

## 74F350 4-Bit Shifter with 3-STATE Outputs

### General Description

The 74F350 is a specialized multiplexer that accepts a 4-bit word and shifts it 0, 1, 2 or 3 places, as determined by two Select ( $S_0$ ,  $S_1$ ) inputs. For expansion to longer words, three linking inputs are provided for lower-order bits; thus two packages can shift an 8-bit word, four packages a 16-bit word, etc. Shifting by more than three places is accomplished by paralleling the 3-STATE outputs of different packages and using the Output Enable ( $\overline{OE}$ ) inputs as a third Select level. With appropriate interconnections, the 74F350 can perform zero-backfill, sign-extend or end-around (barrel) shift functions.

### Features

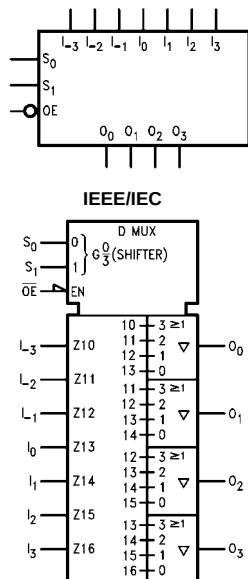
- Linking inputs for word expansion
- 3-STATE outputs for extending shift range

### Ordering Code:

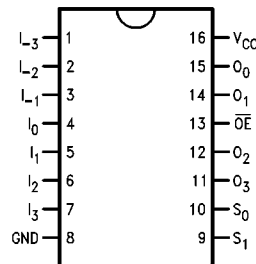
| Order Number | Package Number | Package Description                                                         |
|--------------|----------------|-----------------------------------------------------------------------------|
| 74F350SC     | M16A           | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow |
| 74F350SJ     | M16D           | 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide               |
| 74F350PC     | N16E           | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide       |

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

### Logic Symbols



### Connection Diagram



### Truth Table

| Inputs          |       |       | Outputs  |          |          |       |
|-----------------|-------|-------|----------|----------|----------|-------|
| $\overline{OE}$ | $S_1$ | $S_0$ | $O_0$    | $O_1$    | $O_2$    | $O_3$ |
| H               | X     | X     | Z        | Z        | Z        | Z     |
| L               | L     | L     | $I_0$    | $I_1$    | $I_2$    | $I_3$ |
| L               | L     | H     | $I_{-1}$ | $I_0$    | $I_1$    | $I_2$ |
| L               | H     | L     | $I_{-2}$ | $I_{-1}$ | $I_0$    | $I_1$ |
| L               | H     | H     | $I_{-3}$ | $I_{-2}$ | $I_{-1}$ | $I_0$ |

H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Immaterial  
Z = High Impedance

## Unit Loading/Fan Out

| Pin Names       | Description                      | U.I.<br>HIGH/LOW | Input $I_{IH}/I_{IL}$<br>Output $I_{OH}/I_{OL}$ |
|-----------------|----------------------------------|------------------|-------------------------------------------------|
| $S_0, S_1$      | Select Inputs                    | 1.0/2.0          | 20 $\mu$ A/-1.2 mA                              |
| $I_3-I_0$       | Data Inputs                      | 1.0/2.0          | 20 $\mu$ A/-1.2 mA                              |
| $\overline{OE}$ | Output Enable Input (Active LOW) | 1.0/2.0          | 20 $\mu$ A/-1.2 mA                              |
| $O_0-O_3$       | 3-STATE Outputs                  | 150/40 (33.3)    | -3 mA/24 mA (20 mA)                             |

## Functional Description

The 74F350 is operationally equivalent to a 4-input multiplexer with the inputs connected so that the select code causes successive one-bit shifts of the data word. This internal connection makes it possible to perform shifts of 0, 1, 2 or 3 places on words of any length.

A 4-bit data word is introduced at the  $I_n$  inputs and is shifted according to the code applied to the select inputs  $S_0, S_1$ . Outputs  $O_0-O_3$  are 3-STATE, controlled by an active LOW output enable ( $\overline{OE}$ ). When  $\overline{OE}$  is LOW, data outputs will follow selected data inputs; when HIGH, the data outputs will be forced to the high impedance state. This feature allows shifters to be cascaded on the same output lines or to a common bus. The shift function can be

logical, with zeros pulled in at either or both ends of the shifting field; arithmetic, where the sign bit is repeated during a shift down; or end around, where the data word forms a continuous loop.

## Logic Equations

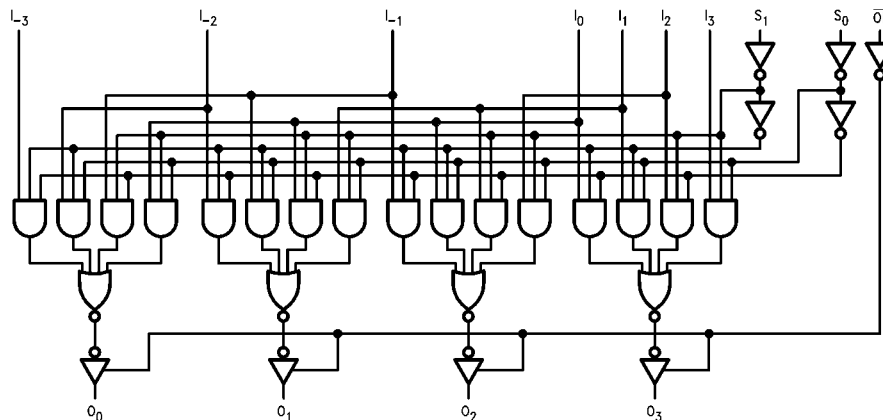
$$O_0 = \overline{S_0}\overline{S_1}I_0 + S_0\overline{S_1}I_{-1} + \overline{S_0}S_1I_{-2} + S_0S_1I_{-3}$$

$$O_1 = \overline{S_0}\overline{S_1}I_1 + S_0\overline{S_1}I_0 + \overline{S_0}S_1I_{-1} + S_0S_1I_{-2}$$

$$O_2 = \overline{S_0}\overline{S_1}I_2 + S_0\overline{S_1}I_1 + \overline{S_0}S_1I_0 + S_0S_1I_{-1}$$

$$O_3 = \overline{S_0}\overline{S_1}I_3 + S_0\overline{S_1}I_2 + \overline{S_0}S_1I_1 + S_0S_1I_0$$

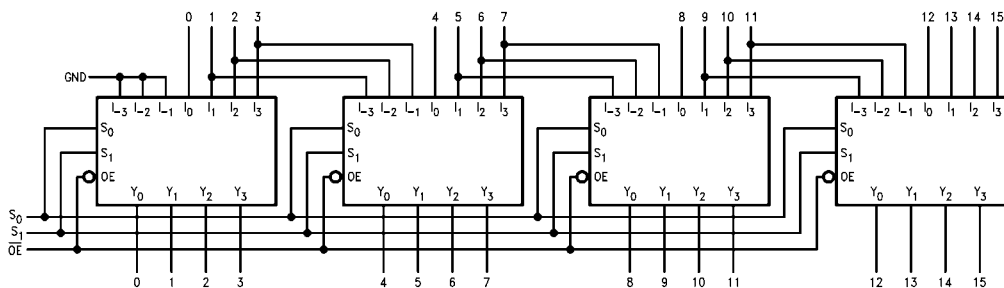
## Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

## Applications

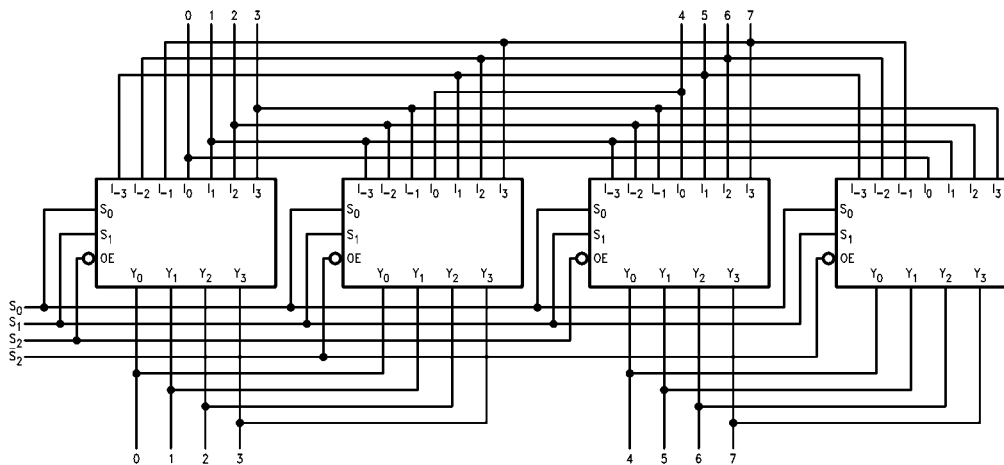
**16-Bit Shift-Up 0 to 3 Places, Zero Backfill**



**Function Table**

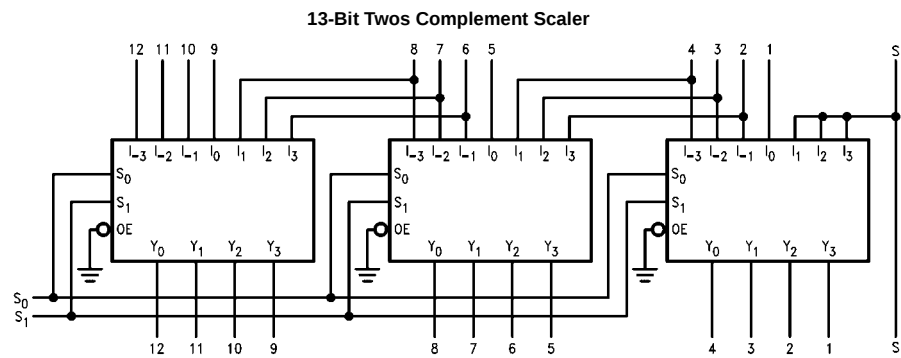
| S <sub>1</sub> | S <sub>0</sub> | Shift Function |
|----------------|----------------|----------------|
| L              | L              | No Shift       |
| L              | H              | Shift 1 Place  |
| H              | L              | Shift 2 Places |
| H              | H              | Shift 3 Places |

**8-Bit End Around Shift 0 to 7 Places**



**Function Table**

| S <sub>2</sub> | S <sub>1</sub> | S <sub>0</sub> | Shift Function     |
|----------------|----------------|----------------|--------------------|
| L              | L              | L              | No Shift           |
| L              | L              | H              | Shift End Around 1 |
| L              | H              | L              | Shift End Around 2 |
| L              | H              | H              | Shift End Around 3 |
| H              | L              | L              | Shift End Around 4 |
| H              | L              | H              | Shift End Around 5 |
| H              | H              | L              | Shift End Around 6 |
| H              | H              | H              | Shift End Around 7 |



Function Table

| $S_1$ | $S_0$       | Scale |
|-------|-------------|-------|
| L     | L+8         | $1/8$ |
| L     | H+4         | $1/4$ |
| H     | L+2         | $1/2$ |
| H     | H No Change | 1     |

**Absolute Maximum Ratings**(Note 1)

|                                             |                   |
|---------------------------------------------|-------------------|
| Storage Temperature                         | –65°C to +150°C   |
| Ambient Temperature under Bias              | –55°C to +125°C   |
| Junction Temperature under Bias             | –55°C to +150°C   |
| V <sub>CC</sub> Pin Potential to Ground Pin | –0.5V to +7.0V    |
| Input Voltage (Note 2)                      | –0.5V to +7.0V    |
| Input Current (Note 2)                      | –30 mA to +5.0 mA |

Voltage Applied to Output

in HIGH State (with V<sub>CC</sub> = 0V)Standard Output –0.5V to V<sub>CC</sub>

3-STATE Output –0.5V to +5.5V

Current Applied to Output

in LOW State (Max) twice the rated I<sub>OL</sub> (mA)**Recommended Operating Conditions**

|                              |                |
|------------------------------|----------------|
| Free Air Ambient Temperature | 0°C to +70°C   |
| Supply Voltage               | +4.5V to +5.5V |

**Note 1:** Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

**Note 2:** Either voltage limit or current limit is sufficient to protect inputs.

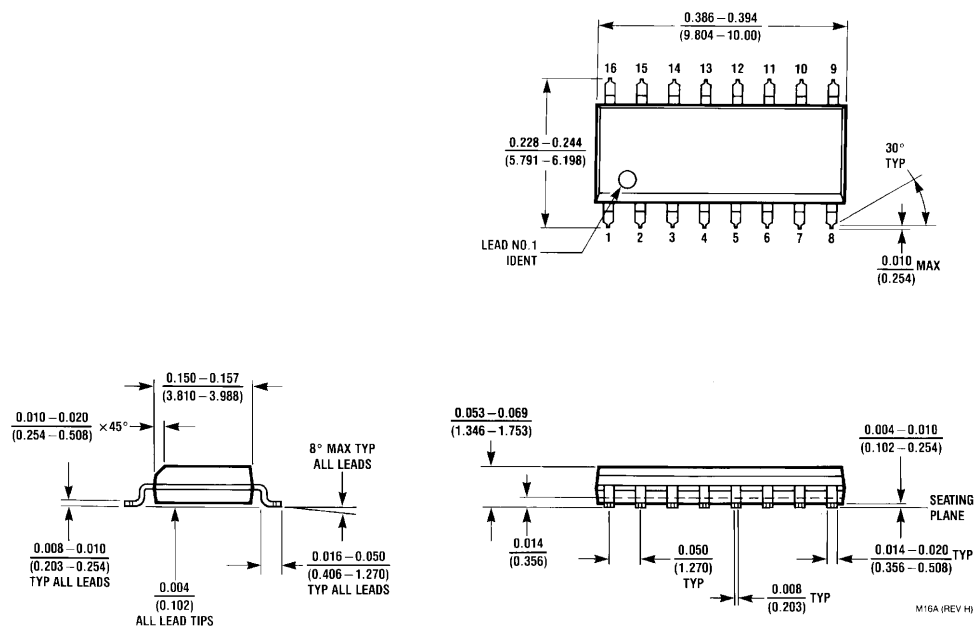
**DC Electrical Characteristics**

| Symbol           | Parameter                         | Min                                                                                     | Typ                      | Max  | Units | V <sub>CC</sub> | Conditions                                                                                               |
|------------------|-----------------------------------|-----------------------------------------------------------------------------------------|--------------------------|------|-------|-----------------|----------------------------------------------------------------------------------------------------------|
| V <sub>IH</sub>  | Input HIGH Voltage                | 2.0                                                                                     |                          |      | V     |                 | Recognized as a HIGH Signal                                                                              |
| V <sub>IL</sub>  | Input LOW Voltage                 |                                                                                         |                          | 0.8  | V     |                 | Recognized as a LOW Signal                                                                               |
| V <sub>CD</sub>  | Input Clamp Diode Voltage         |                                                                                         |                          | –1.2 | V     | Min             | I <sub>IN</sub> = –18 mA                                                                                 |
| V <sub>OH</sub>  | Output HIGH Voltage               | 10% V <sub>CC</sub><br>10% V <sub>CC</sub><br>5% V <sub>CC</sub><br>10% V <sub>CC</sub> | 2.5<br>2.4<br>2.7<br>2.7 |      | V     | Min             | I <sub>OH</sub> = –1 mA<br>I <sub>OH</sub> = –3 mA<br>I <sub>OH</sub> = –1 mA<br>I <sub>OH</sub> = –3 mA |
| V <sub>OL</sub>  | Output LOW Voltage                | 10% V <sub>CC</sub>                                                                     |                          | 0.5  | V     | Min             | I <sub>OL</sub> = 24 mA                                                                                  |
| I <sub>IH</sub>  | Input HIGH Current                |                                                                                         |                          | 5.0  | μA    | Max             | V <sub>IN</sub> = 2.7V                                                                                   |
| I <sub>BI</sub>  | Input HIGH Current Breakdown Test |                                                                                         |                          | 7.0  | μA    | Max             | V <sub>IN</sub> = 7.0V                                                                                   |
| I <sub>CEX</sub> | Output HIGH Leakage Current       |                                                                                         |                          | 50   | μA    | Max             | V <sub>OUT</sub> = V <sub>CC</sub>                                                                       |
| V <sub>ID</sub>  | Input Leakage Test                | 4.75                                                                                    |                          |      | V     | 0.0             | I <sub>ID</sub> = 1.9 μA<br>All Other Pins Grounded                                                      |
| I <sub>OD</sub>  | Output Leakage Circuit Current    |                                                                                         |                          | 3.75 | μA    | 0.0             | V <sub>ID</sub> = 150 mV<br>All Other Pins Grounded                                                      |
| I <sub>IL</sub>  | Input LOW Current                 |                                                                                         |                          | –1.2 | mA    | Max             | V <sub>IN</sub> = 0.5V                                                                                   |
| I <sub>OZH</sub> | Output Leakage Current            |                                                                                         |                          | 50   | μA    | Max             | V <sub>OUT</sub> = 2.7V                                                                                  |
| I <sub>OZL</sub> | Output Leakage Current            |                                                                                         |                          | –50  | μA    | Max             | V <sub>OUT</sub> = 0.5V                                                                                  |
| I <sub>OS</sub>  | Output Short-Circuit Current      | –60                                                                                     |                          | –150 | mA    | Max             | V <sub>OUT</sub> = 0V                                                                                    |
| I <sub>ZZ</sub>  | Bus Drainage Test                 |                                                                                         |                          | 500  | μA    | 0.0V            | V <sub>OUT</sub> = 5.25V                                                                                 |
| I <sub>CCH</sub> | Power Supply Current              |                                                                                         | 34                       | 42   | mA    | Max             | V <sub>O</sub> = HIGH                                                                                    |
| I <sub>CCL</sub> | Power Supply Current              |                                                                                         | 40                       | 57   | mA    | Max             | V <sub>O</sub> = LOW                                                                                     |
| I <sub>CCZ</sub> | Power Supply Current              |                                                                                         | 40                       | 57   | mA    | Max             | V <sub>O</sub> = HIGH Z                                                                                  |

## AC Electrical Characteristics

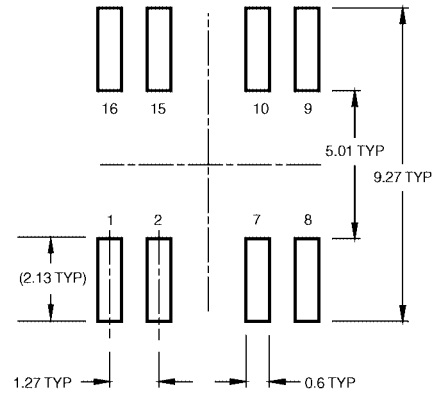
| Symbol           | Parameter                        | T <sub>A</sub> = +25°C<br>V <sub>CC</sub> = +5.0V<br>C <sub>L</sub> = 50 pF |     |      | T <sub>A</sub> = 0°C to +70°C<br>V <sub>CC</sub> = +5.0V<br>C <sub>L</sub> = 50 pF |      | Units |
|------------------|----------------------------------|-----------------------------------------------------------------------------|-----|------|------------------------------------------------------------------------------------|------|-------|
|                  |                                  | Min                                                                         | Typ | Max  | Min                                                                                | Max  |       |
| t <sub>PLH</sub> | Propagation Delay                | 3.0                                                                         | 4.5 | 6.0  | 3.0                                                                                | 7.0  | ns    |
| t <sub>PHL</sub> | I <sub>n</sub> to O <sub>n</sub> | 2.5                                                                         | 4.0 | 5.5  | 2.5                                                                                | 6.5  |       |
| t <sub>PLH</sub> | Propagation Delay                | 4.0                                                                         | 7.8 | 10.0 | 4.0                                                                                | 13.5 | ns    |
| t <sub>PHL</sub> | S <sub>n</sub> to O <sub>n</sub> | 3.0                                                                         | 6.5 | 8.5  | 3.0                                                                                | 9.5  |       |
| t <sub>PZH</sub> | Output Enable Time               | 2.5                                                                         | 5.0 | 7.0  | 2.5                                                                                | 8.0  | ns    |
| t <sub>PZL</sub> |                                  | 4.0                                                                         | 7.0 | 9.0  | 4.0                                                                                | 10.0 |       |
| t <sub>PHZ</sub> | Output Disable Time              | 2.0                                                                         | 3.9 | 5.5  | 2.0                                                                                | 6.5  |       |
| t <sub>PLZ</sub> |                                  | 2.0                                                                         | 4.0 | 5.5  | 2.0                                                                                | 7.5  |       |

# Physical Dimensions inches (millimeters) unless otherwise noted



**16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow  
Package Number M16A**

# Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



LAND PATTERN RECOMMENDATION

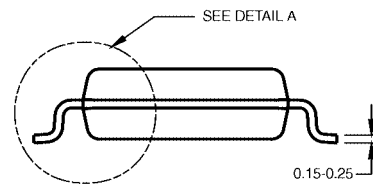


DIMENSIONS ARE IN MILLIMETERS

## NOTES:

- CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.
- DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

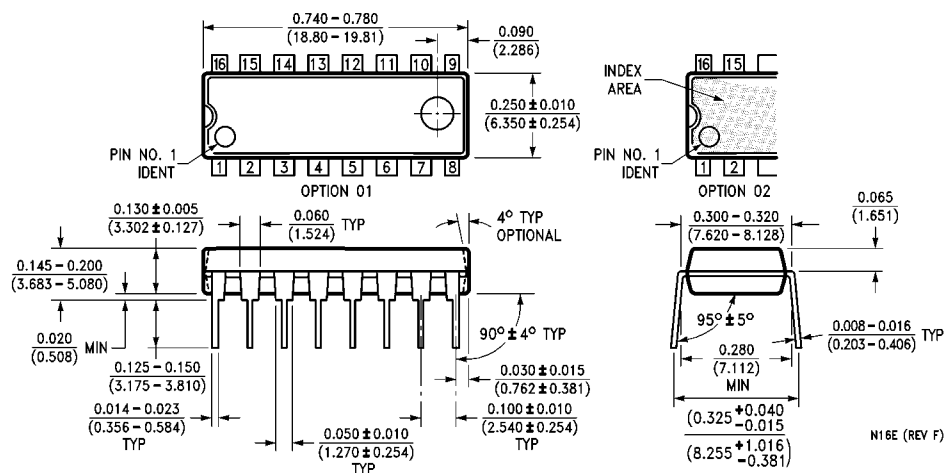
M16DRevB1



DETAIL A

16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide  
Package Number M16D

# Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide  
Package Number N16E

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