

DS92001

3.3V B/LVDS-BLVDS Buffer

General Description

The DS92001 B/LVDS-BLVDS Buffer takes a BLVDS input signal and provides a BLVDS output signal. In many large systems, signals are distributed across backplanes. One of the limiting factors for system speed is the "stub length" or the distance between the transmission line and the unterminated receivers on individual cards. Although it is generally recognized that this distance should be as short as possible to maximize system performance, real-world packaging concerns often make it difficult to make the stubs as short as the designer would like.

The DS92001 has edge transitions optimized for multidrop backplanes where the switching frequency is in the 200 MHz range or less. The output edge rate is critical in some systems where long stubs may be present, and utilizing a slow transition allows for longer stub lengths.

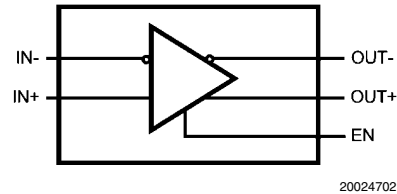
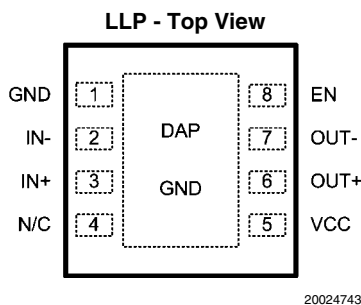
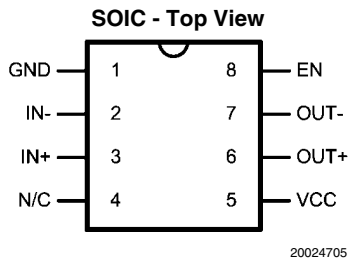
The DS92001, available in the LLP (Leadless Leadframe Package) package, will allow the receiver inputs to be placed very close to the main transmission line, thus improving system performance.

A wide input dynamic range allows the DS92001 to receive differential signals from LVPECL, CML as well as LVDS sources. This will allow the device to also fill the role of an LVPECL-BLVDS or CML-BLVDS translator.

Features

- Single +3.3 V Supply
- Receiver inputs accept LVDS/CML/LVPECL signals
- TRI-STATE outputs
- Receiver input threshold $< \pm 100$ mV
- Fast propagation delay of 1.4 ns (typ)
- Low jitter 400 Mbps fully differential data path
- Compatible with BLVDS 10-bit SerDes (40MHz)
- Compatible with ANSI/TIA/EIA-644-A LVDS standard
- Available in SOIC and space saving LLP package
- Industrial Temperature Range

Connection and Block Diagrams



Functional Operation

BLVDS Inputs	BLVDS Outputs	
	OUT+	OUT-
$[IN+] - [IN-]$	H	L
$VID \geq 0.1V$	H	L
$VID \leq -0.1V$	L	H
$-0.1V \leq VID \leq 0.1V$	Undefined	Undefined

Ordering Information

Order Number	NS Pkg. No.	Pkg. Type
DS92001TMA	M08A	SOIC
DS92001TLD	LDA08A	LLP

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 (V_{CC})	-0.3V to +4V
LVC MOS/LVTTL Input Voltage (EN)	-0.3V to ($V_{CC} + 0.3V$)
B/LVDS Receiver Input Voltage (IN+, IN-)	-0.3V to +4V
BLVDS Driver Output Voltage (OUT+, OUT-)	-0.3V to +4V
BLVDS Output Short Circuit Current	Continuous
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature Range	
Soldering (4 sec.)	+260°C

Maximum Package Power Dissipation at 25°C

M Package	726 mW
Derate M Package	5.8 mW/°C above +25°C
LDA Package	2.44 W
Derate LDA Package	19.49 mW/°C above +25°C
ESD Ratings	
(HBM, 1.5k Ω , 100pF)	$\geq 2.5kV$
(EIAJ, 0 Ω , 200pF)	$\geq 250V$

Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage (V_{CC})	3.0	3.3	3.6	V
Receiver Differential Input Voltage (V_{ID}) with $V_{CM}=1.2V$	0.1		2.4	V
Operating Free Air Temperature	-40	+25	+85	°C
B/LVDS Input Rise/Fall 20% to 80%		2	20	ns

Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. (Notes 2, 3)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LVC MOS/LVTTL DC SPECIFICATIONS (EN)						
V_{IH}	High Level Input Voltage		2.0		V_{CC}	V
V_{IL}	Low Level Input Voltage		GND		0.8	V
I_{IH}	High Level Input Current	$V_{IN} = V_{CC}$ or 2.0V		+7	+20	μA
I_{IL}	Low Level Input Current	$V_{IN} = GND$ or 0.8V	-10	± 1	+10	μA
V_{CL}	Input Clamp Voltage	$I_{CL} = -18$ mA		-0.6	-1.5	V
BLVDS OUTPUT DC SPECIFICATIONS (OUT)						
$ V_{OD} $	Differential Output Voltage (Note 2)	$R_L = 27\Omega$	250	350	500	mV
		$R_L = 50\Omega$	350	450	600	mV
ΔV_{OD}	Change in Magnitude of V_{OD} for Complimentary Output States	$R_L = 27\Omega$ or 50Ω Figure 1, Figure 2			20	mV
V_{OS}	Offset Voltage	$R_L = 27\Omega$ or $R_L = 50\Omega$	1.1	1.25	1.375	V
ΔV_{OS}	Change in Magnitude of V_{OS} for Complimentary Output States	Figure 1		2	20	mV
I_{OZ}	Output TRI-STATE Current	EN = 0V, $V_{OUT} = V_{CC}$ or GND	-20	± 5	+20	μA
I_{OFF}	Power-Off Leakage Current	$V_{CC} = 0V$ or Open Circuit, $V_{OUT} = 3.6V$	-20	± 5	+20	μA
I_{OS1}	Output Short Circuit Current (Note 4)	EN = V_{CC} , $V_{CM} = 1.2V$, $V_{ID} = 200mV$, $V_{OUT+} = 0V$, or $V_{ID} = -200mV$, $V_{CM} = 1.2V$, $V_{OUT-} = 0V$		-30	-60	mA
		$V_{ID} = -200mV$, $V_{CM} = 1.2V$, $V_{OUT+} = V_{CC}$, or $V_{ID} = 200mV$, $V_{CM} = 1.2V$, $V_{OUT-} = V_{CC}$		53	80	mA
I_{OSD}	Differential Output Short Circuit Current (Note 4)	EN = V_{CC} , $V_{ID} = 200mV $, $V_{CM} = 1.2V$, $V_{OD} = 0V$ (connect true and complement outputs through a current meter)		30	42	mA

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
B/LVDS RECEIVER DC SPECIFICATIONS (IN)							
V_{TH}	Differential Input High Threshold (Note 5)	$V_{CM} = +0.05V, +1.2V$ or $+3.25V$		-30	-5	mV	
V_{TL}	Differential Input Low Threshold (Note 5)		-70	-30		mV	
V_{CMR}	Common Mode Voltage Range (Note 5)		$ V_{ID} /2$		V_{CC} $- V_{ID} /2$	V	
I_{IN}	Input Current	$V_{IN} = V_{CC}$	$V_{CC} = 3.6V$ or $0V$		11.5I	120I	μA
		$V_{IN} = 0V$			11.5I	120I	μA
ΔI_{IN}	Change in Magnitude of I_{IN}	$V_{IN} = V_{CC}$			1	6	μA
		$V_{IN} = 0V$			1	6	μA
SUPPLY CURRENT							
I_{CCD}	Total Dynamic Supply Current (includes load current)	$EN = V_{CC}$, $R_L = 27\Omega$ or 50Ω , $C_L = 15$ pF, Freq. = 200MHz 50% duty cycle, $V_{ID} = 200mV$, $V_{CM} = 1.2V$		50	65	mA	
I_{CCZ}	TRI-STATE Supply Current	$EN = 0V$, Freq. = 200MHz 50% duty cycle, $V_{ID} = 200mV$, $V_{CM} = 1.2V$		36	46	mA	

AC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. (Note 3)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LVDS OUTPUT AC SPECIFICATIONS (OUT)						
t_{PHLD}	Differential Propagation Delay High to Low (Note 10)	$V_{ID} = 200\text{mV}$, $V_{CM} = 1.2\text{V}$, $R_L = 27\Omega$ or 50Ω , $C_L = 15\text{pF}$ <i>Figure 3 and Figure 4</i>	1.0	1.4	2.0	ns
t_{PLHD}	Differential Propagation Delay Low to High (Note 10)		1.0	1.4	2.0	ns
t_{SKD1}	Pulse Skew $ t_{PLHD} - t_{PHLD} $ (measure of duty cycle) (Notes 5, 6)		0	20	200	ps
t_{SKD3}	Part-to-Part Skew (Notes 5, 7)		0	200	300	ps
t_{SKD4}	Part-to-Part Skew (Notes 5, 8)		0		1	ns
t_{LHT}	Rise Time (Notes 5, 10) 20% to 80% points	$R_L = 50\Omega$ or 27Ω , $C_L = 15\text{pF}$ <i>Figure 3 and Figure 5</i>	0.350	0.6	1.0	ns
t_{HLT}	Fall Time (Notes 5, 10) 80% to 20% points		0.350	0.6	1.0	ns
t_{PHZ}	Disable Time (Active High to Z)	$R_L = 50\Omega$, $C_L = 15\text{pF}$ <i>Figure 6 and Figure 7</i>		3	25	ns
t_{PLZ}	Disable Time (Active Low to Z)			3	25	ns
t_{PZH}	Enable Time (Z to Active High)			100	120	ns
t_{PZL}	Enable Time (Z to Active Low)			100	120	ns
t_{DJ}	LVDS Data Jitter, Deterministic (Peak-to-Peak) (Note 9)	$V_{ID} = 300\text{mV}$; PRBS = $2^{23} - 1$ data; $V_{CM} = 1.2\text{V}$ at 400Mbps (NRZ)			78	ps
t_{RJ}	LVDS Clock Jitter, Random (Note 9)	$V_{ID} = 300\text{mV}$; $V_{CM} = 1.2\text{V}$ at 200MHz clock			36	ps
f_{MAX}	Maximum guaranteed frequency (Note 11)	$V_{ID} = 200\text{mV}$, $V_{CM} = 1.2\text{V}$	200	300		MHz

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The table of "Electrical Characteristics" specifies conditions of device operation.

Note 2: Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except V_{ID} , V_{OD} , V_{TH} , V_{TL} , and ΔV_{OD} . V_{OD} has a value and direction. Positive direction means OUT+ is a more positive voltage than OUT-.

Note 3: All typical are given for $V_{CC} = +3.3\text{V}$ and $T_A = +25^\circ\text{C}$, unless otherwise stated.

Note 4: Output short circuit current (I_{OS}) is specified as magnitude only, minus sign indicates direction only.

Note 5: The parameters are guaranteed by design. The limits are based on statistical analysis of the device performance over the PVT (process, voltage and temperature) range.

Note 6: t_{SKD1} , $|t_{PLHD} - t_{PHLD}|$, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel (a measure of duty cycle).

Note 7: t_{SKD3} , Part to Part Skew, is defined as the difference between the minimum and maximum specified differential propagation delays. This specification applies to devices at the same V_{CC} and within 5°C of each other within the operating temperature range. This parameter guaranteed by design and characterization.

Note 8: t_{SKD4} , Part to Part Skew, is the differential channel-to-channel skew of any event between devices. This specification applies to devices over recommended operating temperature and voltage ranges, and across process distribution. t_{SKD4} is defined as $|I_{Max} - I_{Min}|$ differential propagation delay.

Note 9: The parameters are guaranteed by design. The limits are based on statistical analysis of the device performance over the PVT range with the following test equipment setup: Agilent 86130A used as stimulus, 5 feet of RG142B cable with DUT test board and Agilent 86100A (digital scope mainframe) with Agilent 86122A (20GHz scope module). Data input jitter pk to pk = 22 picoseconds; Clock input jitter = 24 picoseconds; t_{DJ} measured 100 picoseconds, t_{RJ} measured 60 picoseconds.

Note 10: Propagation delay, rise and fall times are guaranteed by design and characterization to 200MHz. Generator for these tests: $50\text{MHz} \leq f \leq 200\text{MHz}$, $Z_o = 50\Omega$, t_r , $t_f \leq 0.5\text{ns}$. Generator used was HP8130A (300MHz capability).

Note 11: f_{MAX} test: Generator (HP8133A or equivalent), Input duty cycle = 50%. Output criteria: $V_{OD} \geq 200\text{mV}$, Duty Cycle better than 45/55%. This specification is guaranteed by design and characterization. A minimum is specified, which means that the device will operate to specified conditions from DC to the minimum guaranteed AC frequency. The typical value is always greater than the minimum guarantee.

DC Test Circuits

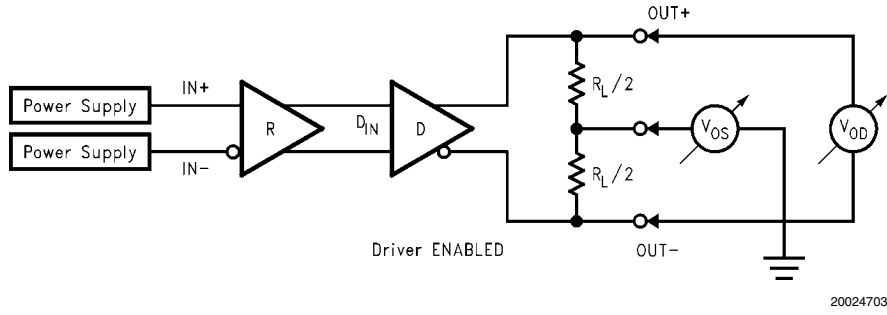


FIGURE 1. Differential Driver DC Test Circuit

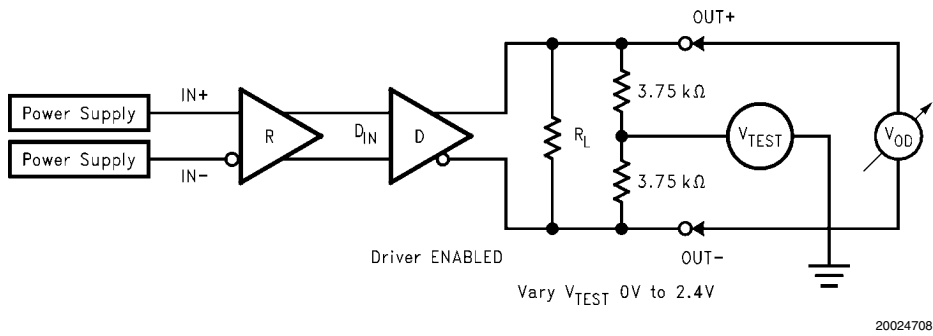
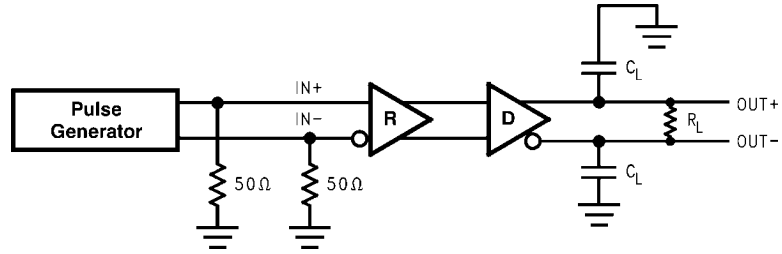


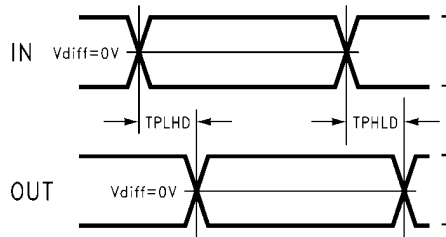
FIGURE 2. Differential Driver Full Load DC Test Circuit

AC Test Circuits and Timing Diagrams



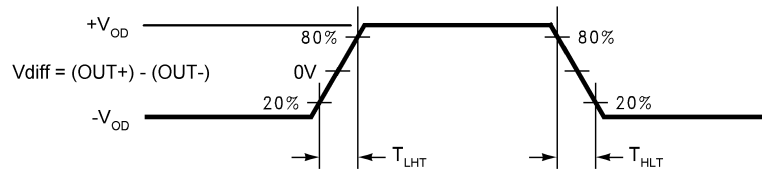
20024706

FIGURE 3. BLVDS Output Load



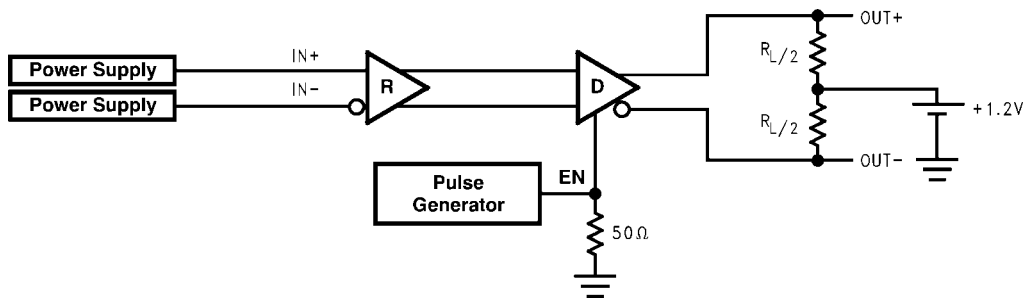
20024707

FIGURE 4. Propagation Delay Low-to-High and High-to-Low



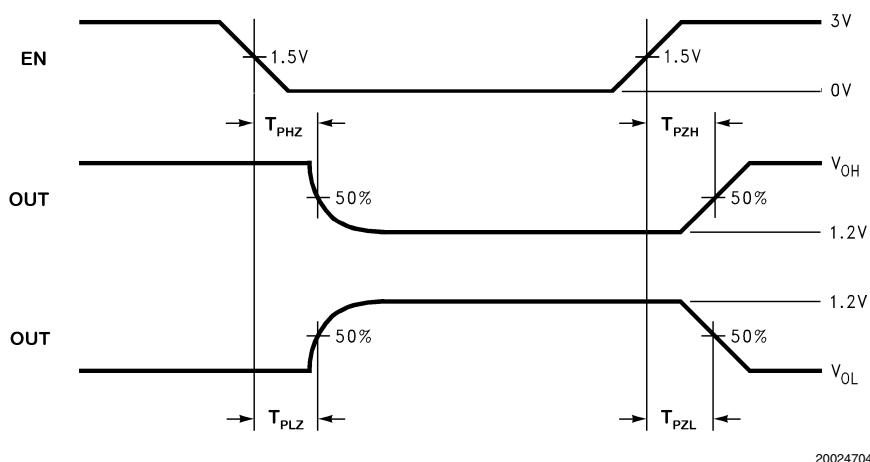
20024709

FIGURE 5. BLVDS Output Transition Time



20024701

FIGURE 6. TRI-STATE Delay Test Circuit



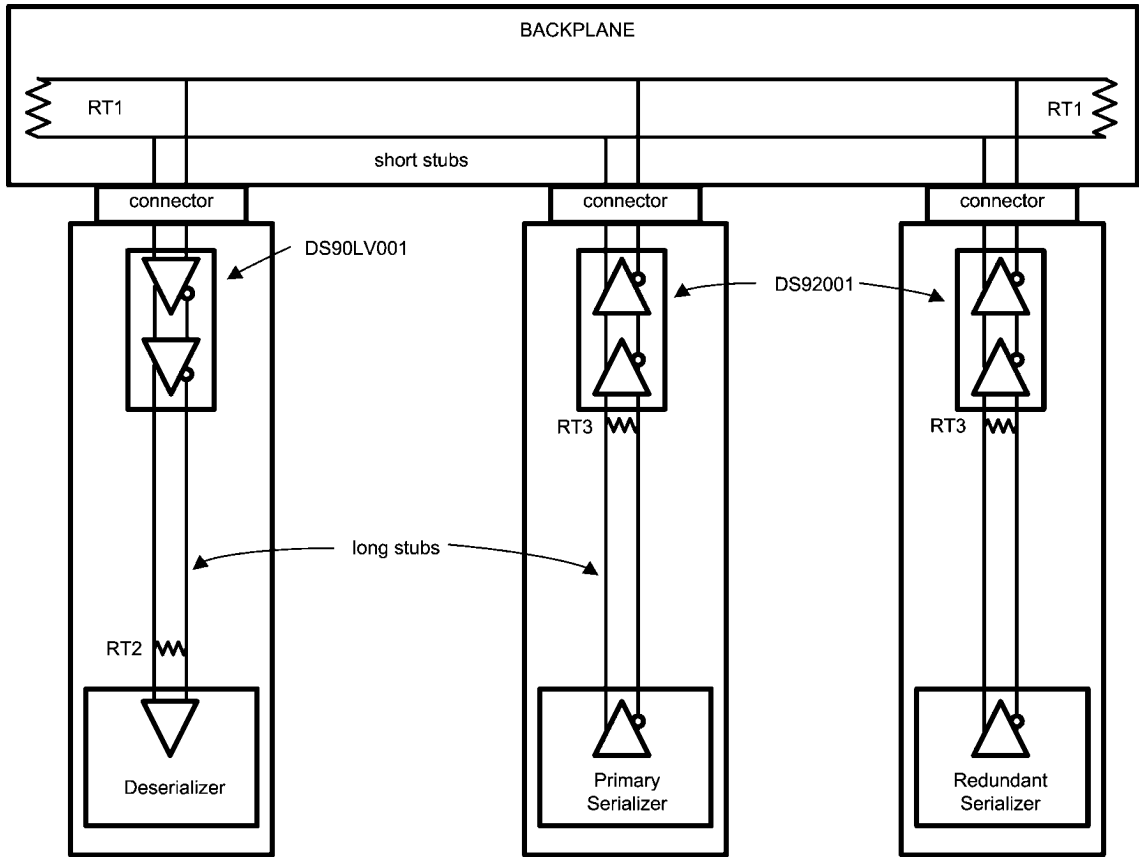
20024704

FIGURE 7. Output active to TRI-STATE and TRI-STATE to active output time

Pin Descriptions (SOIC and LLP)

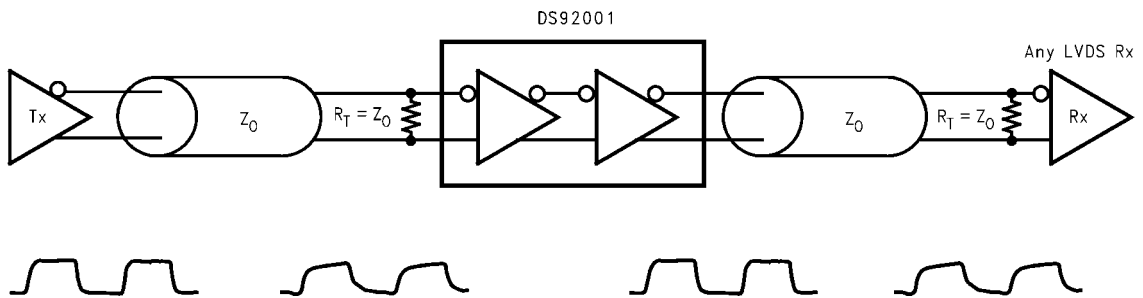
Pin Name	Pin #	Input/Output	Description
GND	1	P	Ground
IN -	2	I	Inverting receiver B/LVDS input pin
IN+	3	I	Non-inverting receiver B/LVDS input pin
N/C	4	NA	"NO CONNECT" pin
V _{CC}	5	P	Power Supply, 3.3V ± 0.3V.
OUT+	6	O	Non-inverting driver BLVDS output pin
OUT -	7	O	Inverting driver BLVDS output pin
EN	8	I	Enable pin. When EN is LOW, the driver is disabled and the BLVDS outputs are in TRI-STATE. When EN is HIGH, the driver is enabled. LVCMOS/LVTTL levels.
GND	DAP	P	LLP Package Ground

Typical Applications



20024711

FIGURE 8. Backplane Stub-Hider Application



20024710

FIGURE 9. Cable Repeater Application

Application Information

The DS92001 can be used as a "stub-hider." In many systems, signals are distributed across backplanes, and one of the limiting factors for system speed is the "stub length" or the distance between the transmission line and the unterminated receivers on the individual cards. See *Figure 8*. Although it is generally recognized that this distance should be as short as possible to maximize system performance, real-world packaging concerns and PCB designs often make it difficult to make the stubs as short as the designer would like. The DS92001, available in the LLP (Leadless Leadframe Package) package, can improve system performance by allowing the receiver to be placed very close to the main transmission line either on the backplane itself or very close to the connector on the card. Longer traces to the LVDS receiver may be placed after the DS92001. This very small LLP package is a 75% space savings over the SOIC package.

The DS92001 may also be used as a repeater as shown in *Figure 9*. The signal is recovered and redriven at full strength down the following segment. The DS92001 may also be used as a level translator, as it accepts LVDS, BLVDS, and LVPECL inputs.

POWER DECOUPLING RECOMMENDATIONS

Bypass capacitors must be used on power pins. Use high frequency ceramic (surface mount is recommended) 0.1 μ F and 0.01 μ F capacitors in parallel at the power supply pin with the smallest value capacitor closest to the device supply pin. Additional scattered capacitors over the printed circuit board will improve decoupling. Multiple vias should be used to connect the decoupling capacitors to the power planes. A 10 μ F (35V) or greater solid tantalum capacitor should be connected at the power entry point on the printed circuit board between the supply and ground.

PC BOARD CONSIDERATIONS

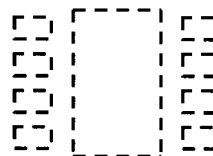
Use at least 4 PCB board layers (top to bottom): LVDS signals, ground, power, TTL signals.

Isolate TTL signals from LVDS signals, otherwise the TTL signals may couple onto the LVDS lines. It is best to put TTL and LVDS signals on different layers which are isolated by a power/ground plane(s).

Keep drivers and receivers as close to the (LVDS port side) connectors as possible.

For PC board considerations for the LLP package, please refer to application note AN-1187 "Leadless Leadframe Package." It is important to note that to optimize signal integrity (minimize jitter and noise coupling), the LLP thermal land pad, which is a metal (normally copper) rectangular region located under the package as seen in *Figure 10*, should be attached to ground and match the dimensions of the exposed pad on the PCB (1:1 ratio).

Top View



20024744

FIGURE 10. LLP Thermal Land Pad and Pin Pads - Top View

DIFFERENTIAL TRACES

Use controlled impedance traces which match the differential impedance of your transmission medium (ie. cable) and termination resistor. Run the differential pair trace lines as close together as possible as soon as they leave the IC (stubs should be < 10mm long). This will help eliminate reflections and ensure noise is coupled as common-mode. In fact, we have seen that differential signals which are 1mm apart radiate far less noise than traces 3mm apart since magnetic field cancellation is much better with the closer traces. In addition, noise induced on the differential lines is much more likely to appear as common-mode which is rejected by the receiver.

Match electrical lengths between traces to reduce skew. Skew between the signals of a pair means a phase difference between signals which destroys the magnetic field cancellation benefits of differential signals and EMI will result. Do not rely solely on the auto-route function for differential traces. Carefully review dimensions to match differential impedance and provide isolation for the differential lines. Minimize the number of vias and other discontinuities on the line.

Avoid 90° turns (these cause impedance discontinuities). Use arcs or 45° bevels.

Within a pair of traces, the distance between the two traces should be minimized to maintain common-mode rejection of the receivers. On the printed circuit board, this distance should remain constant to avoid discontinuities in differential impedance. Minor violations at connection points are allowable.

TERMINATION

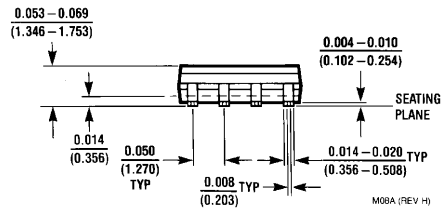
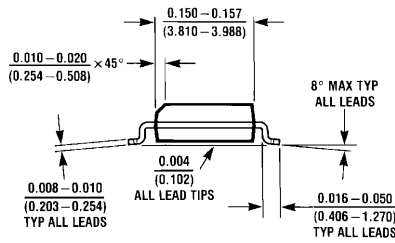
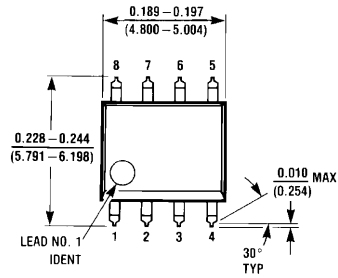
Use a termination resistor which best matches the differential impedance or your transmission line. The resistor should be between 90 Ω and 130 Ω for point-to-point links. Multidrop (driver in the middle) or multipoint configurations are typically terminated at both ends. The termination value may be lower than 100 Ω due to loading effects and in the 50 Ω to 100 Ω range. Remember that the current mode outputs need the termination resistor to generate the differential voltage.

Surface mount 1% - 2% resistors are the best. PCB stubs, component lead, and the distance from the termination to the receiver inputs should be minimized. The distance between the termination resistor and the receiver should be < 10mm (12mm MAX).

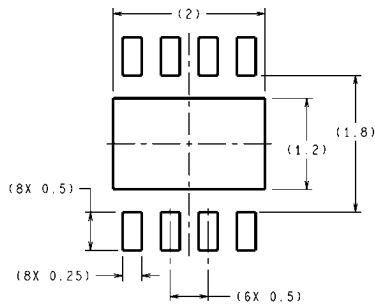
PROBING LVDS TRANSMISSION LINES

Always use high impedance (> 100k Ω), low capacitance (< 2 pF) scope probes with a wide bandwidth (1 GHz) scope. Improper probing will give deceiving results.

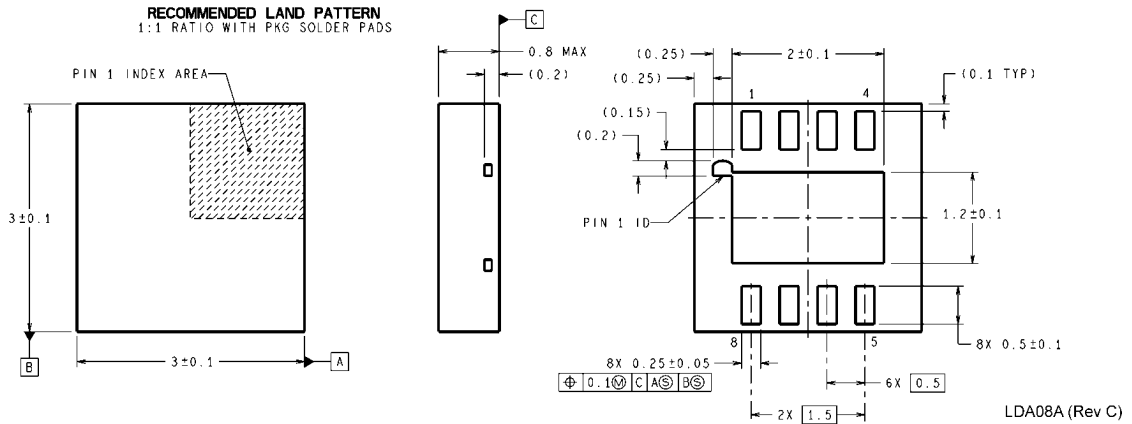
Physical Dimensions inches (millimeters) unless otherwise noted



Order Number DS92001TMA
See NS Package Number M08A



DIMENSIONS ARE IN MILLIMETERS



Order Number DS92001TLD
See NS Package Number LDA08A

Notes

DS92001

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH	www.national.com/webench
Audio	www.national.com/audio	Analog University	www.national.com/AU
Clock Conditioners	www.national.com/timing	App Notes	www.national.com/appnotes
Data Converters	www.national.com/adc	Distributors	www.national.com/contacts
Displays	www.national.com/displays	Green Compliance	www.national.com/quality/green
Ethernet	www.national.com/ethernet	Packaging	www.national.com/packaging
Interface	www.national.com/interface	Quality and Reliability	www.national.com/quality
LVDS	www.national.com/lvds	Reference Designs	www.national.com/refdesigns
Power Management	www.national.com/power	Feedback	www.national.com/feedback
Switching Regulators	www.national.com/switchers		
LDOs	www.national.com/ldo		
LED Lighting	www.national.com/led		
PowerWise	www.national.com/powerwise		
Serial Digital Interface (SDI)	www.national.com/sdi		
Temperature Sensors	www.national.com/tempsensors		
Wireless (PLL/VCO)	www.national.com/wireless		

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2008 National Semiconductor Corporation

For the most current product information visit us at www.national.com



**National Semiconductor
Americas Technical
Support Center**
Email: support@nsc.com
Tel: 1-800-272-9959

**National Semiconductor Europe
Technical Support Center**
Email: europe.support@nsc.com
German Tel: +49 (0) 180 5010 771
English Tel: +44 (0) 870 850 4288

**National Semiconductor Asia
Pacific Technical Support Center**
Email: ap.support@nsc.com

**National Semiconductor Japan
Technical Support Center**
Email: jpn.feedback@nsc.com