National Semiconductor

PRELIMINARY

T-75-45-05

DS75176A/DS75176AT Multipoint RS-485/RS-422 Transceivers

General Description

The DS75176A is a high speed differential TRI-STATE® bus/line transceiver designed to meet the requirements of EIA standard RS485 with extended common mode range (+12V to −7V), for multipoint data transmission. In addition it meets the requirements of RS422.

The driver and receiver outputs feature TRI-STATE capability, for the driver outputs over the entire common mode range of +12V to −7V. Bus contention or fault situations that cause excessive power dissipation within the device are handled by a thermal shutdown circuit, which forces the driver outputs into the high impedance state.

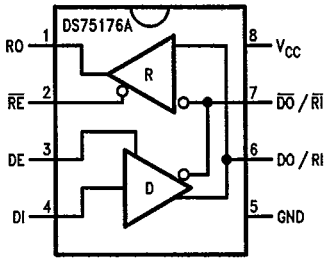
The receiver incorporates a fail safe feature which guarantees a high output state when the inputs are left open.

Both AC and DC specifications are guaranteed over the 0 to 70°C temperature and 4.75V to 5.25V supply voltage range.

Features

- Meets EIA standard RS485 for multipoint bus transmission and RS422.
- Small Outline (SO) Package option available for minimum board space.
- 22 ns driver propagation delays with 8 ns skew (typical).
- Single channel per package isolates faulty channels (from shutting down good channels).
- Single +5V supply.
- −7V to +12V bus common mode range permits ±7V ground difference between devices on the bus.
- Thermal shutdown protection.
- Power-up down glitch-free driver outputs permit live insertion or removal of transceivers.
- High impedance to bus with driver in TRI-STATE or with power off, over the entire common mode range allows the unused devices on the bus to be powered down.
- Pin out capatible with DS3695 and SN75176A.
- Combined impedance of a driver output and receiver input is less than one RS485 unit load, allowing up to 32 transceivers on the bus.
- 70 mV typical receiver hysteresis.

Connection and Logic Diagram



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Top View

Order Number DS75176AN, DS75176AM, DS75176AJ-8, DS75176ATN
See NS Package Number N08E, M08A or J08A

Absolute Maximum Ratings (Note 1)

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

Supply Voltage, V_{CC}	7V
Control Input Voltages	7V
Driver Input Voltage	7V
Driver Output Voltages	+15V/ −10V
Receiver Input Voltages (DS75176A)	+15V/ −10V
Receiver Output Voltage	5.5V
Continuous Power Dissipation @25°C for M Package	675 mW (Note 5)
Continuous Power Dissipation @25°C (for N Package)	900 mW (Note 4)
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 4 seconds)	260°C

Recommended Operating Conditions

	Min	Max	Units
Supply Voltage, V_{CC}	4.75	5.25	V
Voltage at Any Bus Terminal (Separate or Common Mode)	−7	+12	V
Operating Free Air Temperature T_A			
DS75176A	0	+70	°C
DS75176AT	−40	+85	°C
Differential Input Voltage, VID (Note 6)			+12V

Electrical Characteristics (Notes 2 and 3)

$0°C \le T_A \le 70°C$, $4.75V < V_{CC} < 5.25V$ unless otherwise specified

Symbol	Parameter		Conditions		Min	Typ	Max	Units
V_{OD1}	Differential Driver Output Voltage (Unloaded)		$I_O = 0$				5	V
V_{OD2}	Differential Driver Output Voltage (with Load)		*(Figure 1)*	R = 50Ω; (RS-422) (Note 4)	2			V
				R = 27Ω; (RS-485)	1.5			V
ΔV_{OD}	Change in Magnitude of Driver Differential Output Voltage For Complementary Output States		*(Figure 1)*	R = 27Ω			0.2	V
V_{OC}	Driver Common Mode Output Voltage						3.0	V
$\Delta\lvert V_{OC}\rvert$	Change in Magnitude of Driver Common Mode Output Voltage For Complementary Output States						0.2	V
V_{IH}	Input High Voltage	DI, DE, $\overline{RE}$, E			2			V
V_{IL}	Input Low Voltage						0.8	
V_{CL}	Input Clamp Voltage			$I_{IN} = -18$ mA			−1.5	
I_{IL}	Input Low Current			$V_{IL} = 0.4V$			−200	μA
I_{IH}	Input High Current			$V_{IH} = 2.4V$			20	μA
I_{IN}	Input Current	DO/RI, $\overline{DO}/\overline{RI}$	$V_{CC} = 0V$ or 5.25V, DE = 0V	$V_{IN} = 12V$			+1.0	mA
				$V_{IN} = -7V$			−0.8	mA
V_{TH}	Differential Input Threshold Voltage for Receiver		$-7V \le V_{CM} \le +12V$		−0.2		+0.2	V
ΔV_{TH}	Receiver Input Hysteresis		$V_{CM} = 0V$			70		mV
V_{OH}	Receiver Output High Voltage		$I_{OH} = -400$ μA		2.4			V
V_{OL}	Output Low Voltage	RO	$I_{OL} = 16$ mA (Note 7)				0.5	V
		$\overline{LF}$	$I_{OL} = 8$ mA				0.45	V
I_{OZR}	OFF-State (High Impedance) Output Current at Receiver		$V_{CC} = Max$, $0.4V \le V_O \le 2.4V$				±20	μA
R_{IN}	Receiver Input Resistance		$-7V \le V_{CM} \le +12V$		12			kΩ
I_{CC}	Supply Current		No Load (Note 7)	Driver Outputs Enabled		35	50	mA
				Driver Outputs Disabled		27	40	mA

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Electrical Characteristics (Notes 2 and 3)

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$0°C \le T_A \le 70°C$, $4.75V < V_{CC} < 5.25V$ unless otherwise specified (Continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{OSD}	Driver Short-Circuit Output Current	$V_O = -7V$ (Note 7)			−250	mA
		$V_O = +12V$ (Note 7)			+250	mA
I_{OSR}	Receiver Short-Circuit Output Current	$V_O = 0V$	−15		−85	mA

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 $V_{CC} = 5V$ and $T_A = 25°C$.

Note 4: Derate linearly at 5.56 mW/°C to 650 mW at 70°C.

Note 5: Derate linearly @ 6.11 mW/°C to 400 mW at 70°C.

Note 6: Differential - Input/Output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.

Note 7: All worst case parameters for which note 7 is applied, must be increased by 10% for DS75176AT. The other parameters remain valid for $-40°C < T_A < +85°C$.

Switching Characteristics $4.75V \le V_{CC} \le 5.25V$; $0°C < T_A < 70°C$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PLH}	Driver Input to Output	$R_{L_{DIFF}} = 60\Omega$, $C_{L1} = C_{L2} = 100$ pF (*Figures 3* and *5*)		22		ns
t_{PHL}	Driver Input to Output			22		ns
t_{SKEW}	Driver Output to Output			8		ns
t_r	Driver Rise Time	$R_{L_{DIFF}} = 60\Omega$, $C_{L1} = C_{L2} = 100$ pF (*Figures 3* and *5*)		10		ns
t_f	Driver Fall Time			10		ns
t_{ZH}	Driver Enable to Output High	$C_L = 100$ pF (*Figures 4* and *6*) S1 Open		35		ns
t_{ZL}	Driver Enable to Output Low	$C_L = 100$ pF (*Figures 4* and *6*) S2 Open		35		ns
t_{LZ}	Driver Disable Time from Low	$C_L = 15$ pF (*Figures 4* and *6*) S2 Open		15		ns
t_{HZ}	Driver Disable Time from High	$C_L = 15$ pF (*Figures 4* and *6*) S1 Open		15		ns
t_{PLH}	Receiver Input to Output	$C_L = 15$ pF (*Figures 2* and *7*) S1 and S2 Closed		25		ns
t_{PHL}	Receiver Input to Output			25		ns
t_{ZL}	Receiver Enable to Output Low	$C_L = 15$ pF (*Figures 2* and *8*) S2 Open		15		ns
t_{ZH}	Receiver Enable to Output High	$C_L = 15$ pF (*Figures 2* and *8*) S1 Open		15		ns
t_{LZ}	Receiver Disable from Low	$C_L = 15$ pF (*Figures 2* and *8*) S2 Open		12		ns
t_{HZ}	Receiver Disable from High	$C_L = 15$ pF (*Figures 2* and *8*) S1 Open		12		ns

AC Test Circuits

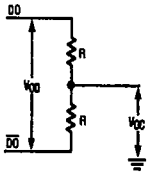

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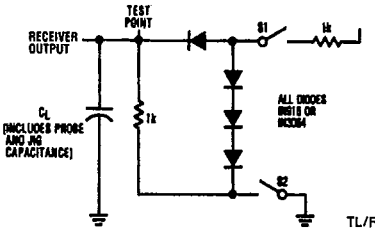
FIGURE 1



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Note: S1 and S2 of load circuit are closed except as otherwise mentioned.

FIGURE 2

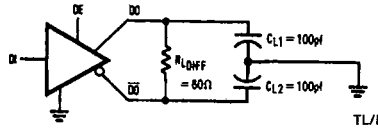

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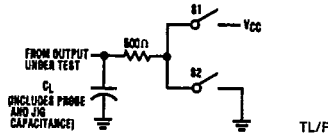
FIGURE 3



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Note: Unless otherwise specified the switches are closed.

FIGURE 4

Switching Time Waveforms

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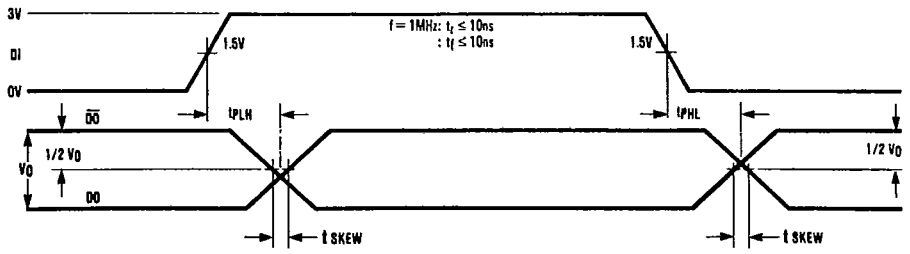

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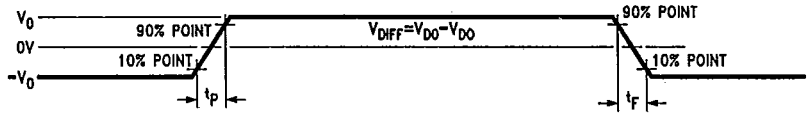

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FIGURE 5. Driver Propagation Delays

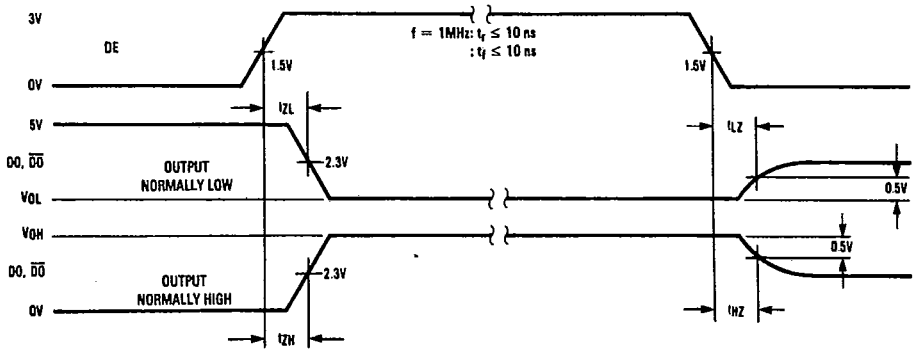

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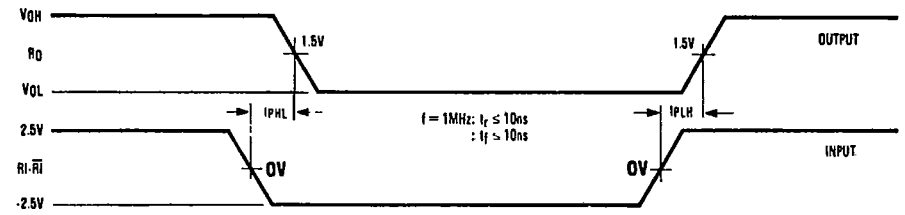
FIGURE 6. Driver Enable and Disable Times



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Note: Differential input voltage may may be realized by grounding $\overline{RI}$ and pulsing RI between +2.5V and −2.5V

FIGURE 7. Receiver Propagation Delays

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Switching Time Waveforms (Continued)

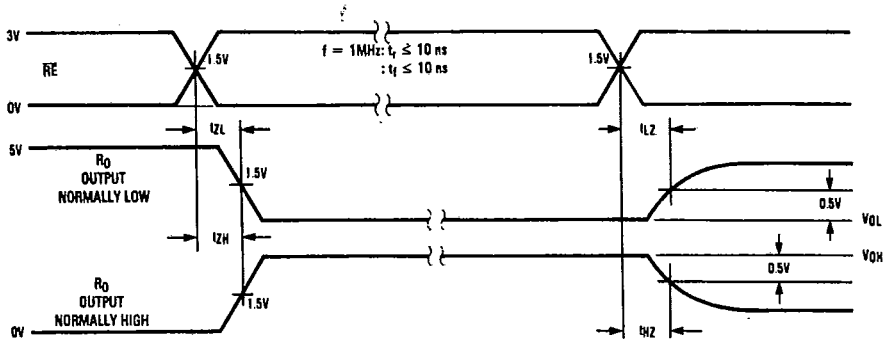

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FIGURE 8. Receiver Enable and Disable Times

Function Tables

DS75176A Transmitting

Inputs			Line Condition	Outputs	
$\overline{RE}$	DE	DI		$\overline{DO}$	DO
X	1	1	No Fault	0	1
X	1	0	No Fault	1	0
X	0	X	X	Z	Z
X	1	X	Fault	Z	Z

DS75176A Receiving

Inputs			Outputs
$\overline{RE}$	DE	RI-$\overline{RI}$	RO
0	0	$\geq +0.2V$	1
0	0	$\leq -0.2V$	0
0	0	Inputs Open**	1
1	0	X	Z

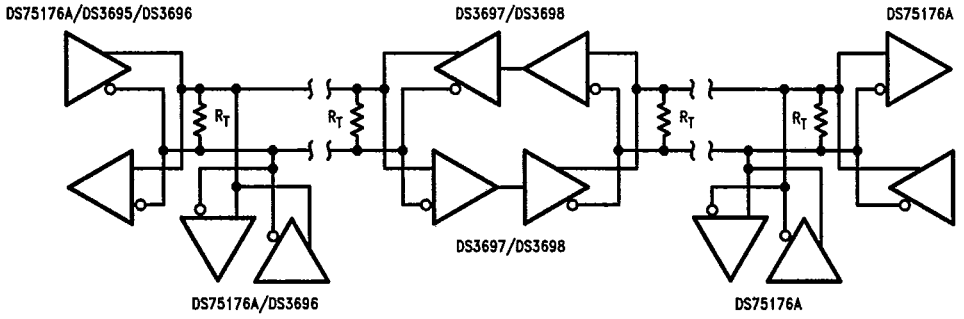
X — Don't care condition

Z — High Impedance state

Fault — Improper line conditons causing excessive power dissipation in the driver, such as shorts or bus contention situations

**This is a fail safe condition

Typical Application



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