



# 3.3V CMOS 16-BIT REGISTERED TRANSCEIVER WITH 3-STATE OUTPUTS, 5 VOLT TOLERANT I/O, BUS-HOLD

**IDT74LVCH16543A**

## FEATURES:

- Typical  $t_{sk(o)}$  (Output Skew) < 250ps
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- $V_{CC} = 3.3V \pm 0.3V$ , Normal Range
- $V_{CC} = 2.7V$  to  $3.6V$ , Extended Range
- CMOS power levels (0.4μ W typ. static)
- All inputs, outputs, and I/O are 5V tolerant
- Supports hot insertion
- Available in TSSOP package

## DRIVE FEATURES:

- High Output Drivers:  $\pm 24mA$
- Reduced system switching noise

## APPLICATIONS:

- 5V and 3.3V mixed voltage systems
- Data communication and telecommunication systems

## DESCRIPTION

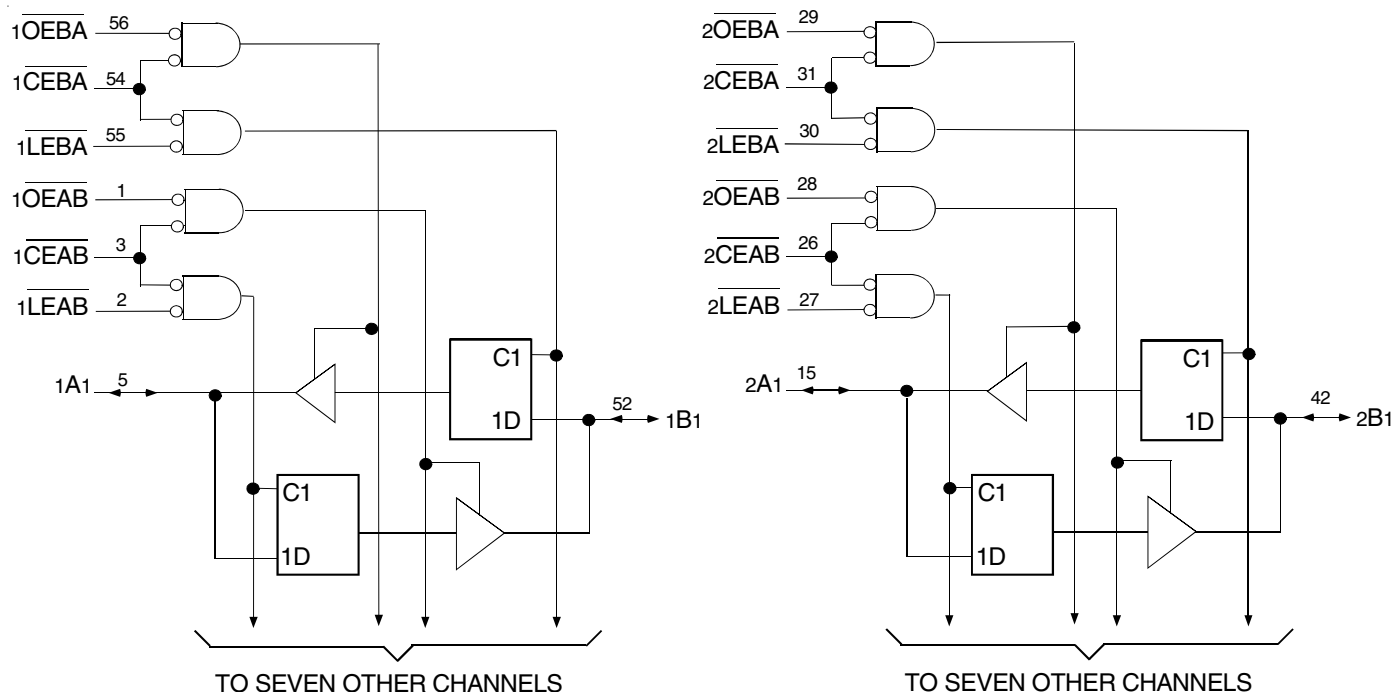
The LVCH16543A 16-bit registered transceiver is built using advanced dual metal CMOS technology. The LVCH16543A can be used as two 8-bit transceivers or one 16-bit transceiver. Separate latch-enable ( $\overline{LEAB}$  or  $\overline{LEBA}$ ) and output-enable ( $\overline{OEAB}$  or  $\overline{OEBA}$ ) inputs are provided for each register to permit independent control in either direction of data flow. The A-to-B enable ( $\overline{CEAB}$ ) input must be low in order to enter data from the A port or to output data from the B port.  $\overline{LEAB}$  controls the latch function. When  $\overline{LEAB}$  is low, the A to B latches are transparent. A subsequent low-to-high transition of  $\overline{LEAB}$  puts the A latches in the storage mode.  $\overline{OEAB}$  performs output enable function on the B port. Data flow from the B port to the A port is similar but requires using  $\overline{CEBA}$ ,  $\overline{LEBA}$ , and  $\overline{OEBA}$  inputs. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

All pins of this 16-bit registered transceiver can be driven from either 3.3V or 5V devices. This feature allows the use of this device as a translator in a mixed 3.3V/5V supply system.

The LVCH16543A has been designed with a  $\pm 24mA$  output driver. This driver is capable of driving a moderate to heavy load while maintaining speed performance.

The LVCH16543A has "bus-hold" which retains the inputs' last state whenever the input goes to a high impedance. This prevents floating inputs and eliminates the need for pull-up/down resistors.

## FUNCTIONAL BLOCK DIAGRAM

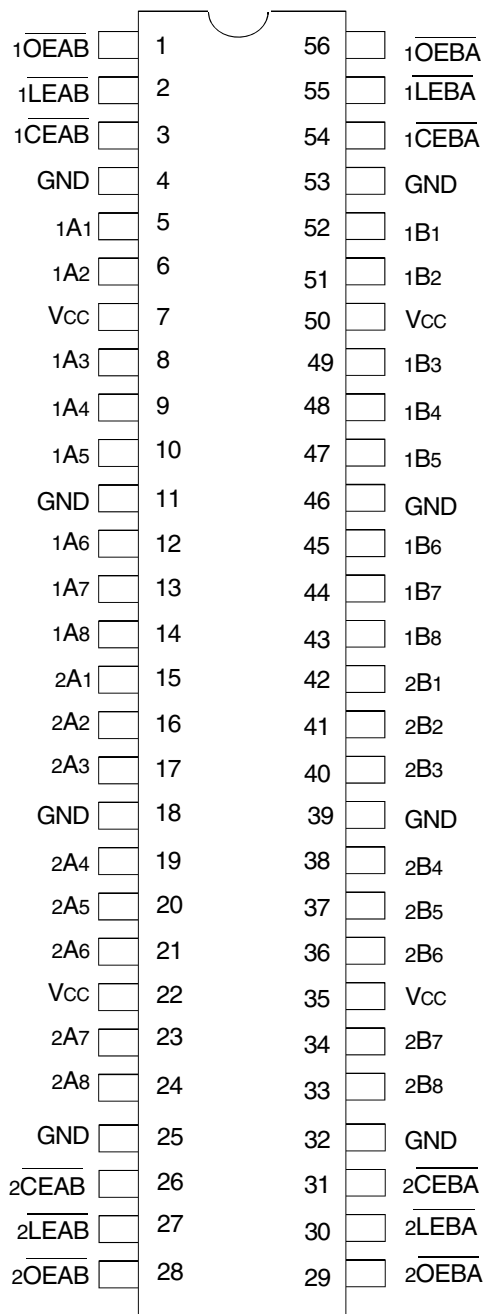


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INDUSTRIAL TEMPERATURE RANGE

March 2009

## PIN CONFIGURATION



TSSOP  
TOP VIEW

## CAPACITANCE ( $T_A = +25^\circ\text{C}$ , $F = 1.0\text{MHz}$ )

| Symbol           | Parameter <sup>(1)</sup> | Conditions            | Typ. | Max. | Unit |
|------------------|--------------------------|-----------------------|------|------|------|
| C <sub>IN</sub>  | Input Capacitance        | V <sub>IN</sub> = 0V  | 4.5  | 6    | pF   |
| C <sub>OUT</sub> | Output Capacitance       | V <sub>OUT</sub> = 0V | 6.5  | 8    | pF   |
| C <sub>I/O</sub> | I/O Port Capacitance     | V <sub>IN</sub> = 0V  | 6.5  | 8    | pF   |

### NOTE:

1. As applicable to the device type.

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

| Symbol                             | Description                                                           | Max          | Unit |
|------------------------------------|-----------------------------------------------------------------------|--------------|------|
| V <sub>TERM</sub>                  | Terminal Voltage with Respect to GND                                  | -0.5 to +6.5 | V    |
| T <sub>STG</sub>                   | Storage Temperature                                                   | -65 to +150  | °C   |
| I <sub>OUT</sub>                   | DC Output Current                                                     | -50 to +50   | mA   |
| I <sub>IK</sub><br>I <sub>OK</sub> | Continuous Clamp Current,<br>V <sub>I</sub> < 0 or V <sub>O</sub> < 0 | -50          | mA   |
| I <sub>CC</sub><br>I <sub>SS</sub> | Continuous Current through each<br>V <sub>CC</sub> or GND             | ±100         | mA   |

### NOTE:

1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## PIN DESCRIPTION

| Pin Names                  | Description                                                 |
|----------------------------|-------------------------------------------------------------|
| x $\overline{\text{OEAB}}$ | A-to-B Output Enable Input (Active LOW)                     |
| x $\overline{\text{OEBA}}$ | B-to-A Output Enable Input (Active LOW)                     |
| x $\overline{\text{CEAB}}$ | A-to-B Enable Input (Active LOW)                            |
| x $\overline{\text{CEBA}}$ | B-to-A Enable Input (Active LOW)                            |
| x $\overline{\text{LEAB}}$ | A-to-B Latch Enable Input (Active LOW)                      |
| x $\overline{\text{LEBA}}$ | B-to-A Latch Enable Input (Active LOW)                      |
| xAx                        | A-to-B Data Inputs or B-to-A 3-State Outputs <sup>(1)</sup> |
| xBx                        | B-to-A Data Inputs or A-to-B 3-State Outputs <sup>(1)</sup> |

### NOTE:

1. These pins have "Bus-Hold". All other pins are standard inputs, outputs, or I/Os.

## FUNCTION TABLE (EACH 8-BIT SECTION)<sup>(1,2)</sup>

| Inputs                     |                            |                            | Latch Status | Output Buffers                   |
|----------------------------|----------------------------|----------------------------|--------------|----------------------------------|
| x $\overline{\text{CEAB}}$ | x $\overline{\text{LEAB}}$ | x $\overline{\text{OEAB}}$ | xAx to xBx   | xBx                              |
| H                          | X                          | X                          | Storing      | High Z                           |
| X                          | X                          | H                          | Storing      | High Z                           |
| L                          | L                          | L                          | Transparent  | Current A Inputs                 |
| L                          | H                          | L                          | Storing      | Previous <sup>(3)</sup> A Inputs |
| L                          | L                          | H                          | Transparent  | High Z                           |
| L                          | H                          | H                          | Storing      | High Z                           |
| X                          | H                          | X                          | Storing      | Not Recommended                  |

### NOTES:

- H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Don't Care  
Z = High-Impedance
- A-to-B data flow is shown. B-to-A data flow is similar but uses x $\overline{\text{CEBA}}$ , x $\overline{\text{LEBA}}$ , and x $\overline{\text{OEBA}}$ .
- Before x $\overline{\text{LEAB}}$  LOW-to-HIGH transition.

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Operating Condition:  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

| Symbol                              | Parameter                                              | Test Conditions                                                       |                                          | Min. | Typ. <sup>(1)</sup> | Max.     | Unit          |
|-------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------|------|---------------------|----------|---------------|
| $V_{IH}$                            | Input HIGH Voltage Level                               | $V_{CC} = 2.3\text{V}$ to $2.7\text{V}$                               |                                          | 1.7  | —                   | —        | V             |
|                                     |                                                        | $V_{CC} = 2.7\text{V}$ to $3.6\text{V}$                               |                                          | 2    | —                   | —        |               |
| $V_{IL}$                            | Input LOW Voltage Level                                | $V_{CC} = 2.3\text{V}$ to $2.7\text{V}$                               |                                          | —    | —                   | 0.7      | V             |
|                                     |                                                        | $V_{CC} = 2.7\text{V}$ to $3.6\text{V}$                               |                                          | —    | —                   | 0.8      |               |
| $I_{IH}$<br>$I_{IL}$                | Input Leakage Current                                  | $V_{CC} = 3.6\text{V}$                                                | $V_I = 0$ to $5.5\text{V}$               | —    | —                   | $\pm 5$  | $\mu\text{A}$ |
| $I_{OZH}$<br>$I_{OZL}$              | High Impedance Output Current<br>(3-State Output pins) | $V_{CC} = 3.6\text{V}$                                                | $V_O = 0$ to $5.5\text{V}$               | —    | —                   | $\pm 10$ | $\mu\text{A}$ |
| $I_{OFF}$                           | Input/Output Power Off Leakage                         | $V_{CC} = 0\text{V}$ , $V_{IN}$ or $V_O \leq 5.5\text{V}$             |                                          | —    | —                   | $\pm 50$ | $\mu\text{A}$ |
| $V_{IK}$                            | Clamp Diode Voltage                                    | $V_{CC} = 2.3\text{V}$ , $I_{IN} = -18\text{mA}$                      |                                          | —    | -0.7                | -1.2     | V             |
| $V_H$                               | Input Hysteresis                                       | $V_{CC} = 3.3\text{V}$                                                |                                          | —    | 100                 | —        | mV            |
| $I_{CCL}$<br>$I_{CCH}$<br>$I_{CCZ}$ | Quiescent Power Supply Current                         | $V_{CC} = 3.6\text{V}$                                                | $V_{IN} = \text{GND}$ or $V_{CC}$        | —    | —                   | 10       | $\mu\text{A}$ |
|                                     |                                                        |                                                                       | $3.6 \leq V_{IN} \leq 5.5\text{V}^{(2)}$ | —    | —                   | 10       |               |
| $\Delta I_{CC}$                     | Quiescent Power Supply Current Variation               | One input at $V_{CC} - 0.6\text{V}$ , other inputs at $V_{CC}$ or GND |                                          | —    | —                   | 500      | $\mu\text{A}$ |

### NOTES:

- Typical values are at  $V_{CC} = 3.3\text{V}$ ,  $+25^{\circ}\text{C}$  ambient.
- This applies in the disabled state only.

## BUS-HOLD CHARACTERISTICS

| Symbol                   | Parameter <sup>(1)</sup>         | Test Conditions        |                            | Min. | Typ. <sup>(2)</sup> | Max.      | Unit          |
|--------------------------|----------------------------------|------------------------|----------------------------|------|---------------------|-----------|---------------|
| $I_{BHH}$<br>$I_{BHL}$   | Bus-Hold Input Sustain Current   | $V_{CC} = 3\text{V}$   | $V_I = 2\text{V}$          | -75  | —                   | —         | $\mu\text{A}$ |
|                          |                                  |                        | $V_I = 0.8\text{V}$        | 75   | —                   | —         |               |
| $I_{BHH}$<br>$I_{BHL}$   | Bus-Hold Input Sustain Current   | $V_{CC} = 2.3\text{V}$ | $V_I = 1.7\text{V}$        | —    | —                   | —         | $\mu\text{A}$ |
|                          |                                  |                        | $V_I = 0.7\text{V}$        | —    | —                   | —         |               |
| $I_{BHHO}$<br>$I_{BHLO}$ | Bus-Hold Input Overdrive Current | $V_{CC} = 3.6\text{V}$ | $V_I = 0$ to $3.6\text{V}$ | —    | —                   | $\pm 500$ | $\mu\text{A}$ |

### NOTES:

- Pins with Bus-Hold are identified in the pin description.
- Typical values are at  $V_{CC} = 3.3\text{V}$ ,  $+25^{\circ}\text{C}$  ambient.

## OUTPUT DRIVE CHARACTERISTICS

| Symbol | Parameter           | Test Conditions <sup>(1)</sup> |               | Min.      | Max. | Unit |
|--------|---------------------|--------------------------------|---------------|-----------|------|------|
| VOH    | Output HIGH Voltage | VCC = 2.3V to 3.6V             | IOH = – 0.1mA | VCC – 0.2 | —    | V    |
|        |                     | VCC = 2.3V                     | IOH = – 6mA   | 2         | —    |      |
|        |                     | VCC = 2.3V                     | IOH = – 12mA  | 1.7       | —    |      |
|        |                     | VCC = 2.7V                     |               | 2.2       | —    |      |
|        |                     | VCC = 3V                       |               | 2.4       | —    |      |
|        |                     | VCC = 3V                       | IOH = – 24mA  | 2         | —    |      |
| VOL    | Output LOW Voltage  | VCC = 2.3V to 3.6V             | IOL = 0.1mA   | —         | 0.2  | V    |
|        |                     | VCC = 2.3V                     | IOL = 6mA     | —         | 0.4  |      |
|        |                     |                                | IOL = 12mA    | —         | 0.7  |      |
|        |                     | VCC = 2.7V                     | IOL = 12mA    | —         | 0.4  |      |
|        |                     | VCC = 3V                       | IOL = 24mA    | —         | 0.55 |      |

### NOTE:

1. VIH and VIL must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate VCC range. TA = – 40°C to + 85°C.

## OPERATING CHARACTERISTICS, VCC = 3.3V ± 0.3V, TA = 25°C

| Symbol | Parameter                                                      | Test Conditions     | Typical | Unit |
|--------|----------------------------------------------------------------|---------------------|---------|------|
| CPD    | Power Dissipation Capacitance per Transceiver Outputs enabled  | CL = 0pF, f = 10Mhz | 44      | pF   |
| CPD    | Power Dissipation Capacitance per Transceiver Outputs disabled |                     | 4       |      |

## SWITCHING CHARACTERISTICS<sup>(1)</sup>

| Symbol       | Parameter                                                       | VCC = 2.7V |      | VCC = 3.3V ± 0.3V |      | Unit |
|--------------|-----------------------------------------------------------------|------------|------|-------------------|------|------|
|              |                                                                 | Min.       | Max. | Min.              | Max. |      |
| tPLH<br>tPHL | Propagation Delay, Transparent Mode<br>xAx to xBx or xBx to xAx | —          | 6.1  | 1.2               | 5.4  | ns   |
| tPLH<br>tPHL | Propagation Delay<br>xLEBA to xAx, xLEAB to xBx                 | —          | 7.4  | 1.5               | 6.1  | ns   |
| tPZH<br>tPZL | Output Enable Time<br>xCEBA or xCEAB to xAx or xBx              | —          | 7.9  | 1.2               | 6.6  | ns   |
| tPZH<br>tPZL | Output Enable Time<br>xOEBA or xOEAB to xAx or xBx              | —          | 7.6  | 1                 | 6.3  | ns   |
| tPHZ<br>tPLZ | Output Disable Time<br>xCEBA or xCEAB to xAx or xBx             | —          | 7.1  | 1.5               | 6.6  | ns   |
| tPHZ<br>tPLZ | Output Disable Time<br>xOEBA or xOEAB to xAx or xBx             | —          | 6.9  | 1.5               | 6.3  | ns   |
| tsu          | Set-up Time, data before CE↑                                    | 1.1        | —    | 1.1               | —    | ns   |
| tsu          | Set-up Time, data before LE↑, CE LOW                            | 1.1        | —    | 1.1               | —    | ns   |
| tH           | Hold Time, data after CE↑                                       | 1.9        | —    | 1.9               | —    | ns   |
| tH           | Hold Time, data after LE↑, CE LOW                               | 1.9        | —    | 1.9               | —    | ns   |
| tw           | Pulse Duration, xLEBA or xLEAB, xCEBA or xCEAB LOW              | 3.3        | —    | 3.3               | —    | ns   |
| tsk(0)       | Output Skew <sup>(2)</sup>                                      | —          | —    | —                 | 500  | ps   |

### NOTES:

1. See TEST CIRCUITS AND WAVEFORMS. TA = – 40°C to + 85°C.
2. Skew between any two outputs of the same package and switching in the same direction.



## ORDERING INFORMATION

| XX          | LVC      | X      | XX          | XXXX    | XX        |                                                                        |
|-------------|----------|--------|-------------|---------|-----------|------------------------------------------------------------------------|
| Temp. Range | Bus-Hold | Family | Device Type | Package |           |                                                                        |
|             |          |        |             |         | PA<br>PAG | Thin Shrink Small Outline Package<br>TSSOP - Green                     |
|             |          |        |             |         | 543A      | 16-Bit Registered Transceiver with 3-State Outputs,<br>5V Tolerant I/O |
|             |          |        |             |         | 16        | Double-Density, $\pm 24\text{mA}$                                      |
|             |          |        |             |         | H         | Bus-hold                                                               |
|             |          |        |             |         | 74        | $-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$                         |



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