



March 1993  
Revised March 2005

## 74ACTQ541 Quiet Series Octal Buffer/Line Driver with 3-STATE Outputs

### General Description

The 74ACTQ541 is an octal buffer/line driver designed to be employed as memory and address drivers, clock drivers and bus oriented transmitter/receivers.

This device is similar in function to the 74ACTQ244 while providing flow-through architecture (inputs on opposite side from outputs). This pinout arrangement makes this device especially useful as an output port for microprocessors, allowing ease of layout and greater PC board density.

The 74ACTQ541 utilizes FACT Quiet Series™ technology to guarantee quiet output switching and improved dynamic threshold performance. FACT Quiet Series features GTO™ output control and undershoot corrector in addition to split ground bus for superior performance.

### Features

- $I_{CC}$  and  $I_{OZ}$  reduced by 50%
- Guaranteed simultaneous switching noise level and dynamic threshold performance
- Guaranteed pin-to-pin skew AC performance
- Inputs and outputs on opposite sides of package for easy board layout
- Non-inverting 3-STATE outputs
- Guaranteed 4 kV minimum ESD immunity
- TTL compatible inputs
- Outputs source/sink 24 mA

### Ordering Code:

| Order Number                | Package Number | Package Description  |
|-----------------------------|----------------|--|
| 74ACTQ541SC                 | M20B           | 20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide         |
| 74ACTQ541SCX_NL<br>(Note 1) |                | Pb-Free 20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74ACTQ541MTC                | MTC20          | 20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide        |
| 74ACTQ541PC                 | N20A           | 20-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide             |

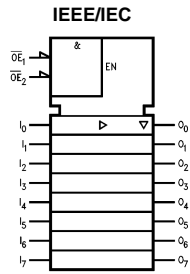
Device also available in Tape and Reel. Specify by appending suffix letter "X" to the order code.

**Note 1:** "\_NL" indicates Pb-Free package (per JEDEC J-STD-020B). Device available in Tape and Reel only.

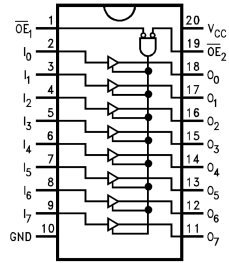
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74ACTQ541 Quiet Series Octal Buffer/Line Driver with 3-STATE Outputs

**Logic Symbol**



**Connection Diagram**



**Pin Descriptions**

| Pin Name                            | Pin Description                    |
|-------------------------------------|------------------------------------|
| $\overline{OE}_1 - \overline{OE}_2$ | 3-STATE Output Enable (Active-LOW) |
| $I_0 - I_7$                         | Inputs                             |
| $O_1 - O_7$                         | Outputs                            |

**Truth Table**

| Inputs            |                   |   | Outputs |
|-------------------|-------------------|---|---------|
| $\overline{OE}_1$ | $\overline{OE}_2$ | I |         |
| L                 | L                 | H | H       |
| H                 | X                 | X | Z       |
| X                 | H                 | X | Z       |
| L                 | L                 | L | L       |

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

**Absolute Maximum Ratings**(Note 2)

|  |                          |
|--|--------------------------|
| 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 ( $T_J$ )             | 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 2:** 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                                   | $V_{CC}$<br>(V) | $T_A = +25^\circ\text{C}$ |                   | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ |  | Units         | Conditions  |
|-----------|---|-----------------|---------------------------|-------------------|---|--|---------------|---|
|           |   |                 | Typ                       | Guaranteed Limits |   |  |               |   |
| $V_{IH}$  | Minimum HIGH Level<br>Input Voltage         | 4.5             | 1.5                       | 2.0               | 2.0   |  | V             | $V_{OUT} = 0.1V$<br>or $V_{CC} - 0.1V$  |
|           |   | 5.5             | 1.5                       | 2.0               | 2.0   |  |               |   |
| $V_{IL}$  | Maximum LOW Level<br>Input Voltage          | 4.5             | 1.5                       | 0.8               | 0.8   |  | V             | $V_{OUT} = 0.1V$<br>or $V_{CC} - 0.1V$  |
|           |   | 5.5             | 1.5                       | 0.8               | 0.8   |  |               |   |
| $V_{OH}$  | Minimum HIGH Level<br>Output Voltage        | 3.0             | 2.99                      | 2.9               | 2.9   |  | V             | $I_{OUT} = -50 \mu\text{A}$   |
|           |   | 4.5             | 4.49                      | 4.4               | 4.4   |  |               |   |
|           |   | 4.5             |                           | 3.86              | 3.76  |  | V             | $V_{IN} = V_{IL}$ or $V_{IH}$ (Note 3)<br>$I_{OH} = -24 \text{ mA}$<br>-24 mA |
|           |   | 5.5             |                           | 4.86              | 4.76  |  |               |   |
| $V_{OL}$  | Maximum LOW Level<br>Output Voltage         | 3.0             | 0.002                     | 0.1               | 0.1   |  | V             | $I_{OUT} = 50 \mu\text{A}$  |
|           |   | 4.5             | 0.001                     | 0.1               | 0.1   |  |               |   |
|           |   | 4.5             |                           | 0.36              | 0.44  |  | V             | $V_{IN} = V_{IL}$ or $V_{IH}$ (Note 3)<br>$I_{OH} = 24 \text{ mA}$<br>24 mA   |
|           |   | 5.5             |                           | 0.36              | 0.44  |  |               |   |
| $I_{IN}$  | Maximum Input Leakage Current               | 5.5             |                           | $\pm 0.1$         | $\pm 1.0$                                       |  | $\mu\text{A}$ | $V_I = V_{CC}, \text{GND}$  |
| $I_{OZ}$  | Maximum 3-STATE<br>Leakage Current          | 5.5             |                           | $\pm 0.25$        | $\pm 2.5$                                       |  | $\mu\text{A}$ | $V_I = V_{IL}, V_{IH}$<br>$V_O = V_{CC}, \text{GND}$                          |
| $I_{CCT}$ | Maximum $I_{CC}$ /Input                     | 5.5             | 0.6                       |                   | 1.5   |  | mA            | $V_I = V_{CC} - 2.1V$   |
| $I_{OLD}$ | Minimum Dynamic<br>Output Current (Note 4)  | 5.5             |                           |                   | 75  |  | mA            | $V_{OLD} = 1.65V$ Max   |
|           |   | 5.5             |                           |                   | -75   |  | mA            | $V_{OHD} = 3.85V$ Min   |
| $I_{CC}$  | Maximum Quiescent<br>Supply Current         | 5.5             |                           | 4.0               | 40.0  |  | $\mu\text{A}$ | $V_{IN} = V_{CC}$ or GND  |
| $V_{OLP}$ | Quiet Output<br>Maximum Dynamic $V_{OL}$    | 5.0             | 1.1                       | 1.5               |   |  | V             | Figure 1, Figure 2<br>(Note 5)(Note 6)  |
|           |   | 5.0             | -0.6                      | -1.2              |   |  |               |   |
| $V_{OLV}$ | Quiet Output<br>Minimum Dynamic $V_{OL}$    | 5.0             | -0.6                      | -1.2              |   |  | V             | Figure 1, Figure 2<br>(Note 5)(Note 6)  |
|           |   | 5.0             | 1.9                       | 2.2               |   |  |               |   |
| $V_{IHD}$ | Minimum HIGH Level<br>Dynamic Input Voltage | 5.0             | 1.9                       | 2.2               |   |  | V             | (Note 5)(Note 7)  |
| $V_{ILD}$ | Maximum LOW Level<br>Dynamic Input Voltage  | 5.0             | 1.2                       | 0.8               |   |  | V             | (Note 5)(Note 7)  |

**Note 3:** All outputs loaded; thresholds on input associated with output under test.

**Note 4:** Maximum test duration 2.0 ms, one output loaded at a time.

**Note 5:** Plastic DIP package.

**Note 6:** Max number of outputs defined as (n). Data inputs are driven 0V to 3V. One output @ GND.

**Note 7:** Max number of Data Inputs (n) switching. (n-1) Inputs switching 0V to 5V (ACQ). Input-under-test switching: 5V to threshold ( $V_{ILD}$ ), 0V to threshold ( $V_{IHD}$ ),  $f = 1$  MHz.

## AC Electrical Characteristics

| Symbol            | Parameter                    | V <sub>CC</sub><br>(V)<br>(Note 8) | 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            | 5.0                                | 2.0  | 4.5 | 7.0 | 2.0   | 7.5 | ns    |
| t <sub>PHL</sub>  | Data to Output               |                                    | 2.0  | 5.5 | 7.0 | 2.0   | 7.5 |       |
| t <sub>PZH</sub>  | Output Enable Time           | 5.0                                | 2.0  | 5.0 | 9.0 | 2.0   | 9.5 | ns    |
| t <sub>PZL</sub>  |                              |                                    | 2.0  | 6.5 | 9.0 | 2.0   | 9.5 |       |
| t <sub>PHZ</sub>  | Output Disable Time          | 5.0                                | 1.5  | 5.5 | 7.5 | 1.5   | 8.0 | ns    |
| t <sub>PLZ</sub>  |                              |                                    | 1.5  | 5.5 | 7.5 | 1.5   | 8.0 |       |
| t <sub>OSSL</sub> | Output to Output             |                                    |  | 0.5 | 1.0 |   | 1.0 | ns    |
| t <sub>OSLH</sub> | Skew Data to Output (Note 9) |                                    |  | 0.5 | 1.0 |   | 1.0 |       |

**Note 8:** Voltage Range 5.0 is 5.0V ± 0.5V

**Note 9:** Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t<sub>OSSL</sub>) or LOW-to-HIGH (t<sub>OSLH</sub>). Parameter guaranteed by design.

## Capacitance

| Symbol          | Parameter                     | Typ | Units | Conditions             |
|-----------------|-------------------------------|-----|-------|------------------------|
| C <sub>IN</sub> | Input Capacitance             | 4.5 | pF    | V <sub>CC</sub> = OPEN |
| C <sub>PD</sub> | Power Dissipation Capacitance | 70  | 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:

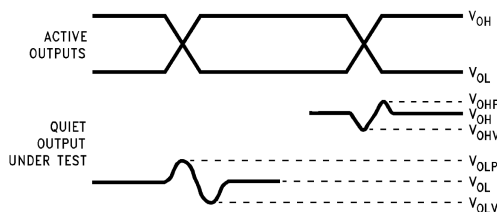
Hewlett Packard Model 8180A Word Generator

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.



$V_{OHV}$  and  $V_{OLP}$  are measured with respect to ground reference.

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

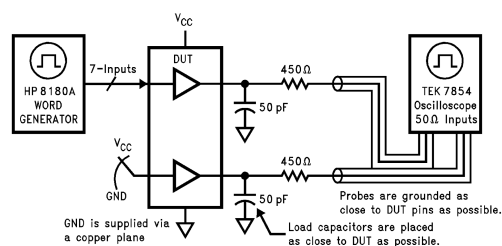
**FIGURE 1. Quiet Output Noise Voltage Waveforms**

$V_{OLP}/V_{OLV}$  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.

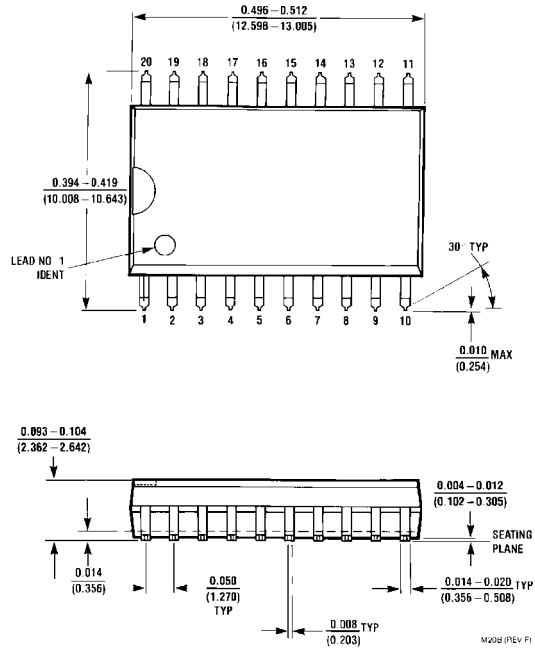
$V_{ILD}$  and  $V_{IHD}$ :

- 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 on the measurements.



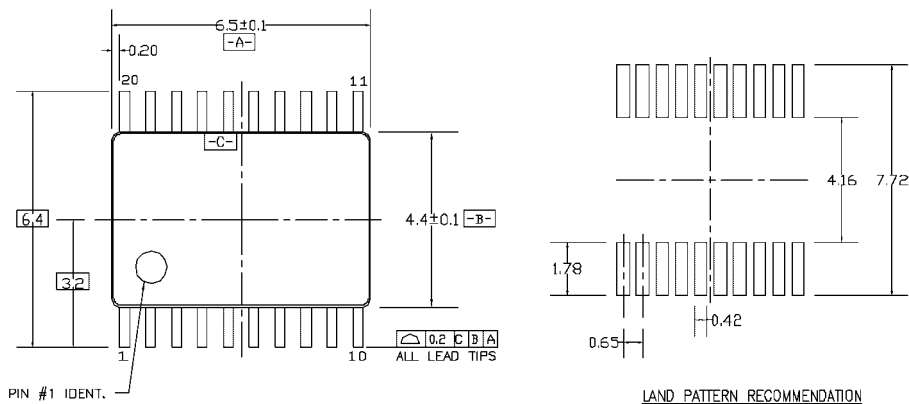
**FIGURE 2. Simultaneous Switching Test Circuit**

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



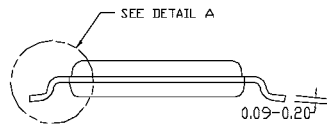
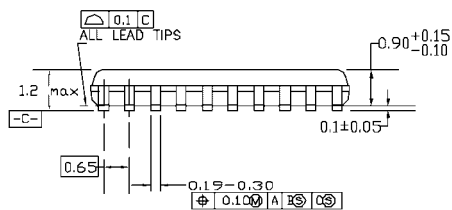
**20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide  
Package Number M20B**

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

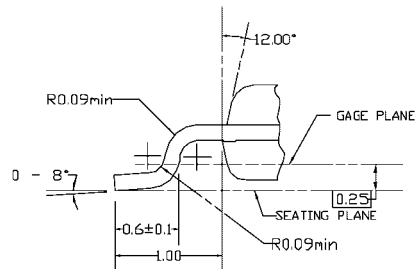


PIN #1 IDENT.

LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS



DETAIL A

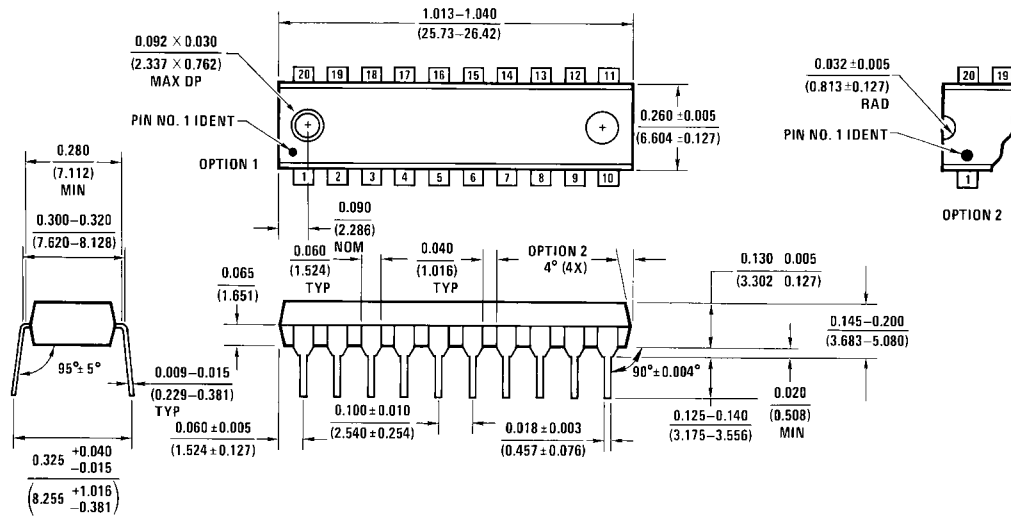
NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AC, REF NOTE 6, DATE 7/93.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLDS FLASH, AND TIE BAR EXTRUSIONS.
- D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MTC20REVD1

**20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide Package Number MTC20**

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



**20-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide  
Package Number N20A**

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