National Semiconductor

# DS75361 Dual TTL-to-MOS Driver

## General Description

The DS75361 is a monolithic integrated dual TTL-to-MOS driver interface circuit. The device accepts standard TTL input signals and provides high-current and high-voltage output levels for driving MOS circuits. It is used to drive address, control, and timing inputs for several types of MOS RAMs including the 1103 and MM5270 and MM5280.

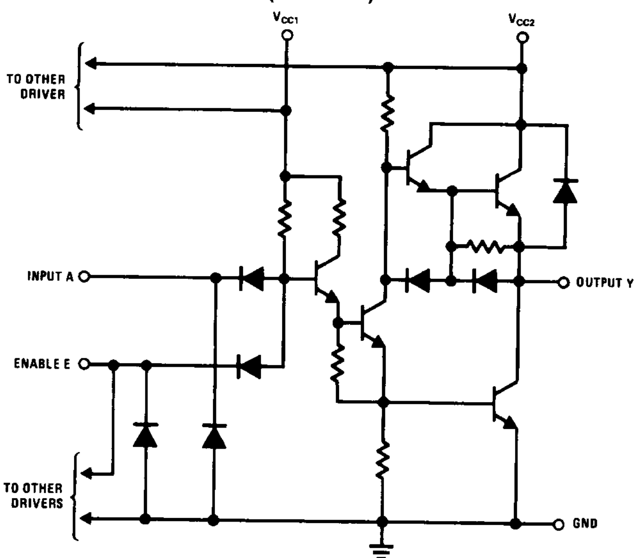
The DS75361 operates from standard TTL 5V supplies and the MOS $V_{SS}$ supply in many applications. The device has been optimized for operation with $V_{CC2}$ supply voltage from 16V to 20V; however, it is designed for use over a much wider range of $V_{CC2}$.

## Features

- Capable of driving high-capacitance loads
- Compatible with many popular MOS RAMs
- $V_{CC2}$ supply voltage variable over wide range to 24V
- Diode-clamped inputs
- TTL compatible
- Operates from standard bipolar and MOS supplies
- High-speed switching
- Transient overdrive minimizes power dissipation
- Low standby power dissipation

## Schematic and Connection Diagrams

(1/2 shown)

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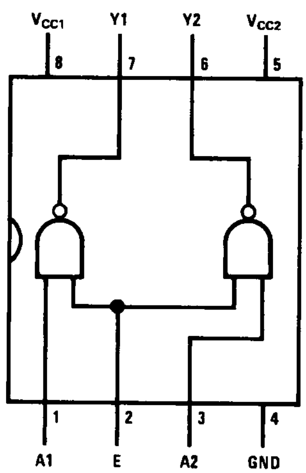
**Dual-In-Line Package**

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**Top View**

**Order Number DS75361N**
**See NS Package Number N08E**

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## 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 Range of $V_{CC1}$ (Note 1) | −0.5 to 7V |
| Supply Voltage Range of $V_{CC2}$ | −0.5V to 25V |
| Input Voltage | 5.5V |
| Inter-Input Voltage (Note 4) | 5.5V |
| Storage Temperature Range | −65°C to +150°C |
| Maximum Power Dissipation* at 25°C | |
| Molded Package | 1022 mW |
| Lead Temperature 1/16 inch from Case for 10 Seconds: N or P Package | 200°C |

*Derate molded package 8.2 mW/° above about 25°C.

## Operating Conditions

| | Min | Max | Units |
|---|---|---|---|
| Supply Voltage ($V_{CC1}$) | 4.75 | 5.25 | V |
| Supply Voltage ($V_{CC2}$) | 4.75 | 24 | V |
| Operating Temperature ($T_A$) | 0 | +70 | °C |

## Electrical Characteristics (Notes 2 and 3)

| Symbol | Parameter | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | High-Level Input Voltage | | | 2 | | | V |
| $V_{IL}$ | Low-Level Input Voltage | | | | | 0.8 | V |
| $V_I$ | Input Clamp Voltage | $I_I = -12$ mA | | | | −1.5 | V |
| $V_{OH}$ | High-Level Output Voltage | $V_{IL} = 0.8V$, $I_{OH} = -50\ \mu A$ | | $V_{CC2} - 1$ | $V_{CC2} - 0.7$ | | V |
| | | $V_{IL} = 0.8V$, $I_{OH} = -10$ mA | | $V_{CC2} - 2.3$ | $V_{CC2} - 1.8$ | | V |
| $V_{OL}$ | Low-Level Output Voltage | $V_{IH} = 2V$, $I_{OL} = 10$ mA | | | 0.15 | 0.3 | V |
| | | $V_{CC2} = 15V$ to 24V, $V_{IH} = 2V$, $I_{OL} = 40$ mA | | | 0.25 | 0.5 | V |
| $V_O$ | Output Clamp Voltage | $V_I = 0V$, $I_{OH} = 20$ mA | | | | $V_{CC2} + 1.5$ | V |
| $I_I$ | Input Current at Maximum Input Voltage | $V_I = 5.5V$ | | | | 1 | mA |
| $I_{IH}$ | High-Level Input Current | $V_I = 2.4V$ | A Inputs | | | 40 | μA |
| | | | E Input | | | 80 | μA |
| $I_{IL}$ | Low-Level Input Current | $V_I = 0.4V$ | A Inputs | | −1 | −1.6 | mA |
| | | | E Input | | −2 | −3.2 | mA |
| $I_{CC1(H)}$ | Supply Current from $V_{CC1}$, Both Outputs High | $V_{CC1} = 5.25V$, All Inputs at 0V, | $V_{CC2} = 24V$, No Load | | 2 | 4 | mA |
| $I_{CC2(H)}$ | Supply Current from $V_{CC2}$, Both Outputs High | | | | | 0.5 | mA |
| $I_{CC1(L)}$ | Supply Current from $V_{CC1}$, Both Outputs Low | $V_{CC1} = 5.25V$, All Inputs at 5V, | $V_{CC2} = 24V$, No Load | | 16 | 24 | mA |
| $I_{CC2(L)}$ | Supply Current from $V_{CC2}$, Both Outputs Low | | | | 7 | 11 | mA |
| $I_{CC2(S)}$ | Supply Current from $V_{CC2}$, Stand-by Condition | $V_{CC1} = 0V$, All Inputs at 5V, | $V_{CC2} = 24V$, No Load | | | 0.5 | 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 0°C to +70°C range for the DS75361. All typical values are for $T_A = 25°C$ and $V_{CC1} = 5V$ and $V_{CC2} = 20V$.

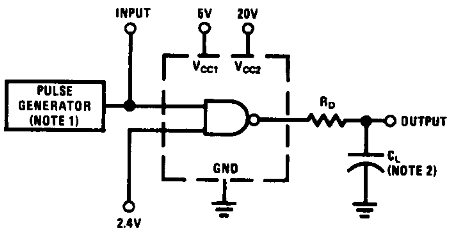
**Note 3:** All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

**Note 4:** This rating applies between the A input of either driver and the common E input.

## Switching Characteristics $V_{CC1} = 5V$, $V_{CC2} = 20V$, $T_A = 25°C$

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $t_{DLH}$ | Delay Time, Low-to-High Level Output | $C_L = 390$ pF, $R_D = 10\Omega$ *(Figure 1)* | | 11 | 20 | ns |
| $t_{DHL}$ | Delay Time, High-to-Low Level Output | | | 10 | 18 | ns |
| $t_{TLH}$ | Transition Time, Low-to-High Level Output | | | 25 | 40 | ns |
| $t_{THL}$ | Transition Time, High-to-Low Level Output | | | 21 | 35 | ns |
| tPLH | Propagation Delay Time, Low-to-High Level Output | | 10 | 36 | 55 | ns |
| $t_{PHL}$ | Propagation Delay Time, High-to-Low Level Output | | 10 | 31 | 47 | ns |

## AC Test Circuit and Switching Time Waveforms

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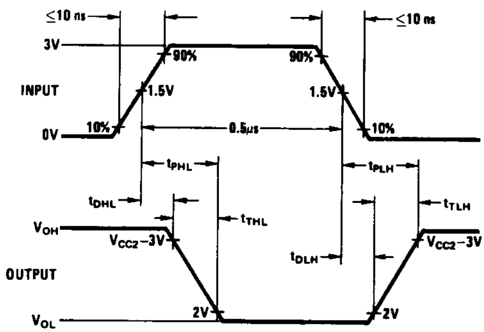


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**Note 1:** The pulse generator has the following characteristics: PRR = 1 MHz, $Z_{OUT} = 50\Omega$.

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

**FIGURE 1. Switching Times, Each Driver**

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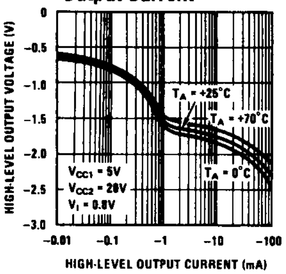
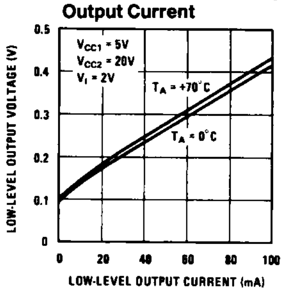
## Typical Performance Characteristics

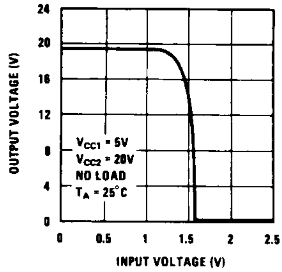
**High-Level Output Voltage vs Output Current**



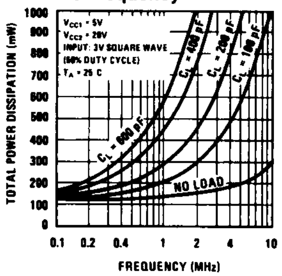

**Low-Level Output Voltage vs Output Current**



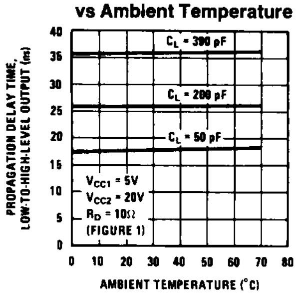

**Voltage Transfer Characteristics**



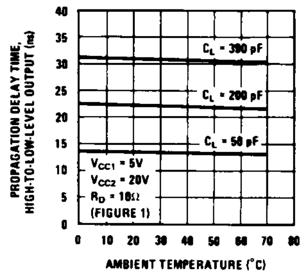

**Total Dissipation (Both Drivers) vs Frequency**



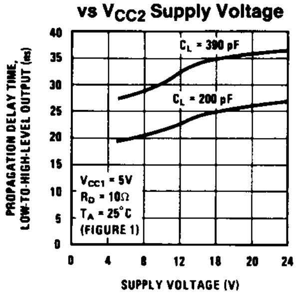

**Propagation Delay Time, Low-to-High Level Output vs Ambient Temperature**



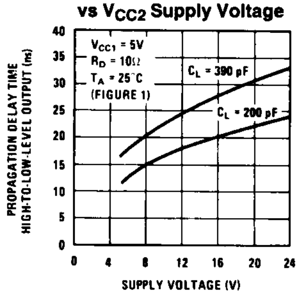

**Propagation Delay Time, High-to-Low Level Output vs Ambient Temperature**



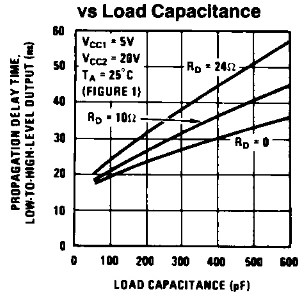

**Propagation Delay Time, Low-to-High Level Output vs $V_{CC2}$ Supply Voltage**



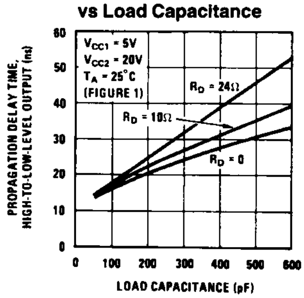

**Propagation Delay Time, High-to-Low Level Output vs $V_{CC2}$ Supply Voltage**




**Propagation Delay Time, Low-to-High Level Output vs Load Capacitance**




**Propagation Delay Time, High-to-Low Level Output vs Load Capacitance**

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## Typical Applications

The fast switching speeds of this device may produce undesirable output transient overshoot because of load or wiring inductance. A small series damping resistor may be used to reduce or eliminate this output transient overshoot. The optimum value of the damping resistor to use depends on the specific load characteristics and switching speed. A typical value would be between 10Ω and 30Ω *(Figure 3)*.

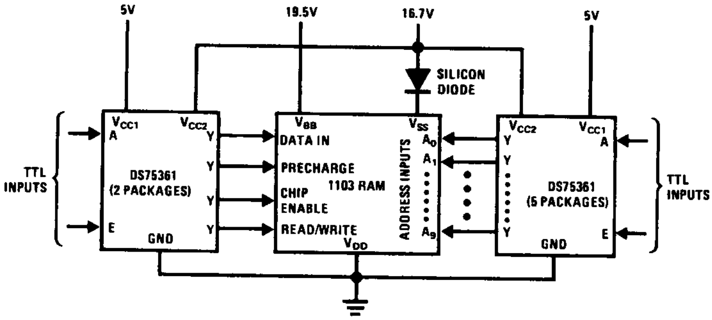


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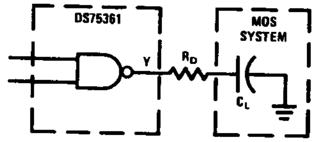
**FIGURE 2. Interconnection of DS75361 Devices with 1103 RAM**

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**Note:** $R_D \approx 10\Omega$ to $30\Omega$ (Optional).

**FIGURE 3. Use of Damping Resistor to Reduce or Eliminate Output Transient Overshoot in Certain DS75361 Applications**

## Thermal Information

**POWER DISSIPATION PRECAUTIONS**

Significant power may be dissipated in the DS75361 driver when charging and discharging high-capacitance loads over a wide voltage range at high frequencies. The total dissipation curve shows the power dissipated in a typical DS75361 as a function of load capacitance and frequency. Average power dissipated by this driver can be broken into three components:

$$P_{T(AV)} = P_{DC(AV)} + P_{C(AV)} + P_{S(AV)}$$

where $P_{DC(AV)}$ is the steady-state power dissipation with the output high or low, $P_{C(AV)}$ is the power level during charging or discharging of the load capacitance, and $P_{S(AV)}$ is the power dissipation during switching between the low and high levels. None of these include energy transferred to the load and all are averaged over a full cycle.

The power components per driver channel are:

$$P_{DC(AV)} = \frac{P_L t_L + P_H t_H}{T}$$

$$P_{C(AV)} \approx C\, V_C^2\, f$$

$$P_{S(AV)} = \frac{P_{LH} t_{LH} + P_{HL} t_{HL}}{T}$$

where the times are defined in *Figure 4*.

$P_L$, $P_H$, $P_{LH}$, and $P_{HL}$ are the respective instantaneous levels of power dissipation and C is load capacitance.

The DS75361 is so designed that $P_S$ is a negligible portion of $P_T$ in most applications. Except at very high frequencies, $t_L + t_H \gg t_{LH} + t_{HL}$ so that $P_S$ can be neglected. The total dissipation curve for no load demonstrates this point. The power dissipation contributions from both channels are then added together to obtain total device power.

The following example illustrates this power calculation technique. Assume both channels are operating identically with C = 200 pF, f = 2 MHz, $V_{CC1}$ = 5V, $V_{CC2}$ = 20V, and duty cycle = 60% outputs high ($t_H/T$ = 0.6). Also, assume $V_{OH}$ = 19.3V, $V_{OL}$ = 0.1V, $P_S$ is negligible, and that the current from $V_{CC2}$ is negligible when the output is high.

On a per-channel basis using data sheet values:

$$P_{DC(AV)} = \left[ (5V)\left(\frac{2\text{ mA}}{2}\right) + (20V)\left(\frac{0\text{ mA}}{2}\right) \right](0.6) + \left[ (5V)\left(\frac{16\text{ mA}}{2}\right) + (20V)\left(\frac{7\text{ mA}}{2}\right) \right](0.4)$$

$P_{DC(AV)}$ = 47 mW per channel

$P_{C(AV)} \approx$ (200 pF) $(19.2V)^2$ (2 MHz)

$P_{C(AV)} \approx$ 148 mW per channel.

For the total device dissipation of the two channels:

$P_{T(AV)} \approx 2\,(47 + 148)$

$P_{T(AV)} \approx$ 390 mW typical for total package.

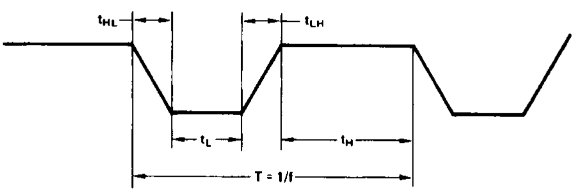


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**FIGURE 4. Output Voltage Waveform**