

## SCAN92LV090

# 9 Channel Bus LVDS Transceiver w/ Boundary SCAN

### General Description

The SCAN92LV090A is one in a series of Bus LVDS transceivers designed specifically for the high speed, low power proprietary backplane or cable interfaces. The device operates from a single 3.3V power supply and includes nine differential line drivers and nine receivers. To minimize bus loading, the driver outputs and receiver inputs are internally connected. The separate I/O of the logic side allows for loop back support. The device also features a flow through pin out which allows easy PCB routing for short stubs between its pins and the connector.

The driver translates 3V TTL levels (single-ended) to differential Bus LVDS (BLVDS) output levels. This allows for high speed operation, while consuming minimal power with reduced EMI. In addition, the differential signaling provides common mode noise rejection of  $\pm 1V$ .

The receiver threshold is less than  $\pm 100$  mV over a  $\pm 1V$  common mode range and translates the differential Bus LVDS to standard (TTL/CMOS) levels.

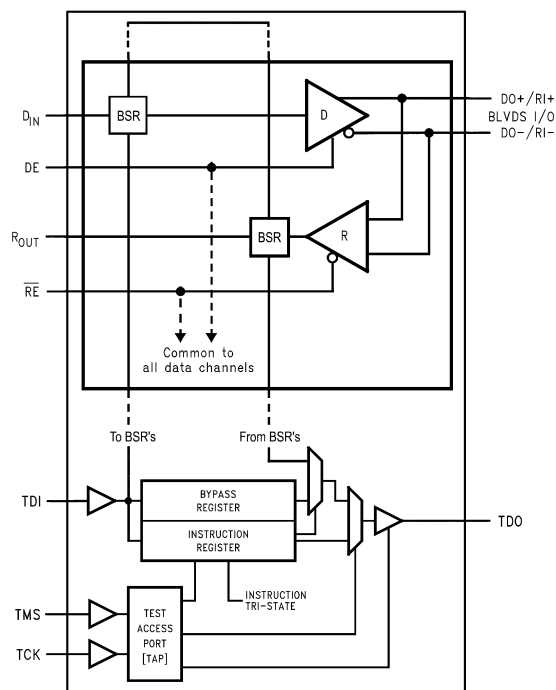
This device is compliant with IEEE 1149.1 Standard Test Access Port and Boundary Scan Architecture with the incorporation of the defined boundary-scan test logic and test

access port consisting of Test Data Input (TDI), Test Data Out (TDO), Test Mode Select (TMS), Test Clock (TCK), and the optional Test Reset ( $\overline{TRST}$ ).

### Features

- IEEE 1149.1 (JTAG) Compliant
- Bus LVDS Signaling
- Low power CMOS design
- High Signaling Rate Capability (above 100 Mbps)
- 0.1V to 2.3V Common Mode Range for  $V_{ID} = 200mV$
- $\pm 100$  mV Receiver Sensitivity
- Supports open and terminated failsafe on port pins
- 3.3V operation
- Glitch free power up/down (Driver & Receiver disabled)
- Light Bus Loading (5 pF typical) per Bus LVDS load
- Designed for Double Termination Applications
- Balanced Output Impedance
- Product offered in 64 pin LQFP package and BGA package
- High impedance Bus pins on power off ( $V_{CC} = 0V$ )

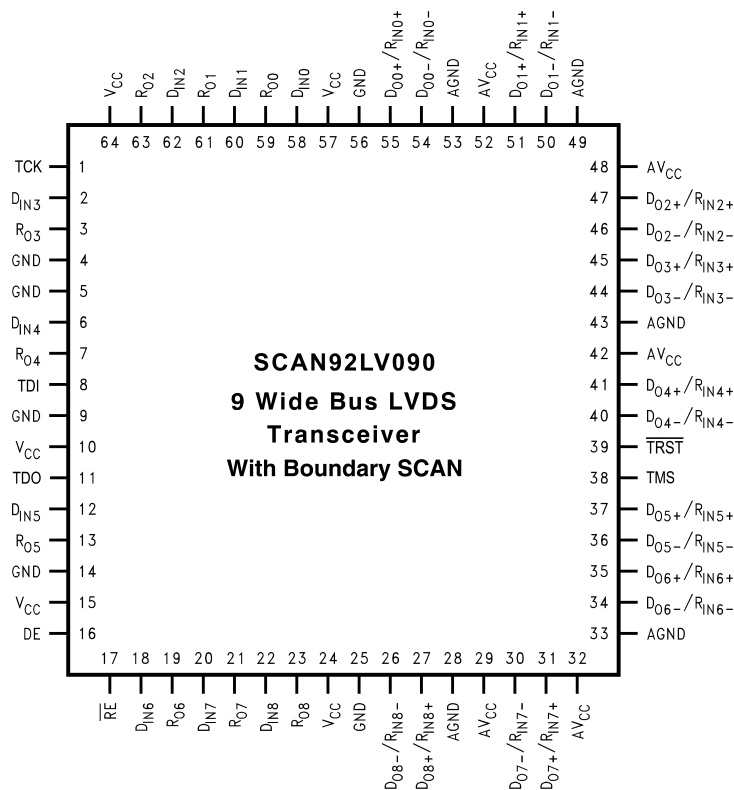
### Simplified Functional Diagram



DS101242-1

TRI-STATE® is a registered trademark of National Semiconductor Corporation.

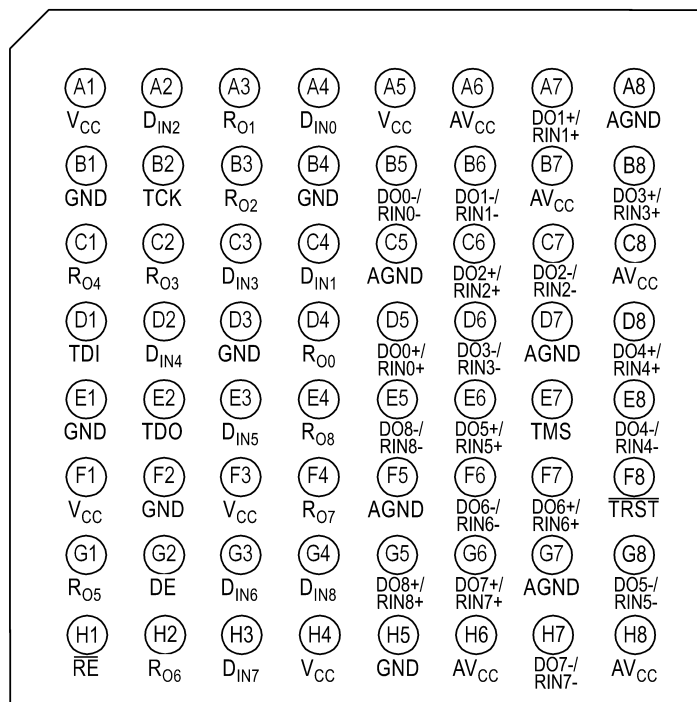
# Connection Diagram



DS101242-2

## Top View

Order Number **SCAN92LV090VEH**  
See NS Package Number **VEH064DB**



DS101242-16

## Top View

Order Number **SCAN92LV090SLC**  
See NS Package Number **SLC64A**

## Pinout Description

Pin Name	TQFP Pin #	BGA Pin #	Input/Output	Descriptions
DO+/RI+	27, 31, 35, 37, 41, 45, 47, 51, 55	A7, B8, C6, D5, D8, E6, F7, G5, G6	I/O	True Bus LVDS Driver Outputs and Receiver Inputs.
DO-/RI-	26, 30, 34, 36, 40, 44, 46, 50, 54	B5, B6, C7, D6, E5, E8, F6, G8, H7	I/O	Complimentary Bus LVDS Driver Outputs and Receiver Inputs.
D <sub>IN</sub>	2, 6, 12, 18, 20, 22, 58, 60, 62	A2, A4, C3, C4, D2, E3, G3, G4, H3	I	TTL Driver Input.
RO	3, 7, 13, 19, 21, 23, 59, 61, 63	A3, B3, C1, C2, D4, E4, F4, G1, H2	O	TTL Receiver Output.
$\overline{RE}$	17	H1	I	Receiver Enable TTL Input (Active Low).
DE	16	G2	I	Driver Enable TTL Input (Active High).
GND	4, 5, 9, 14, 25, 56	B1, B4, D3, E1, F2, H5	Power	Ground for digital circuitry (must connect to GND on PC board). These pins connected internally.
V <sub>CC</sub>	10, 15, 24, 57, 64	A1, A5, F1, F3, H4	Power	V <sub>CC</sub> for digital circuitry (must connect to V <sub>CC</sub> on PC board). These pins connected internally.
AGND	28, 33, 43, 49, 53	A8, C5, D7, F5, G7	Power	Ground for analog circuitry (must connect to GND on PC board). These pins connected internally.
AV <sub>CC</sub>	29, 32, 42, 48, 52	A6, B7, C8, H6, H8	Power	Analog V <sub>CC</sub> (must connect to V <sub>CC</sub> on PC board). These pins connected internally.
$\overline{TRST}$	39	F8	I	Test Reset Input to support IEEE 1149.1 (Active Low)
TMS	38	E7	I	Test Mode Select Input to support IEEE 1149.1
TCK	1	B2	I	Test Clock Input to support IEEE 1149.1
TDI	8	D1	I	Test Data Input to support IEEE 1149.1
TDO	11	E2	O	Test Data Output to support IEEE 1149.1

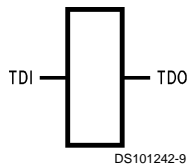
## Description of Boundary-Scan Circuitry

The SCAN92LV090 features two unique Scan test modes, each which requires a unique BSDL model depending on the level of test access and fault coverage goals. In the first mode (Mode0), only the TTL Inputs and Outputs of each transceiver are accessible via a 1149.1 compliant protocol. In the second mode (Mode1), the TTL Inputs and Outputs are accessible by a 1149.1 compliant method while the Differential I/O pins are accessible by a 1149.1 compatible technique which evaluates the signal integrity and modifies the data in the differential BSR as appropriate.

All test modes are handled by the ATPG software, and BSDL selection should be invisible to the user.

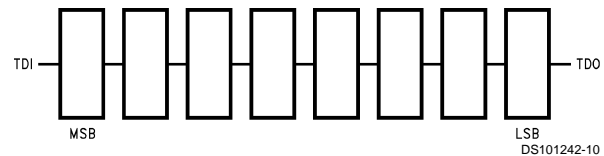
The BYPASS register is a single bit shift register stage identical to scan cell TYPE1. It captures a fixed logic low.

### Bypass Register Scan Chain Definition Logic 0



The INSTRUCTION register is an eight-bit register which captures the value 00111101.

### Instruction Register Scan Chain Definition



### MSB → LSB (Mode0)

Instruction Code	Instruction
00000000	EXTEST
10000010	SAMPLE/PRELOAD
10000111	CLAMP
00000110	HIGHZ
All Others	BYPASS

### MSB → LSB (Mode1)

Instruction Code	Instruction
10011001	EXTEST
10010010	SAMPLE/PRELOAD
10001111	CLAMP
00000110	HIGHZ
All Others	BYPASS

**Absolute Maximum Ratings** (Notes 2, 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage ( $V_{CC}$ )	4.0V
Enable Input Voltage (DE, $\overline{RE}$ )	-0.3V to ( $V_{CC} + 0.3V$ )
Driver Input Voltage ( $D_{IN}$ )	-0.3V to ( $V_{CC} + 0.3V$ )
Receiver Output Voltage ( $R_{OUT}$ )	-0.3V to ( $V_{CC} + 0.3V$ )
Bus Pin Voltage (DO/RI $\pm$ )	-0.3V to +3.9V
ESD (HBM 1.5 k $\Omega$ , 100 pF)	>4.5 kV
Driver Short Circuit Duration	momentary
Receiver Short Circuit Duration	momentary
Maximum Package Power Dissipation at 25°C	
LQFP	1.74 W
Derate LQFP Package	13.9 mW/°C

$\theta_{ja}$	71.7°C/W
$\theta_{jc}$	10.9°C/W
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 4 sec.)	260°C

**Recommended Operating Conditions**

	Min	Max	Units
Supply Voltage ( $V_{CC}$ )	3.0	3.6	V
Receiver Input Voltage	0.0	2.4	V
Operating Free Air Temperature	-40	+85	°C
Maximum Input Edge Rate (Note 6)(20% to 80%)			$\Delta t/\Delta V$
Data		1.0	ns/V
Control		3.0	ns/V

**DC Electrical Characteristics**

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

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units
$V_{OD}$	Output Differential Voltage	$R_L = 27\Omega$ , Figure 1	DO+/RI+, DO-/RI-	240	300	460	mV
$\Delta V_{OD}$	$V_{OD}$ Magnitude Change					27	mV
$V_{OS}$	Offset Voltage			1.1	1.3	1.5	V
$\Delta V_{OS}$	Offset Magnitude Change				5	10	mV
$V_{OH}$	Driver Output High Voltage	$R_L = 27\Omega$			1.4	1.65	V
$V_{OL}$	Driver Output Low Voltage	$R_L = 27\Omega$		0.95	1.1		V
$I_{OSD}$	Output Short Circuit Current (Note 10)	$V_{OD} = 0V$ , DE = $V_{CC}$ , Driver outputs shorted together			36	65	mA
$V_{OH}$	Voltage Output High (Note 11)	$V_{ID} = +300\text{ mV}$	$R_{OUT}$	$V_{CC}-0.2$			V
		Inputs Open		$V_{CC}-0.2$			V
		Inputs Terminated, $R_L = 27\Omega$		$V_{CC}-0.2$			V
$V_{OL}$	Voltage Output Low	$I_{OL} = 2.0\text{ mA}$ , $V_{ID} = -300\text{ mV}$			0.05	0.075	V
$I_{OD}$	Receiver Output Dynamic Current (Note 10)	$V_{ID} = 300\text{ mV}$ , $V_{OUT} = V_{CC}-1.0V$		-110	75		mA
		$V_{ID} = -300\text{ mV}$ , $V_{OUT} = 1.0V$			75	110	mA
$V_{TH}$	Input Threshold High	DE = 0V, $V_{CM} = 1.5V$	DO+/RI+, DO-/RI-			+100	mV
$V_{TL}$	Input Threshold Low			-100			mV
$V_{CMR}$	Receiver Common Mode Range			$ V_{ID} /2$		2.4 – $ V_{ID} /2$	V
$I_{IN}$	Input Current	DE = 0V, $\overline{RE} = 2.4V$ , $V_{IN} = +2.4V$ or 0V		-25	$\pm 1$	+25	$\mu A$
		$V_{CC} = 0V$ , $V_{IN} = +2.4V$ or 0V		-20	$\pm 1$	+20	$\mu A$
$V_{IH}$	Minimum Input High Voltage		$D_{IN}$ , DE, $\overline{RE}$ , TCK, $\overline{TRST}$ , TMS, TDI	2.0		$V_{CC}$	V
$V_{IL}$	Maximum Input Low Voltage			GND		0.8	V

## DC Electrical Characteristics (Continued)

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

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units
$I_{IH}$	Input High Current	$V_{IN} = V_{CC}$ or 2.4V	$D_{IN}, DE, \overline{RE}$	-20	$\pm 10$	+20	$\mu A$
$I_{IL}$	Input Low Current	$V_{IN} = GND$ or 0.4V		-20	$\pm 10$	+20	$\mu A$
$V_{CL}$	Input Diode Clamp Voltage	$I_{CLAMP} = -18 \text{ mA}$		-1.5	-0.8		V
$I_{IH}$	Input High Current	$V_{IN} = V_{CC}$	$TDI, TMS, TCK, \overline{TRST}$	-20		+20	$\mu A$
$I_{ILR}$	Input Low Current	$V_{IN} = GND, V_{CC} = 3.6V$	$TDI, TMS, \overline{TRST}$	-25		-115	$\mu A$
$I_{IL}$	Input Low Current	$V_{IN} = GND$	TCK	-20		+20	$\mu A$
$I_{CCD}$	Power Supply Current Drivers Enabled, Receivers Disabled	No Load, $DE = \overline{RE} = V_{CC},$ $DIN = V_{CC}$ or GND	$V_{CC}$		50	80	mA
$I_{CCR}$	Power Supply Current Drivers Disabled, Receivers Enabled	$DE = \overline{RE} = 0V, V_{ID} = \pm 300mV$			50	80	mA
$I_{CCZ}$	Power Supply Current, Drivers and Receivers TRI-STATE®	$DE = 0V; \overline{RE} = V_{CC},$ $DIN = V_{CC}$ or GND			50	80	mA
$I_{CC}$	Power Supply Current, Drivers and Receivers Enabled	$DE = V_{CC}; \overline{RE} = 0V,$ $DIN = V_{CC}$ or GND, $R_L = 27\Omega$			160	210	mA
$I_{CCS}$	Power Supply Current (SCAN Test Mode), Drivers and Receivers Enabled	$DE = V_{CC}; \overline{RE} = 0V,$ $DIN = V_{CC}$ or GND, $R_L = 27\Omega, TAP$ in any state other than Test-Logic-Reset			180	230	mA
$I_{OFF}$	Power Off Leakage Current	$V_{CC} = 0V$ or OPEN, $D_{IN}, DE, \overline{RE} = 0V$ or OPEN, $V_{APPLIED} = 3.6V$ (Port Pins)	$DO+/RI+, DO-/RI-$	-20		+20	$\mu A$
$C_{OUTPUT}$	Capacitance @ Bus Pins		$DO+/RI+, DO-/RI-$		5		pF
$C_{OUTPUT}$	Capacitance @ $R_{OUT}$		$R_{OUT}$		7		pF

## AC Electrical Characteristics

Over recommended operating supply voltage and temperature ranges unless otherwise specified (Note 6)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DIFFERENTIAL DRIVER TIMING REQUIREMENTS</b>						
$t_{PHLD}$	Differential Prop. Delay High to Low (Note 8)	$R_L = 27\Omega,$ <i>Figure 2, Figure 3</i> $C_L = 10 \text{ pF}$	1.0	1.8	2.6	ns
$t_{PLHD}$	Differential Prop. Delay Low to High (Note 8)		1.0	1.8	2.6	ns
$t_{SKD1}$	Differential Skew $ t_{PHLD} - t_{PLHD} $ (Note 9)			120		ps
$t_{SKD2}$	Chip to Chip Skew (Note 12)				1.6	ns
$t_{SKD3}$	Channel to Channel Skew (Note 13)			0.25	0.55	ns
$t_{TLH}$	Transition Time Low to High			0.5	1.2	ns
$t_{THL}$	Transition Time High to Low			0.5	1.2	ns
$t_{PHZ}$	Disable Time High to Z	$R_L = 27\Omega,$ <i>Figure 4, Figure 5</i> $C_L = 10 \text{ pF}$		3	8	ns
$t_{PLZ}$	Disable Time Low to Z			3	8	ns
$t_{PZH}$	Enable Time Z to High			3	8	ns
$t_{PZL}$	Enable Time Z to Low			3	8	ns

## AC Electrical Characteristics (Continued)

Over recommended operating supply voltage and temperature ranges unless otherwise specified (Note 6)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DIFFERENTIAL RECEIVER TIMING REQUIREMENTS						
t <sub>PHLD</sub>	Differential Prop. Delay High to Low (Note 8)	Figure 6, Figure 7 C <sub>L</sub> = 35 pF	2.0	2.4	3.9	ns
t <sub>PLHD</sub>	Differential Prop Delay Low to High (Note 8)		2.0	2.4	3.9	ns
t <sub>SDK1</sub>	Differential Skew  t <sub>PHLD</sub> –t <sub>PLHD</sub>   (Note 9)			210		ps
t <sub>SDK2</sub>	Chip to Chip Skew (Note 12)				1.9	ns
t <sub>SDK3</sub>	Channel to Channel skew (Note 13)			0.35	0.7	ns
t <sub>TLH</sub>	Transition Time Low to High			1.5	2.5	ns
t <sub>THL</sub>	Transition Time High to Low		1.5	2.5	ns	
t <sub>PHZ</sub>	Disable Time High to Z	R <sub>L</sub> = 500Ω, Figure 8, Figure 9 C <sub>L</sub> = 35 pF		4.5	10	ns
t <sub>PLZ</sub>	Disable Time Low to Z			3.5	8	ns
t <sub>PZH</sub>	Enable Time Z to High			3.5	8	ns
t <sub>PZL</sub>	Enable Time Z to Low			3.5	8	ns
SCAN CIRCUITRY TIMING REQUIREMENTS						
f <sub>MAX</sub>	Maximum TCK Clock Frequency	R <sub>L</sub> = 500Ω, C <sub>L</sub> = 35 pF	25.0	75.0		MHz
t <sub>S</sub>	TDI to TCK, H or L		1.5			ns
t <sub>H</sub>	TDI to TCK, H or L		1.5			ns
t <sub>S</sub>	TMS to TCK, H or L		2.5			ns
t <sub>H</sub>	TMS to TCK, H or L		1.5			ns
t <sub>W</sub>	TCK Pulse Width, H or L		10.0			ns
t <sub>W</sub>	TRST Pulse Width, L		2.5			ns
t <sub>REC</sub>	Recovery Time, TRST to TCK		2.0			ns

**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 devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

**Note 2:** All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to ground unless otherwise specified except  $V_{OD}$ ,  $\Delta V_{OD}$  and  $V_{ID}$ .

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

**Note 4:** ESD Rating: HBM (1.5 k $\Omega$ , 100 pF) > 4.5 kV EIAJ (0 $\Omega$ , 200 pF) > 300V.

**Note 5:**  $C_L$  includes probe and fixture capacitance.

**Note 6:** Generator waveforms for all tests unless otherwise specified:  $f = 25 \text{ MHz}$ ,  $Z_O = 50\Omega$ ,  $t_r$ ,  $t_f = < 1.0 \text{ ns}$  (0%–100%). To ensure fastest propagation delay and minimum skew, data input edge rates should be equal to or faster than 1ns/V; control signals equal to or faster than 3ns/V. In general, the faster the input edge rate, the better the AC performance.

**Note 7:** The DS92LV090A functions within datasheet specification when a resistive load is applied to the driver outputs.

**Note 8:** Propagation delays are guaranteed by design and characterization.

**Note 9:**  $t_{SKD1} |t_{PHLD} - t_{PLHD}|$  is the worse case skew between any channel and any device over recommended operation conditions.

**Note 10:** Only one output at a time should be shorted, do not exceed maximum package power dissipation capacity.

**Note 11:**  $V_{OH}$  failsafe terminated test performed with 27 $\Omega$  connected between RI+ and RI– inputs. No external voltage is applied.

**Note 12:** Chip to Chip skew is the difference in differential propagation delay between any channels of any devices, either edge.

**Note 13:** Channel to Channel skew is the difference in driver output or receiver output propagation delay between any channels within a device, common edge.

## Applications Information

General application guidelines and hints may be found in the following application notes: AN-808, AN-1108, AN-977, AN-971, and AN-903.

There are a few common practices which should be implied when designing PCB for Bus LVDS signaling. Recommended practices are:

- Use at least 4 PCB board layer (Bus LVDS signals, ground, power and TTL signals).
- Keep drivers and receivers as close to the (Bus LVDS port side) connector as possible.
- Bypass each Bus LVDS device and also use distributed bulk capacitance between power planes. Surface mount capacitors placed close to power and ground pins work best. Two or three high frequency, multi-layer ceramic (MLC) surface mount (0.1  $\mu\text{F}$ , 0.01  $\mu\text{F}$ , 0.001  $\mu\text{F}$ ) in parallel should be used between each  $V_{CC}$  and ground. The capacitors should be as close as possible to the  $V_{CC}$  pin.

Multiple vias should be used to connect  $V_{CC}$  and Ground planes to the pads of the by-pass capacitors.

In addition, randomly distributed by-pass capacitors should be used.

- Use the termination resistor which best matches the differential impedance of your transmission line.
- Leave unused Bus LVDS receiver inputs open (floating). Limit traces on unused inputs to <0.5 inches.
- Isolate TTL signals from Bus LVDS signals

### MEDIA (CONNECTOR or BACKPLANE) SELECTION:

- Use controlled impedance media. The backplane and connectors should have a matched differential impedance.

TABLE 1. Functional Table

MODE SELECTED	DE	$\overline{\text{RE}}$
DRIVER MODE	H	H
RECEIVER MODE	L	L
TRI-STATE MODE	L	H
LOOP BACK MODE	H	L

TABLE 2. Transmitter Mode

INPUTS		OUTPUTS	
DE	$D_{IN}$	DO+	DO-
H	L	L	H
H	H	H	L
H	$0.8V < D_{IN} < 2.0V$	X	X
L	X	Z	Z

TABLE 3. Receiver Mode

INPUTS		OUTPUT
$\overline{\text{RE}}$	$(RI+) - (RI-)$	
L	L ( $< -100 \text{ mV}$ )	L
L	H ( $> +100 \text{ mV}$ )	H
L	$-100 \text{ mV} < V_{ID} < +100 \text{ mV}$	X
H	X	Z

X = High or Low logic state

L = Low state

Z = High impedance state

H = High state

## Test Circuits and Timing Waveforms

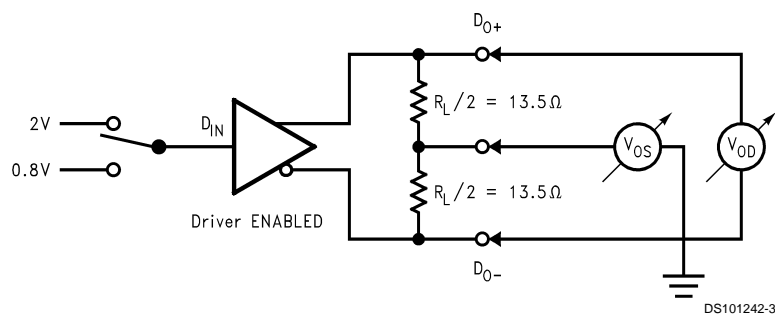


FIGURE 1. Differential Driver DC Test Circuit

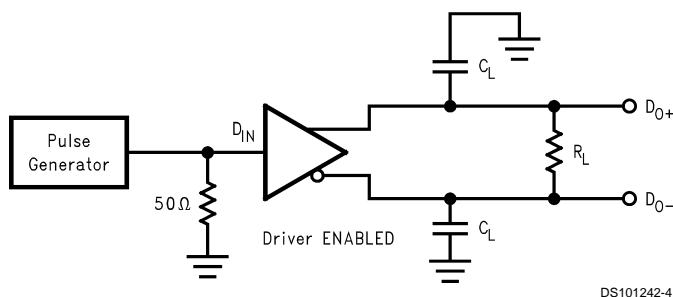


FIGURE 2. Differential Driver Propagation Delay and Transition Time Test Circuit

## Test Circuits and Timing Waveforms (Continued)

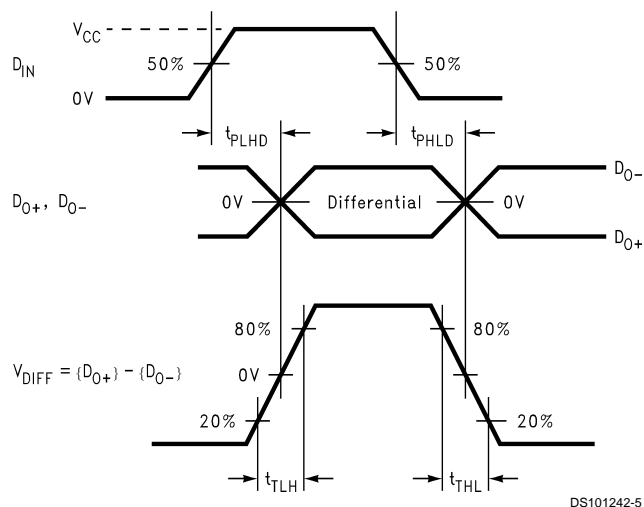


FIGURE 3. Differential Driver Propagation Delay and Transition Time Waveforms

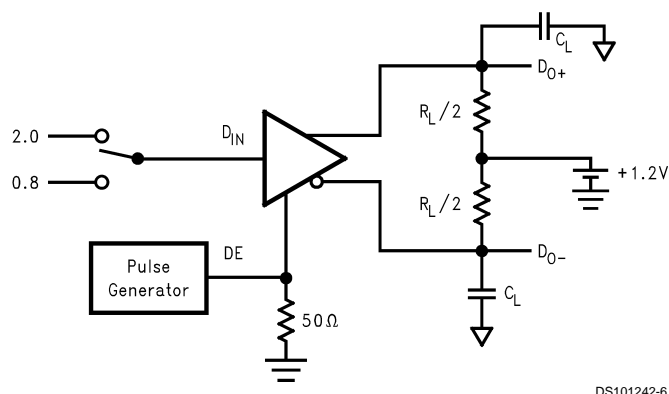


FIGURE 4. Driver TRI-STATE Delay Test Circuit

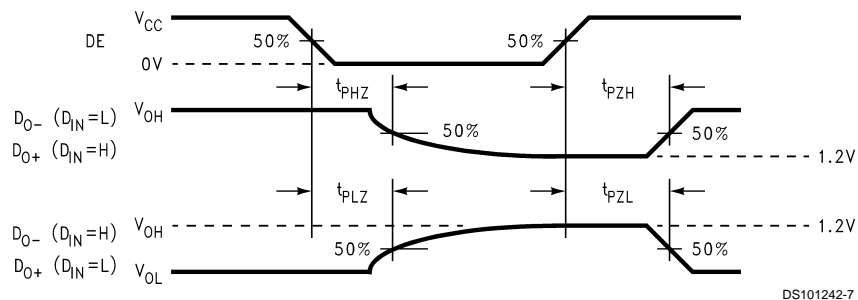


FIGURE 5. Driver TRI-STATE Delay Waveforms

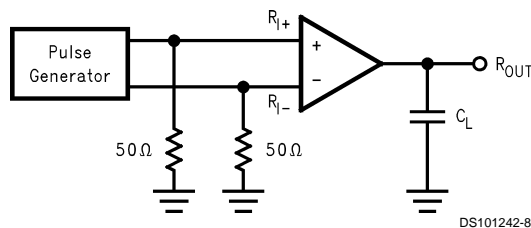


FIGURE 6. Receiver Propagation Delay and Transition Time Test Circuit



## Test Circuits and Timing Waveforms (Continued)

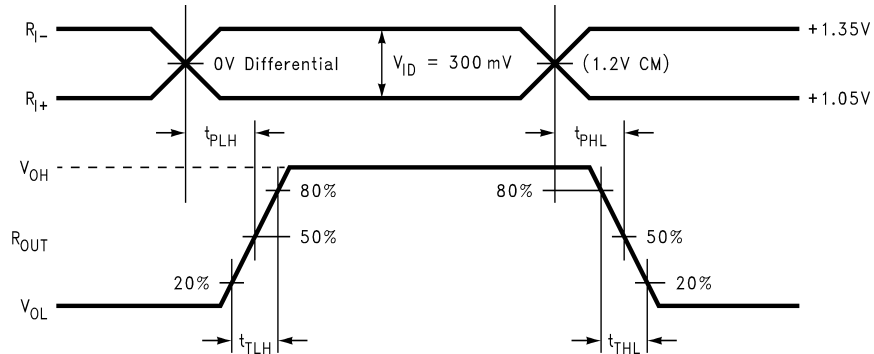


FIGURE 7. Receiver Propagation Delay and Transition Time Waveforms

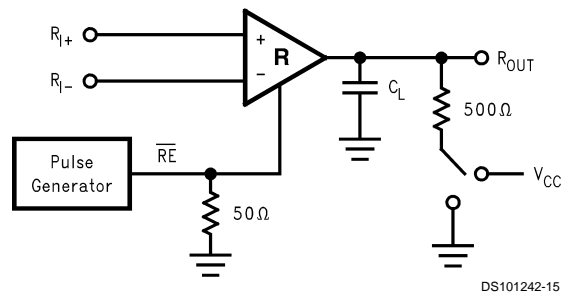


FIGURE 8. Receiver TRI-STATE Delay Test Circuit

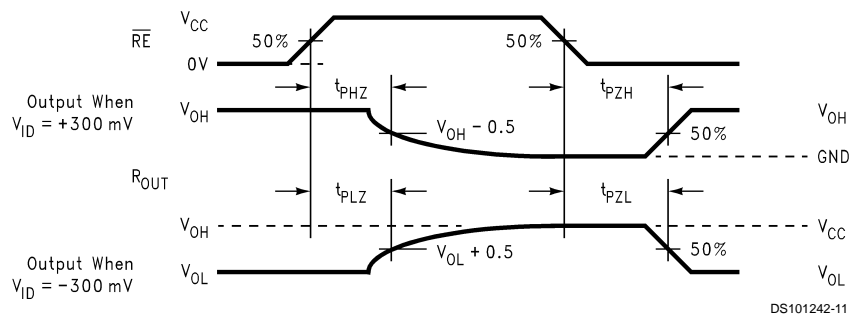
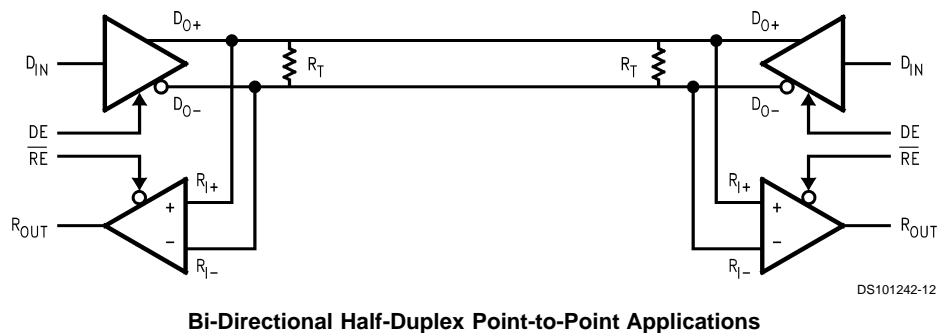


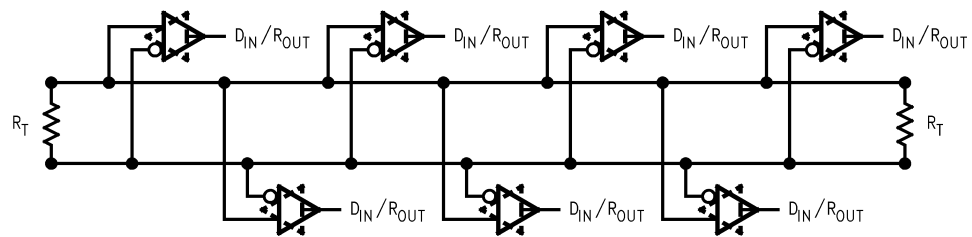
FIGURE 9. Receiver TRI-STATE Delay Waveforms

## Typical Bus Application Configurations



Bi-Directional Half-Duplex Point-to-Point Applications

## Typical Bus Application Configurations (Continued)

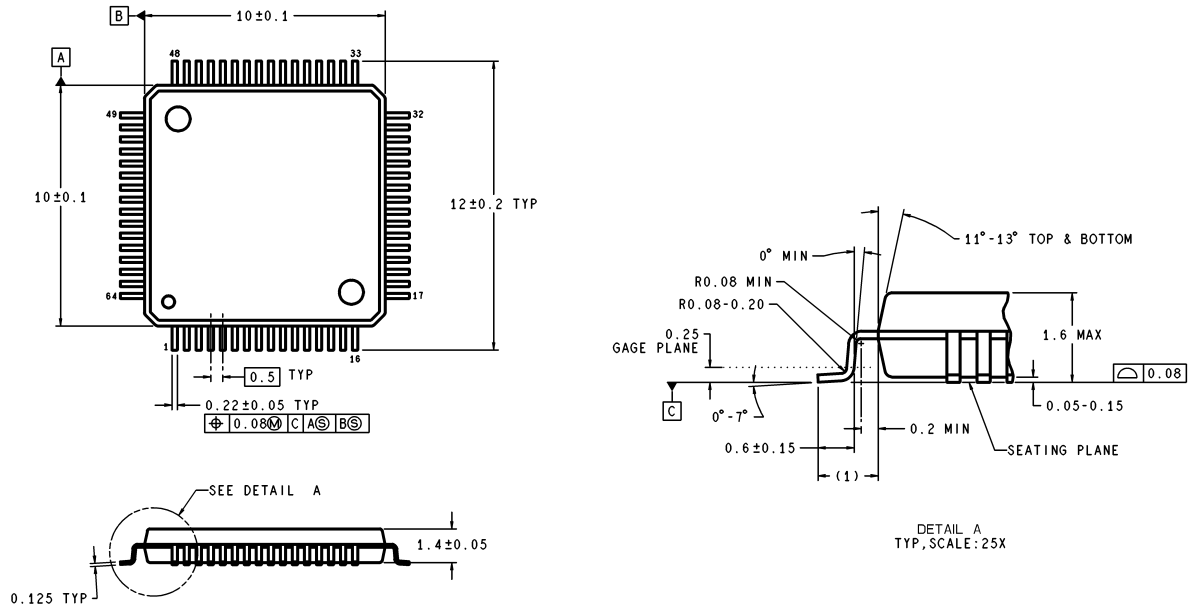


DS101242-13

**Multi-Point Bus Applications**

# Physical Dimensions

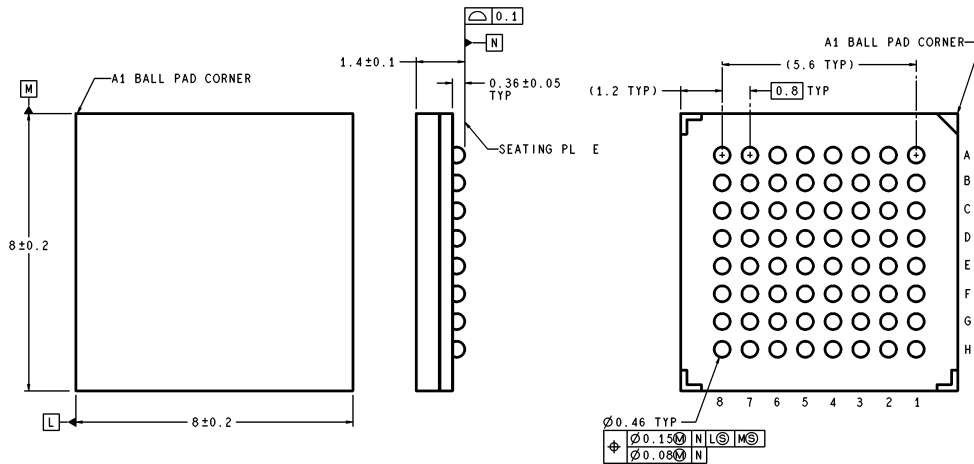
All dimensions are in millimeters



DIMENSIONS ARE IN MILLIMETERS

VEH64A (Rev C)

**64-Lead Molded LQFP Package**  
**Order Number SCAN92LV090VEH**  
**NS Package Number VEH064DB**



DIMENSIONS ARE IN MILLIMETERS

SLC64A (Rev B)

**64-Lead Ball Grid Array Package**  
**Order Number SCAN92LV090SLC**  
**NS Package Number SLC64A**

## Notes

### LIFE SUPPORT POLICY

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

1. Life support devices or systems are devices or systems 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.
2. A critical component is any component of 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  
Corporation**

Americas  
Tel: 1-800-272-9959  
Fax: 1-800-737-7018  
Email: support@nsc.com  
www.national.com

**National Semiconductor  
Europe**

Fax: +49 (0) 180-530 85 86  
Email: europe.support@nsc.com  
Deutsch Tel: +49 (0) 69 9508 6208  
English Tel: +44 (0) 870 24 0 2171  
Français Tel: +33 (0) 1 41 91 8790

**National Semiconductor  
Asia Pacific Customer  
Response Group**

Tel: 65-2544466  
Fax: 65-2504466  
Email: ap.support@nsc.com

**National Semiconductor  
Japan Ltd.**

Tel: 81-3-5639-7560  
Fax: 81-3-5639-7507