

**SN54LS440 THRU SN54LS442, SN54LS444
SN74LS440 THRU SN74LS442, SN74LS444
QUADRUPLE TRIDIRECTIONAL BUS TRANSCEIVERS**
SDLS176 D2425, AUGUST 1979 - REVISED MARCH 1988

- 3-Way Asynchronous Communication
- On-Chip Bus Selection Decoding
- Input Hysteresis Improves Noise Margin
- Choice of Open-Collector or 3-State Outputs

description

These bus transceivers are designed for asynchronous three-way communication between four-line data buses. They give the designer a choice of selecting inverting, noninverting, or a combination of inverting and noninverting data paths with either 3-state or open-collector outputs.

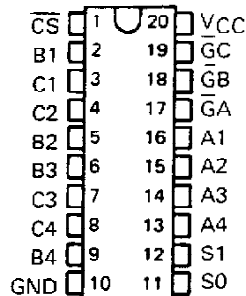
The S0 and S1 inputs select the bus from which data are to be transferred. The \bar{G} inputs enable the bus or buses to which data are to be transferred. The port for any bus selected for input and any other bus not enabled for output will be at high impedance including those of the open-collector devices.

The SN54LS440 through SN54LS442 and SN54LS444 are characterized for operation over the fullmilitary temperature range of -55°C to 125°C . The SN74LS440 through SN74LS442 and SN74LS444 are characterized for operation from 0°C to 70°C .

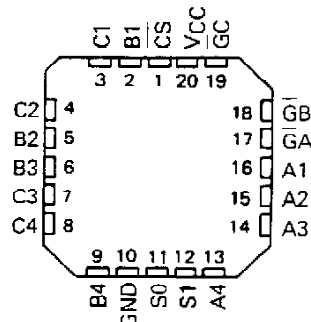
FUNCTION TABLE

| INPUTS | | | | | | TRANSFERS BETWEEN BUSES | | |
|------------|----|----|-------------|-------------|-------------|-------------------------|------------------------------------|------------------------------------|
| \bar{CS} | S1 | S0 | \bar{G}_A | \bar{G}_B | \bar{G}_C | 'LS440 'LS442 | 'LS441 | 'LS444 |
| H | X | X | X | X | X | None | None | None |
| X | H | H | X | X | X | None | None | None |
| X | X | X | H | H | H | None | None | None |
| X | L | L | X | H | H | None | None | None |
| X | L | H | H | X | H | None | None | None |
| X | H | L | H | H | X | None | None | None |
| L | L | L | X | L | L | $A \cdot B, A \cdot C$ | $\bar{A} \cdot B, \bar{A} \cdot C$ | $\bar{A} \cdot B, \bar{A} \cdot C$ |
| L | L | H | L | X | L | $B \cdot C, B \cdot A$ | $\bar{B} \cdot C, \bar{B} \cdot A$ | $B \cdot C, \bar{B} \cdot A$ |
| L | H | L | L | L | X | $C \cdot A, C \cdot B$ | $\bar{C} \cdot A, \bar{C} \cdot B$ | $\bar{C} \cdot A, C \cdot B$ |
| L | L | L | X | L | H | $A \cdot B$ | $\bar{A} \cdot B$ | $\bar{A} \cdot B$ |
| L | L | H | H | X | L | $B \cdot C$ | $\bar{B} \cdot C$ | $B \cdot C$ |
| L | H | L | L | H | X | $C \cdot A$ | $\bar{C} \cdot A$ | $\bar{C} \cdot A$ |
| L | L | L | X | H | L | $A \cdot C$ | $\bar{A} \cdot C$ | $\bar{A} \cdot C$ |
| L | L | H | L | X | H | $B \cdot A$ | $\bar{B} \cdot A$ | $\bar{B} \cdot A$ |
| L | H | L | H | L | X | $C \cdot B$ | $\bar{C} \cdot B$ | $C \cdot B$ |

**SN54LS' . . . J PACKAGE
SN74LS' . . . DW OR N PACKAGE
(TOP VIEW)**



**SN54LS' . . . FK PACKAGE
(TOP VIEW)**



| DEVICE | OUTPUT | LOGIC |
|--------|----------------|----------------|
| 'LS440 | Open-Collector | True |
| 'LS441 | Open-Collector | Inverting |
| 'LS442 | 3-State | True |
| 'LS444 | 3-State | True/Inverting |

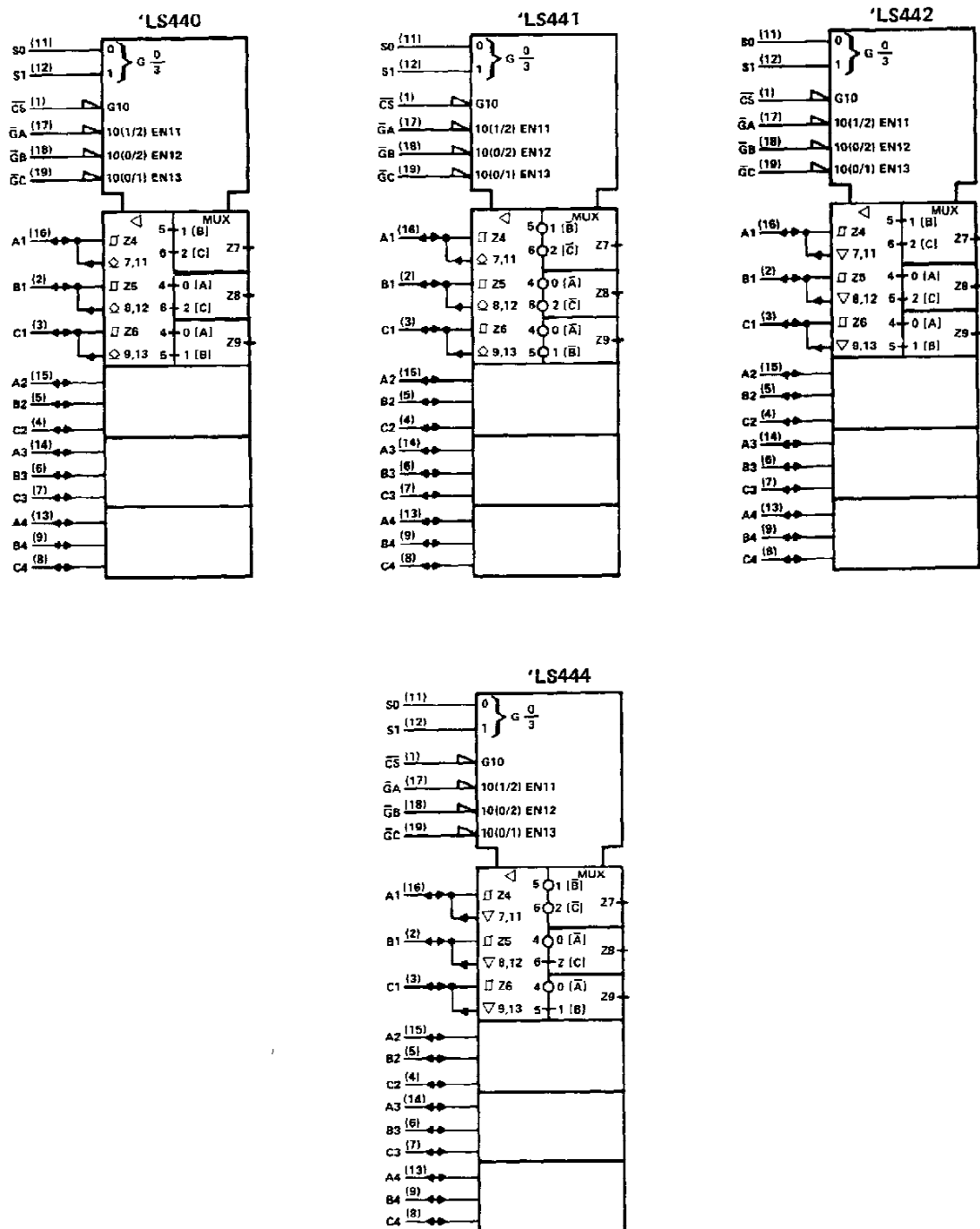
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**SN54LS440 THRU SN54LS442, SN54LS444
SN74LS440 THRU SN74LS442, SN74LS444
QUADRUPLE TRIDIRECTIONAL BUS TRANSCEIVERS**

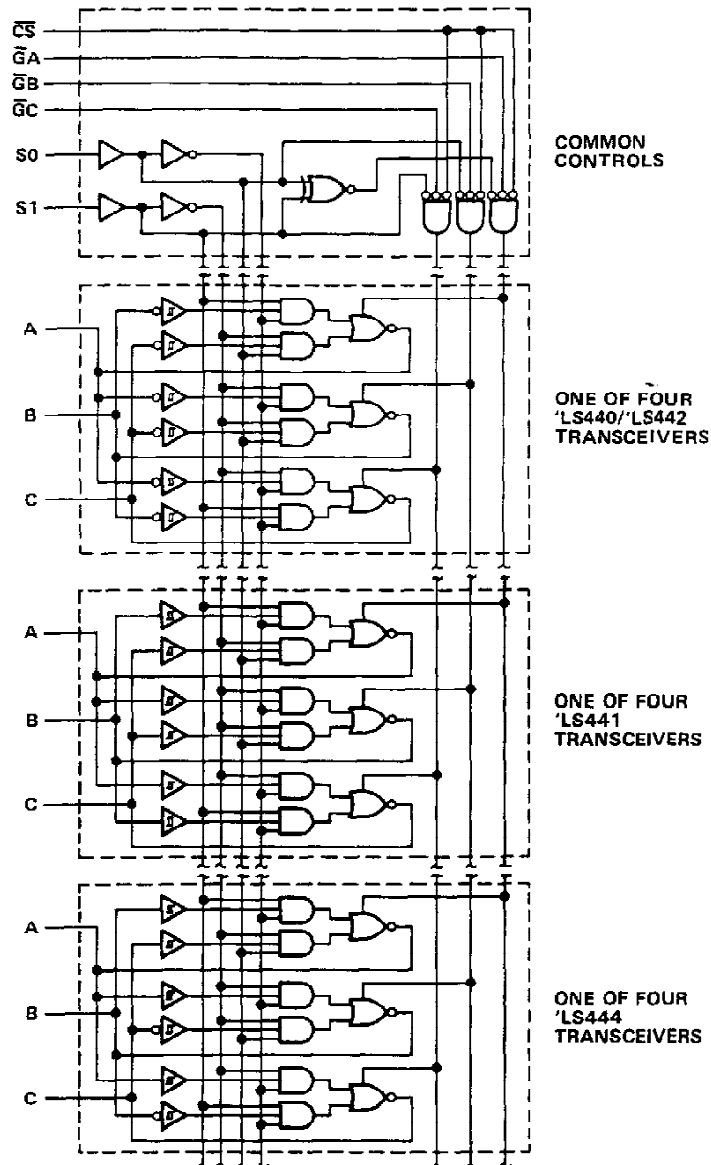
logic symbols†



† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12. Pin numbers shown are for DW, J, and N packages.

**SN54LS440 THRU SN74LS442, SN54LS444
SN74LS440 THRU SN74LS442, SN74LS444
QUADRUPE TRIDIRECTIONAL BUS TRANSCEIVERS**

logic diagram (composite showing one of four transceivers from each type, positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

| | |
|---|--|
| Supply voltage, V_{CC} (see Note 1) | 7 V |
| Input voltage | 7 V |
| Off-state output voltage | 5.5 V |
| Operating free-air temperature range: SN54LS' | -55°C to 125°C |
| SN74LS' | 0°C to 70°C |
| Storage temperature range | -65°C to 150°C |

NOTE 1: Voltage values are with respect to network ground terminal.

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SN54LS440, SN54LS441

SN74LS440, SN74LS441

QUAD TRIDIRECTIONAL BUS TRANSCEIVERS WITH OPEN-COLLECTOR OUTPUTS

recommended operating conditions

| | SN54LS440 SN54LS441 | | | SN74LS440 SN74LS441 | | | UNIT |
|---------------------------------------|------------------------|-----|-----|------------------------|-----|------|------|
| | MIN | NOM | MAX | MIN | NOM | MAX | |
| Supply voltage, V_{CC} (see Note 1) | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| High-level output voltage, V_{OH} | | | 5.5 | | | 5.5 | V |
| Low-level output current, I_{OL} | | | 12 | | | 24 | mA |
| Operating free-air temperature, T_A | -55 | | 125 | 0 | | 70 | °C |

NOTE 1: Voltage values are with respect to the network ground terminal.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | SN54LS* | | | SN74LS* | | | UNIT |
|-----------|--|---|---------|------|------|---------|------|------|------|
| | | | MIN | TYP‡ | MAX | MIN | TYP‡ | MAX | |
| V_{IH} | High-level input voltage | | 2 | | | 2 | | | V |
| V_{IL} | Low-level input voltage | | | | 0.5 | | | 0.6 | V |
| V_{IK} | Input clamp voltage | $V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$ | | | -1.5 | | | -1.5 | V |
| | Hysteresis ($V_{T+} - V_{T-}$) A,B,C input | $V_{CC} = \text{MIN}$ | 0.1 | 0.4 | | 0.2 | 0.4 | | V |
| I_{OH} | High-level output current | $V_{CC} = \text{MIN}, V_{OH} = 5.5 \text{ V}, V_{IH} = 2 \text{ V}, V_{IL} = V_{ILmax}$ | | | 100 | | | 100 | µA |
| V_{OL} | Low-level output voltage | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{ILmax}, I_{OL} = 12 \text{ mA}$ | 0.25 | 0.4 | | 0.25 | 0.4 | | V |
| | | $I_{OL} = 24 \text{ mA}$ | | | | 0.35 | 0.5 | | V |
| I_I | Input current at maximum input voltage | A,B,C input $V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$ | | | 0.1 | | | 0.1 | mA |
| | | All others $V_I = 7 \text{ V}$ | | | 0.1 | | | 0.1 | mA |
| I_{IH} | High-level input current | $V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$ | | | 20 | | | 20 | µA |
| I_{IL} | Low-level input current | $V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$ | | | -0.4 | | | -0.4 | mA |
| I_{CC} | Supply current | Outputs low $V_{CC} = \text{MAX}, \text{Outputs open}$ | 62 | 90 | | 62 | 90 | | mA |
| | | Outputs disabled | 64 | 95 | | 64 | 95 | | mA |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ \text{C}$.

switching characteristics at $V_{CC} = 5 \text{ V}, R_L = 667 \Omega, C_L = 45 \text{ pF}, T_A = 25^\circ \text{C}$, see note 2

| PARAMETER | | FROM (INPUT) | TO (OUTPUT) | 'LS440 | | | 'LS441 | | | UNIT |
|-----------|---|-----------------|----------------|--------|-----|-----|--------|-----|-----|------|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| t_{PLH} | Propagation delay time, low-to-high level output | A | B | 24 | 35 | | 21 | 30 | | ns |
| | | A | C | 24 | 35 | | 21 | 30 | | |
| | | B | A | 24 | 35 | | 21 | 30 | | |
| | | B | C | 24 | 35 | | 21 | 30 | | |
| | | C | A | 24 | 35 | | 21 | 30 | | |
| t_{PHL} | Propagation delay time, high-to-low level output | C | B | 24 | 35 | | 21 | 30 | | ns |
| | | A | B | 20 | 30 | | 9 | 15 | | |
| | | A | C | 20 | 30 | | 9 | 15 | | |
| | | B | A | 20 | 30 | | 9 | 15 | | |
| | | B | C | 20 | 30 | | 9 | 15 | | |
| t_{PLH} | Propagation delay time, low-to-high level output | C | A | 20 | 30 | | 9 | 15 | | ns |
| | | C | B | 20 | 30 | | 9 | 15 | | |
| | | Any \bar{G} | A,B,C | 29 | 45 | | 23 | 35 | | |
| t_{PHL} | Propagation delay time, high-to-low level output | S0,S1 | A,B,C | 33 | 50 | | 27 | 40 | | ns |
| | | \bar{CS} | A,B,C | 31 | 45 | | 26 | 40 | | |
| | | Any \bar{G} | A,B,C | 27 | 40 | | 20 | 30 | | |
| t_{PHL} | Propagation delay time, high-to-low level output | S0,S1 | A,B,C | 32 | 50 | | 26 | 40 | | ns |
| | | \bar{CS} | A,B,C | 28 | 45 | | 21 | 30 | | |
| | | Any \bar{G} | A,B,C | 27 | 40 | | 20 | 30 | | |

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.



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SN54LS442, SN54LS444
SN74LS442, SN74LS444

QUAD TRIDIRECTIONAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

recommended operating conditions

| | SN54LS442 SN54LS444 | | | SN74LS442 SN74LS444 | | | UNIT |
|---------------------------------------|------------------------|-----|-----|------------------------|-----|------|------|
| | MIN | NOM | MAX | MIN | NOM | MAX | |
| Supply voltage, V_{CC} (see Note 1) | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| High-level output current, I_{OH} | | | -12 | | | -15 | mA |
| Low-level output current, I_{OL} | | | 12 | | | 24 | mA |
| Operating free-air temperature, T_A | -55 | | 125 | 0 | | 70 | °C |

NOTE 1: Voltage values are with respect to the network ground terminal.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | | | TEST CONDITIONS† | | SN54LS* | | | SN74LS* | | | UNIT |
|-----------|--|-----------------|---|--------------------------|---------|------|------|---------|------|------|------|
| | | | | | MIN | TYP‡ | MAX | MIN | TYP‡ | MAX | |
| V_{IH} | High level input voltage | | | | 2 | | | 2 | | | V |
| V_{IL} | Low-level input voltage | | | | | | 0.5 | | | 0.6 | V |
| V_{IK} | Input clamp voltage | | $V_{CC} = \text{MIN.}$ | $I_I = -18 \text{ mA}$ | | | -1.5 | | | -1.5 | V |
| | Hysteresis ($V_{T+} - V_{T-}$) | A, B, C input | $V_{CC} = \text{MIN.}$ | | 0.1 | 0.4 | | 0.2 | 0.4 | | V |
| V_{OH} | High-level output voltage | | $V_{CC} = \text{MIN.},$ $V_{IH} = 2 \text{ V},$ $V_{IL} = V_{IL \text{ max}}$ | $I_{OH} = -3 \text{ mA}$ | 2.4 | 3.4 | | 2.4 | 3.4 | | V |
| | | | | $I_{OH} = \text{MAX}$ | 2 | | | 2 | | | |
| V_{OL} | Low-level output voltage | | $V_{CC} = \text{MIN.},$ $V_{IH} = 2 \text{ V},$ $V_{IL} = V_{IL \text{ max}}$ | $I_{OL} = 12 \text{ mA}$ | | 0.25 | 0.4 | | 0.25 | 0.4 | V |
| | | | | $I_{OL} = 24 \text{ mA}$ | | | | | 0.35 | 0.5 | |
| I_{OZH} | Off-state output current, high-level voltage applied | | $V_{CC} = \text{MAX.},$ \overline{CS} at 2 V | $V_O = 2.7 \text{ V}$ | | | 20 | | | 20 | μA |
| I_{OZL} | Off-state output current, low-level voltage applied | | | $V_O = 0.4 \text{ V}$ | | | -400 | | | -400 | |
| I_I | Input current at maximum input voltage | A, B, C | $V_{CC} = \text{MAX.}$ | $V_I = 5.5 \text{ V}$ | | | 0.1 | | | 0.1 | mA |
| | | Others | | $V_I = 7 \text{ V}$ | | | 0.1 | | | 0.1 | |
| I_{IH} | High-level input current | | $V_{CC} = \text{MAX.},$ | $V_I = 2.7 \text{ V}$ | | | 20 | | | 20 | μA |
| I_{IL} | Low-level input current | | $V_{CC} = \text{MAX.},$ | $V_I = 0.4 \text{ V}$ | | | -0.4 | | | -0.4 | mA |
| I_{OS} | Short circuit output current‡ | | $V_{CC} = \text{MAX.}$ | | -40 | | -225 | -40 | | -225 | mA |
| I_{CC} | Supply current | Outputs low | $V_{CC} = \text{MAX.},$ | Outputs open | | 62 | 90 | | 62 | 90 | mA |
| | | Outputs at Hi-Z | | | | 64 | 95 | | 64 | 95 | |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}.$

§ Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.



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SN54LS442, SN54LS444

SN74LS442, SN74LS444

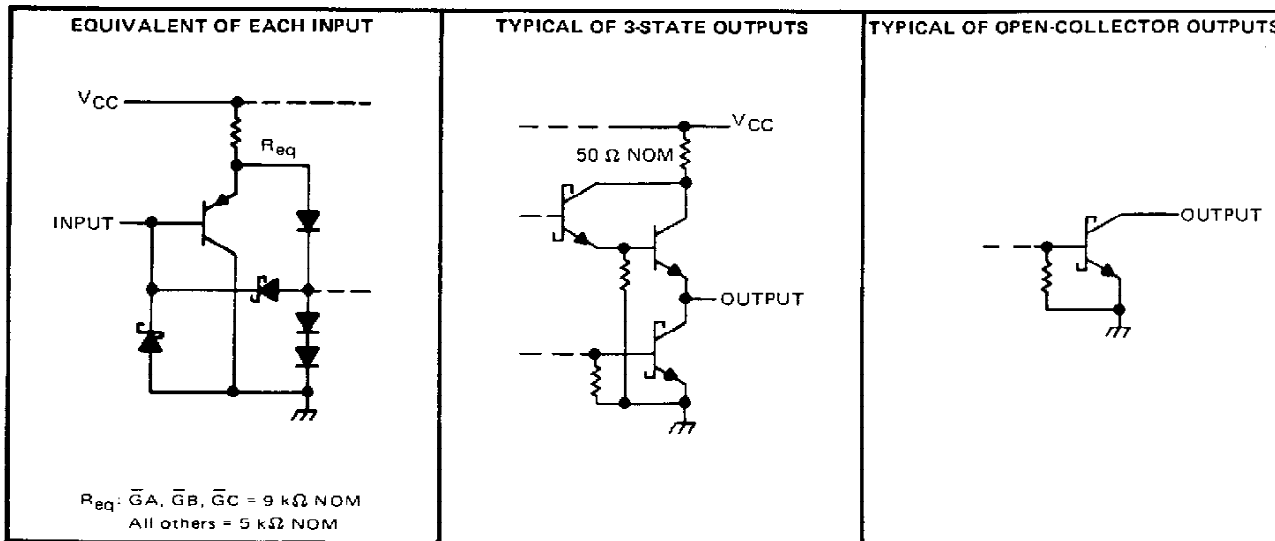
QUAD TRIDIRECTIONAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

switching characteristics at $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$, see note 2

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | 'LS442 | | | 'LS444 | | | UNIT |
|---|-------------------------------------|----------------|---|--------|-----|-----|--------|-----|-----|------|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| t_{PLH} Propagation delay time, low-to-high level output | A | B | $C_L = 45\text{ pF}$, $R_L = 667\ \Omega$ | | 10 | 14 | | 9 | 14 | ns |
| | A | C | | | 10 | 14 | | 9 | 14 | |
| | B | A | | | 10 | 14 | | 9 | 14 | |
| | B | C | | | 10 | 14 | | 10 | 14 | |
| | C | A | | | 10 | 14 | | 9 | 14 | |
| | C | B | | | 10 | 14 | | 10 | 14 | |
| t_{PHL} Propagation delay time, high-to-low level output | A | B | | | 13 | 20 | | 7 | 13 | ns |
| | A | C | | | 13 | 20 | | 7 | 13 | |
| | B | A | | | 13 | 20 | | 7 | 13 | |
| | B | C | | | 13 | 20 | | 13 | 20 | |
| | C | A | | | 13 | 20 | | 7 | 13 | |
| | C | B | | | 13 | 20 | | 13 | 20 | |
| t_{PZL} Output enable time to low level | Any \overline{G} | A,B,C | $C_L = 5\text{ pF}$, $R_L = 667\ \Omega$ | | 22 | 33 | | 22 | 33 | ns |
| | S0,S1 | A,B,C | | | 28 | 42 | | 28 | 42 | |
| | \overline{CS} | A,B,C | | | 23 | 36 | | 23 | 36 | |
| t_{PZH} Output enable time to high level | \overline{G} , S, \overline{CS} | A,B,C | | | 21 | 32 | | 24 | 32 | ns |
| t_{PLZ} Output disable time from low level | \overline{G} , S, \overline{CS} | A,B,C | | | 14 | 35 | | 14 | 25 | ns |
| t_{PHZ} Output disable time from high level | \overline{G} , S, \overline{CS} | A,B,C | | | 14 | 25 | | 14 | 25 | ns |

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

schematics of inputs and outputs



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