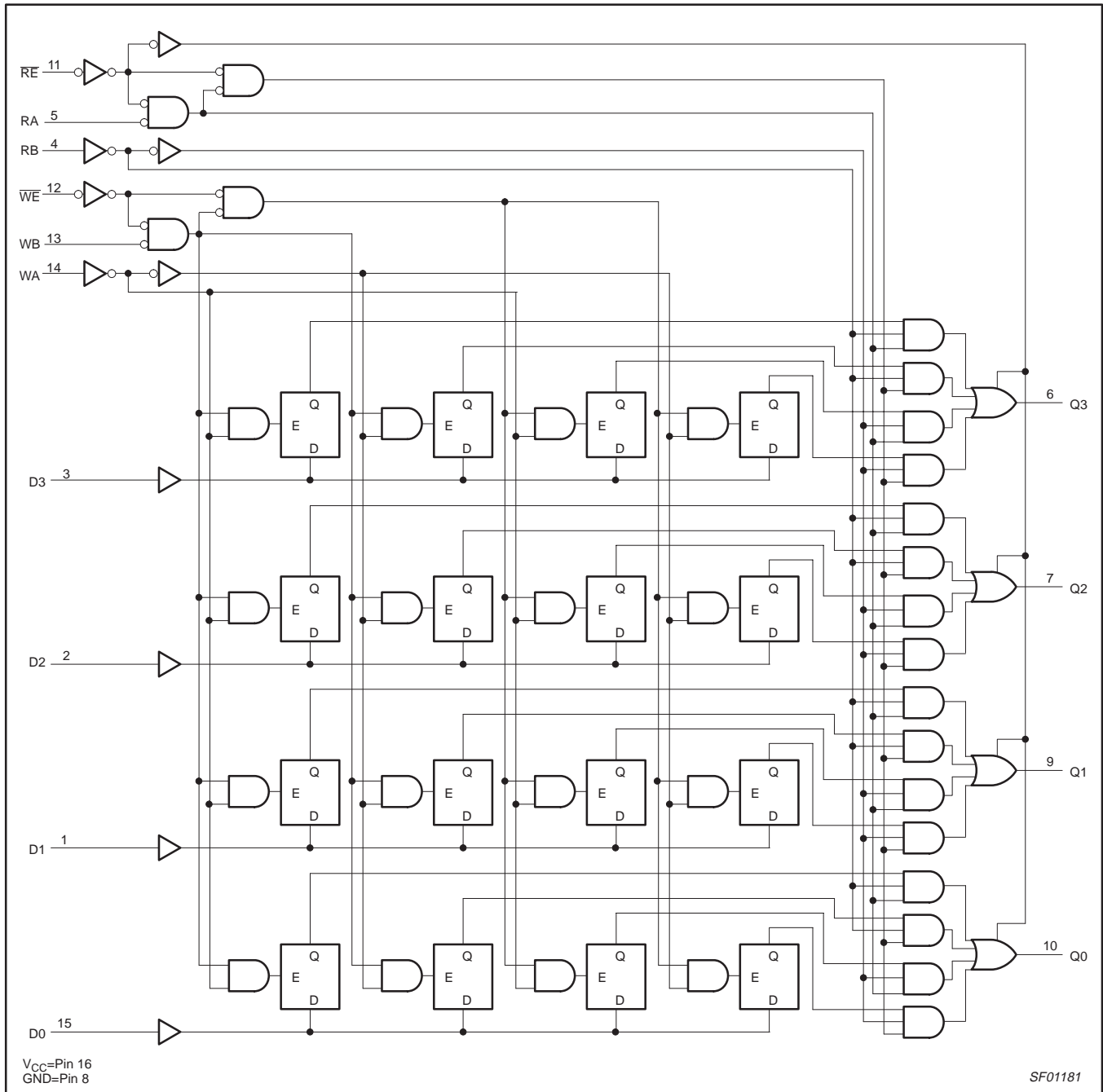
| INPUT | INTERNAL LATCHES* | OUTPUT | OPERATING MODE |
|-------|-------------------|--------|----------------|
| RE    |                   | Qn     |                |
| L     | L                 | L      | Read           |
| L     | H                 | H      |                |
| H     | X                 | Z      | Disabled       |

H = High voltage level  
L = Low voltage level  
X = Don't care  
Z = High impedance "off" state  
\* = The selection of "internal latches" by Read Address (RA and RB) are not constrained by WE or RE operation.

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## LOGIC DIAGRAM



## 4 x 4 register file (3-State)

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**ABSOLUTE MAXIMUM RATINGS**

(Operation beyond the limits set forth in this table may impair the useful life of the device.  
Unless otherwise noted these limits are over the operating free-air temperature range.)

| SYMBOL    | PARAMETER                                      | RATING           | UNIT |
|-----------|--|------------------|------|
| $V_{CC}$  | Supply voltage                                 | -0.5 to +7.0     | V    |
| $V_{IN}$  | Input voltage                                  | -0.5 to +7.0     | V    |
| $I_{IN}$  | Input current                                  | -30 to +5        | mA   |
| $V_{OUT}$ | Voltage applied to output in High output state | -0.5 to $V_{CC}$ | V    |
| $I_{OUT}$ | Current applied to output in Low output state  | 48               | mA   |
| $T_{amb}$ | Operating free-air temperature range           | 0 to +70         | °C   |
| $T_{stg}$ | Storage temperature                            | -65 to +150      | °C   |

**RECOMMENDED OPERATING CONDITIONS**

| SYMBOL    | PARAMETER                            | LIMITS |     |     | UNIT |
|-----------|--------------------------------------|--------|-----|-----|------|
|           |                                      | MIN    | NOM | MAX |      |
| $V_{CC}$  | Supply voltage                       | 4.5    | 5.0 | 5.5 | V    |
| $V_{IH}$  | High-level input voltage             | 2.0    |     |     | V    |
| $V_{IL}$  | Low-level input voltage              |        |     | 0.8 | V    |
| $I_{IK}$  | Input clamp current                  |        |     | -18 | mA   |
| $I_{OH}$  | High-level output current            |        |     | -3  | mA   |
| $I_{OL}$  | Low-level output current             |        |     | 24  | mA   |
| $T_{amb}$ | Operating free-air temperature range | 0      |     | 70  | °C   |

**DC ELECTRICAL CHARACTERISTICS**

(Over recommended operating free-air temperature range unless otherwise noted.)

| SYMBOL    | PARAMETER  | TEST CONDITIONS <sup>NO TAG</sup>          | LIMITS                |               |      | UNIT    |    |
|-----------|--|--|-----------------------|---------------|------|---------|----|
|           |  |  | MIN                   | TYP<br>NO TAG | MAX  |         |    |
| $V_{OH}$  | High-level output voltage                            | $V_{CC} = \text{MIN}, V_{IL} = \text{MAX}$ | $\pm 10\%V_{CC}$      | 2.4           |      | V       |    |
|           |  | $V_{IH} = \text{MIN}, I_{OH} = \text{MAX}$ | $\pm 5\%V_{CC}$       | 2.7           | 3.4  |         |    |
| $V_{OL}$  | Low-level output voltage                             | $V_{CC} = \text{MIN}, V_{IL} = \text{MAX}$ | $\pm 10\%V_{CC}$      |               | 0.35 | V       |    |
|           |  | $V_{IH} = \text{MIN}, I_{OL} = \text{MAX}$ | $\pm 5\%V_{CC}$       |               | 0.35 |         |    |
| $V_{IK}$  | Input clamp voltage                                  | $V_{CC} = \text{MIN}, I_I = I_{IK}$        |                       | -0.73         | -1.2 | V       |    |
| $I_I$     | Input current at maximum input voltage               | $V_{CC} = \text{MAX}, V_I = 7.0V$          |                       |               | 100  | $\mu A$ |    |
| $I_{IH}$  | High-level input current                             | $V_{CC} = \text{MAX}, V_I = 2.7V$          |                       |               | 20   | $\mu A$ |    |
| $I_{IL}$  | Low-level input current                              | $V_{CC} = \text{MAX}, V_I = 0.5V$          |                       |               | -0.6 | mA      |    |
| $I_{OZH}$ | Off state output current, High-level voltage applied | $V_{CC} = \text{MAX}, V_O = 2.7V$          |                       |               | 50   | $\mu A$ |    |
| $I_{OZL}$ | Off state output current, Low-level voltage applied  | $V_{CC} = \text{MAX}, V_O = 0.5V$          |                       |               | -50  | $\mu A$ |    |
| $I_{OS}$  | Short-circuit output current <sup>NO TAG</sup>       | $V_{CC} = \text{MAX}$                      |                       | -60           | -150 | mA      |    |
| $I_{CC}$  | Supply current (total)                               | $I_{CCH}$                                  | $V_{CC} = \text{MAX}$ |               | 50   | 70      | mA |
|           |  | $I_{CCL}$                                  |                       |               | 50   | 70      | mA |
|           |  | $I_{CCZ}$                                  |                       |               | 55   | 80      | mA |

**NOTES:**

- For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
- All typical values are at  $V_{CC} = 5V, T_{amb} = 25^\circ C$ .
- Not more than one output should be shorted at a time. For testing  $I_{OS}$ , the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting

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of a High output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests,  $I_{OS}$  tests should be performed last.

## AC ELECTRICAL CHARACTERISTICS

| SYMBOL                 | PARAMETER                                  | TEST CONDITION           | LIMITS   |            |              |   |              | UNIT     |
|------------------------|--|--------------------------|--|------------|--------------|---|--------------|----------|
|                        |  |                          | $T_{amb} = +25^{\circ}\text{C}$<br>$V_{CC} = +5.0\text{V}$<br>$C_L = 50\text{pF}$ ,<br>$R_L = 500\Omega$ |            |              | $T_{amb} = 0^{\circ}\text{C to } +70^{\circ}\text{C}$<br>$V_{CC} = +5.0\text{V} \pm 10\%$<br>$C_L = 50\text{pF}$ ,<br>$R_L = 500\Omega$ |              |          |
|                        |  |                          | MIN  | TYP        | MAX          | MIN   | MAX          |          |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation delay<br>RA, RB to Qn          | Waveform 3, 4            | 3.5<br>4.0   | 5.5<br>5.5 | 9.0<br>8.5   | 3.0<br>3.5  | 10.0<br>9.9  | ns<br>ns |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation delay<br>WE to Qn              | Waveform 1, 2            | 5.0<br>6.5   | 7.0<br>8.5 | 10.0<br>11.5 | 4.5<br>6.0  | 11.0<br>12.5 | ns<br>ns |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation delay<br>Dn to Qn              | Waveform 1, 2            | 3.5<br>6.0   | 6.0<br>8.0 | 8.5<br>11.0  | 3.0<br>5.5  | 9.5<br>12.5  | ns<br>ns |
| $t_{PZH}$<br>$t_{PZL}$ | RE Enable time<br>Qn to High or Low level  | Waveform 5<br>Waveform 6 | 3.0<br>4.5   | 7.0<br>6.5 | 12.0<br>9.0  | 2.5<br>4.0  | 13.0<br>10.0 | ns<br>ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | RE Disable time<br>Qn to High or Low level | Waveform 5<br>Waveform 6 | 2.0<br>3.0   | 3.0<br>5.0 | 6.5<br>8.5   | 1.5<br>3.0  | 7.5<br>8.5   | ns<br>ns |

## AC SETUP REQUIREMENTS

| SYMBOL               | PARAMETER   | TEST CONDITION | LIMITS  |     |     |  |     | UNIT     |
|----------------------|---|----------------|---|-----|-----|--|-----|----------|
|                      |   |                | $T_{amb} = +25^{\circ}\text{C}$<br>$V_{CC} = +5.0\text{V}$<br>$C_L = 50\text{pF}$ , $R_L = 500\Omega$ |     |     | $T_{amb} = 0^{\circ}\text{C to } +70^{\circ}\text{C}$<br>$V_{CC} = +5.0\text{V} \pm 10\%$<br>$C_L = 50\text{pF}$ , $R_L = 500\Omega$ |     |          |
|                      |   |                | MIN   | TYP | MAX | MIN  | MAX |          |
| $t_s(H)$<br>$t_s(L)$ | Setup time, High or Low<br>Dn to positive going $\overline{WE}$       | Waveform 3, 4  | 1.5<br>6.0  |     |     | 1.5<br>7.0   |     | ns<br>ns |
| $t_h(H)$<br>$t_h(L)$ | Hold time, High or Low<br>Dn to positive going $\overline{WE}$        | Waveform 3, 4  | 0<br>1.0  |     |     | 0<br>1.0   |     | ns<br>ns |
| $t_s(H)$<br>$t_s(L)$ | Setup time, High or Low<br>WA, WB to negative going $\overline{WE}^1$ | Waveform 3, 4  | 0<br>0  |     |     | 0<br>0   |     | ns<br>ns |
| $t_h(H)$<br>$t_h(L)$ | Hold time, High or Low<br>WA, WB to negative going $\overline{WE}^1$  | Waveform 3, 4  | 0<br>0  |     |     | 0<br>0   |     | ns<br>ns |
| $t_w(L)$             | $\overline{WE}$ Pulse width, Low                                      | Waveform 3, 4  | 6.5   |     |     | 8.5  |     | ns       |

## NOTES:

- Write Address (WA, WB) setup time will protect the data written into the previous address. If protection of data in the previous address is not required, setup time for Write Address to  $\overline{WE}$  can be ignored. Any address selection sustained for the final 7ns of the  $\overline{WE}$  pulse during hold time for Write Address to  $\overline{WE}$  will result in data being written into that location.

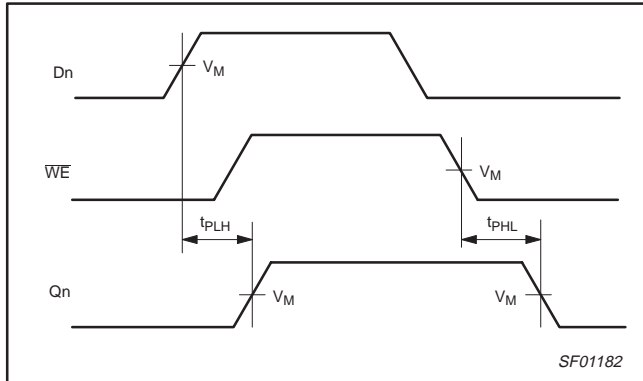
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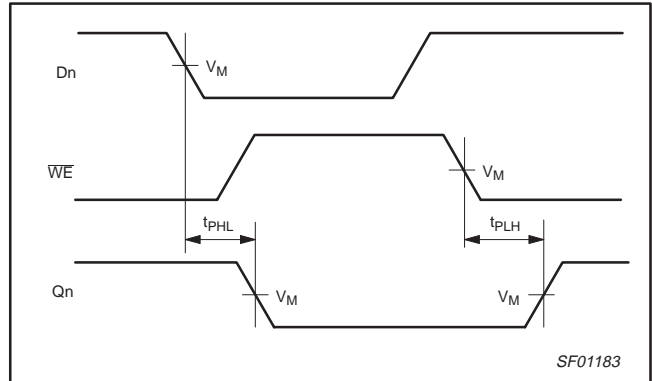
## AC WAVEFORMS

For all waveforms,  $V_M=1.5V$ .

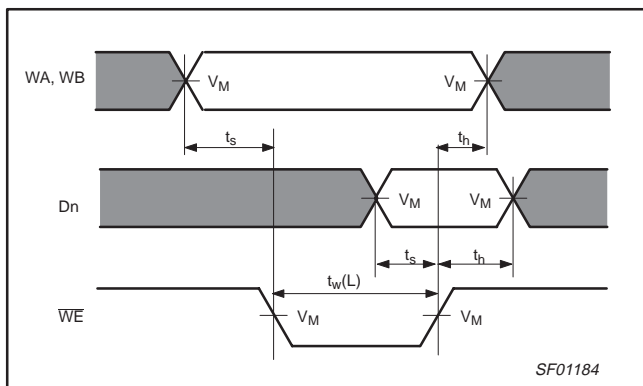
The shaded areas indicate when the input is permitted to change for predictable output performance.



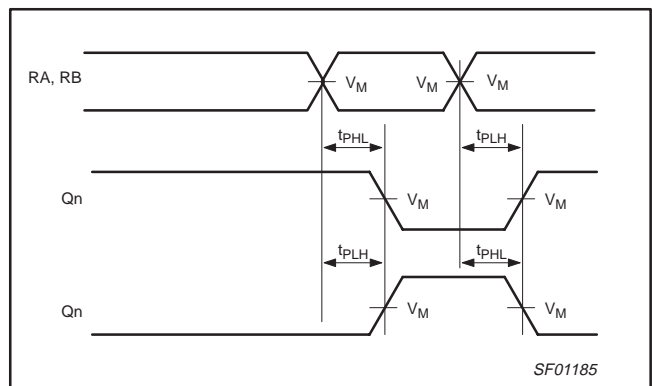
**Waveform 1. Propagation Delay, Write Enable and Data to Output**



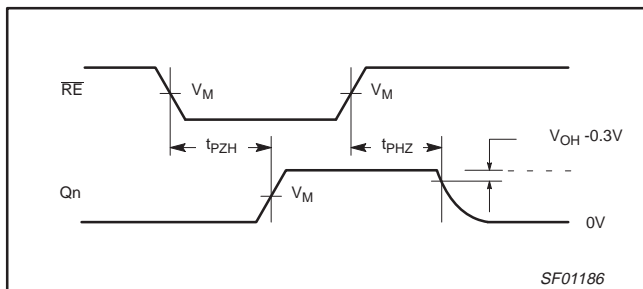
**Waveform 2. Propagation Delay, Write Enable and Data to Output**



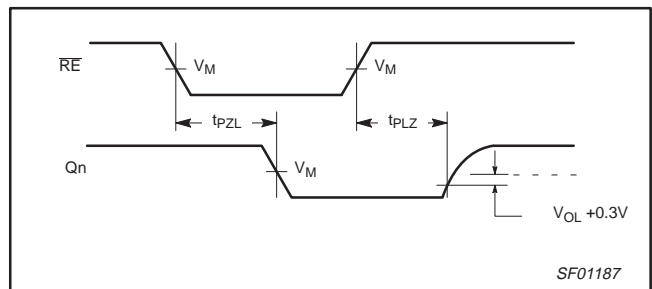
**Waveform 3. Setup and Hold Times for Write Address to Write Enable and Data to Write Enable**



**Waveform 4. Propagation Delays for Read Address to Output**



**Waveform 5. 3-State Output Enable Time to High Level and Output Disable Time from High Level**

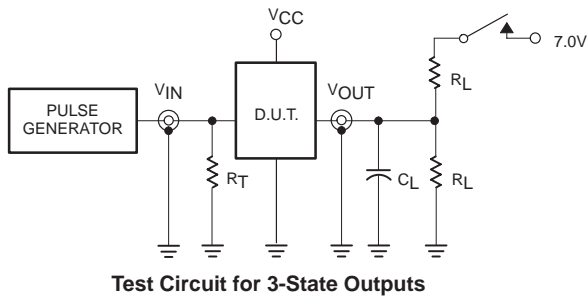


**Waveform 6. 3-State Output Enable Time to Low Level and Output Disable Time from Low Level**

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## TEST CIRCUIT AND WAVEFORM



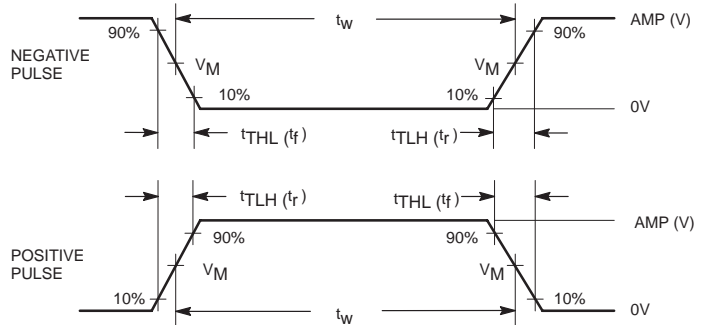
Test Circuit for 3-State Outputs

### SWITCH POSITION

| TEST      | SWITCH |
|-----------|--------|
| $t_{PLZ}$ | closed |
| $t_{PZL}$ | closed |
| All other | open   |

### DEFINITIONS:

- $R_L$  = Load resistor; see AC electrical characteristics for value.
- $C_L$  = Load capacitance includes jig and probe capacitance; see AC electrical characteristics for value.
- $R_T$  = Termination resistance should be equal to  $Z_{OUT}$  of pulse generators.



Input Pulse Definition

| family | INPUT PULSE REQUIREMENTS |       |           |       |           |           |
|--------|--------------------------|-------|-----------|-------|-----------|-----------|
|        | amplitude                | $V_M$ | rep. rate | $t_w$ | $t_{TLH}$ | $t_{THL}$ |
| 74F    | 3.0V                     | 1.5V  | 1MHz      | 500ns | 2.5ns     | 2.5ns     |

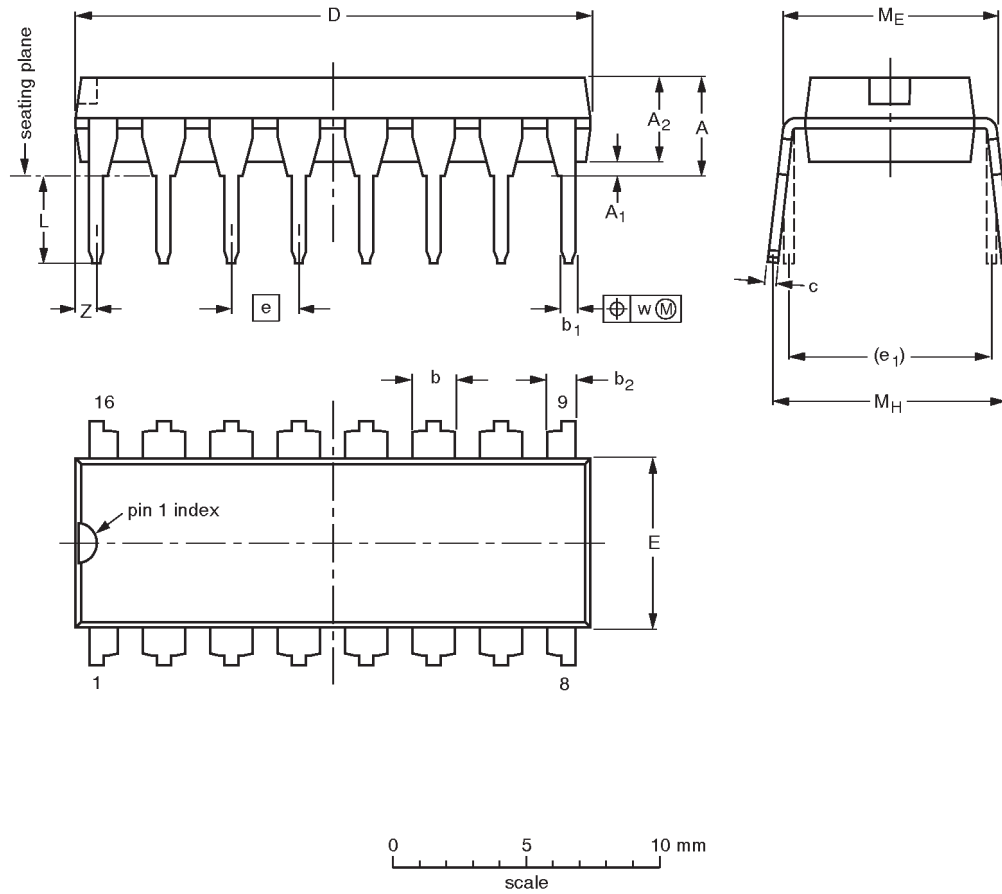
SF00777

Register file

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DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4



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

| UNIT   | A max. | A <sub>1</sub> min. | A <sub>2</sub> max. | b              | b <sub>1</sub> | b <sub>2</sub> | c              | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | e <sub>1</sub> | L            | M <sub>E</sub> | M <sub>H</sub> | w     | Z <sup>(1)</sup> max. |
|--------|--------|---------------------|---------------------|----------------|----------------|----------------|----------------|------------------|------------------|------|----------------|--------------|----------------|----------------|-------|-----------------------|
| mm     | 4.2    | 0.51                | 3.2                 | 1.73<br>1.30   | 0.53<br>0.38   | 1.25<br>0.85   | 0.36<br>0.23   | 19.50<br>18.55   | 6.48<br>6.20     | 2.54 | 7.62           | 3.60<br>3.05 | 8.25<br>7.80   | 10.0<br>8.3    | 0.254 | 0.76                  |
| inches | 0.17   | 0.020               | 0.13                | 0.068<br>0.051 | 0.021<br>0.015 | 0.049<br>0.033 | 0.014<br>0.009 | 0.77<br>0.73     | 0.26<br>0.24     | 0.10 | 0.30           | 0.14<br>0.12 | 0.32<br>0.31   | 0.39<br>0.33   | 0.01  | 0.030                 |

**Note**

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

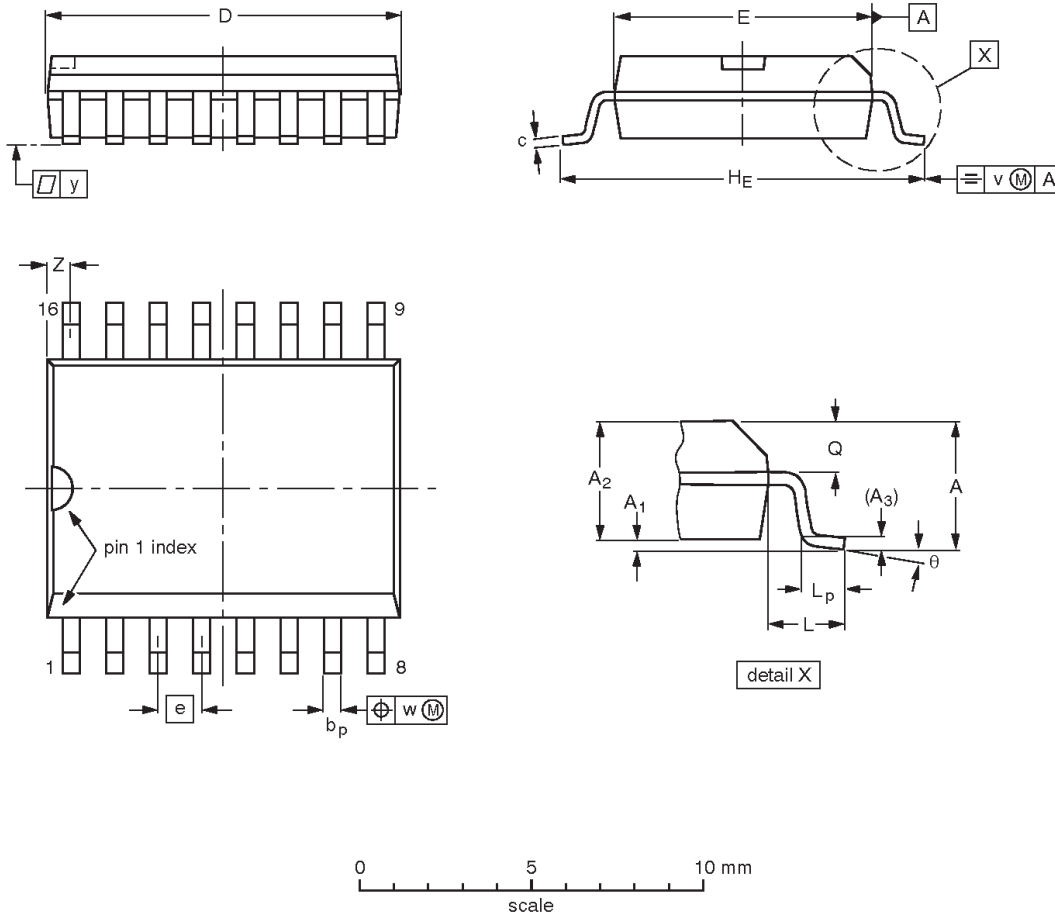
| OUTLINE VERSION | REFERENCES |       |      |  | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|-------|------|--|---------------------|----------------------|
|                 | IEC        | JEDEC | EIAJ |  |                     |                      |
| SOT38-4         |            |       |      |  |                     | 92-11-17<br>95-01-14 |

Register file

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SO16: plastic small outline package; 16 leads; body width 7.5 mm

SOT162-1



**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>(1)</sup> | e     | H <sub>E</sub> | L     | L <sub>p</sub> | Q              | v    | w    | y     | z <sup>(1)</sup> | θ        |
|--------|--------|----------------|----------------|----------------|----------------|----------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm     | 2.65   | 0.30<br>0.10   | 2.45<br>2.25   | 0.25           | 0.49<br>0.36   | 0.32<br>0.23   | 10.5<br>10.1     | 7.6<br>7.4       | 1.27  | 10.65<br>10.00 | 1.4   | 1.1<br>0.4     | 1.1<br>1.0     | 0.25 | 0.25 | 0.1   | 0.9<br>0.4       | 8°<br>0° |
| inches | 0.10   | 0.012<br>0.004 | 0.096<br>0.089 | 0.01           | 0.019<br>0.014 | 0.013<br>0.009 | 0.41<br>0.40     | 0.30<br>0.29     | 0.050 | 0.419<br>0.394 | 0.055 | 0.043<br>0.016 | 0.043<br>0.039 | 0.01 | 0.01 | 0.004 | 0.035<br>0.016   |          |

**Note**

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

| OUTLINE VERSION | REFERENCES |          |      |  | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|----------|------|--|---------------------|----------------------|
|                 | IEC        | JEDEC    | EIAJ |  |                     |                      |
| SOT162-1        | 075E03     | MS-013AA |      |  |                     | 95-01-24<br>97-05-22 |

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Register file

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**NOTES**

## Register file

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## Data sheet status

| Data sheet status         | Product status | Definition [1]   |
|---------------------------|----------------|--|
| Objective specification   | Development    | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.  |
| Preliminary specification | Qualification  | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| Product specification     | Production     | This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.   |

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

## Definitions

**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 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.

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