



## DS1648/DS3648/DS1678/DS3678 TRI-STATE® TTL to MOS Multiplexers/Drivers

### General Description

The DS1648/DS3648 and DS1678/DS3678 are quad 2-input multiplexers with TRI-STATE outputs designed to drive the large capacitive loads (up to 500 pF) associated with MOS memory systems. A PNP input structure is employed to minimize input currents so that driver loading in large memory systems is reduced. The circuit employs Schottky-clamped transistors for high speed and TRI-STATE outputs for bus operation.

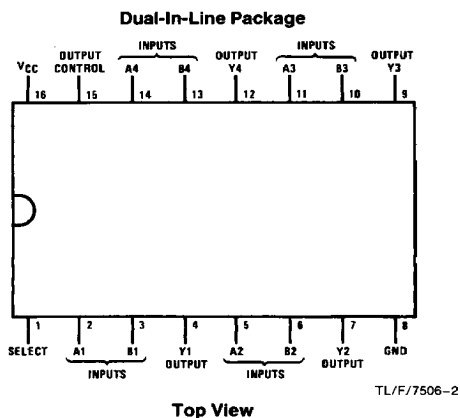
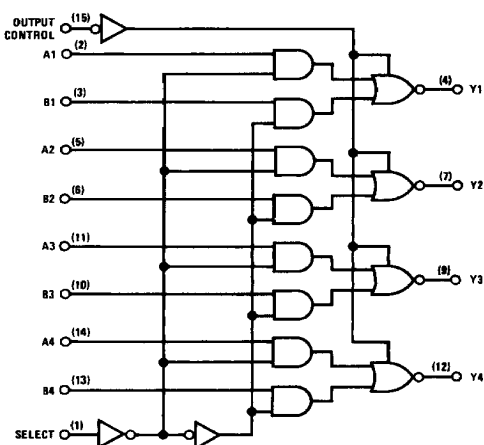
The DS1648/DS3648 has a 15Ω resistor in series with the outputs to dampen transients caused by the fast-switching

output. The DS1678/DS3678 has a direct, low impedance output for use with or without an external resistor.

### Features

- TRI-STATE outputs interface directly with system-bus
- Schottky-clamped for better ac performance
- PNP inputs to minimize input loading
- TTL compatible
- High-speed capacitive load drivers
- Built-in damping resistor (DS1648/DS3648 only)

### Logic and Connection Diagrams



Order Number DS1648J, DS3648J, DS1678J  
DS3678J, DS3648N or DS3678N  
See NS Package Number J16A or N16A

**Absolute Maximum Ratings** (Note 1)

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

|                                    |                 |
|------------------------------------|-----------------|
| Supply Voltage                     | 7V              |
| Logical "1" Input Voltage          | 7V              |
| Logical "0" Input Voltage          | -1.5V           |
| Storage Temperature Range          | -65°C to +150°C |
| Maximum Power Dissipation* at 25°C |                 |
| Cavity Package                     | 1433 mW         |
| Molded Package                     | 1362 mW         |
| Lead Temperature                   |                 |
| (Soldering, 10 seconds)            | 300°C           |

\* Derate cavity package 9.6 mW/°C above 25°C; derate molded package 10.9 mW/°C above 25°C.

**Operating Conditions**

|                             | Min | Max  | Units |
|-----------------------------|-----|------|-------|
| Supply Voltage ( $V_{CC}$ ) | 4.5 | 5.5  | V     |
| Temperature ( $T_A$ )       |     |      |       |
| DS1648, DS1678              | -55 | +125 | °C    |
| DS3648, DS3678              | 0   | +70  | °C    |

**Electrical Characteristics** (Notes 2 and 3)

| Symbol             | Parameter                              | Conditions                                                | Min           | Typ    | Max   | Units |   |
|--------------------|----------------------------------------|-----------------------------------------------------------|---------------|--------|-------|-------|---|
| V <sub>IN(1)</sub> | Logical "1" Input Voltage              |                                                           | 2.0           |        |       | V     |   |
| V <sub>IN(0)</sub> | Logical "0" Input Voltage              |                                                           |               |        | 0.8   | V     |   |
| I <sub>IN(1)</sub> | Logical "1" Input Current              | V <sub>CC</sub> = 5.5V, V <sub>IN</sub> = 5.5V            |               | 0.1    | 40    | μA    |   |
| I <sub>IN(0)</sub> | Logical "0" Input Current              | V <sub>CC</sub> = 5.5V, V <sub>IN</sub> = 0.5V            |               | − 50   | − 250 | μA    |   |
| V <sub>CLAMP</sub> | Input Clamp Voltage                    | V <sub>CC</sub> = 4.5V, I <sub>IN</sub> = − 18 mA         |               | − 0.75 | − 1.2 | V     |   |
| V <sub>OH</sub>    | Logical "1" Output Voltage (No Load)   | V <sub>CC</sub> = 4.5V, I <sub>OH</sub> = − 10 μA         | DS1648/DS1678 | 2.7    | 3.6   | V     |   |
|                    |                                        |                                                           | DS3648/DS3678 | 2.8    | 3.6   | V     |   |
| V <sub>OL</sub>    | Logical "0" Output Voltage (No Load)   | V <sub>CC</sub> = 4.5V, I <sub>OL</sub> = 10 μA           | DS1648/DS1678 |        | 0.25  | 0.4   | V |
|                    |                                        |                                                           | DS3648/DS3678 |        | 0.25  | 0.35  | V |
| V <sub>OH</sub>    | Logical "1" Output Voltage (With Load) | V <sub>CC</sub> = 4.5V, I <sub>OH</sub> = − 1.0 mA        | DS1648        | 2.4    | 3.5   | V     |   |
|                    |                                        |                                                           | DS1678        | 2.5    | 3.5   | V     |   |
|                    |                                        |                                                           | DS3648        | 2.6    | 3.5   | V     |   |
|                    |                                        |                                                           | DS3678        | 2.7    | 3.5   | V     |   |
| V <sub>OL</sub>    | Logical "0" Output Voltage (With Load) | V <sub>CC</sub> = 4.5V, I <sub>OL</sub> = 20 mA           | DS1648        |        | 0.6   | 1.1   | V |
|                    |                                        |                                                           | DS1678        |        | 0.4   | 0.5   | V |
|                    |                                        |                                                           | DS3648        |        | 0.6   | 1.0   | V |
|                    |                                        |                                                           | DS3678        |        | 0.4   | 0.5   | V |
| I <sub>1D</sub>    | Logical "1" Drive Current              | V <sub>CC</sub> = 4.5V, V <sub>OUT</sub> = 0V, (Note 4)   |               | − 250  |       | mA    |   |
| I <sub>0D</sub>    | Logical "0" Drive Current              | V <sub>CC</sub> = 4.5V, V <sub>OUT</sub> = 4.5V, (Note 4) |               | 150    |       | mA    |   |
| I <sub>HI-Z</sub>  | TRI-STATE Output Current               | V <sub>OUT</sub> = 0.4V to 2.4V, Output Control = 2.0V    | − 40          |        | 40    | μA    |   |
| I <sub>CC</sub>    | Power Supply Current                   | V <sub>CC</sub> = 5.5V                                    |               |        |       |       |   |
|                    |                                        | Output Control = 3V<br>All Other Inputs at 0V             |               | 42     | 60    | mA    |   |
|                    |                                        | All Inputs at 0V                                          |               | 20     | 32    | mA    |   |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

**Note 2:** Unless otherwise specified min/max limits apply across the -55°C to +125°C temperature range for the DS1648 and DS1678 and across the 0°C to +70°C range for the DS3648 and DS3678. All typical values for  $T_A = 25^\circ C$  and  $V_{CC} = 5V$ .

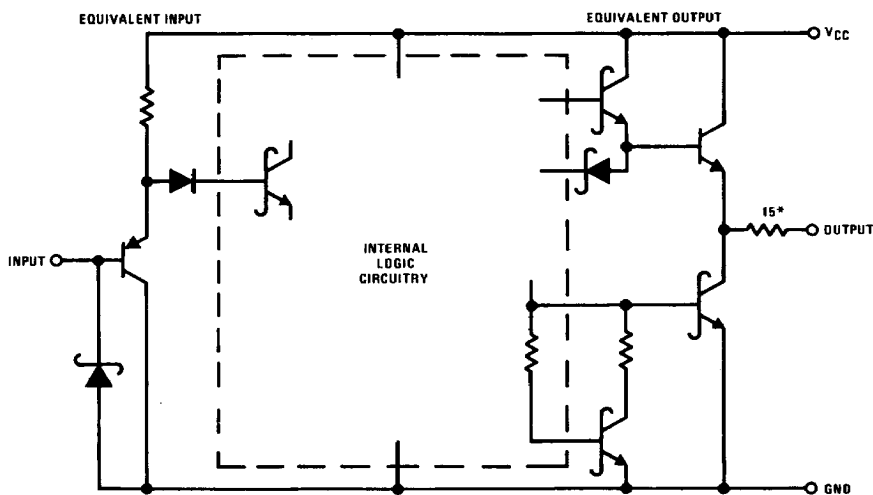
**Note 3:** All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

**Note 4:** When measuring output drive current and switching response for the DS1678 and DS3678 a 15 $\Omega$  resistor should be placed in series with each output. This resistor is internal to the DS1648/DS3648 and need not be added.

# Switching Characteristics $V_{CC} = 5V$ , $T_A = 25^\circ C$ (Note 4)

| Symbol     | Parameter                                                                        | Conditions                                                               | Min | Typ | Max | Units |
|------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----|-----|-----|-------|
| $t_{s\pm}$ | Storage Delay Negative Edge                                                      | (Figure 1)<br>$C_L = 50\text{ pF}$                                       |     | 5   | 7   | ns    |
|            |                                                                                  | $C_L = 500\text{ pF}$                                                    |     | 9   | 12  | ns    |
| $t_{s\mp}$ | Storage Delay Positive Edge                                                      | (Figure 1)<br>$C_L = 50\text{ pF}$                                       |     | 6   | 8   | ns    |
|            |                                                                                  | $C_L = 500\text{ pF}$                                                    |     | 9   | 13  | ns    |
| $t_F$      | Fall Time                                                                        | (Figure 1)<br>$C_L = 50\text{ pF}$                                       |     | 5   | 8   | ns    |
|            |                                                                                  | $C_L = 500\text{ pF}$                                                    |     | 22  | 35  | ns    |
| $t_R$      | Rise Time                                                                        | (Figure 1)<br>$C_L = 50\text{ pF}$                                       |     | 6   | 9   | ns    |
|            |                                                                                  | $C_L = 500\text{ pF}$                                                    |     | 22  | 35  | ns    |
| $t_{zL}$   | Delay from Output Control Input to Logical "0" Level (from High Impedance State) | $C_L = 50\text{ pF}$ , $R_L = 2\text{ k}\Omega$ to $V_{CC}$ , (Figure 2) |     | 10  | 15  | ns    |
| $t_{zH}$   | Delay from Output Control Input to Logical "1" Level (from High Impedance State) | $C_L = 50\text{ pF}$ , $R_L = 2\text{ k}\Omega$ to GND (Figure 2)        |     | 8   | 15  | ns    |
| $t_{LZ}$   | Delay from Output Control Input to High Impedance State (from Logical "0" Level) | $C_L = 50\text{ pF}$ , $R_L = 400\Omega$ to $V_{CC}$ , (Figure 3)        |     | 15  | 25  | ns    |
| $t_{HZ}$   | Delay from Output Control Input to High Impedance State (from Logical "1" Level) | $C_L = 50\text{ pF}$ , $R_L = 400\Omega$ to GND, (Figure 3)              |     | 10  | 25  | ns    |
| $t_{s\pm}$ | Propagation Delay to Logical "0" Transition When Select Selects A                | $C_L = 50\text{ pF}$ , (Figure 1)                                        |     | 12  | 15  | ns    |
| $t_{s\mp}$ | Propagation Delay to Logical "1" Transition When Select Selects A                | $C_L = 50\text{ pF}$ , (Figure 1)                                        |     | 14  | 17  | ns    |
| $t_{s\pm}$ | Propagation Delay to Logical "0" Transition When Select Selects B                | $C_L = 50\text{ pF}$ , (Figure 1)                                        |     | 16  | 20  | ns    |
| $t_{s\mp}$ | Propagation Delay to Logical "1" Transition When Select Selects B                | $C_L = 50\text{ pF}$ , (Figure 1)                                        |     | 14  | 20  | ns    |

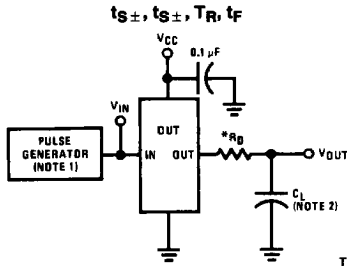
## Schematic Diagram



\*DS1648/DS3648 only

TL/F/7506-3

# AC Test Circuits and Switching Time Waveforms

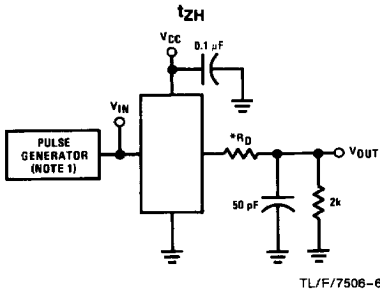


TL/F/7506-4

**Note 1:** The pulse generator has the following characteristics:  $Z_{OUT} = 50\Omega$  and  $PRR \leq 1$  MHz. Rise and fall times between 10% and 90% points  $\leq 5$  ns.

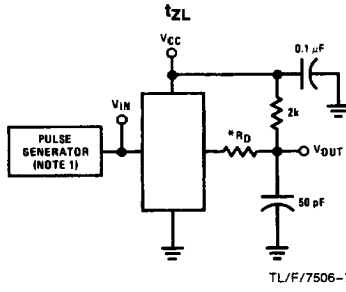
**Note 2:**  $C_L$  includes probe and jig capacitance.

FIGURE 1



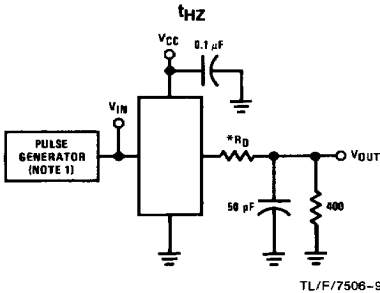
TL/F/7506-6

\*Internal on DS1648 and DS3648



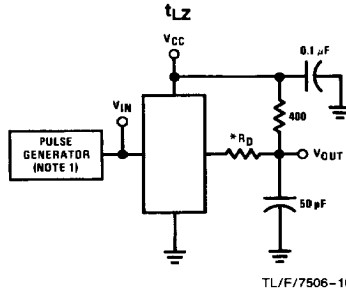
TL/F/7506-7

FIGURE 2



TL/F/7506-9

\*Internal on DS1648 and DS3648



TL/F/7506-10

FIGURE 3

## Truth Table

| Output Control | Inputs |   |   | Outputs |
|----------------|--------|---|---|---------|
|                | Select | A | B |         |
| H              | X      | X | X | Hi-Z    |
| L              | L      | L | X | H       |
| L              | L      | H | X | L       |
| L              | H      | X | L | H       |
| L              | H      | X | H | L       |

H = High level

L = Low level

X = Don't care

Hi-Z = TRI-STATE mode

## Typical Applications

