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# DS91M124

## 125 MHz 1:4 M-LVDS Repeater with LVCMOS Input

### General Description

The DS91M124 is a 1:4 M-LVDS repeater for driving and distributing clock or data signals to up to four multipoint networks. M-LVDS (Multipoint LVDS) is a new family of bus interface devices based on LVDS technology specifically designed for multipoint and multidrop cable and backplane applications. It differs from standard LVDS in providing increased drive current to handle double terminations that are required in multipoint applications. Controlled transition times minimize reflections that are common in multipoint configurations due to unterminated stubs.

A single DS91M124 channel is a 1:4 repeater that accepts LVTTTL/LVCMOS signals at the driver inputs and converts them to differential M-LVDS signal levels. It features independent driver enable pins for each driver output.

The DS91M124 has a flow-through pinout for easy PCB layout. It provides a new alternative for high speed multipoint interface applications. It is packaged in a space saving SOIC-16 package.

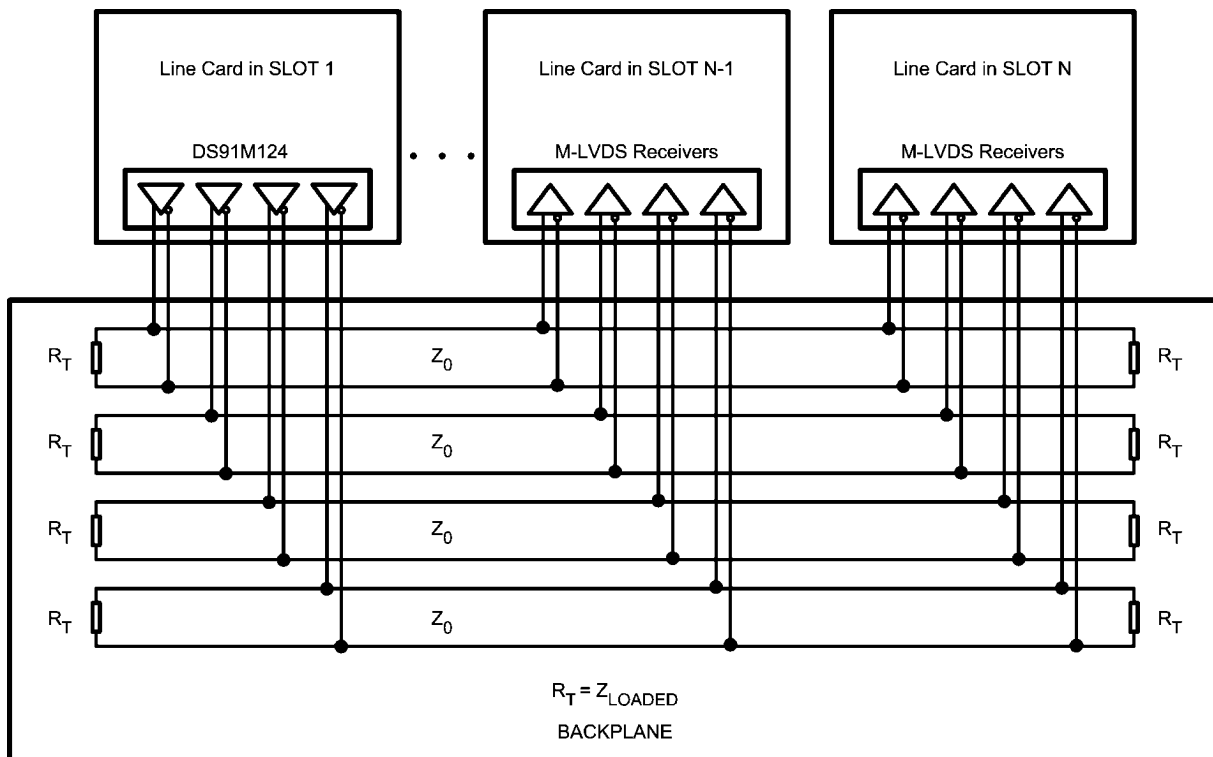
### Features

- DC - 125 MHz / 250 Mbps low jitter, low skew, low power operation
- Independent Driver Enable pins
- Conforms to TIA/EIA-899 M-LVDS Standard
- Controlled transition times minimize reflections
- 8 kV ESD on M-LVDS I/O pins protects adjoining components
- Flow-through pinout simplifies PCB layout
- Industrial operating temperature range ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )
- Available in a space saving SOIC-16 package

### Applications

- Multidrop / Multipoint clock and data distribution
- High-Speed, Low Power, Short-Reach alternative to TIA/EIA-485/422
- Clock distribution in AdvancedTCA (ATCA) and MicroTCA ( $\mu\text{TCA}$ ) backplanes

### Typical Application

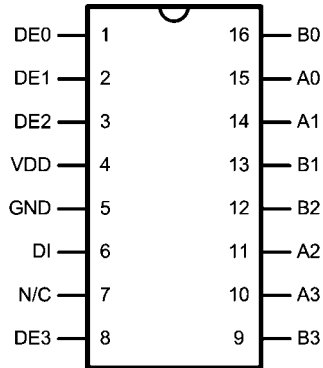


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## Ordering Information

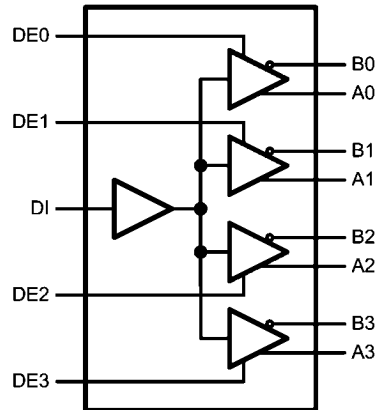
Order Number	Function	Package Type
DS91M124TMA	1:4 Repeater	SOIC-16

## Pin Diagram



30049801

## Logic Diagram



30049803

## Pin Descriptions

Number	Name	I/O, Type	Description
1, 2, 3, 8	DE	I, LVCMOS	Driver enable pin: When a DE pin is low, the corresponding driver output is disabled. When a DE pin is high, the corresponding driver output is enabled. There is a 300 k $\Omega$ pulldown resistor on each DE pin.
6	DI	I, LVCMOS	Driver input pin.
5	GND	Power	Ground pin.
10, 11, 14, 15	A	O, M-LVDS	Non-inverting driver output pins.
9, 12, 13, 16	B	O, M-LVDS	Inverting driver output pins.
4	V <sub>DD</sub>	Power	Power supply pin, +3.3V $\pm$ 0.3V
7	N/C	N/A	NO CONNECT pin.

## Absolute Maximum Ratings *(Note 4)*

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

Power Supply Voltage	-0.3V to +4V
LVC MOS Input Voltage	-0.3V to ( $V_{DD} + 0.3V$ )
M-LVDS Output Voltage	-1.9V to +5.5V
M-LVDS Output Short Circuit Current Duration	Continuous
Junction Temperature	+140°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature Range	
Soldering (4 sec.)	+260°C
Maximum Package Power Dissipation @ +25°C	
MA Package	2.21W
Derate MA Package	19.2 mW/°C above +25°C
Package Thermal Resistance (4-Layer, 2 oz. Cu, JEDEC)	
$\theta_{JA}$	+52°C/W
$\theta_{JC}$	+19°C/W

## ESD Susceptibility

HBM <i>(Note 1)</i>	≥8 kV
MM <i>(Note 2)</i>	≥250V
CDM <i>(Note 3)</i>	≥1250V

**Note 1:** Human Body Model, applicable std. JESD22-A114C

**Note 2:** Machine Model, applicable std. JESD22-A115-A

**Note 3:** Field Induced Charge Device Model, applicable std. JESD22-C101-C

## Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage, $V_{DD}$	3.0	3.3	3.6	V
Voltage at Any Bus Terminal (Separate or Common-Mode)	-1.4		+3.8	V
LV TTL Input Voltage High $V_{IH}$	2.0		$V_{DD}$	V
LV TTL Input Voltage Low $V_{IL}$	0		0.8	V
Operating Free Air Temperature $T_A$	-40	+25	+85	°C

## DC Electrical Characteristics

Over supply voltage and operating temperature ranges, unless otherwise specified. *(Note 5, Note 6, Note 7, Note 10)*

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>LVC MOS DC Specifications</b>						
$V_{IH}$	High-Level Input Voltage		2.0		$V_{DD}$	V
$V_{IL}$	Low-Level Input Voltage		GND		0.8	V
$I_{IH}$	High-Level Input Current	$V_{IH} = 3.6V$	-15	±1	15	μA
$I_{IL}$	Low-Level Input Current	$V_{IL} = 0V$	-15	±1	15	μA
$V_{CL}$	Input Clamp Voltage	$I_{IN} = -18\text{ mA}$	-1.5			V
<b>M-LVDS DC Specifications</b>						
$ V_{AB} $	Differential Output Voltage Magnitude	$R_L = 50\Omega, C_L = 5\text{ pF}$ Figures 1, 3	480		650	mV
$\Delta V_{AB}$	Change in Differential Output Voltage Magnitude Between Logic States		-50		50	mV
$V_{OS(SS)}$	Steady-State Common-Mode Output Voltage	Figures 1, 2 $R_L = 50\Omega$	0.30	1.6	2.10	V
$ \Delta V_{OS(SS)} $	Change in Steady-State Common-Mode Output Voltage Between Logic States		0		50	mV
$V_{A(OC)}$	Maximum Steady-State Open-Circuit Output Voltage	<i>Figure 4</i>	0		2.4	V
$V_{B(OC)}$	Maximum Steady-State Open-Circuit Output Voltage		0		2.4	V
$V_{P(H)}$	Voltage Overshoot, Low-to-High Level Output <i>(Note 8)</i>	$R_L = 50\Omega, C_L = 5\text{ pF}$ $C_D = 0.5\text{ pF}$ Figures 6, 7			$1.2V_{SS}$	V
$V_{P(L)}$	Voltage Overshoot, High-to-Low Level Output <i>(Note 8)</i>		$-0.2V_{SS}$			V
$I_{OS}$	Output Short-Circuit Current <i>(Note 9)</i>	<i>Figure 5</i>	-43		43	mA
$I_A$	Driver High-Impedance Output Current	$V_A = 3.8V, V_B = 1.2V$	0		32	μA
		$V_A = 0V$ or $2.4V, V_B = 1.2V$	-20		20	μA
		$V_A = -1.4V, V_B = 1.2V$	-32		0	μA
$I_B$	Driver High-Impedance Output Current	$V_A = 3.8V, V_B = 1.2V$	0		32	μA
		$V_A = 0V$ or $2.4V, V_B = 1.2V$	-20		20	μA
		$V_A = -1.4V, V_B = 1.2V$	-32		0	μA
$I_{AB}$	Driver High-Impedance Output Differential Current ( $I_A - I_B$ )	$V_A = V_B, -1.4V \leq V \leq 3.8V$	-4		4	μA

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$I_{A(OFF)}$	Driver High-Impedance Output Power-Off Current	$V_A = 3.8V, V_B = 1.2V$ $DE_n = 0V$ $0V \leq V_{DD} \leq 1.5V$	0		32	$\mu A$
		$V_A = 0V \text{ or } 2.4V, V_B = 1.2V$ $DE_n = 0V$ $0V \leq V_{DD} \leq 1.5V$	-20		20	$\mu A$
		$V_A = -1.4V, V_B = 1.2V$ $DE_n = 0V$ $0V \leq V_{DD} \leq 1.5V$	-32		0	$\mu A$
$I_{B(OFF)}$	Driver High-Impedance Output Power-Off Current	$V_A = 3.8V, V_B = 1.2V$ $DE_n = 0V$ $0V \leq V_{DD} \leq 1.5V$	0		32	$\mu A$
		$V_A = 0V \text{ or } 2.4V, V_B = 1.2V$ $DE_n = 0V$ $0V \leq V_{DD} \leq 1.5V$	-20		20	$\mu A$
		$V_A = -1.4V, V_B = 1.2V$ $DE_n = 0V$ $0V \leq V_{DD} \leq 1.5V$	-32		0	$\mu A$
$I_{AB(OFF)}$	Driver High-Impedance Output Power-Off Current ( $I_{A(OFF)} - I_{B(OFF)}$ )	$V_A = V_B, -1.4V \leq V \leq 3.8V$ $DE_n = 0V$ $0V \leq V_{DD} \leq 1.5V$	-4		4	$\mu A$
$C_A$	Driver Output Capacitance	$V_{DD} = 0V$		7.8		pF
$C_B$	Driver Output Capacitance			7.8		pF
$C_{AB}$	Driver Output Differential Capacitance			3		pF
$C_{A/B}$	Driver Output Capacitance Balance ( $C_A/C_B$ )			1		
$I_{CCL}$	Loaded Supply Current Enabled	$R_L = 50\Omega$ (All Outputs) $DI = V_{DD}$ or GND $DE_n = V_{DD}$ or GND (All Outputs)		65	75	mA
$I_{CCZ}$	No Load Supply Current Disabled	$DI = V_{DD}$ or GND, $DE_n = GND$ (All Outputs)		19	24	mA

**Note 4:** "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the Absolute Maximum Ratings or other conditions beyond those indicated in the Recommended Operating Conditions is not implied. The Recommended Operating Conditions indicate conditions at which the device is functional and the device should not be operated beyond such conditions.

**Note 5:** The Electrical Characteristics tables list guaranteed specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not guaranteed.

**Note 6:** Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except  $V_{OD}$  and  $\Delta V_{OD}$ .

**Note 7:** Typical values represent most likely parametric norms for  $V_{DD} = +3.3V$  and  $T_A = +25^\circ C$ , and at the Recommended Operation Conditions at the time of product characterization and are not guaranteed.

**Note 8:** Specification is guaranteed by characterization and is not tested in production.

**Note 9:** Output short circuit current ( $I_{OS}$ ) is specified as magnitude only, minus sign indicates direction only.

**Note 10:**  $C_L$  includes fixture capacitance and  $C_D$  includes probe capacitance.

## Switching Characteristics

Over supply voltage and operating temperature ranges, unless otherwise specified. (Note 11, Note 12, Note 18)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{PHL}$	Differential Propagation Delay High to Low	$R_L = 50\Omega$ $C_L = 5\text{ pF}$ $C_D = 0.5\text{ pF}$ Figures 6, 7	1.8	3.9	6.5	ns
$t_{PLH}$	Differential Propagation Delay Low to High		1.8	3.9	6.5	ns
$t_{SKD1}$	Differential Pulse Skew $ t_{PHL} - t_{PLH} $ (Note 13, Note 14)		0	25	100	ps
$t_{SKD2}$	Channel-to-Channel Skew (Note 13, Note 15)		0	70	250	ps
$t_{SKD3}$	Differential Part-to-Part Skew (Note 13, Note 16) (Constant $T_A$ and $V_{DD}$ )		0	1.5	2	ns
$t_{SKD4}$	Differential Part-to-Part Skew (Note 13, Note 17)		0		4.7	ns
$t_{TLH}$	Rise Time (Note 13)		1.1	2.0	3.0	ns
$t_{THL}$	Fall Time (Note 13)	1.1	2.0	3.0	ns	
$t_{PHZ}$	Disable Time High to Z	$R_L = 50\Omega$ $C_L = 5\text{ pF}$ $C_D = 0.5\text{ pF}$ Figures 8, 9		6	11	ns
$t_{PLZ}$	Disable Time Low to Z			6	11	ns
$t_{PZH}$	Enable Time Z to High			6	11	ns
$t_{PZL}$	Enable Time Z to Low			6	11	ns
$f_{MAX}$	Maximum Operating Frequency (Note 13)			125		

**Note 11:** The Electrical Characteristics tables list guaranteed specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not guaranteed.

**Note 12:** Typical values represent most likely parametric norms for  $V_{DD} = +3.3V$  and  $T_A = +25^\circ C$ , and at the Recommended Operation Conditions at the time of product characterization and are not guaranteed.

**Note 13:** Specification is guaranteed by characterization and is not tested in production.

**Note 14:**  $t_{SKD1}$ ,  $|t_{PLHD} - t_{PHLD}|$ , Pulse Skew, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.

**Note 15:**  $t_{SKD2}$ , Channel-to-Channel Skew, is the difference in propagation delay ( $t_{PLHD}$  or  $t_{PHLD}$ ) among all output channels.

**Note 16:**  $t_{SKD3}$ , Part-to-Part Skew, is defined as the difference between the minimum and maximum differential propagation delays. This specification applies to devices at the same  $V_{DD}$  and within  $5^\circ C$  of each other within the operating temperature range.

**Note 17:**  $t_{SKD4}$ , 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  $|Max - Min|$  differential propagation delay.

**Note 18:**  $C_L$  includes fixture capacitance and  $C_D$  includes probe capacitance.

# Test Circuits and Waveforms

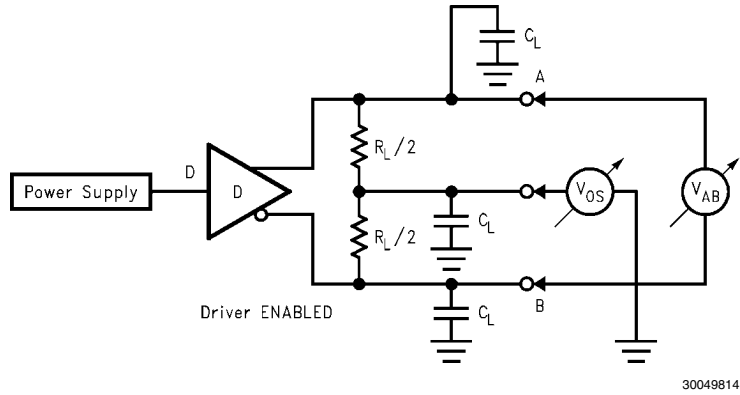


FIGURE 1. Differential Driver Test Circuit

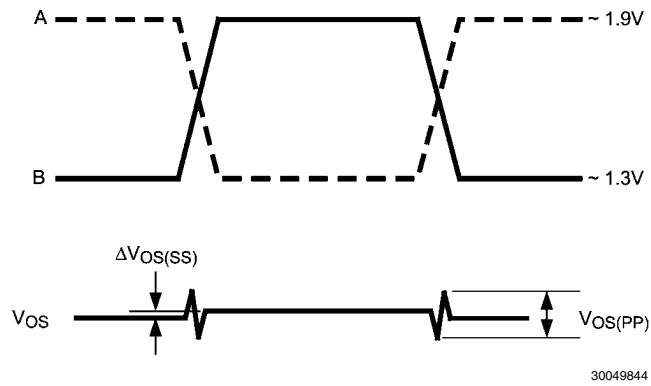


FIGURE 2. Differential Driver Waveforms

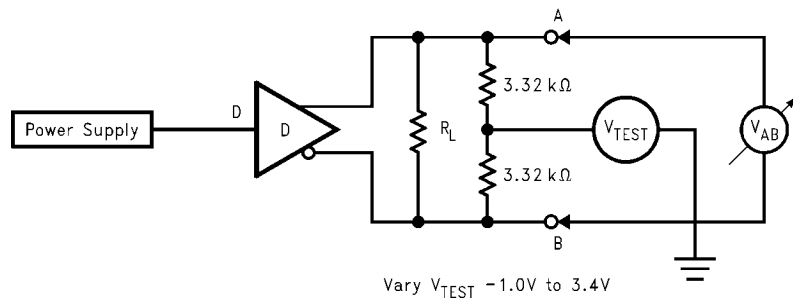
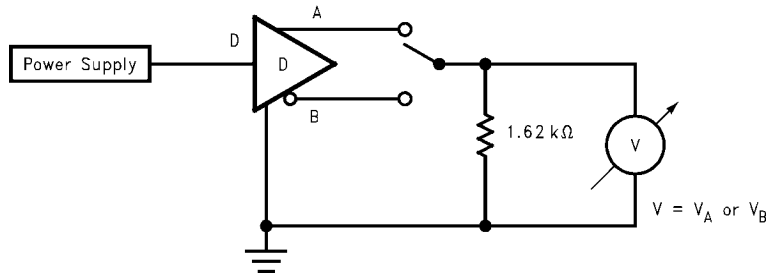
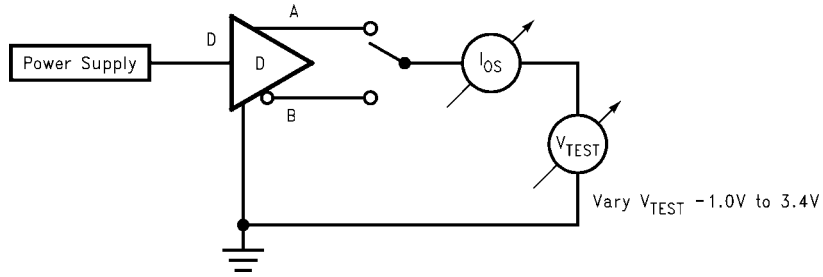


FIGURE 3. Differential Driver Full Load Test Circuit



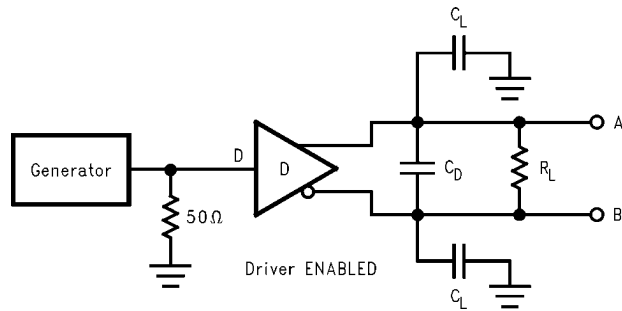
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FIGURE 4. Differential Driver DC Open Test Circuit



30049825

FIGURE 5. Differential Driver Short-Circuit Test Circuit



30049816

FIGURE 6. Driver Propagation Delay and Transition Time Test Circuit



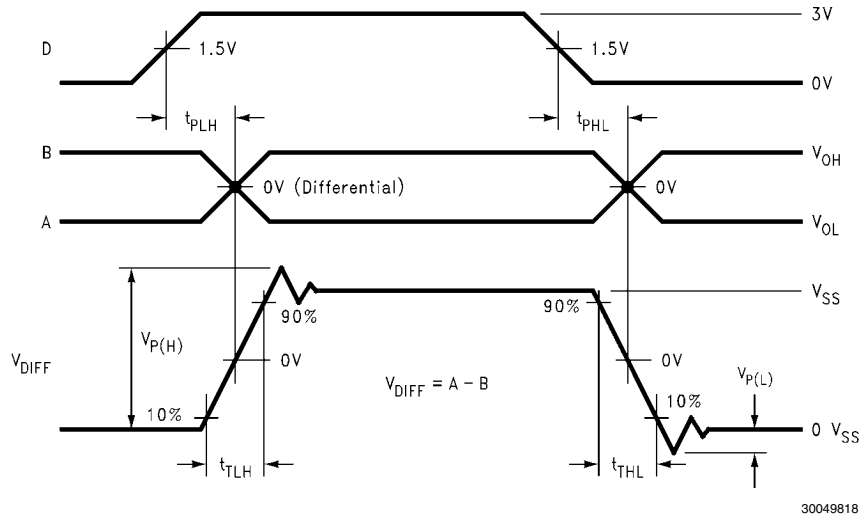


FIGURE 7. Driver Propagation Delays and Transition Time Waveforms

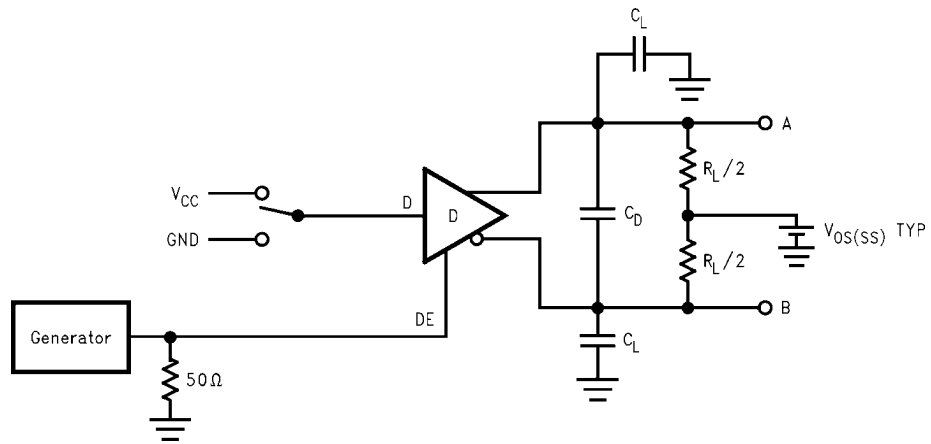


FIGURE 8. Driver TRI-STATE Delay Test Circuit

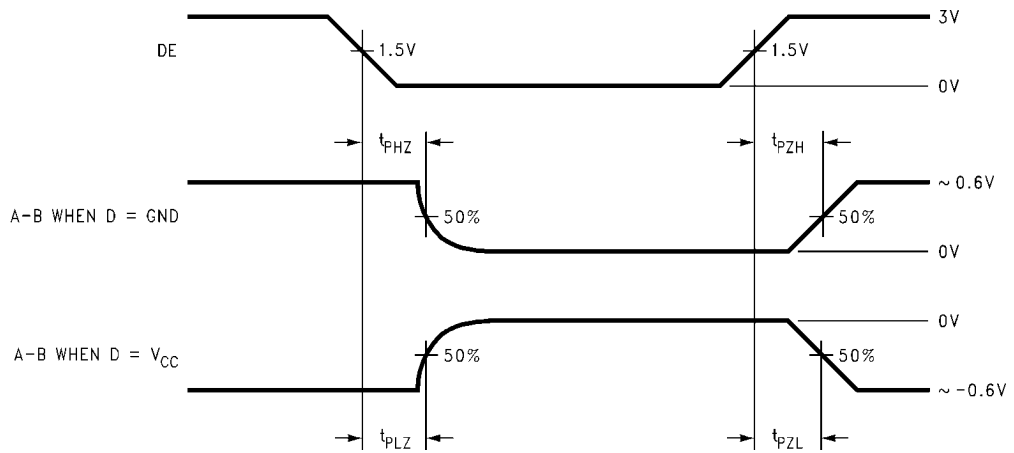
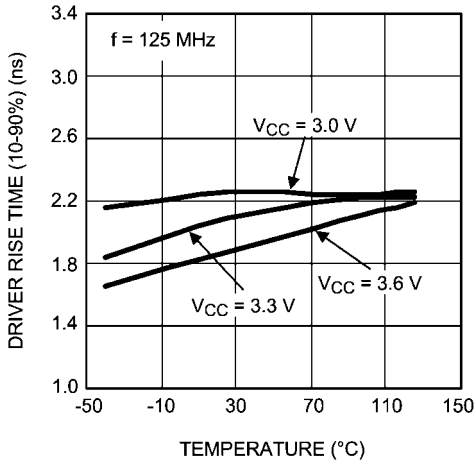
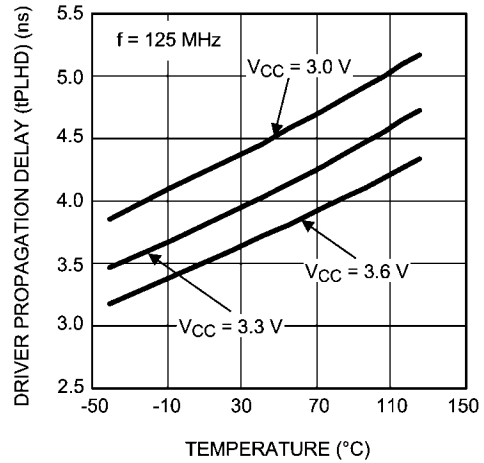


FIGURE 9. Driver TRI-STATE Delay Waveforms

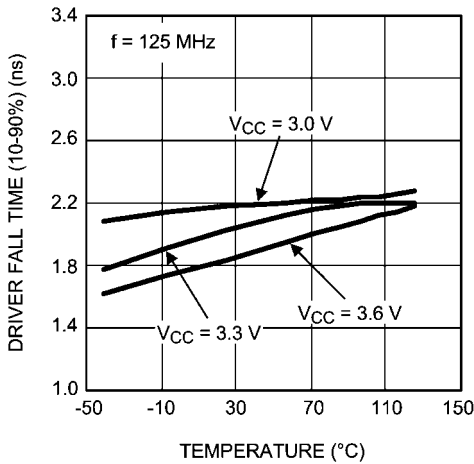
# Typical Performance Characteristics



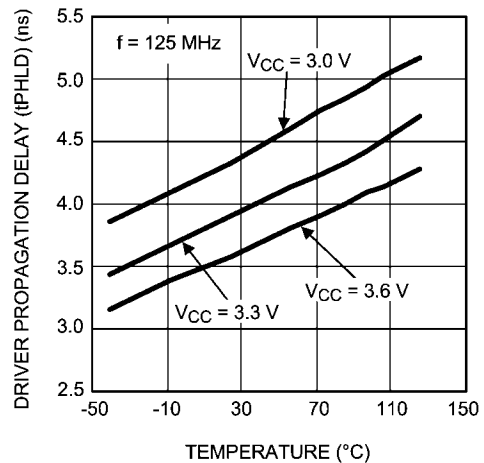
Driver Rise Time as a Function of Temperature



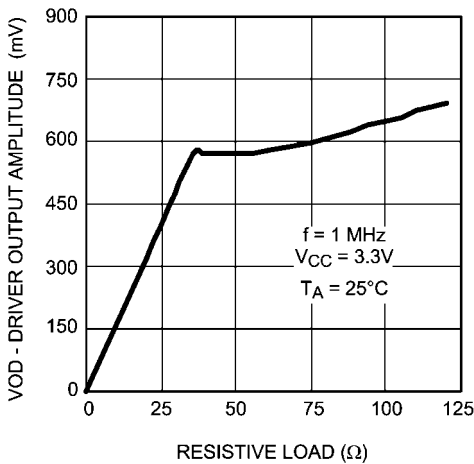
Driver Propagation Delay (tPLHD) as a Function of Temperature



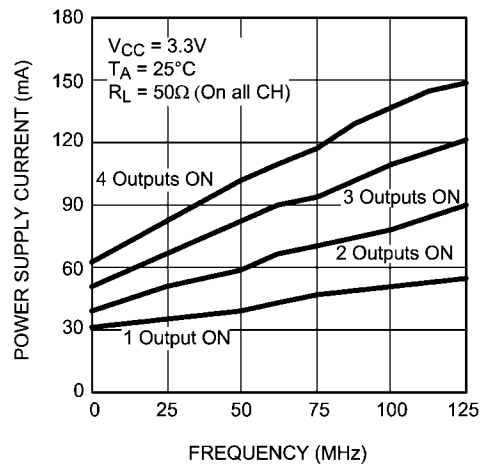
Driver Fall Time as a Function of Temperature



Driver Propagation Delay (tPLHD) as a Function of Temperature

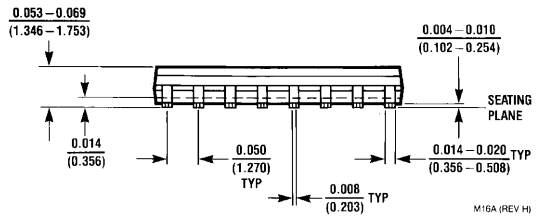
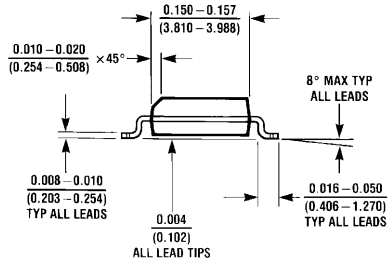
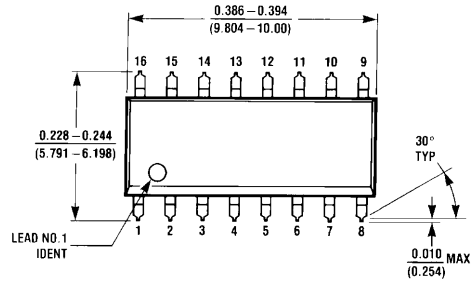


Driver Output Signal Amplitude as a Function of Resistive Load



Driver Power Supply Current as a Function of Frequency

**Physical Dimensions** inches (millimeters) unless otherwise noted



**16-Lead (0.150 Wide) Molded Small Outline Package, JEDEC  
Order Number DS91M124TMA  
NS Package Number M16A**

M16A (REV H)

# Notes

## Notes

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LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage Reference	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Solutions	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
Temperature Sensors	<a href="http://www.national.com/tempensors">www.national.com/tempensors</a>	SolarMagic™	<a href="http://www.national.com/solarmagic">www.national.com/solarmagic</a>
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