



July 1990  
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# 74ACTQ153

## Quiet Series Dual 4-Input Multiplexer

### General Description

The ACTQ153 is a high-speed dual 4-input multiplexer with common select inputs and individual enable inputs for each section. It can select two lines of data from four sources. The two buffered outputs present data in the true (non-inverted) form. In addition to multiplexer operation, the ACTQ153 can act as a function generator and generate any two functions of three variables.

### Features

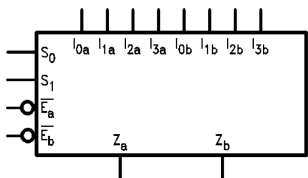
- Outputs source/sink 24 mA
- ACTQ153 has TTL-compatible inputs
- Guaranteed simultaneous switching noise level and dynamic threshold performance
- Improved latch-up immunity

### Ordering Code:

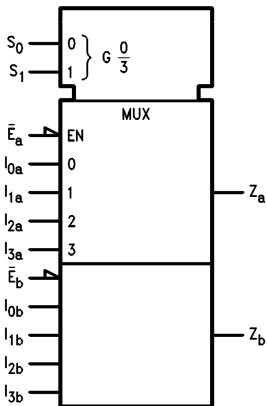
| Order Number | Package Number | Package Description   |
|--------------|----------------|---|
| 74ACTQ153SC  | M16A           | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow |
| 74ACTQ153PC  | N16E           | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide       |

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

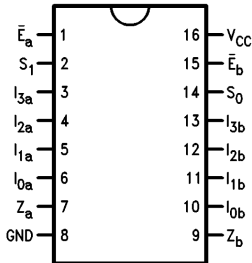
### Logic Symbols



IEEE/IEC



### Connection Diagram



### Pin Descriptions

| Pin Names                         | Description          |
|-----------------------------------|----------------------|
| I <sub>0a</sub> - I <sub>3a</sub> | Side A Data Inputs   |
| I <sub>0b</sub> - I <sub>3b</sub> | Side B Data Inputs   |
| S <sub>0</sub> , S <sub>1</sub>   | Common Select Inputs |
| $\bar{E}_a$                       | Side A Enable Input  |
| $\bar{E}_b$                       | Side B Enable Input  |
| Z <sub>a</sub>                    | Side A Output        |
| Z <sub>b</sub>                    | Side B Output        |

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Functional Description

The ACTQ153 is a dual 4-input multiplexer. It can select two bits of data from up to four sources under the control of the common Select inputs ( $S_0$ ,  $S_1$ ). The two 4-input multiplexer circuits have individual active-LOW Enables ( $\bar{E}_a$ ,  $\bar{E}_b$ ) which can be used to strobe the outputs independently. When the Enables ( $\bar{E}_a$ ,  $\bar{E}_b$ ) are HIGH, the corresponding outputs ( $Z_a$ ,  $Z_b$ ) are forced LOW. The ACTQ153 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 Select inputs. The logic equations for the outputs are shown below.

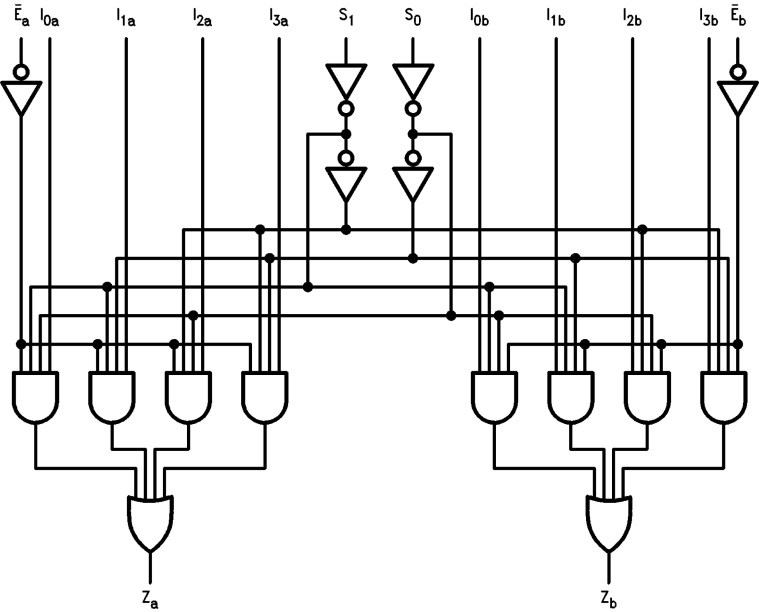
$$Z_a = \bar{E}_a \cdot (I_{0a} \cdot \bar{S}_1 \cdot \bar{S}_0 + I_{1a} \cdot \bar{S}_1 \cdot S_0 + I_{2a} \cdot S_1 \cdot \bar{S}_0 + I_{3a} \cdot S_1 \cdot S_0)$$
$$Z_b = \bar{E}_b \cdot (I_{0b} \cdot \bar{S}_1 \cdot \bar{S}_0 + I_{1b} \cdot \bar{S}_1 \cdot S_0 + I_{2b} \cdot S_1 \cdot \bar{S}_0 + I_{3b} \cdot S_1 \cdot S_0)$$

Truth Table

| Select Inputs  |                | Inputs (a or b) |                |                |                |                | Outputs |
|----------------|----------------|-----------------|----------------|----------------|----------------|----------------|---------|
| S <sub>0</sub> | S <sub>1</sub> | $\overline{E}$  | I <sub>0</sub> | I <sub>1</sub> | I <sub>2</sub> | I <sub>3</sub> | Z       |
| X              | X              | H               | X              | X              | X              | X              | L       |
| L              | L              | L               | L              | X              | X              | X              | L       |
| L              | L              | L               | H              | X              | X              | X              | H       |
| H              | L              | L               | X              | L              | X              | X              | L       |
| H              | L              | L               | X              | H              | X              | X              | H       |
| L              | H              | L               | X              | X              | L              | X              | L       |
| L              | H              | L               | X              | X              | H              | X              | H       |
| H              | H              | L               | X              | X              | X              | L              | L       |
| H              | H              | L               | X              | X              | X              | H              | H       |

H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Immaterial

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.

## Absolute Maximum Ratings (Note 1)

|  |                          |
|--|--------------------------|
| Supply Voltage ( $V_{CC}$ )  | -0.5V to +7.0V           |
| DC Input Diode Current ( $I_{IK}$ )                                    |                          |
| $V_I = -0.5V$  | -20 mA                   |
| $V_I = V_{CC} + 0.5V$  | +20 mA                   |
| DC Input Voltage ( $V_I$ )   | -0.5V to $V_{CC} + 0.5V$ |
| DC Output Diode Current ( $I_{OK}$ )                                   |                          |
| $V_O = -0.5V$  | -20 mA                   |
| $V_O = V_{CC} + 0.5V$  | +20 mA                   |
| DC Output Voltage ( $V_O$ )  | -0.5V to $V_{CC} + 0.5V$ |
| DC Output Source or Sink Current ( $I_O$ )                             | $\pm 50$ mA              |
| DC $V_{CC}$ or Ground Current per Output Pin ( $I_{CC}$ or $I_{GND}$ ) | $\pm 50$ mA              |
| Storage Temperature ( $T_{STG}$ )                                      | -65°C to +150°C          |
| DC Latch-Up Source or Sink Current                                     | $\pm 300$ mA             |
| Junction Temperature ( $T_J$ )   |                          |
| PDIP   | 140°C                    |

## Recommended Operating Conditions

|   |                |
|---|----------------|
| Supply Voltage ( $V_{CC}$ )                 | 4.5V to 5.5V   |
| Input Voltage ( $V_I$ )                     | 0V to $V_{CC}$ |
| Output Voltage ( $V_O$ )                    | 0V to $V_{CC}$ |
| Operating Temperature ( $T_A$ )             | -40°C to +85°C |
| Minimum Input Edge Rate $\Delta V/\Delta t$ |                |
| $V_{IN}$ from 0.8V to 2.0V                  |                |
| $V_{CC}$ @ 4.5V, 5.5V                       | 125 mV/ns      |

**Note 1:** Absolute maximum ratings are those values beyond which damage to the device may occur. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. Fairchild does not recommend operation of FACT™ circuits outside databook specifications.

## DC Electrical Characteristics

| Symbol           | Parameter                                | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> = -40°C to +85°C | Units | Conditions  |
|------------------|--|------------------------|------------------------|-------------------|---------------------------------|-------|---|
|                  |  |                        | Typ                    | Guaranteed Limits |                                 |       |   |
| V <sub>IH</sub>  | Minimum HIGH Level<br>Input Voltage      | 4.5                    | 1.5                    | 2.0               | 2.0                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V  |
|                  |  | 5.5                    | 1.5                    | 2.0               | 2.0                             |       |   |
| V <sub>IL</sub>  | Maximum LOW Level<br>Input Voltage       | 4.5                    | 1.5                    | 0.8               | 0.8                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V  |
|                  |  | 5.5                    | 1.5                    | 0.8               | 0.8                             |       |   |
| V <sub>OH</sub>  | Minimum HIGH Level<br>Output Voltage     | 4.5                    | 4.49                   | 4.4               | 4.4                             | V     | I <sub>OUT</sub> = -50 μA   |
|                  |  | 5.5                    | 5.49                   | 5.4               | 5.4                             |       |   |
|                  |  | 4.5                    |                        | 3.86              | 3.76                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OH</sub> = -24 mA<br>I <sub>OH</sub> = -24 mA (Note 2) |
|                  |  | 5.5                    |                        | 4.86              | 4.76                            |       |   |
| V <sub>OL</sub>  | Maximum LOW Level<br>Output Voltage      | 4.5                    | 0.001                  | 0.1               | 0.1                             | V     | I <sub>OUT</sub> = 50 μA  |
|                  |  | 5.5                    | 0.001                  | 0.1               | 0.1                             |       |   |
|                  |  | 4.5                    |                        | 0.36              | 0.44                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OL</sub> = 24 mA<br>I <sub>OL</sub> = 24 mA (Note 2)   |
|                  |  | 5.5                    |                        | 0.36              | 0.44                            |       |   |
| I <sub>IN</sub>  | Maximum Input Leakage Current            | 5.5                    |                        | ±0.1              | ±1.0                            | μA    | V <sub>I</sub> = V <sub>CC</sub> , GND  |
| I <sub>CCT</sub> | Maximum I <sub>CC</sub> /Input           | 5.5                    | 0.6                    |                   | 1.5                             | μA    | V <sub>I</sub> = V <sub>CC</sub> - 2.1V   |
| I <sub>OLD</sub> | Minimum Dynamic                          | 5.5                    |                        |                   | 75                              | mA    | V <sub>OLD</sub> = 1.65V Max  |
| I <sub>OHD</sub> | Output Current (Note 3)                  | 5.5                    |                        |                   | -75                             | mA    | V <sub>OHD</sub> = 3.85V Min  |
| I <sub>CC</sub>  | Maximum Quiescent Supply Current         | 5.5                    |                        | 8.0               | 80.0                            | μA    | V <sub>IN</sub> = V <sub>CC</sub> or GND  |
| V <sub>OLP</sub> | Maximum HIGH Level<br>Output Noise       | 5.0                    | 1.1                    | 1.5               |                                 | V     | Figures 1, 2<br>(Note 4)(Note 5)  |
| V <sub>OLV</sub> | Maximum LOW Level Output Noise           | 5.0                    | -0.6                   | -1.2              |                                 | V     | Figures 1, 2  |
| V <sub>IHD</sub> | Minimum HIGH Level Dynamic Input Voltage | 5.0                    | 1.9                    | 2.2               |                                 | V     | (Note 4)(Note 6)  |
| V <sub>ILD</sub> | Maximum LOW Level Dynamic Input Voltage  | 5.0                    | 1.2                    | 0.8               |                                 | V     | (Note 4)(Note 6)  |

**Note 2:** All outputs loaded; thresholds on input associated with output under test.

**Note 3:** Maximum test duration 2.0 ms, one output loaded at a time.

**Note 4:** Worst case package.

**Note 5:** Max number of outputs defined as (n). Data Inputs are driven 0V to 5V. One Data Input @  $V_{IN} = GND$ .

**Note 6:** Max number of Data Inputs (n) switching. (n-1) inputs switching 0V to 5V. Input-under-test switching: 5V to threshold ( $V_{ILD}$ ), 0V to threshold ( $V_{IHD}$ ),  $f = 1$  MHz.

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### AC Electrical Characteristics

| Symbol           | Parameter   | V <sub>CC</sub><br>(V)<br>(Note 7) | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |     |      | T <sub>A</sub> = -40°C to +85°C<br>C <sub>L</sub> = 50 pF |      | Units |
|------------------|---|------------------------------------|--|-----|------|---|------|-------|
|                  |   |                                    | Min  | Typ | Max  | Min   | Max  |       |
| t <sub>PLH</sub> | Propagation Delay<br>S <sub>n</sub> to Z <sub>n</sub>   | 5.0                                | 3.0  | 7.0 | 11.5 | 2.0   | 13.5 | ns    |
| t <sub>PHL</sub> | Propagation Delay<br>S <sub>n</sub> to Z <sub>n</sub>   | 5.0                                | 3.0  | 7.0 | 11.5 | 2.5   | 13.5 | ns    |
| t <sub>PLH</sub> | Propagation Delay<br>$\overline{E}_n$ to Z <sub>n</sub> | 5.0                                | 2.0  | 6.5 | 10.5 | 2.0   | 12.5 | ns    |
| t <sub>PHL</sub> | Propagation Delay<br>$\overline{E}_n$ to Z <sub>n</sub> | 5.0                                | 3.0  | 6.0 | 9.5  | 2.5   | 11.0 | ns    |
| t <sub>PLH</sub> | Propagation Delay<br>I <sub>n</sub> to Z <sub>n</sub>   | 5.0                                | 2.5  | 5.5 | 9.5  | 2.0   | 11.0 | ns    |
| t <sub>PHL</sub> | Propagation Delay<br>I <sub>n</sub> to Z <sub>n</sub>   | 5.0                                | 2.0  | 5.5 | 9.5  | 2.0   | 11.0 | ns    |

Note 7: Voltage Range 5.0 is 5.0V ± 0.5V

### Capacitance

| Symbol          | Parameter                     | Typ  | Units | Conditions             |
|-----------------|-------------------------------|------|-------|------------------------|
| C <sub>IN</sub> | Input Capacitance             | 4.5  | pF    | V <sub>CC</sub> = 5.0V |
| C <sub>PD</sub> | Power Dissipation Capacitance | 65.0 | pF    | V <sub>CC</sub> = 5.0V |

## FACT Noise Characteristics

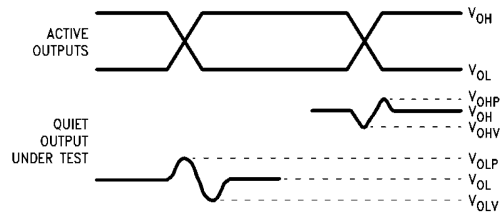
The setup of a noise characteristics measurement is critical to the accuracy and repeatability of the tests. The following is a brief description of the setup used to measure the noise characteristics of FACT.

### Equipment:

Hewlett Packard Model 8180A Word Generator  
PC-163A Test Fixture  
Tektronics Model 7854 Oscilloscope

### Procedure:

1. Verify Test Fixture Loading: Standard Load 50 pF, 500Ω.
2. Deskew the HFS generator so that no two channels have greater than 150 ps skew between them. This requires that the oscilloscope be deskewed first. It is important to deskew the HFS generator channels before testing. This will ensure that the outputs switch simultaneously.
3. Terminate all inputs and outputs to ensure proper loading of the outputs and that the input levels are at the correct voltage.
4. Set the HFS generator to toggle all but one output at a frequency of 1 MHz. Greater frequencies will increase DUT heating and effect the results of the measurement.
5. Set the HFS generator input levels at 0V LOW and 3V HIGH for ACT devices and 0V LOW and 5V HIGH for AC devices. Verify levels with an oscilloscope.



**Note 8:**  $V_{OHV}$  and  $V_{OLP}$  are measured with respect to ground reference.

**Note 9:** Input pulses have the following characteristics:  $f = 1$  MHz,  $t_r = 3$  ns,  $t_f = 3$  ns, skew < 150 ps.

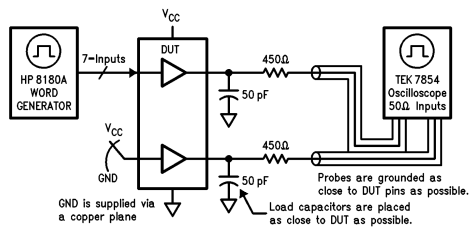
**FIGURE 1. Quiet Output Noise Voltage Waveforms**

$V_{OLP}/V_{OLV}$  and  $V_{OHP}/V_{OHV}$ :

- Determine the quiet output pin that demonstrates the greatest noise levels. The worst case pin will usually be the furthest from the ground pin. Monitor the output voltages using a 50Ω coaxial cable plugged into a standard SMB type connector on the test fixture. Do not use an active FET probe.
- Measure  $V_{OLP}$  and  $V_{OLV}$  on the quiet output during the worst case transition for active and enable. Measure  $V_{OHP}$  and  $V_{OHV}$  on the quiet output during the worst case active and enable transition.
- Verify that the GND reference recorded on the oscilloscope has not drifted to ensure the accuracy and repeatability of the measurements.

$V_{ILD}$  and  $V_{IHD}$ :

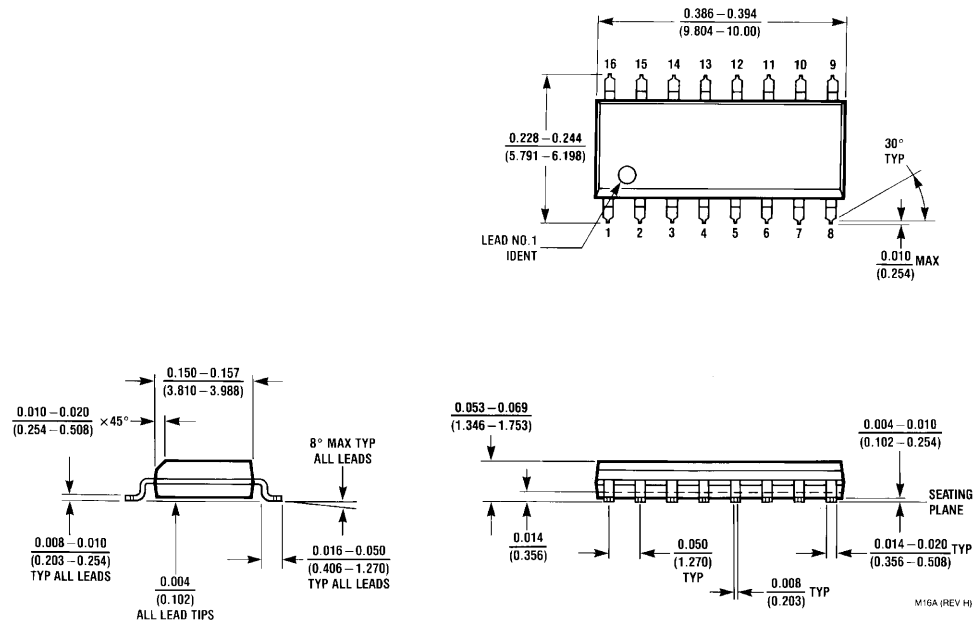
- Monitor one of the switching outputs using a 50Ω coaxial cable plugged into a standard SMB type connector on the test fixture. Do not use an active FET probe.
- First increase the input LOW voltage level,  $V_{IL}$ , until the output begins to oscillate or steps out a min of 2 ns. Oscillation is defined as noise on the output LOW level that exceeds  $V_{IL}$  limits, or on output HIGH levels that exceed  $V_{IH}$  limits. The input LOW voltage level at which oscillation occurs is defined as  $V_{ILD}$ .
- Next decrease the input HIGH voltage level,  $V_{IH}$ , until the output begins to oscillate or steps out a min of 2 ns. Oscillation is defined as noise on the output LOW level that exceeds  $V_{IL}$  limits, or on output HIGH levels that exceed  $V_{IH}$  limits. The input HIGH voltage level at which oscillation occurs is defined as  $V_{IHD}$ .
- Verify that the GND reference recorded on the oscilloscope has not drifted to ensure the accuracy and repeatability of the measurements.



**FIGURE 2. Simultaneous Switching Test Circuit**

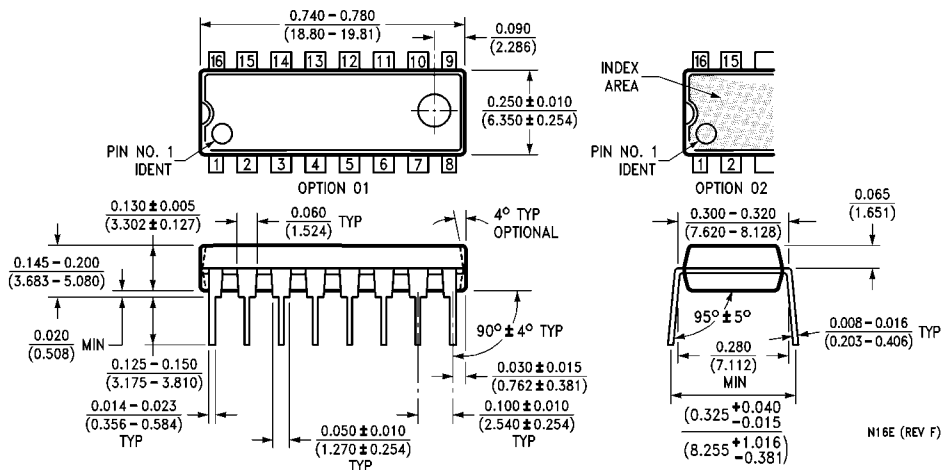
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# Physical Dimensions inches (millimeters) unless otherwise noted



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

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



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