

## DS91D176/DS91C176 Multipoint-LVDS (M-LVDS) Transceivers

### General Description

The DS91C176 and DS91D176 are high-speed M-LVDS differential transceivers designed for multipoint applications with multiple drivers or receivers. Multipoint LVDS (M-LVDS) is a new bus interface standard (TIA/EIA-899) based on LVDS but including several enhancements to improve multipoint performance. M-LVDS devices have superior drive capability and can support up to 32 loads. Along with increased drive, M-LVDS devices are required to have a controlled edge rate to minimize reflections and EMI. The 1 nSec minimum edge rate is tolerant of stub lengths up to 2 inches in length. M-LVDS devices also have a very large common mode range for additional noise margin in heavily loaded and noisy backplane environments.

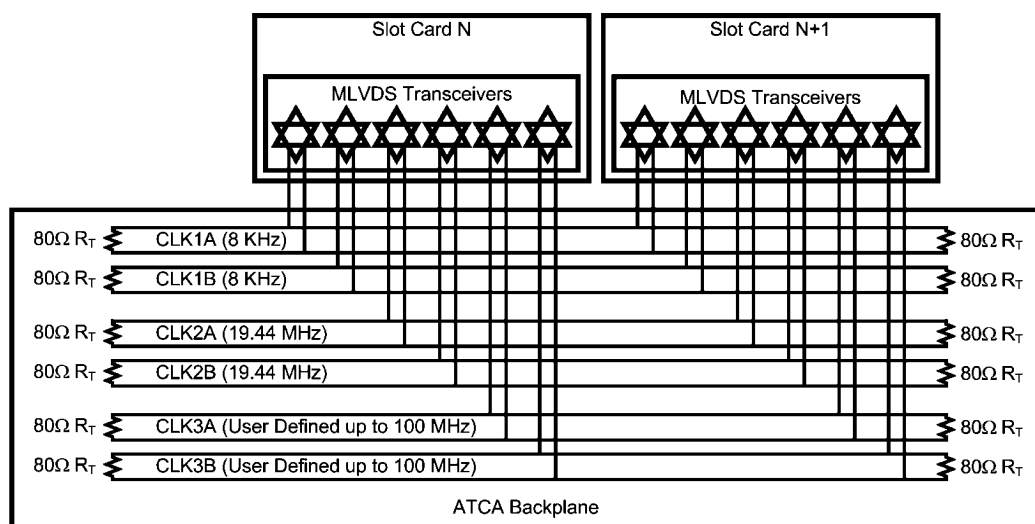
The DS91C176/DS91D176 are half-duplex transceivers that accept LVTTTL/LVCMOS signals at the driver inputs and convert them to differential M-LVDS signal levels. The receiver inputs accept low voltage differential signals (LVDS, B-LVDS, M-LVDS, LV-PECL) and convert them to 3V LVCMOS sig-

nals. The DS91D176 has a M-LVDS type 1 receiver input with no offset. The DS91C176 receiver contains an M-LVDS type 2 failsafe circuit with an internal 100 mV offset that provides a LOW output for both short and open input conditions.

### Features

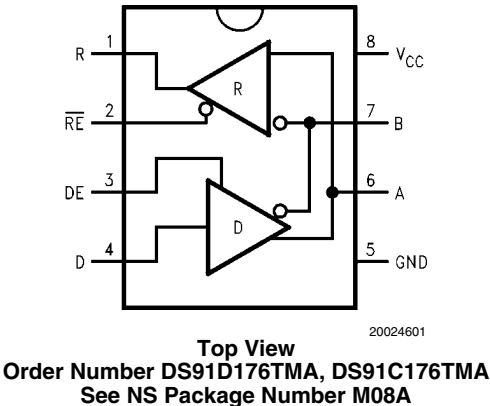
- Meets TIA/EIA-899 M-LVDS Standard
- Capable of driving 32 LVDS loads
- Controlled Edge Rates Tolerant to Stubs
- Wide Common Mode for Increased Noise Immunity
- DS91D176 has type 1 receiver input
- DS91C176 has type 2 receiver with fail-safe
- Up to 200 Mbps operation
- Industrial temperature range
- Single 3.3V supply
- 8-lead SOIC package

### Typical Application in AdvancedTCA Clock Distribution



20024630

Connection and Logic Diagram



Ordering Information

Order Number	Receiver Input	Function	Package Type
DS91D176TMA	type 1	Data (0V threshold receiver)	SOIC/M08A
DS91C176TMA	type 2	Control (100 mV offset fail-safe receiver)	SOIC/M08A

M-LVDS Receiver Types

The EIA/TIA-899 M-LVDS standard specifies two different types of receiver input stages. A type 1 receiver has a conventional threshold that is centered at the midpoint of the input amplitude,  $V_{ID}/2$ . A type 2 receiver has a built in offset that is 100mV greater than  $V_{ID}/2$ . The type 2 receiver offset acts as a failsafe circuit where open or short circuits at the input will always result in the output stage being driven to a low logic state.

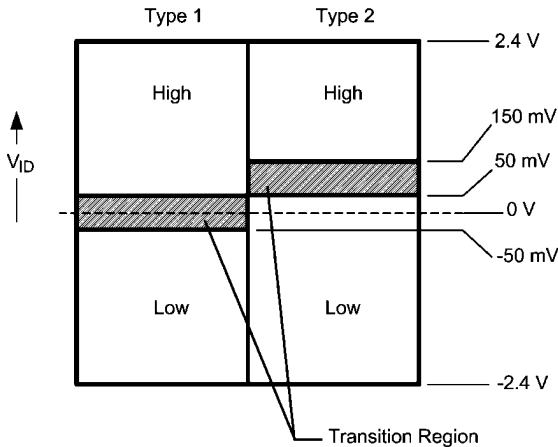


FIGURE 1. M-LVDS Receiver Input Thresholds

## 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
Control Input Voltages	-0.3V to ( $V_{CC} + 0.3V$ )
Driver Input Voltage	-0.3V to ( $V_{CC} + 0.3V$ )
Driver Output Voltages	-1.8V to +4.1V
Receiver Input Voltages	-1.8V to +4.1V
Receiver Output Voltage	-0.3V to ( $V_{CC} + 0.3V$ )
Maximum Package Power Dissipation at +25°C	
SOIC Package	833 mW
Derate SOIC Package	6.67 mW/°C above +25°C
Thermal Resistance	
$\theta_{JA}$	150°C/W
$\theta_{JC}$	63°C/W
Maximum Junction Temperature	150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature	
(Soldering, 4 seconds)	260°C

ESD Ratings:

(HBM 1.5k $\Omega$ , 100pF)

$\geq 8$  kV

(EIAJ 0 $\Omega$ , 200pF)

$\geq 250$  V

(CDM 0 $\Omega$ , 0pF)

$\geq 1000$  V

## Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage, $V_{CC}$	3.0	3.3	3.6	V
Voltage at Any Bus Terminal (Separate or Common-Mode)	-1.4		+3.8	V
Differential Input Voltage $V_{ID}$			2.4	V
LVTTL Input Voltage High $V_{IH}$	2.0		$V_{CC}$	V
LVTTL Input Voltage Low $V_{IL}$	0		0.8	V
Operating Free Air Temperature $T_A$	-40	+25	+85	°C

## Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. (Notes 2, 3, 4, 8)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>M-LVDS Driver</b>						
$ V_{AB} $	Differential output voltage magnitude	$R_L = 50\Omega$ , $C_L = 5pF$	480		650	mV
$\Delta V_{AB}$	Change in differential output voltage magnitude between logic states	Figure 2 and Figure 4	-50	0	+50	mV
$V_{OS(SS)}$	Steady-state common-mode output voltage	$R_L = 50\Omega$ , $C_L = 5pF$	0.3	1.8	2.1	V
$ \Delta V_{OS(SS)} $	Change in steady-state common-mode output voltage between logic states	Figure 2 and Figure 3	0		+50	mV
$V_{OS(PP)}$	Peak-to-peak common-mode output voltage	( $V_{OS(PP)}$ @ 500KHz clock)		135		mV
$V_{A(OC)}$	Maximum steady-state open-circuit output voltage	Figure 5	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	$R_L = 50\Omega$ , $C_L = 5pF$ , $C_D = 0.5pF$			$1.2V_{SS}$	V
$V_{P(L)}$	Voltage overshoot, high-to-low level output	Figure 7 and Figure 8 (Note 9)	-0.2 $V_S$			V
$I_{IH}$	High-level input current (LVTTL inputs)	$V_{IH} = 2.0V$	-15		15	$\mu A$
$I_{IL}$	Low-level input current (LVTTL inputs)	$V_{IL} = 0.8V$	-15		15	$\mu A$
$V_{IKL}$	Input Clamp Voltage (LVTTL inputs)	$I_{IN} = -18mA$	-1.5			V
$I_{OS}$	Differential short-circuit output current	Figure 6	-43		43	mA
<b>M-LVDS Receiver</b>						
$V_{IT+}$	Positive-going differential input voltage threshold	See Function Tables	Type 1		20	50 mV
			Type 2		94	150 mV
$V_{IT-}$	Negative-going differential input voltage threshold	See Function Tables	Type 1	-50	20	mV
			Type 2	50	94	mV
$V_{OH}$	High-level output voltage (LVTTL output)	$I_{OH} = -8mA$	2.4	2.7		V
$V_{OL}$	Low-level output voltage (LVTTL output)	$I_{OL} = 8mA$		0.28	0.4	V
$I_{OZ}$	TRI-STATE output current	$V_O = 0V$ or 3.6V	-10		10	$\mu A$
$I_{OSR}$	Short-circuit receiver output current (LVTTL output)	$V_O = 0V$		-48	-90	mA

Symbol	Parameter	Conditions	Min	Typ	Max	Units
M-LVDS Bus (Input and Output) Pins						
I <sub>A</sub>	Transceiver input/output current	V <sub>A</sub> = 3.8V, V <sub>B</sub> = 1.2V			32	μA
		V <sub>A</sub> = 0V or 2.4V, V <sub>B</sub> = 1.2V	-20		+20	μA
		V <sub>A</sub> = -1.4V, V <sub>B</sub> = 1.2V	-32			μA
I <sub>B</sub>	Transceiver input/output current	V <sub>B</sub> = 3.8V, V <sub>A</sub> = 1.2V			32	μA
		V <sub>B</sub> = 0V or 2.4V, V <sub>A</sub> = 1.2V	-20		+20	μA
		V <sub>B</sub> = -1.4V, V <sub>A</sub> = 1.2V	-32			μA
I <sub>AB</sub>	Transceiver input/output differential current (I <sub>A</sub> - I <sub>B</sub> )	V <sub>A</sub> = V <sub>B</sub> , -1.4V ≤ V ≤ 3.8V	-4		+4	μA
I <sub>A(OFF)</sub>	Transceiver input/output power-off current	V <sub>A</sub> = 3.8V, V <sub>B</sub> = 1.2V, DE = V <sub>CC</sub> = 1.5V			32	μA
		V <sub>A</sub> = 0V or 2.4V, V <sub>B</sub> = 1.2V, DE = V <sub>CC</sub> = 1.5V	-20		+20	μA
		V <sub>A</sub> = -1.4V, V <sub>B</sub> = 1.2V, DE = V <sub>CC</sub> = 1.5V	-32			μA
I <sub>B(OFF)</sub>	Transceiver input/output power-off current	V <sub>B</sub> = 3.8V, V <sub>A</sub> = 1.2V, DE = V <sub>CC</sub> = 1.5V			32	μA
		V <sub>B</sub> = 0V or 2.4V, V <sub>A</sub> = 1.2V, DE = V <sub>CC</sub> = 1.5V	-20		+20	μA
		V <sub>B</sub> = -1.4V, V <sub>A</sub> = 1.2V, DE = V <sub>CC</sub> = 1.5V	-32			μA
I <sub>AB(OFF)</sub>	Transceiver input/output power-off differential current (I <sub>A(OFF)</sub> - I <sub>B(OFF)</sub> )	V <sub>A</sub> = V <sub>B</sub> , -1.4V ≤ V ≤ 3.8V, V <sub>CC</sub> = 1.5V, DE = 1.5V	-4		+4	μA
C <sub>A</sub>	Transceiver input/output capacitance	V <sub>CC</sub> = OPEN		9		pF
C <sub>B</sub>	Transceiver input/output capacitance			9		pF
C <sub>AB</sub>	Transceiver input/output differential capacitance			5.7		pF
C <sub>A/B</sub>	Transceiver input/output capacitance balance (C <sub>A</sub> /C <sub>B</sub> )			1.0		
SUPPLY CURRENT (V <sub>CC</sub> )						
I <sub>CCD</sub>	Driver Supply Current	R <sub>L</sub> = 50Ω, DE = V <sub>CC</sub> , $\overline{RE}$ = V <sub>CC</sub>		20	29.5	mA
I <sub>CCZ</sub>	TRI-STATE Supply Current	DE = GND, $\overline{RE}$ = V <sub>CC</sub>		6	9.0	mA
I <sub>CCR</sub>	Receiver Supply Current	DE = GND, $\overline{RE}$ = GND		14	18.5	mA

## Switching Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. (Notes 3, 8)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DRIVER AC SPECIFICATION</b>						
$t_{PLH}$	Differential Propagation Delay Low to High	$R_L = 50\Omega$ , $C_L = 5\text{ pF}$ , $C_D = 0.5\text{ pF}$ <i>Figure 7 and Figure 8</i>	1.3	3.4	5.0	ns
$t_{PHL}$	Differential Propagation Delay High to Low		1.3	3.1	5.0	ns
$t_{SKD1} (t_{sk(p)})$	Pulse Skew $ t_{PLHD} - t_{PHLD} $ (Notes 5, 9)			300	420	ps
$t_{SKD3}$	Part-to-Part Skew (Notes 6, 9)				1.3	ns
$t_{TLH} (t_r)$	Rise Time (Note 9)		1.0	1.8	3.0	ns
$t_{THL} (t_f)$	Fall Time (Note 9)		1.0	1.8	3.0	ns
$t_{PZH}$	Enable Time (Z to Active High)	$R_L = 50\Omega$ , $C_L = 5\text{ pF}$ , $C_D = 0.5\text{ pF}$ <i>Figure 9 and Figure 10</i>			8	ns
$t_{PZL}$	Enable Time (Z to Active Low )				8	ns
$t_{PLZ}$	Disable Time (Active Low to Z)				8	ns
$t_{PHZ}$	Disable Time (Active High to Z)				8	ns
$t_{JIT}$	Random Jitter, RJ (Note 9)	100 MHz Clock Pattern (Note 7)		2.5	5.5	psrms
$f_{MAX}$	Maximum Data Rate		200			Mbps
<b>RECEIVER AC SPECIFICATION</b>						
$t_{PLH}$	Propagation Delay Low to High	$C_L = 15\text{ pF}$ <i>Figures 11, 12 and Figure 13</i>	2.0	4.7	7.5	ns
$t_{PHL}$	Propagation Delay High to Low		2.0	5.3	7.5	ns
$t_{SKD1} (t_{sk(p)})$	Pulse Skew $ t_{PLHD} - t_{PHLD} $ (Notes 5, 9)			0.6	1.7	ns
$t_{SKD3}$	Part-to-Part Skew (Notes 6, 9)				1.3	ns
$t_{TLH} (t_r)$	Rise Time (Note 9)		0.5	1.2	2.5	ns
$t_{THL} (t_f)$	Fall Time (Note 9)		0.5	1.2	2.5	ns
$t_{PZH}$	Enable Time (Z to Active High)	$R_L = 500\Omega$ , $C_L = 15\text{ pF}$ <i>Figure 14 and Figure 15</i>			10	ns
$t_{PZL}$	Enable Time (Z to Active Low)				10	ns
$t_{PLZ}$	Disable Time (Active Low to Z)				10	ns
$t_{PHZ}$	Disable Time (Active High to Z)				10	ns
$f_{MAX}$	Maximum Data Rate		200			Mbps

**Note 1:** "Absolute Maximum Ratings" are those 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 tables of "Electrical Characteristics" provide 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 device ground unless otherwise specified.

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

**Note 4:** The algebraic convention, in which the least positive (most negative) limit is designated as minimum, is used in this datasheet.

**Note 5:**  $t_{SKD1}$ ,  $|t_{PLHD} - t_{PHLD}|$ , is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.

**Note 6:**  $t_{SKD3}$ , 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  $5^\circ\text{C}$  of each other within the operating temperature range.

**Note 7:** Stimulus and fixture Jitter has been subtracted.

**Note 8:**  $C_L$  includes fixture capacitance and  $C_D$  includes probe capacitance.

**Note 9:** Not production tested. Guaranteed by a statistical analysis on a sample basis at the time of characterization.

## Test Circuits and Waveforms

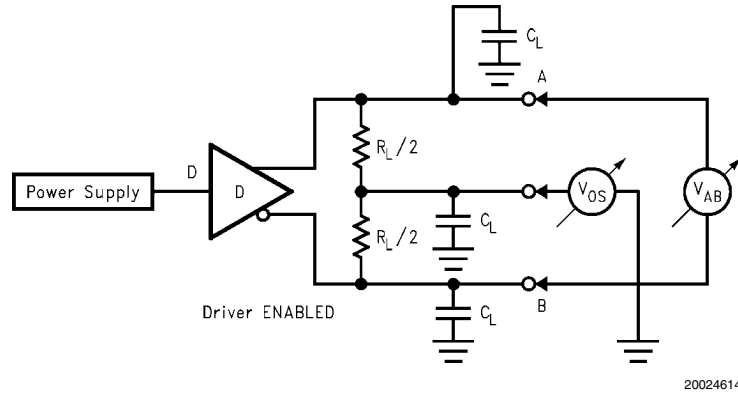


FIGURE 2. Differential Driver Test Circuit

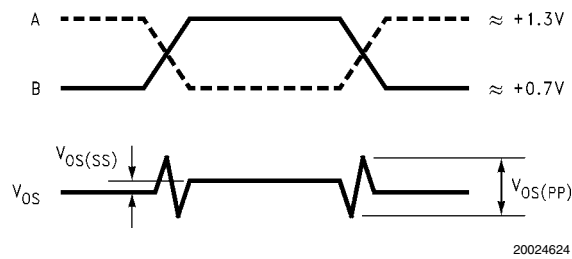


FIGURE 3. Differential Driver Waveforms

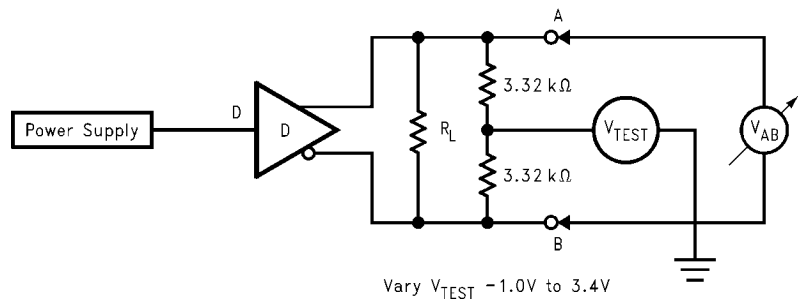


FIGURE 4. Differential Driver Full Load Test Circuit

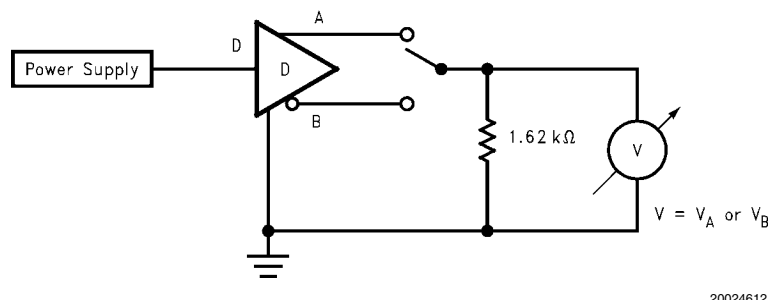
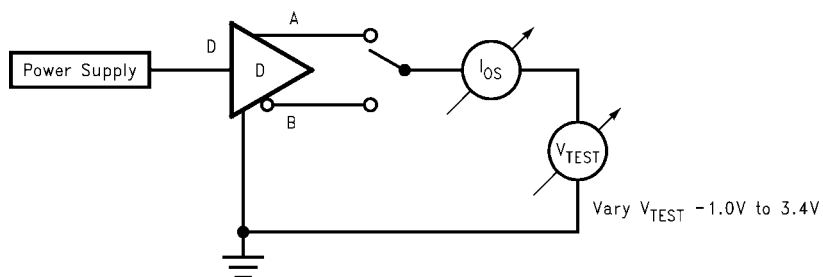
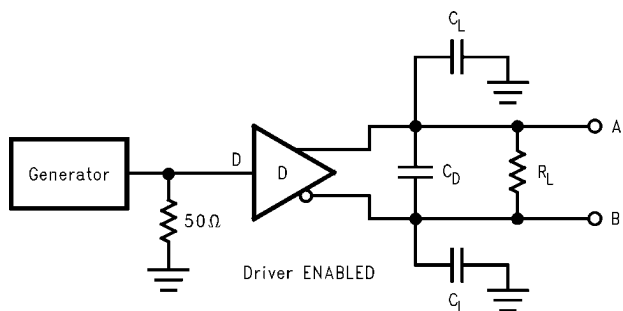


FIGURE 5. Differential Driver DC Open Test Circuit



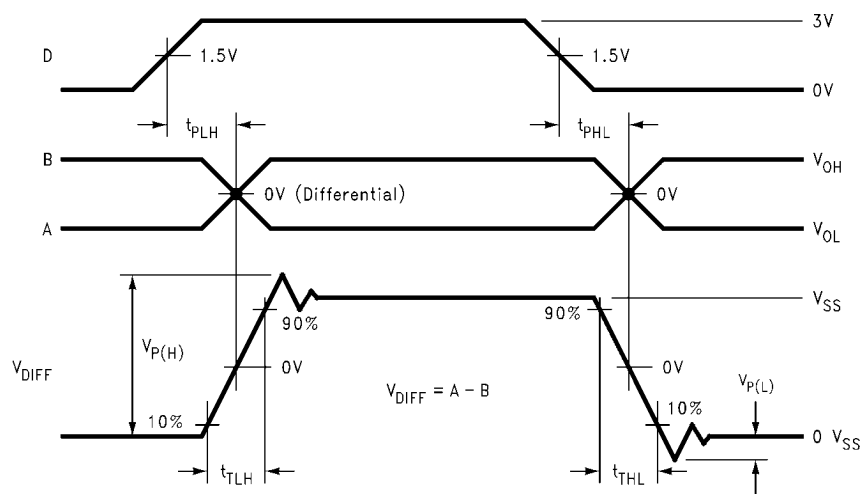
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FIGURE 6. Differential Driver Short-Circuit Test Circuit



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FIGURE 7. Driver Propagation Delay and Transition Time Test Circuit



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FIGURE 8. Driver Propagation Delays and Transition Time Waveforms

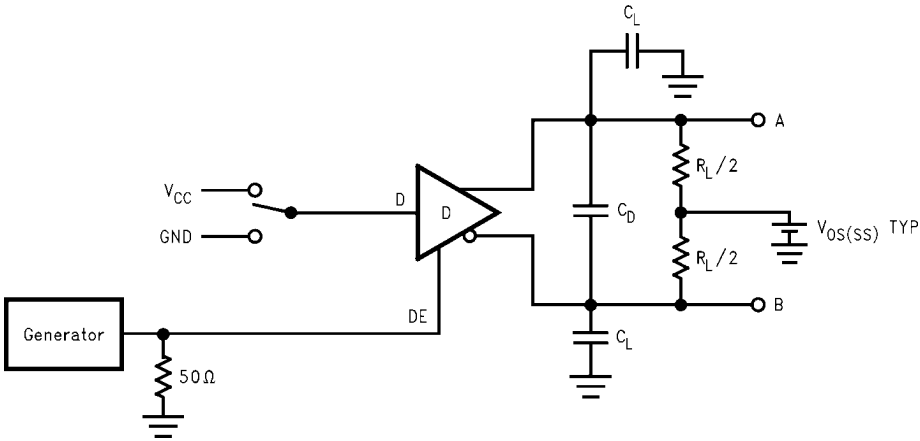


FIGURE 9. Driver TRI-STATE Delay Test Circuit

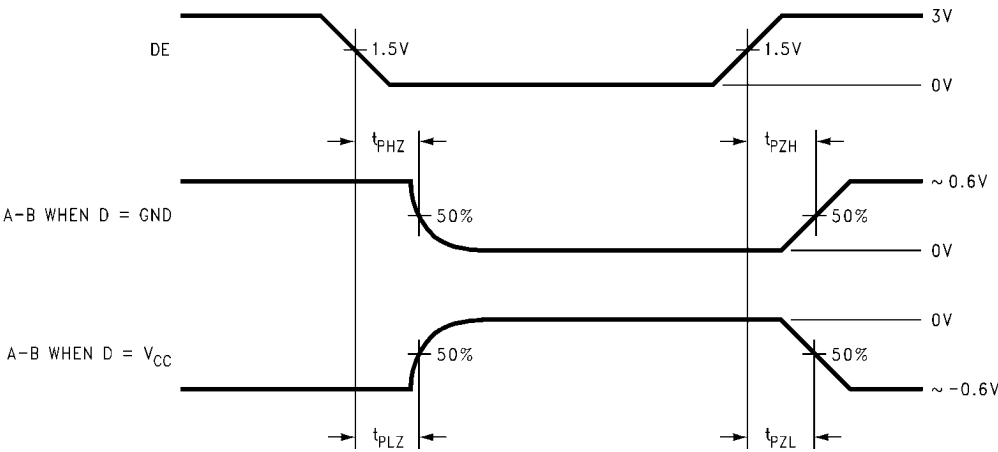


FIGURE 10. Driver TRI-STATE Delay Waveforms

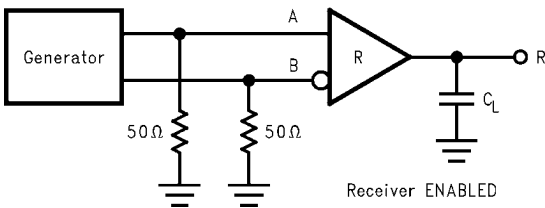


FIGURE 11. Receiver Propagation Delay and Transition Time Test Circuit



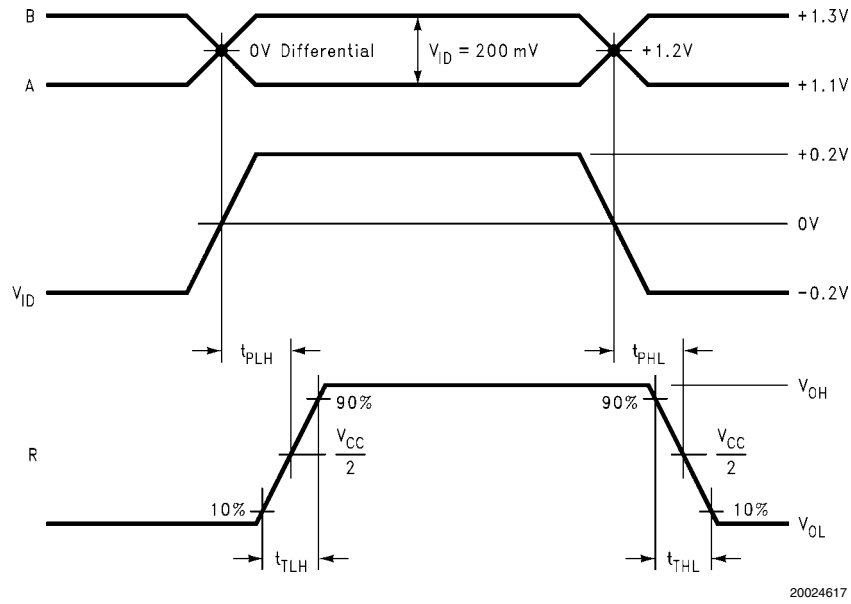


FIGURE 12. Type 1 Receiver Propagation Delay and Transition Time Waveforms

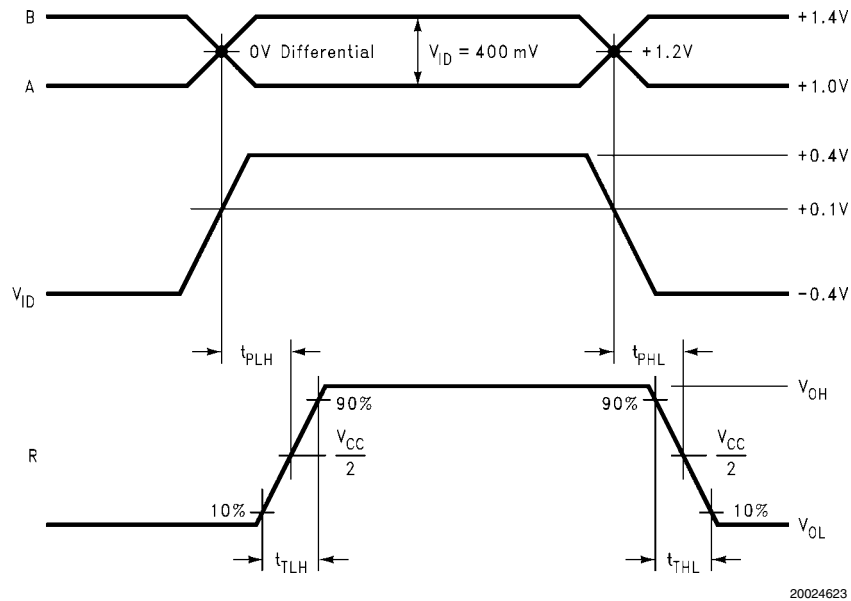


FIGURE 13. Type 2 Receiver Propagation Delay and Transition Time Waveforms

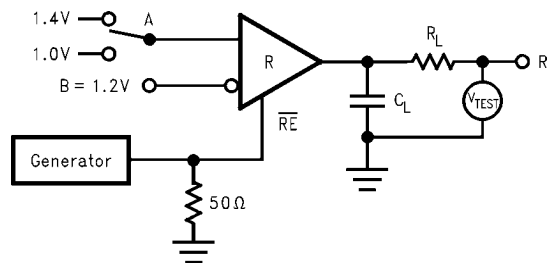


FIGURE 14. Receiver TRI-STATE Delay Test Circuit

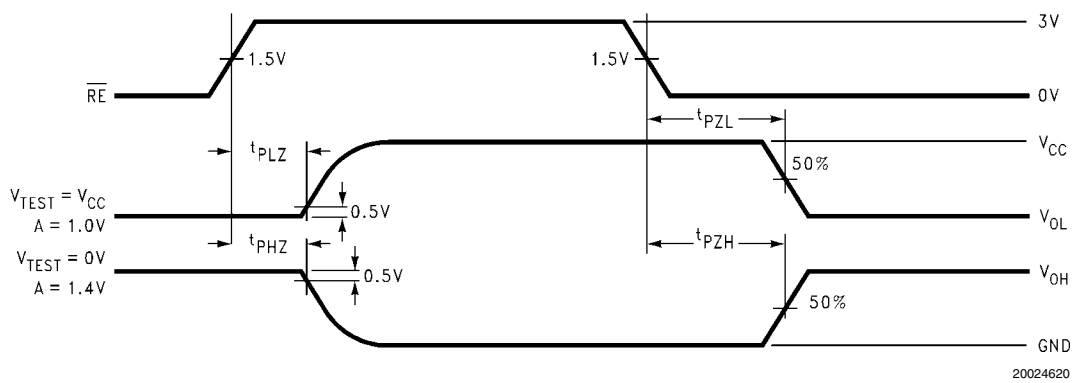


FIGURE 15. Receiver TRI-STATE Delay Waveforms

## Function Tables

DS91D176/DS91C176 Transmitting

Inputs			Outputs	
$\overline{RE}$	DE	D	B	A
X	2.0V	2.0V	L	H
X	2.0V	0.8V	H	L
X	0.8V	X	Z	Z

X — Don't care condition  
Z — High impedance state

DS91D176 Receiving

Inputs			Output
$\overline{RE}$	DE	A – B	R
0.8V	0.8V	$\geq +0.05V$	H
0.8V	0.8V	$\leq -0.05V$	L
0.8V	0.8V	0V	X
2.0V	0.8V	X	Z

X — Don't care condition  
Z — High impedance state

DS91C176 Receiving

Inputs			Output
$\overline{RE}$	DE	A – B	R
0.8V	0.8V	$\geq +0.15V$	H
0.8V	0.8V	$\leq +0.05V$	L
0.8V	0.8V	0V	L
2.0V	0.8V	X	Z

X — Don't care condition  
Z — High impedance state

DS91D176 Receiver Input Threshold Test Voltages

Applied Voltages		Resulting Differential Input Voltage	Resulting Common-Mode Input Voltage	Receiver Output
$V_{IA}$	$V_{IB}$	$V_{ID}$	$V_{IC}$	R
2.400V	0.000V	2.400V	1.200V	H
0.000V	2.400V	-2.400V	1.200V	L
3.800V	3.750V	0.050V	3.775V	H
3.750V	3.800V	-0.050V	3.775V	L
-1.400V	-1.350V	-0.050V	-1.375V	H
-1.350V	-1.400V	0.050V	-1.375V	L

H — High Level  
L — Low Level  
Output state assumes that the receiver is enabled ( $\overline{RE} = L$ )

DS91C176 Receiver Input Threshold Test Voltages

Applied Voltages		Resulting Differential Input Voltage	Resulting Common-Mode Input Voltage	Receiver Output
$V_{IA}$	$V_{IB}$	$V_{ID}$	$V_{IC}$	R
2.400V	0.000V	2.400V	1.200V	H
0.000V	2.400V	-2.400V	1.200V	L
3.800V	3.650V	0.150V	3.725V	H
3.800V	3.750V	0.050V	3.775V	L
-1.250V	-1.400V	0.150V	-1.325V	H
-1.350V	-1.400V	0.050V	-1.375V	L

H — High Level  
L — Low Level  
Output state assumes that the receiver is enabled ( $\overline{RE} = L$ )

## Pin Descriptions

Pin No.	Name	Description
1	R	Receiver output pin
2	$\overline{RE}$	Receiver enable pin: When $\overline{RE}$ is high, the receiver is disabled. When $\overline{RE}$ is low or open, the receiver is enabled.
3	DE	Driver enable pin: When DE is low, the driver is disabled. When DE is high, the driver is enabled.
4	D	Driver input pin
5	GND	Ground pin
6	A	Non-inverting driver output pin/Non-inverting receiver input pin
7	B	Inverting driver output pin/Inverting receiver input pin
8	$V_{CC}$	Power supply pin, $+3.3V \pm 0.3V$

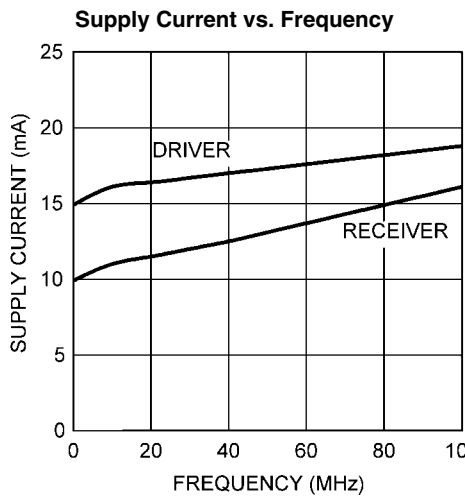
## Application Information

### STUB LENGTH

Stub lengths should be kept to a minimum. For a general approximation, if the electrical length of a trace is greater than 1/5 of the transition edge, then the trace is considered a transmission line. If the velocity equals 160 ps per inch for a

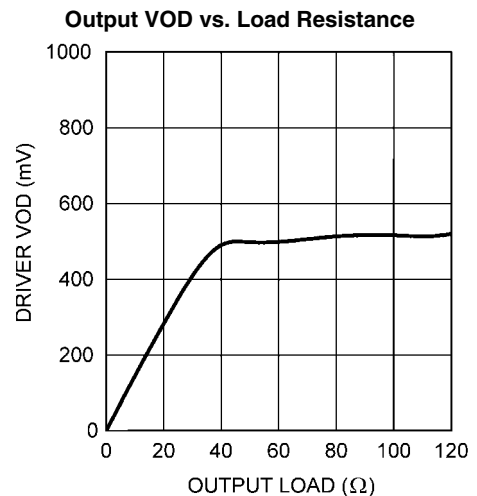
typical loaded backplane, then the maximum stub length is 312 ps/160 ps/inch or 1.95 inches (approximately 2 inches). To determine the maximum stub for your backplane, the propagation velocity for the backplane is required (refer to application notes AN-905 and AN-808).

## Typical Performance Characteristics



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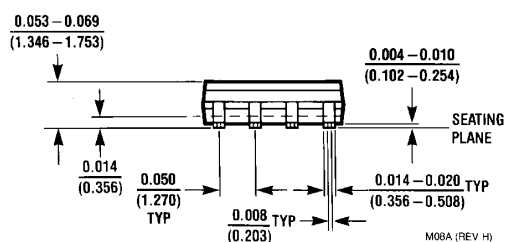
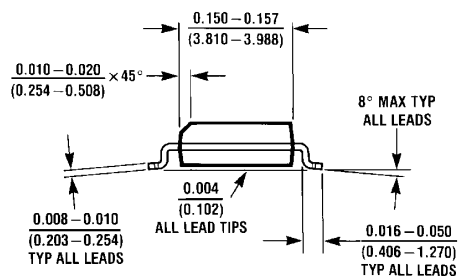
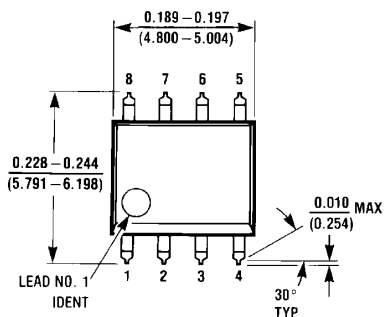
Supply Current measured using a clock pattern with driver terminated to 50ohms.  $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$   
 $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$ .



20024663

**FIGURE 16. SOIC performance Characteristics**

# Physical Dimensions inches (millimeters) unless otherwise noted



M08A (REV. H)

Order Number DS91D176TMA, DS91C176TMA  
See NS package Number M08A

## Notes

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