



3.3V CMOS 18-BIT UNIVERSAL BUS TRANSCIVER WITH 3 STATE OUTPUTS, 5 VOLT TOLERANT I/O

IDT74LVC16601A

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 (0.4 μ W typ. static)
- All inputs, outputs, and I/O are 5V tolerant
- Supports hot insertion
- Available in SSOP and TSSOP packages

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 LVC16601A 18-bit universal bus transceiver is built using advanced dual metal CMOS technology. This 18-bit universal bus transceiver combines D-type latches and D-type flip-flops to allow data flow in transparent, latched and clocked modes.

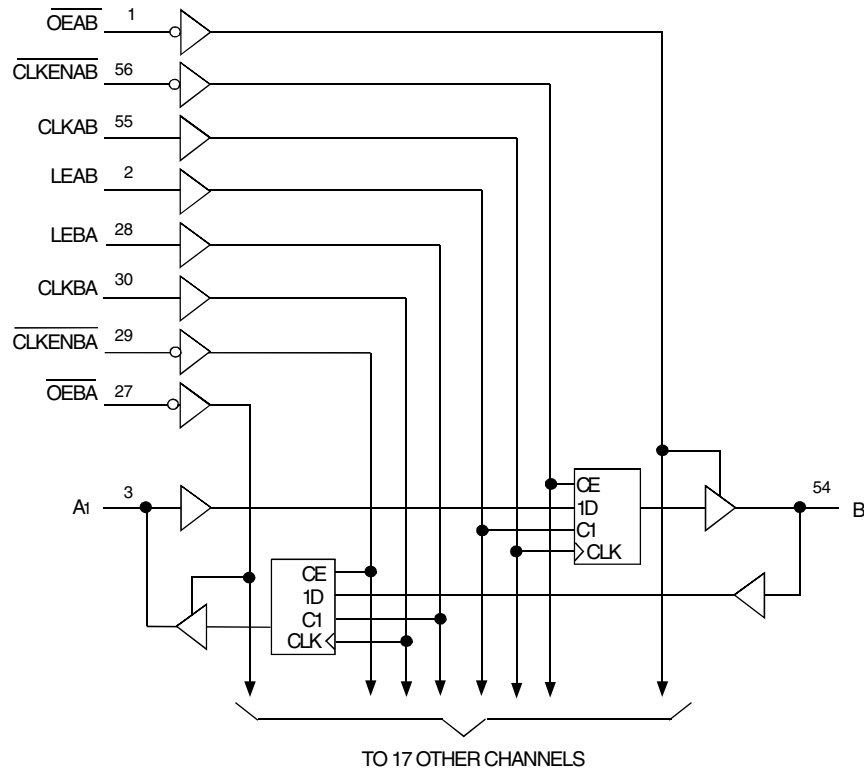
Data flow in each direction is controlled by output-enable (\overline{OEAB} and \overline{OEBA}), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs. The clock can be controlled by the clock-enable ($\overline{CLKENAB}$ and $\overline{CLKENBA}$) inputs.

For A-to-B data flow, the device operates in the transparent mode when LEAB is high. When LEAB is low, the A data is latched if CLKAB is held at a high or low logic level. If LEAB is low, the A-bus data is stored in the latch/flip-flop on the LOW-to-HIGH transition of CLKAB. Output enable \overline{OEAB} is active low. When \overline{OEAB} is low, the outputs are active. When \overline{OEAB} is high, the outputs are in the high-impedance state. Data flow for B to A is similar to that of A to B but uses \overline{OEBA} , LEBA, CLKBA and $\overline{CLKENBA}$.

All pins 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 LVC16601A has been designed with a $\pm 24mA$ output driver. This driver is capable of driving a moderate to heavy load while maintaining speed performance.

FUNCTIONAL BLOCK DIAGRAM

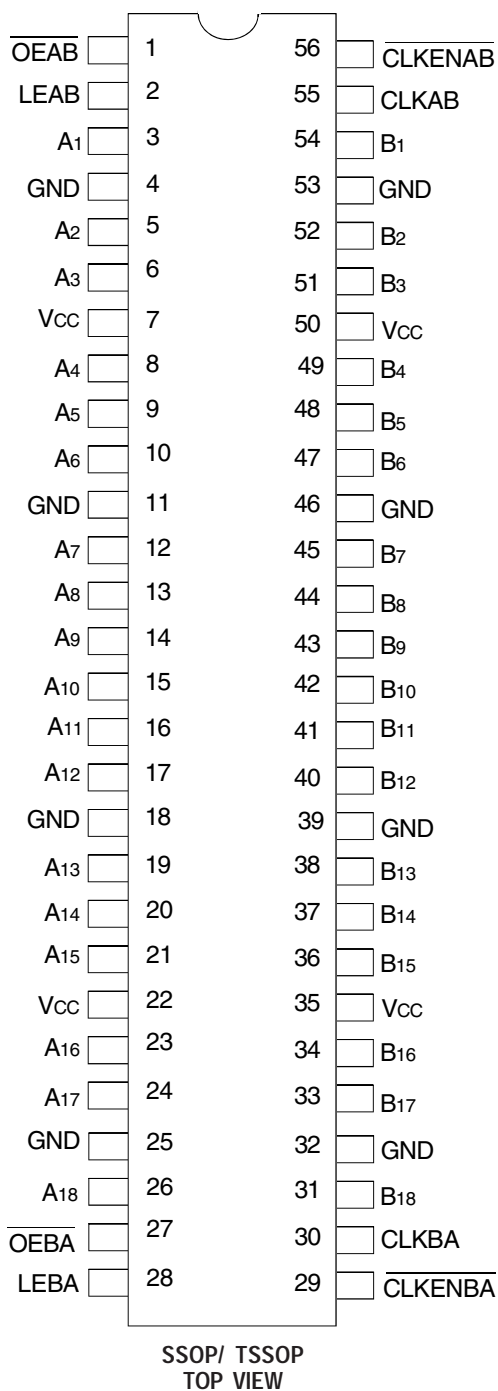


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INDUSTRIAL TEMPERATURE RANGE

JANUARY 2004

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Symbol	Description	Max	Unit
VTERM	Terminal Voltage with Respect to GND	-0.5 to +6.5	V
TSTG	Storage Temperature	-65 to +150	°C
I _{OUT}	DC Output Current	-50 to +50	mA
I _{IK} I _{OK}	Continuous Clamp Current, V _I < 0 or V _O < 0	-50	mA
I _{CC} I _{SS}	Continuous Current through each V _{CC} or GND	±100	mA

NOTE:

- 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
\overline{OEAB}	A-to-B Output Enable Input (Active LOW)
\overline{OEBA}	B-to-A Output Enable Input (Active LOW)
LEAB	A-to-B Latch Enable Input
LEBA	B-to-A Latch Enable Input
CLKAB	A-to-B Clock Input
CLKBA	B-to-A Clock Input
A _x	A-to-B Data Inputs or B-to-A 3-State Outputs
B _x	B-to-A Data Inputs or A-to-B 3-State Outputs
$\overline{CLKENAB}$	A-to-B Clock Enable Input (Active LOW)
$\overline{CLKENBA}$	B-to-A Clock Enable Input (Active LOW)

FUNCTION TABLE^(1,2)

Inputs				Outputs	
$\overline{CLKENAB}$	\overline{OEAB}	LEAB	CLKAB	A _x	B _x
X	H	X	X	X	Z
X	L	H	X	L	L
X	L	H	X	H	H
H	L	L	X	X	B ⁽³⁾
L	L	L	↑	L	L
L	L	L	↑	H	H
L	L	L	L	X	B ⁽³⁾
L	L	L	H	X	B ⁽⁴⁾

NOTES:

- H = HIGH Voltage Level
X = Don't Care
L = LOW Voltage Level
Z = High-Impedance
↑ = LOW-to-HIGH transition
- A-to-B data flow is shown. B-to-A data flow is similar but uses \overline{OEBA} , LEBA, CLKBA, and $\overline{CLKENBA}$.
- Output level before the indicated steady-state input conditions were established.
- Output level before the indicated steady-state input conditions were established, provided that CLKAB was HIGH before LEAB went LOW.

CAPACITANCE (T_A = +25°C, F = 1.0MHz)

Symbol	Parameter ⁽¹⁾	Conditions	Typ.	Max.	Unit
C _{IN}	Input Capacitance	V _{IN} = 0V	4.5	6	pF
C _{OUT}	Output Capacitance	V _{OUT} = 0V	6.5	8	pF
C _{I/O}	I/O Port Capacitance	V _{IN} = 0V	6.5	8	pF

NOTE:

- As applicable to the device type.

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. ⁽¹⁾	Max.	Unit
V _{IH}	Input HIGH Voltage Level	V _{CC} = 2.3V to 2.7V		1.7	—	—	V
		V _{CC} = 2.7V to 3.6V		2	—	—	
V _{IL}	Input LOW Voltage Level	V _{CC} = 2.3V to 2.7V		—	—	0.7	V
		V _{CC} = 2.7V to 3.6V		—	—	0.8	
I _{IH} I _{IL}	Input Leakage Current	V _{CC} = 3.6V	V _I = 0 to 5.5V	—	—	±5	μA
I _{OZH} I _{OZL}	High Impedance Output Current (3-State Output pins)	V _{CC} = 3.6V	V _O = 0 to 5.5V	—	—	±10	μA
I _{OFF}	Input/Output Power Off Leakage	V _{CC} = 0V, V _{IN} or V _O ≤ 5.5V		—	—	±50	μA
V _{IK}	Clamp Diode Voltage	V _{CC} = 2.3V, I _{IN} = -18mA		—	-0.7	-1.2	V
V _H	Input Hysteresis	V _{CC} = 3.3V		—	100	—	mV
I _{CC1} I _{CC2} I _{CC3}	Quiescent Power Supply Current	V _{CC} = 3.6V	V _{IN} = GND or V _{CC}	—	—	10	μA
			3.6 ≤ V _{IN} ≤ 5.5V ⁽²⁾	—	—	10	
ΔI _{CC}	Quiescent Power Supply Current Variation	One input at V _{CC} - 0.6V, other inputs at V _{CC} or GND		—	—	500	μA

NOTES:

1. Typical values are at V_{CC} = 3.3V, +25°C ambient.
2. This applies in the disabled state only.

OUTPUT DRIVE CHARACTERISTICS

Symbol	Parameter	Test Conditions ⁽¹⁾		Min.	Max.	Unit
V _{OH}	Output HIGH Voltage	V _{CC} = 2.3V to 3.6V	I _{OH} = -0.1mA	V _{CC} - 0.2	—	V
		V _{CC} = 2.3V	I _{OH} = -6mA	2	—	
		V _{CC} = 2.3V	I _{OH} = -12mA	1.7	—	
		V _{CC} = 2.7V		2.2	—	
		V _{CC} = 3V		2.4	—	
		V _{CC} = 3V	I _{OH} = -24mA	2.2	—	
V _{OL}	Output LOW Voltage	V _{CC} = 2.3V to 3.6V	I _{OL} = 0.1mA	—	0.2	V
		V _{CC} = 2.3V	I _{OL} = 6mA	—	0.4	
			I _{OL} = 12mA	—	0.7	
		V _{CC} = 2.7V	I _{OL} = 12mA	—	0.4	
		V _{CC} = 3V	I _{OL} = 24mA	—	0.55	

NOTE:

1. V_{IH} and V_{IL} must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate V_{CC} range. T_A = -40°C to +85°C.

OPERATING CHARACTERISTICS, $V_{CC} = 3.3V \pm 0.3V$, $T_A = 25^\circ C$

Symbol	Parameter	Test Conditions	Typical	Unit
CPD	Power Dissipation Capacitance per Transceiver Outputs enabled	$C_L = 0pF$, $f = 10MHz$		pF
CPD	Power Dissipation Capacitance per Transceiver Outputs disabled			

SWITCHING CHARACTERISTICS⁽¹⁾

Symbol	Parameter	$V_{CC} = 2.7V$		$V_{CC} = 3.3V \pm 0.3V$		Unit
		Min.	Max.	Min.	Max.	
t_{PLH} t_{PHL}	Propagation Delay Ax to Bx or Bx to Ax	—	5.4	—	4.6	ns
t_{PLH} t_{PHL}	Propagation Delay LEBA to Ax, LEAB to Bx	—	6.2	—	5.2	ns
t_{PLH} t_{PHL}	Propagation Delay CLKBA to Ax, CLKAB to Bx	—	6.3	—	5.3	ns
t_{PZH} t_{PZL}	Output Enable Time \overline{OEBA} to Ax, \overline{OEAB} to Bx	—	6.8	—	5.6	ns
t_{PHZ} t_{PLZ}	Output Disable Time \overline{OEBA} to Ax, \overline{OEAB} to Bx	—	6	—	5.2	ns
t_{SU}	Set-up Time HIGH or LOW, Ax to CLKAB, Bx to CLKBA	1.5	—	1.5	—	ns
t_H	Hold Time HIGH or LOW, Ax to CLKAB, Bx to CLKBA	0.8	—	0.8	—	ns
t_{SU}	Set-up Time HIGH or LOW Ax to LEAB, Bx to LEBA	Clock LOW	1	—	1	ns
		Clock HIGH	1	—	1	
t_{SU}	Set-up Time, $\overline{CLKENAB}$ to CLKAB	2.1	—	2.1	—	ns
t_{SU}	Set-up Time, $\overline{CLKENBA}$ to CLKBA	2.1	—	2.1	—	ns
t_H	Hold Time HIGH or LOW, Ax after LEAB, Bx after LEBA	1.8	—	1.8	—	ns
t_H	Hold Time, $\overline{CLKENAB}$ after CLKAB	0.5	—	0.5	—	ns
t_H	Hold Time, $\overline{CLKENBA}$ after CLKBA	0.5	—	0.5	—	ns
t_W	LEAB or LEBA Pulse Width HIGH	3	—	3	—	ns
t_W	CLKAB or CLKBA Pulse Width HIGH or LOW	3	—	3	—	ns
$t_{SK(0)}$	Output Skew ⁽²⁾	—	—	—	500	ps

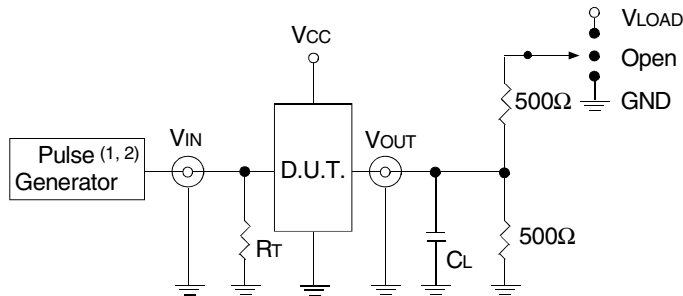
NOTES:

1. See TEST CIRCUITS AND WAVEFORMS. $T_A = -40^\circ C$ to $+85^\circ C$.
2. Skew between any two outputs of the same package and switching in the same direction.

TEST CIRCUITS AND WAVEFORMS

TEST CONDITIONS

Symbol	V _{CC} ⁽¹⁾ = 3.3V±0.3V	V _{CC} ⁽¹⁾ = 2.7V	V _{CC} ⁽²⁾ = 2.5V±0.2V	Unit
V _{LOAD}	6	6	2 x V _{CC}	V
V _{IH}	2.7	2.7	V _{CC}	V
V _T	1.5	1.5	V _{CC} / 2	V
V _{LZ}	300	300	150	mV
V _{HZ}	300	300	150	mV
C _L	50	50	30	pF



Test Circuit for All Outputs

DEFINITIONS:

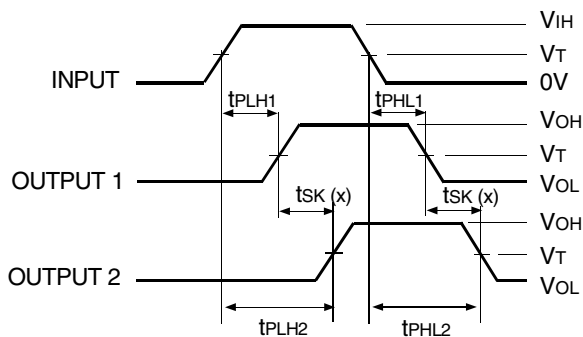
C_L = Load capacitance: includes jig and probe capacitance.
R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator.

NOTES:

1. Pulse Generator for All Pulses: Rate ≤ 10MHz; t_r ≤ 2.5ns; t_r ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 10MHz; t_r ≤ 2ns; t_r ≤ 2ns.

SWITCH POSITION

Test	Switch
Open Drain Disable Low Enable Low	V _{LOAD}
Disable High Enable High	GND
All Other Tests	Open

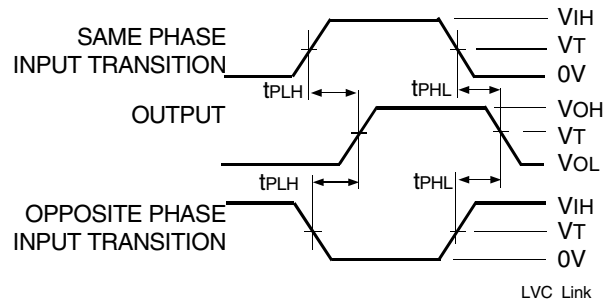


$$tsk(x) = |t_{PLH2} - t_{PLH1}| \text{ or } |t_{PHL2} - t_{PHL1}|$$

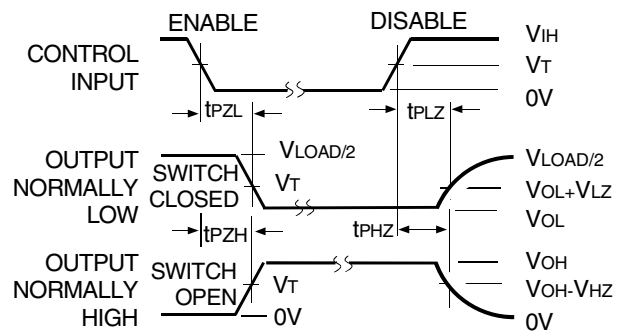
Output Skew - tsk(x)

NOTES:

1. For tsk(o) OUTPUT1 and OUTPUT2 are any two outputs.
2. For tsk(b) OUTPUT1 and OUTPUT2 are in the same bank.



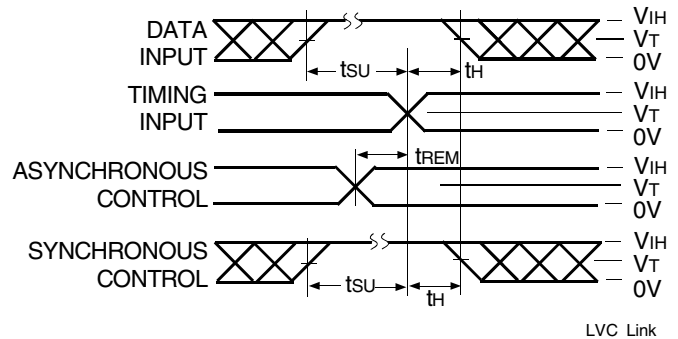
Propagation Delay



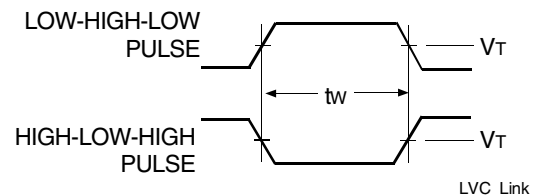
Enable and Disable Times

NOTE:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.

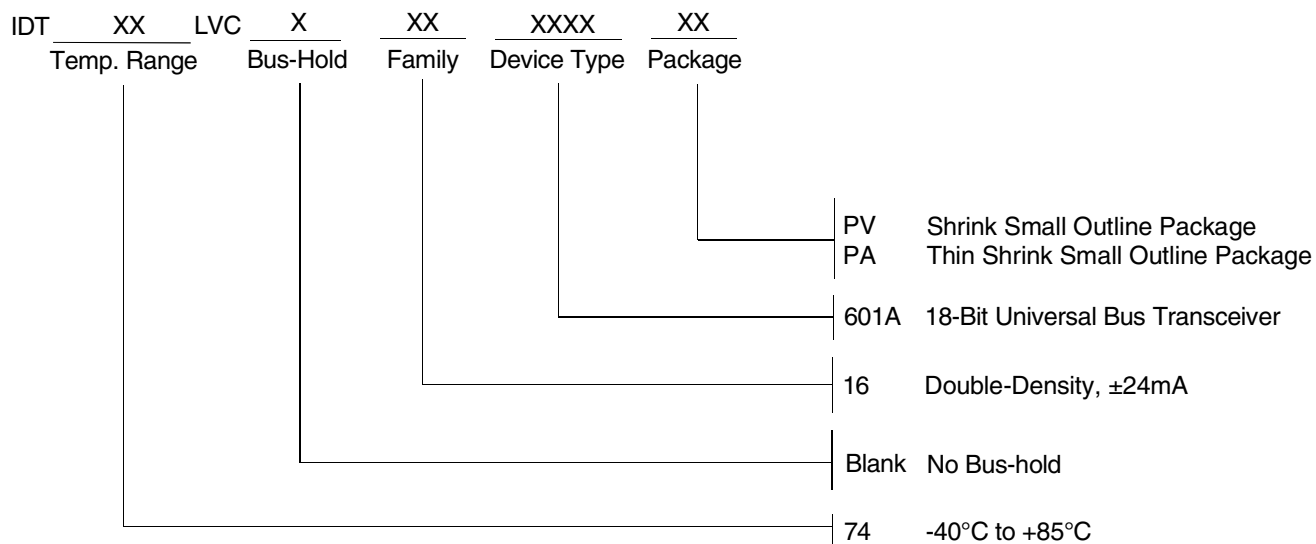


Set-up, Hold, and Release Times



Pulse Width

ORDERING INFORMATION



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