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National Semiconductor

November 9, 2009

DS91D176/DS91C176

100 MHz Single Channel M-LVDS Transceivers

General Description

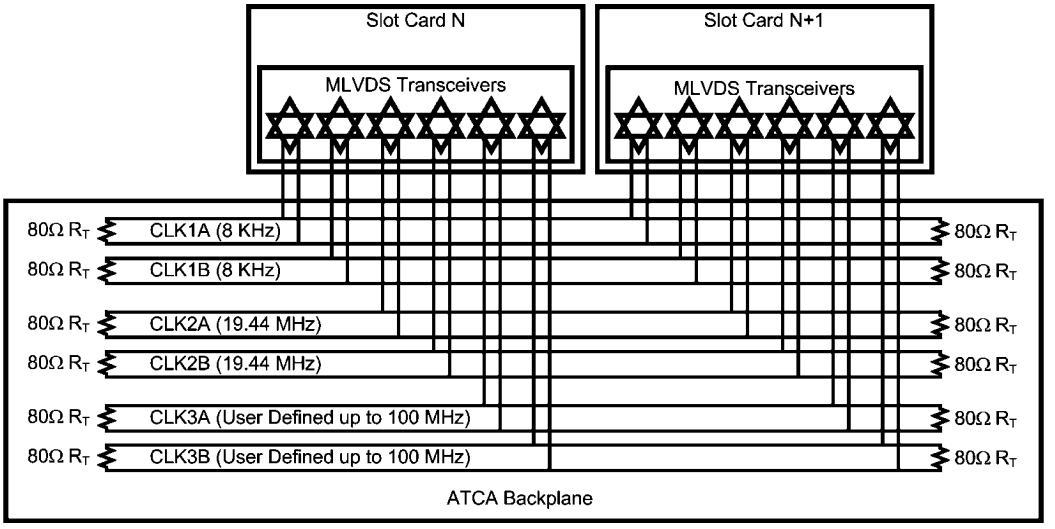
The DS91C176 and DS91D176 are 100 MHz single channel M-LVDS (Multipoint Low Voltage Differential Signaling) transceivers designed for applications that utilize multipoint networks (e.g. clock distribution in ATCA and uTCA based systems). M-LVDS is a new bus interface standard (TIA/EIA-899) optimized for multidrop networks. Controlled edge rates, tight input receiver thresholds and increased drive strength are sone of the key enhancments that make M-LVDS devices an ideal choice for distributing signals via multipoint networks.

The DS91C176/DS91D176 are half-duplex transceivers that accept LVTTL/LVCMOS signals at the driver inputs and convert them to differential M-LVDS signals. The receiver inputs accept low voltage differential signals (LVDS, B-LVDS, M-LVDS, LV-PECL and CML) and convert them to 3V LVCMOS signals. The DS91D176 has a M-LVDS type 1 receiver input with no offset. The DS91C176 has an M-LVDS type 2 receiver which enable failsafe functionality.

Features

- DC to 100+ MHz / 200+ Mbps low power, low EMI operation
- Optimal for ATCA, uTCA clock distribution networks
- Meets or exceeds TIA/EIA-899 M-LVDS Standard
- Wide Input Common Mode Voltage for Increased Noise Immunity
- DS91D176 has type 1 receiver input
- DS91C176 has type 2 receiver with fail-safe
- Industrial temperature range
- Space saving SOIC-8 package

Typical Application in an ATCA Clock Distribution Network



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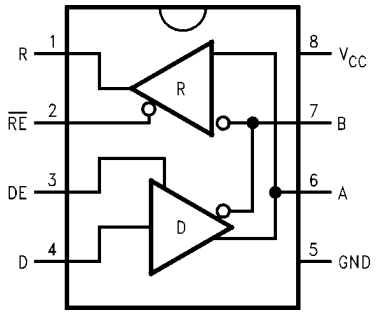
Connection and Logic Diagram



Top View
Order Number DS91D176TMA, DS91C176TMA
See NS Package Number M08A

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.

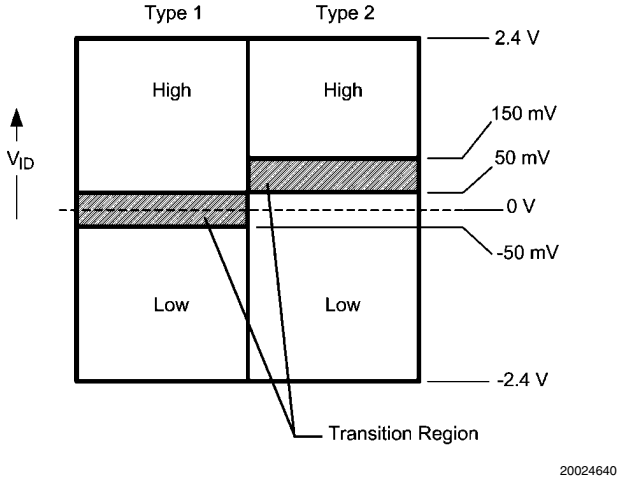


FIGURE 1. M-LVDS Receiver Input Thresholds

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 (4-Layer, 2 oz. Cu, JEDEC)	
θ_{JA}	150°C/W
θ_{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 1.5kΩ, 100pF)	≥ 8 kV
(EIAJ 0Ω, 200pF)	≥ 250 V
(CDM 0Ω, 0pF)	≥ 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. (*Note 2*, *Note 3*, *Note 4*, *Note 8*)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
M-LVDS Driver							
$\lvert V_{AB}\rvert$	Differential output voltage magnitude	R_L = 50Ω, C_L = 5pF		480		650	mV
ΔV_{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 = 50Ω, C_L = 5pF		0.3	1.8	2.1	V
$\lvert\Delta V_{OS(SS)}\rvert$	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 = 50Ω, 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*)		$-0.2V_S$ S			V
I_{IH}	High-level input current (LVTTL inputs)	V_{IH} = 2.0V		-15		15	µA
I_{IL}	Low-level input current (LVTTL inputs)	V_{IL} = 0.8V		-15		15	µA
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
M-LVDS Receiver							
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	µA
I_{OSR}	Short-circuit receiver output current (LVTTL output)	V_O = 0V			-48	-90	mA
M-LVDS Bus (Input and Output) Pins							
I_A	Transceiver input/output current	V_A = 3.8V, V_B = 1.2V				32	µA
		V_A = 0V or 2.4V, V_B = 1.2V		−20		+20	µA
		V_A = −1.4V, V_B = 1.2V		−32			µA

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_B	Transceiver input/output current	V_B = 3.8V, V_A = 1.2V			32	µA
		V_B = 0V or 2.4V, V_A = 1.2V	–20		+20	µA
		V_B = –1.4V, V_A = 1.2V	–32			µA
I_{AB}	Transceiver input/output differential current ($I_A - I_B$)	$V_A = V_B$, –1.4V ≤ V ≤ 3.8V	–4		+4	µA
$I_{A(OFF)}$	Transceiver input/output power-off current	V_A = 3.8V, V_B = 1.2V, DE = V_{CC} 0V ≤ V_{CC} ≤ 1.5V			32	µA
		V_A = 0V or 2.4V, V_B = 1.2V, DE = V_{CC} 0V ≤ V_{CC} ≤ 1.5V	–20		+20	µA
		V_A = –1.4V, V_B = 1.2V, DE =V_{CC} 0V ≤ V_{CC} ≤ 1.5V	–32			µA
$I_{B(OFF)}$	Transceiver input/output power-off current	V_B = 3.8V, V_A = 1.2V, DE = V_{CC} 0V ≤ V_{CC} ≤ 1.5V			32	µA
		V_B = 0V or 2.4V, V_A = 1.2V, DE = V_{CC} 0V ≤ V_{CC} ≤ 1.5V	–20		+20	µA
		V_B = –1.4V, V_A = 1.2V, DE = V_{CC} 0V ≤ V_{CC} ≤ 1.5V	–32			µA
$I_{AB(OFF)}$	Transceiver input/output power-off differential current ($I_{A(OFF)} - I_{B(OFF)}$)	$V_A = V_B$, –1.4V ≤ V ≤ 3.8V, DE = V_{CC} 0V ≤ V_{CC} ≤ 1.5V	–4		+4	µA
C_A	Transceiver input/output capacitance	V_{CC} = OPEN		9		pF
C_B	Transceiver input/output capacitance			9		pF
C_{AB}	Transceiver input/output differential capacitance			5.7		pF
$C_{A/B}$	Transceiver input/output capacitance balance (C_A/C_B)			1.0		
SUPPLY CURRENT (V_{CC})						
I_{CCD}	Driver Supply Current	R_L = 50Ω, DE = V_{CC}, $\overline{RE}$ = V_{CC}		20	29.5	mA
I_{CCZ}	TRI-STATE Supply Current	DE = GND, $\overline{RE}$ = V_{CC}		6	9.0	mA
I_{CCR}	Receiver Supply Current	DE = GND, $\overline{RE}$ = GND		14	18.5	mA

Switching Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DRIVER AC SPECIFICATION						
t_{PLH}	Differential Propagation Delay Low to High	R_L = 50Ω, C_L = 5 pF,	1.3	3.4	5.0	ns
t_{PHL}	Differential Propagation Delay High to Low	C_D = 0.5 pF	1.3	3.1	5.0	ns
t_{SKD1} ($t_{sk(p)}$)	Pulse Skew $\|t_{PLHD} - t_{PHLD}\|$ (*Note 5*, *Note 9*)	*Figure 7* and *Figure 8*		300	420	ps
t_{SKD3}	Part-to-Part Skew (*Note 6*, *Note 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 = 50Ω, C_L = 5 pF,			8	ns
t_{PZL}	Enable Time (Z to Active Low)	C_D = 0.5 pF			8	ns
t_{PLZ}	Disable Time (Active Low to Z)	*Figure 9* and *Figure 10*			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
RECEIVER AC SPECIFICATION						
t_{PLH}	Propagation Delay Low to High	C_L = 15 pF	2.0	4.7	7.5	ns
t_{PHL}	Propagation Delay High to Low	Figures 11, 12 and *Figure 13*	2.0	5.3	7.5	ns
t_{SKD1} ($t_{sk(p)}$)	Pulse Skew $\|t_{PLHD} - t_{PHLD}\|$ (*Note 5*, *Note 9*)			0.6	1.7	ns
t_{SKD3}	Part-to-Part Skew (*Note 6*, *Note 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 = 500Ω, C_L = 15 pF			10	ns
t_{PZL}	Enable Time (Z to Active Low)	*Figure 14* and *Figure 15*			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} = 3.3V and T_A = 25°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°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

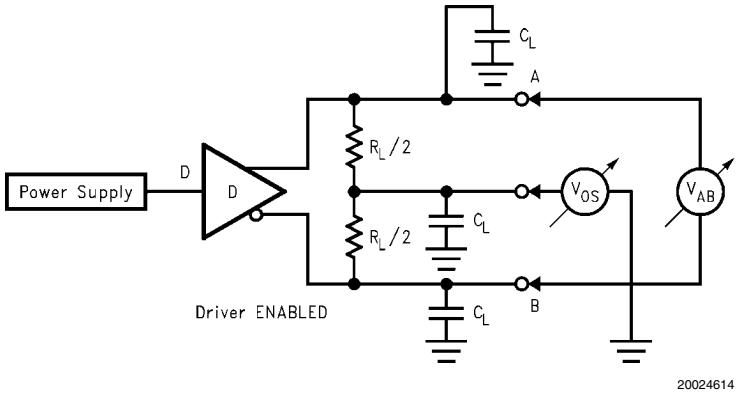


FIGURE 2. Differential Driver Test Circuit

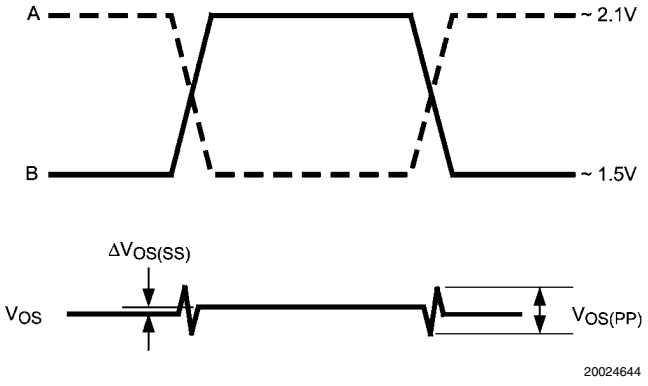


FIGURE 3. Differential Driver Waveforms

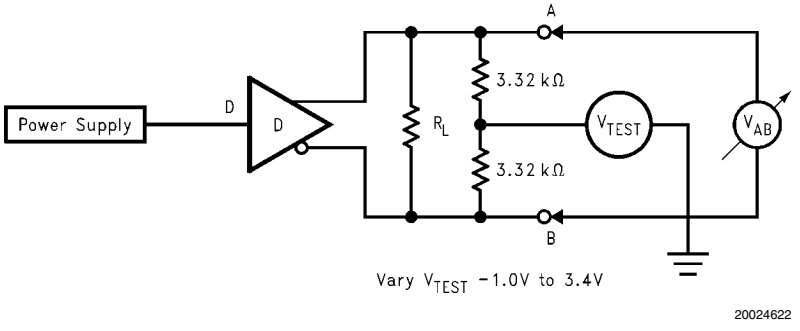


FIGURE 4. Differential Driver Full Load Test Circuit

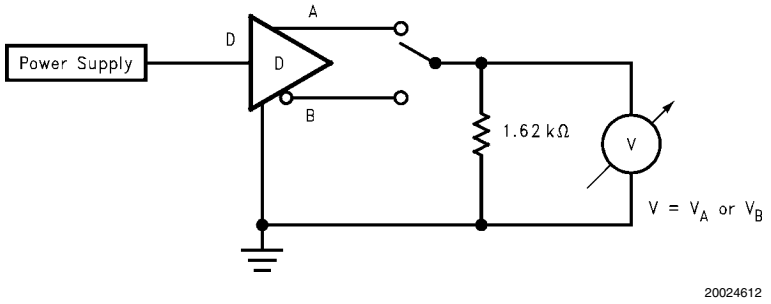


FIGURE 5. Differential Driver DC Open Test Circuit

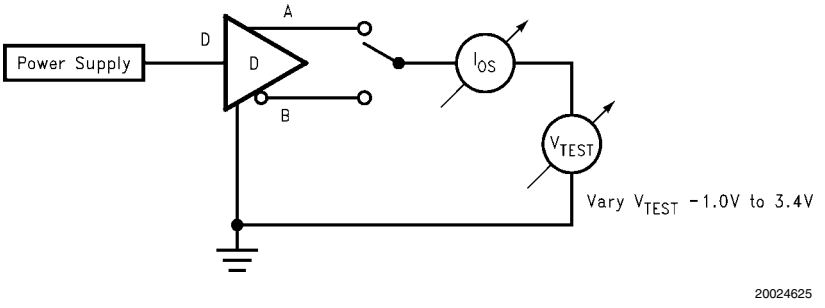


FIGURE 6. Differential Driver Short-Circuit Test Circuit

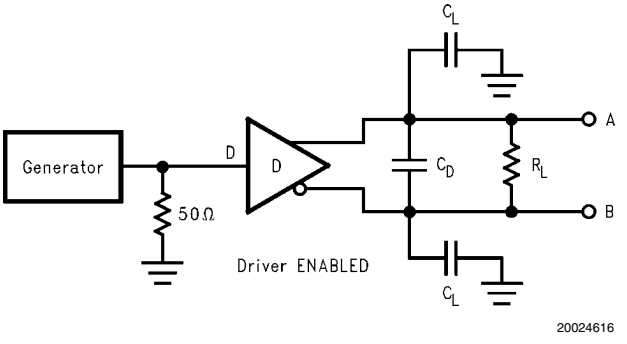


FIGURE 7. Driver Propagation Delay and Transition Time Test Circuit

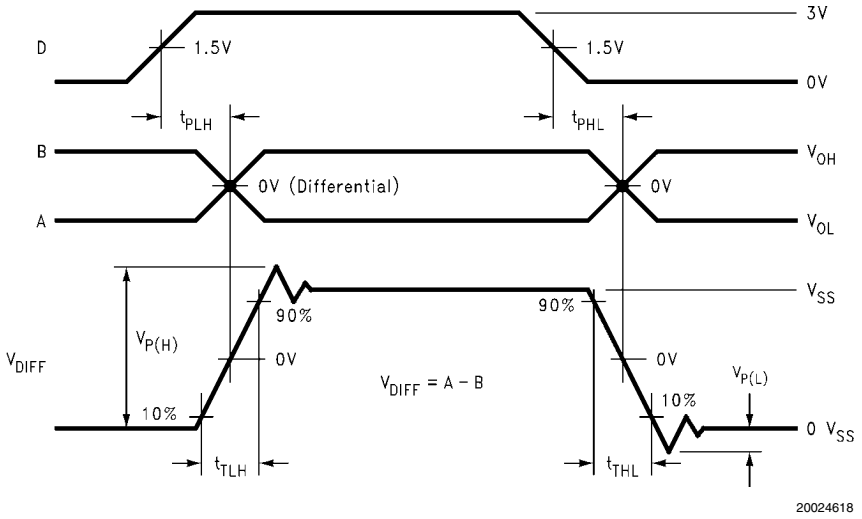


FIGURE 8. Driver Propagation Delays and Transition Time Waveforms

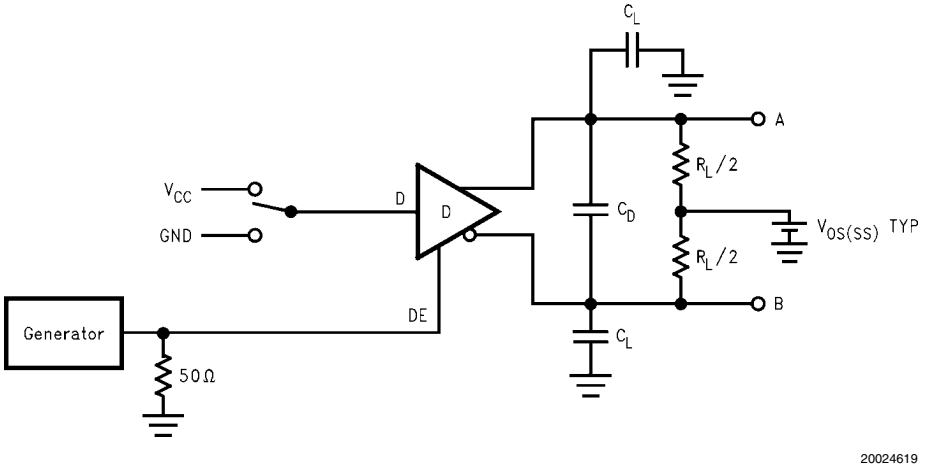


FIGURE 9. Driver TRI-STATE Delay Test Circuit

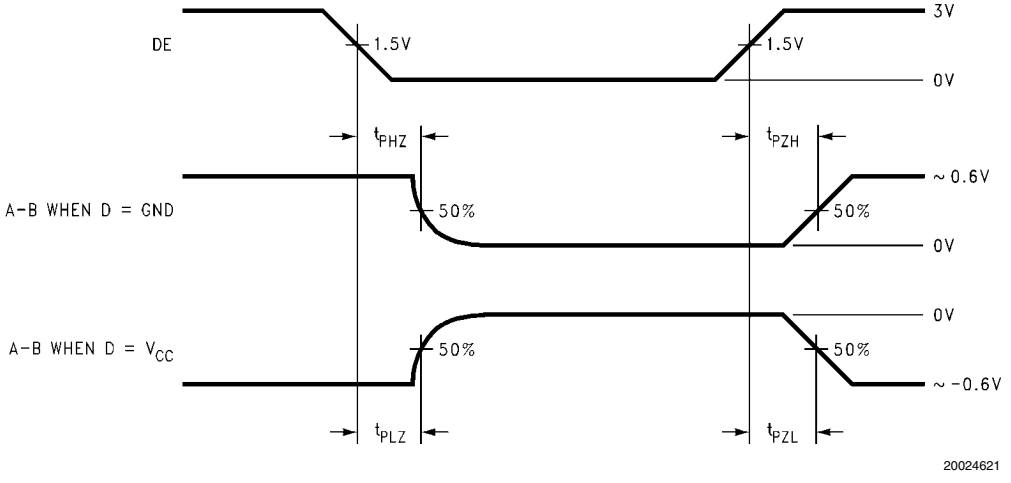


FIGURE 10. Driver TRI-STATE Delay Waveforms

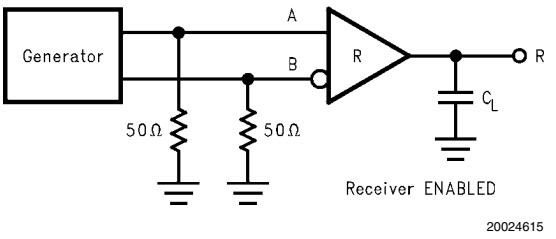


FIGURE 11. Receiver Propagation Delay and Transition Time Test Circuit

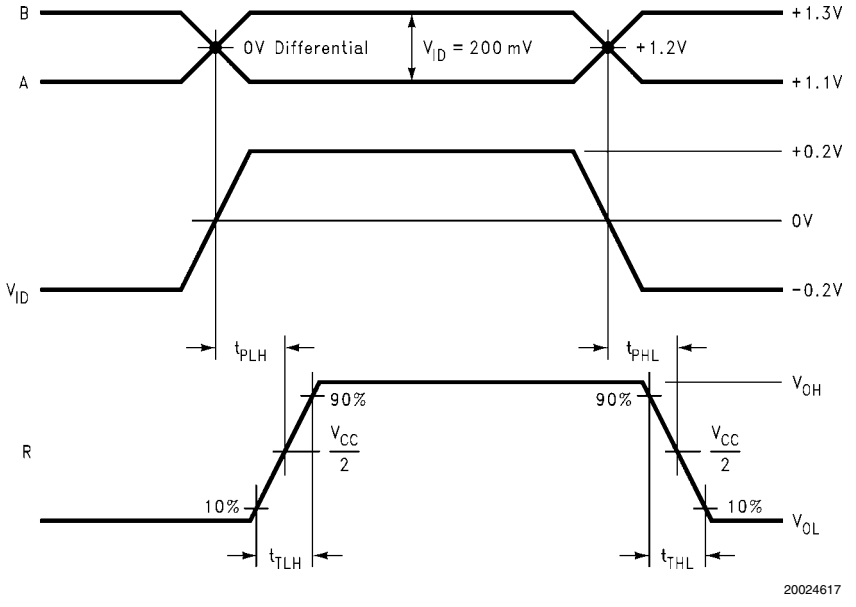


FIGURE 12. Type 1 Receiver Propagation Delay and Transition Time Waveforms

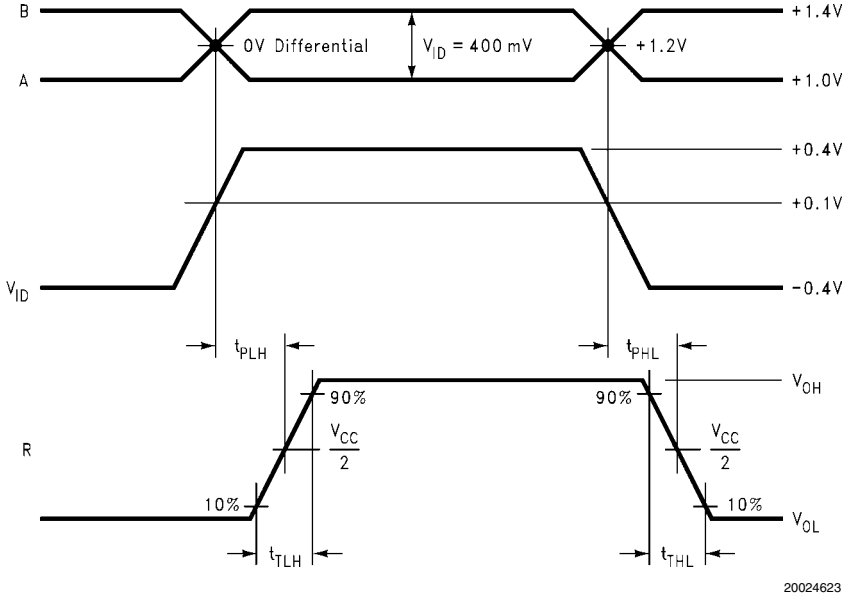


FIGURE 13. Type 2 Receiver Propagation Delay and Transition Time Waveforms

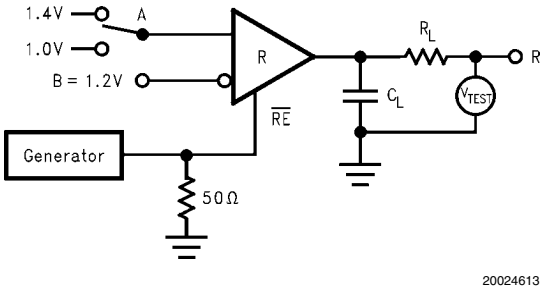


FIGURE 14. Receiver TRI-STATE Delay Test Circuit

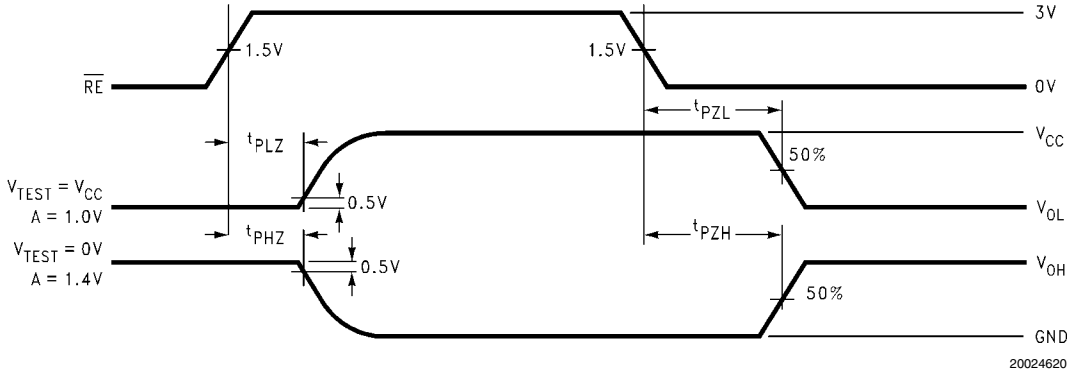


FIGURE 15. Receiver TRI-STATE Delay Waveforms

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	≥ +0.05V	H
0.8V	0.8V	≤ −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	≥ +0.15V	H
0.8V	0.8V	≤ +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

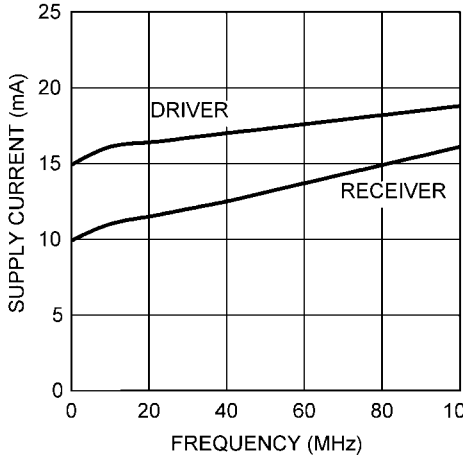
H — High Level
L — Low Level
Output state assumes that the receiver is enabled ($\overline{RE}$ = L)

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 ± 0.3V

Typical Performance Characteristics

Supply Current vs. Frequency



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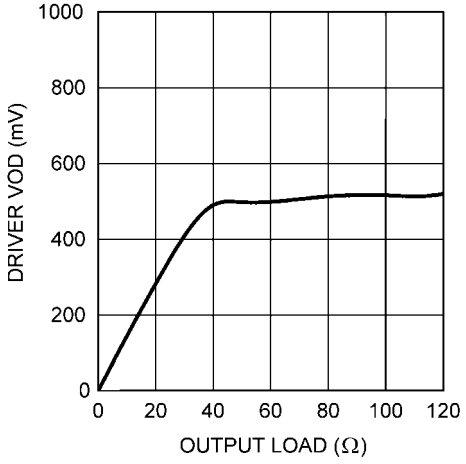
Output VOD vs. Load Resistance



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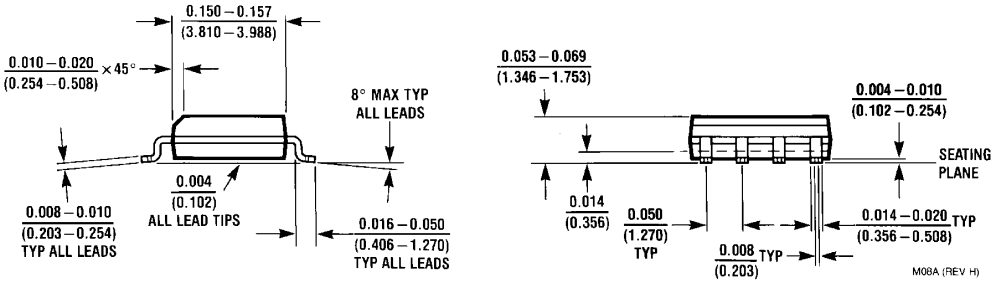
Supply Current measured using a clock pattern with driver terminated to 50ohms .V_{CC} = 3.3V, T_A = +25°C
V_{CC} = 3.3V, T_A = +25°C.

FIGURE 16. DS91D176/DS91C176 Typical Performance Characteristics

Physical Dimensions inches (millimeters) unless otherwise noted



Order Number DS91D176TMA, DS91C176TMA
See NS package Number M08A

Notes

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