

## 54F/74F253

### Dual 4-Input Multiplexer with TRI-STATE® Outputs

#### General Description

The 'F253 is a dual 4-input multiplexer with TRI-STATE® outputs. It can select two bits of data from four sources using common select inputs. The output may be individually switched to a high impedance state with a HIGH on the respective Output Enable ( $\overline{OE}$ ) inputs, allowing the outputs to interface directly with bus oriented systems.

#### Features

- Multifunction capability
- Non-inverting TRI-STATE outputs
- Guaranteed 4000V minimum ESD protection

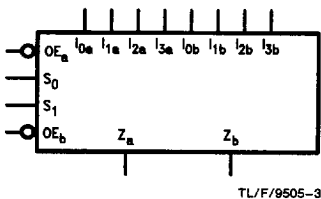
#### Ordering Code: See Section 11

| Commercial        | Military          | Package Number | Package Description                               |
|-------------------|-------------------|----------------|---------------------------------------------------|
| 74F253PC          |                   | N16E           | 16-Lead (0.300" Wide) Molded Dual-In-Line         |
|                   | 54F253DM (Note 2) | J16A           | 16-Lead Ceramic Dual-In-Line                      |
| 74F253SC (Note 1) |                   | M16A           | 16-Lead (0.150" Wide) Molded Small Outline, JEDEC |
| 74F253SJ (Note 1) |                   | M16D           | 16-Lead (0.300" Wide) Molded Small Outline, EIAJ  |
|                   | 54F253FM (Note 2) | W16A           | 16-Lead Cerpack                                   |
|                   | 54F253LL (Note 2) | E20A           | 20-Lead Ceramic Leadless Chip Carrier, Type C     |

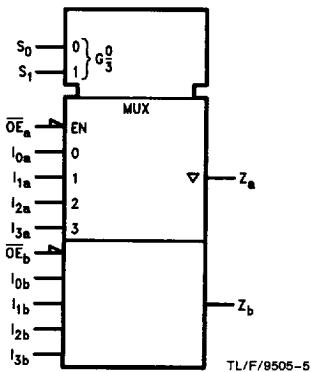
Note 1: Devices also available in 13" reel. Use suffix = SCX and SJX.

Note 2: Military grade device with environmental and burn-in processing. Use suffix = DMQB, FMQB and LMQB.

#### Logic Symbols

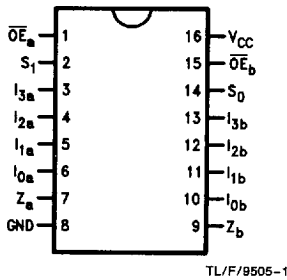


#### IEEE/IEC

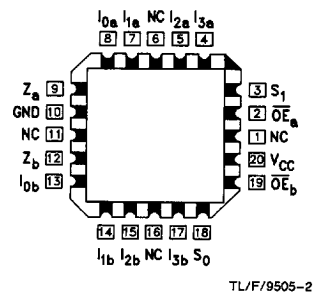


#### Connection Diagrams

##### Pin Assignment for DIP, SOIC and Flatpak



##### Pin Assignment for LCC



# Unit Loading/Fan Out: See Section 2 for U.L. definitions

| Pin Names         | Description                             | 54F/74F          |                                                 |
|-------------------|-----------------------------------------|------------------|-------------------------------------------------|
|                   |                                         | U.L.<br>HIGH/LOW | Input $I_{IH}/I_{IL}$<br>Output $I_{OH}/I_{OL}$ |
| $I_{0a}-I_{3a}$   | Side A Data Inputs                      | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| $I_{0b}-I_{3b}$   | Side B Data Inputs                      | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| $S_0-S_1$         | Common Select Inputs                    | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| $\overline{OE}_a$ | Side A Output Enable Input (Active LOW) | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| $\overline{OE}_b$ | Side B Output Enable Input (Active LOW) | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| $Z_a, Z_b$        | TRI-STATE Outputs                       | 150/40(33.3)     | -3 mA/24 mA (20 mA)                             |

## Functional Description

This device contains two identical 4-input multiplexers with TRI-STATE outputs. They select two bits from four sources selected by common Select inputs ( $S_0, S_1$ ). The 4-input multiplexers have individual Output Enable ( $\overline{OE}_a, \overline{OE}_b$ ) inputs which, when HIGH, force the outputs to a high impedance (High Z) state. This device is the logic implementation of a 2-pole, 4-position switch, where the position of the switch is determined by the logic levels supplied to the two select inputs. The logic equations for the outputs are shown below:

$$Z_a = \overline{OE}_a \cdot (I_{0a} \cdot \overline{S_1} \cdot \overline{S_0} + I_{1a} \cdot \overline{S_1} \cdot S_0 + I_{2a} \cdot S_1 \cdot \overline{S_0} + I_{3a} \cdot S_1 \cdot S_0)$$

$$Z_b = \overline{OE}_b \cdot (I_{0b} \cdot \overline{S_1} \cdot \overline{S_0} + I_{1b} \cdot \overline{S_1} \cdot S_0 + I_{2b} \cdot S_1 \cdot \overline{S_0} + I_{3b} \cdot S_1 \cdot S_0)$$

If the outputs of TRI-STATE devices are tied together, all but one device must be in the high impedance state to avoid high currents that would exceed the maximum ratings. Designers should ensure that Output Enable signals to TRI-STATE devices whose outputs are tied together are designed so that there is no overlap.

## Truth Table

| Select Inputs |       | Data Inputs |       |       |       | Output Enable   | Output |
|---------------|-------|-------------|-------|-------|-------|-----------------|--------|
| $S_0$         | $S_1$ | $I_0$       | $I_1$ | $I_2$ | $I_3$ | $\overline{OE}$ | Z      |
| X             | X     | X           | X     | X     | X     | H               | Z      |
| L             | L     | L           | X     | X     | X     | L               | L      |
| L             | L     | H           | X     | X     | X     | L               | H      |
| H             | L     | X           | L     | X     | X     | L               | L      |
| H             | L     | X           | H     | X     | X     | L               | H      |
| L             | H     | X           | X     | L     | X     | L               | L      |
| L             | H     | X           | X     | H     | X     | L               | H      |
| H             | H     | X           | X     | X     | L     | L               | L      |
| H             | H     | X           | X     | X     | H     | L               | H      |

Address inputs  $S_0$  and  $S_1$  are common to both sections.

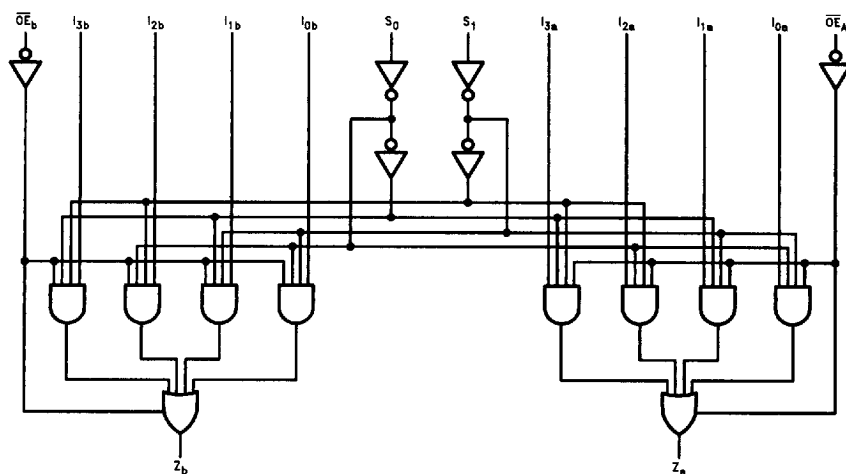
H = HIGH Voltage Level

L = LOW Voltage Level

X = Immaterial

Z = High Impedance

## Logic Diagram



TL/F/9505-4

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

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                                                     |                          |
|---------------------------------------------------------------------|--------------------------|
| Storage Temperature                                                 | -65°C to +150°C          |
| Ambient Temperature under Bias                                      | -55°C to +125°C          |
| Junction Temperature under Bias                                     | -55°C to +175°C          |
| Plastic                                                             | -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> |
| TRI-STATE Output                                                    | -0.5V to +5.5V           |

Current Applied to Output

in LOW State (Max)

twice the rated I<sub>OL</sub> (mA)

ESD Last Passing Voltage (Min)

4000V

**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.

**Recommended Operating Conditions**

Free Air Ambient Temperature

Military

-55°C to +125°C

Commercial

0°C to +70°C

Supply Voltage

Military

+4.5V to +5.5V

Commercial

+4.5V to +5.5V

**DC Electrical Characteristics**

| Symbol           | Parameter                         |                         | 54F/74F     |      |              | Units | V <sub>CC</sub> | Conditions                                          |
|------------------|-----------------------------------|-------------------------|-------------|------|--------------|-------|-----------------|-----------------------------------------------------|
|                  |                                   |                         | Min         | Typ  | Max          |       |                 |                                                     |
| 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               | 54F 10% V <sub>CC</sub> | 2.5         |      |              | V     | Min             | I <sub>OH</sub> = -1 mA                             |
|                  |                                   | 54F 10% V <sub>CC</sub> | 2.4         |      |              |       |                 | I <sub>OH</sub> = -3 mA                             |
|                  |                                   | 74F 10% V <sub>CC</sub> | 2.5         |      |              |       |                 | I <sub>OH</sub> = -1 mA                             |
|                  |                                   | 74F 10% V <sub>CC</sub> | 2.4         |      |              |       |                 | I <sub>OH</sub> = -3 mA                             |
|                  |                                   | 74F 5% V <sub>CC</sub>  | 2.7         |      |              |       |                 | I <sub>OH</sub> = -1 mA                             |
|                  |                                   | 74F 5% V <sub>CC</sub>  | 2.7         |      |              |       |                 | I <sub>OH</sub> = -3 mA                             |
| V <sub>OL</sub>  | Output LOW Voltage                | 54F 10% V <sub>CC</sub> |             |      | 0.5          | V     | Min             | I <sub>OL</sub> = 20 mA                             |
|                  |                                   | 74F 10% V <sub>CC</sub> |             |      | 0.5          |       |                 | I <sub>OL</sub> = 24 mA                             |
| I <sub>IH</sub>  | Input HIGH Current                | 54F                     |             |      | 20.0         | μA    | Max             | V <sub>IN</sub> = 2.7V                              |
|                  |                                   | 74F                     |             |      | 5.0          |       |                 |                                                     |
| I <sub>BVI</sub> | Input HIGH Current Breakdown Test | 54F                     |             |      | 100          | μA    | Max             | V <sub>IN</sub> = 7.0V                              |
|                  |                                   | 74F                     |             |      | 7.0          |       |                 |                                                     |
| I <sub>CEX</sub> | Output HIGH Leakage Current       | 54F                     |             |      | 250          | μA    | Max             | V <sub>OUT</sub> = V <sub>CC</sub>                  |
|                  |                                   | 74F                     |             |      | 50           |       |                 |                                                     |
| V <sub>ID</sub>  | Input Leakage Test                | 74F                     | 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    | 74F                     |             |      | 3.75         | μA    | 0.0             | V <sub>ID</sub> = 150 mV<br>All Other Pins Grounded |
| I <sub>IL</sub>  | Input LOW Current                 |                         |             |      | -0.6         | 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<br>-100 |      | -150<br>-225 | mA    | Max             | V <sub>OUT</sub> = 0V<br>V <sub>OUT</sub> = 0V      |
| I <sub>ZZ</sub>  | Bus Drainage Test                 |                         |             |      | 500          | μA    | 0.0V            | V <sub>OUT</sub> = V <sub>CC</sub>                  |
| I <sub>CCH</sub> | Power Supply Current              |                         |             | 11.5 | 16           | mA    | Max             | V <sub>O</sub> = HIGH                               |
| I <sub>CCL</sub> | Power Supply Current              |                         |             | 16   | 23           | mA    | Max             | V <sub>O</sub> = LOW                                |
| I <sub>CCZ</sub> | Power Supply Current              |                         |             | 16   | 23           | mA    | Max             | V <sub>O</sub> = HIGH Z                             |

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**AC Electrical Characteristics:** See Section 2 for Waveforms and Load Configurations

| Symbol                 | Parameter                           | 74F                                                                            |            |             | 54F                                                |              | 74F                                                |              | Units | Fig. No. |
|------------------------|-------------------------------------|--------------------------------------------------------------------------------|------------|-------------|----------------------------------------------------|--------------|----------------------------------------------------|--------------|-------|----------|
|                        |                                     | $T_A = +25^{\circ}\text{C}$<br>$V_{CC} = +5.0\text{V}$<br>$C_L = 50\text{ pF}$ |            |             | $T_A, V_{CC} = \text{Mil}$<br>$C_L = 50\text{ pF}$ |              | $T_A, V_{CC} = \text{Com}$<br>$C_L = 50\text{ pF}$ |              |       |          |
|                        |                                     | Min                                                                            | Typ        | Max         | Min                                                | Max          | Min                                                | Max          |       |          |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$S_n$ to $Z_n$ | 4.5<br>3.0                                                                     | 8.5<br>6.5 | 11.5<br>9.0 | 3.5<br>2.5                                         | 15.0<br>11.0 | 4.5<br>3.0                                         | 13.0<br>10.0 | ns    | 2-3      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$I_n$ to $Z_n$ | 3.0<br>2.5                                                                     | 5.5<br>4.5 | 7.0<br>6.0  | 2.5<br>2.5                                         | 9.0<br>8.0   | 3.0<br>2.5                                         | 8.0<br>7.0   | ns    | 2-3      |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time                  | 3.0<br>3.0                                                                     | 6.0<br>6.0 | 8.0<br>8.0  | 2.5<br>2.5                                         | 10.0<br>10.0 | 3.0<br>3.0                                         | 9.0<br>9.0   | ns    | 2-5      |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time                 | 2.0<br>2.0                                                                     | 3.7<br>4.4 | 5.0<br>6.0  | 2.0<br>2.0                                         | 6.5<br>8.0   | 2.0<br>2.0                                         | 6.0<br>7.0   |       |          |