National Semiconductor

July 1998

DS75176B/DS75176BT
Multipoint RS-485/RS-422 Transceivers

General Description

The DS75176B 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 is compatible with RS-422.

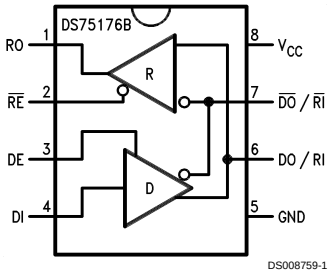
The driver and receiver outputs feature TRI-STATE capability, for the driver outputs over the entire common mode range of +12V to −7V. Bus contention or fault situations that cause excessive power dissipation within the device are handled by a thermal shutdown circuit, which forces the driver outputs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

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 is compatible with RS-422.
- Small Outline (SO) Package option available for minimum board space.
- 22 ns driver propagation delays.
- Single +5V supply.
- −7V to +12V bus common mode range permits ±7V ground difference between devices on the bus.
- Thermal shutdown protection.
- 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 compatible with DS3695/A and SN75176A/B.
- 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



DS008759-1

Top View
Order Number DS75176BN, DS75176BTN, DS75176BM or DS75176BTM
See NS Package Number N08E or M08A

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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}	7V
Control Input Voltages	7V
Driver Input Voltage	7V
Driver Output Voltages	+15V/ −10V
Receiver Input Voltages (DS75176B)	+15V/ −10V
Receiver Output Voltage	5.5V
Continuous Power Dissipation @ 25˚C	
for M Package	675 mW (Note 5)
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			
DS75176B	0	+70	˚C
DS75176BT	−40	+85	˚C
Differential Input Voltage, VID (Note 6)	−12	+12	V

Electrical Characteristics (Notes 2, 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 7)	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		2.7			V
V_{OL}	Output Low Voltage	RO	I_{OL} = 16 mA (Note 7)				0.5	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			55	mA
				Driver Outputs Disabled			35	mA
I_{OSD}	Driver Short-Circuit Output Current		V_O = −7V (Note 7)				−250	mA
			V_O = +12V (Note 7)				+250	mA

Electrical Characteristics (Notes 2, 3) (Continued)

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
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 $T_A = 25^{\circ}C$.

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 DS75176BT. The other parameters remain valid for $-40^{\circ}C < T_A < +85^{\circ}C$.

Switching Characteristics

V_{CC} = 5.0V, $T_A = 25^{\circ}C$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PLH}	Driver Input to Output	R_{LDIFF} = 60Ω		12	22	ns
t_{PHL}	Driver Input to Output	$C_{L1} = C_{L2}$ = 100 pF		17	22	ns
t_r	Driver Rise Time	R_{LDIFF} = 60Ω			18	ns
t_f	Driver Fall Time	$C_{L1} = C_{L2}$ = 100 pF (*Figure 3* and *Figure 5*)			18	ns
t_{ZH}	Driver Enable to Output High	C_L = 100 pF (*Figure 4* and *Figure 6*) S1 Open		29	100	ns
t_{ZL}	Driver Enable to Output Low	C_L = 100 pF (*Figure 4* and *Figure 6*) S2 Open		31	60	ns
t_{LZ}	Driver Disable Time from Low	C_L = 15 pF (*Figure 4* and *Figure 6*) S2 Open		13	30	ns
t_{HZ}	Driver Disable Time from High	C_L = 15 pF (*Figure 4* and *Figure 6*) S1 Open		19	200	ns
t_{PLH}	Receiver Input to Output	C_L = 15 pF (*Figure 2* and *Figure 7*)		30	37	ns
t_{PHL}	Receiver Input to Output	S1 and S2 Closed		32	37	ns
t_{ZL}	Receiver Enable to Output Low	C_L = 15 pF (*Figure 2* and *Figure 8*) S2 Open		15	20	ns
t_{ZH}	Receiver Enable to Output High	C_L = 15 pF (*Figure 2* and *Figure 8*) S1 Open		11	20	ns
t_{LZ}	Receiver Disable from Low	C_L = 15 pF (*Figure 2* and *Figure 8*) S2 Open		28	32	ns
t_{HZ}	Receiver Disable from High	C_L = 15 pF (*Figure 2* and *Figure 8*) S1 Open		13	35	ns

AC Test Circuits

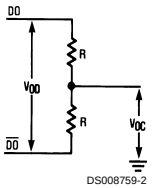
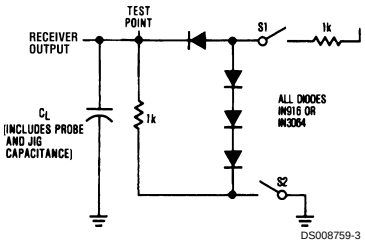


FIGURE 1.



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

FIGURE 2.

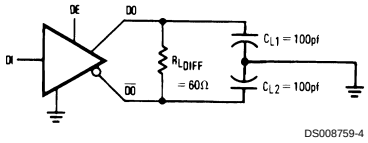
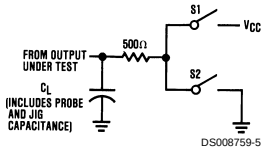


FIGURE 3.



Note: Unless otherwise specified the switches are closed.

FIGURE 4.

Switching Time Waveforms

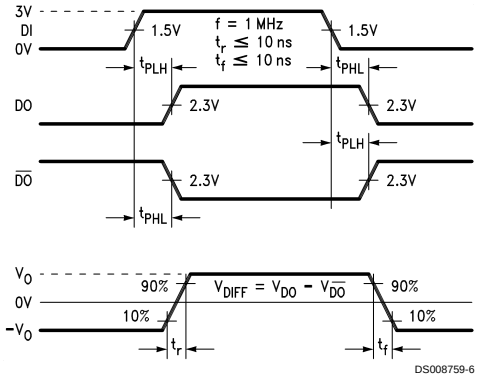


FIGURE 5. Driver Propagation Delays and Transition Times

Switching Time Waveforms (Continued)

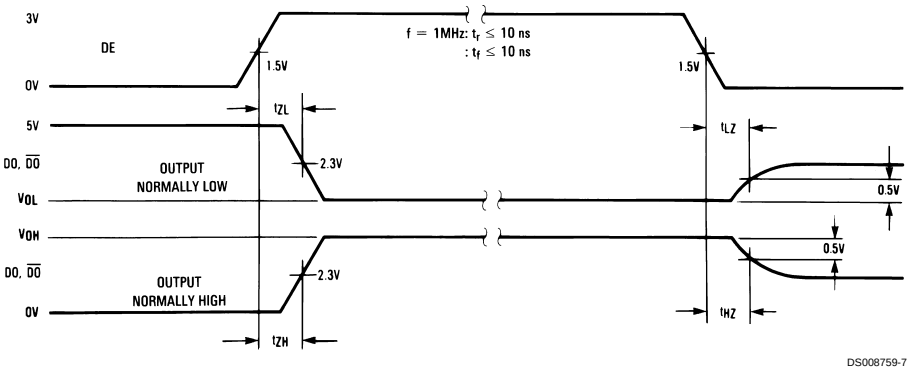
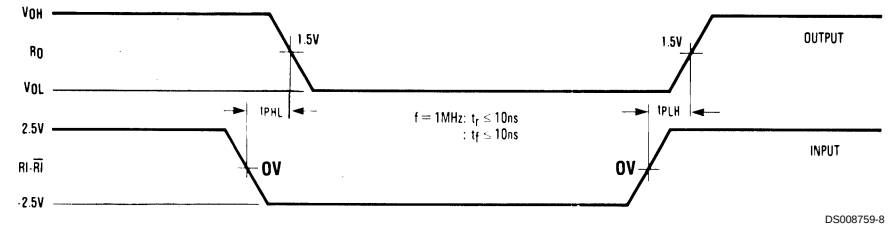


FIGURE 6. Driver Enable and Disable Times



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

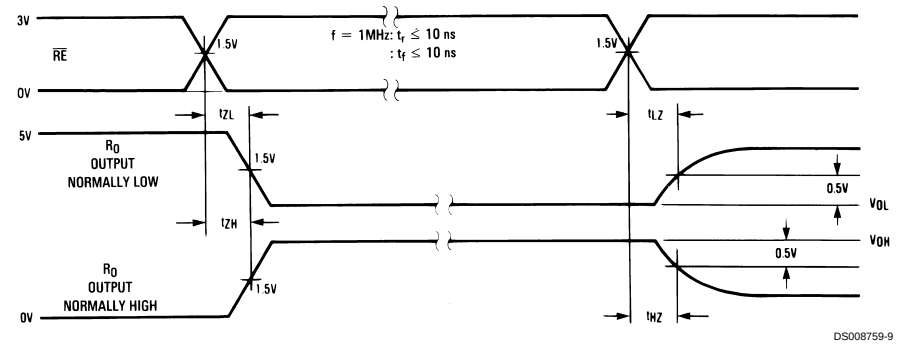


FIGURE 8. Receiver Enable and Disable Times

Function Tables

DS75176B Transmitting

Inputs			Line	Outputs	
$\overline{RE}$	DE	DI	Condition	$\overline{DO}$	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

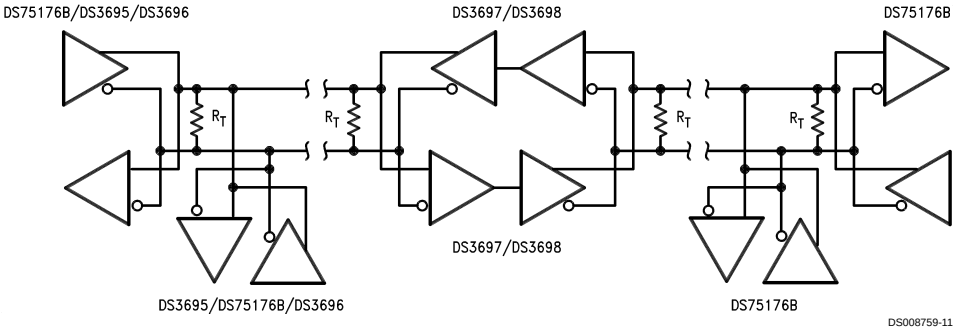
Function Tables (Continued)

DS75176B Receiving

Inputs			Outputs
$\overline{RE}$	DE	RI-$\overline{RI}$	RO
0	0	≥ +0.2V	1
0	0	≤ −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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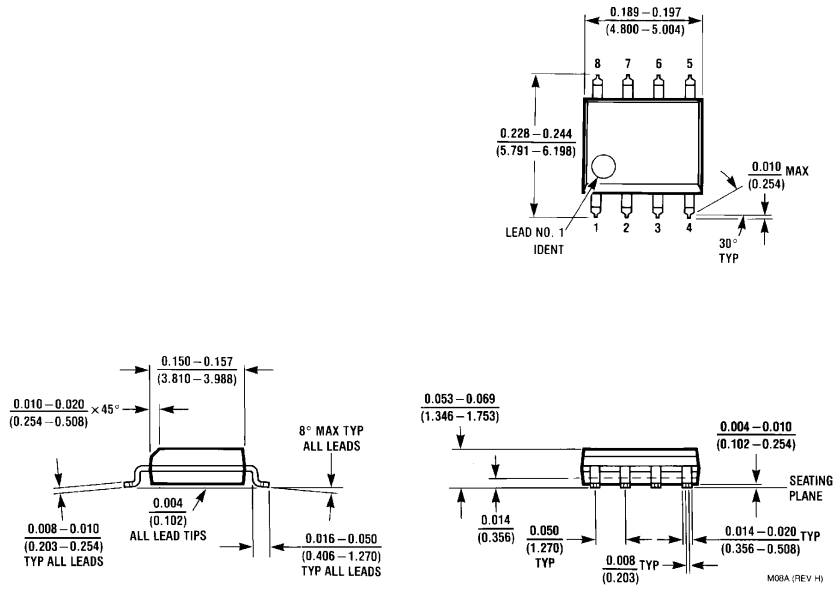
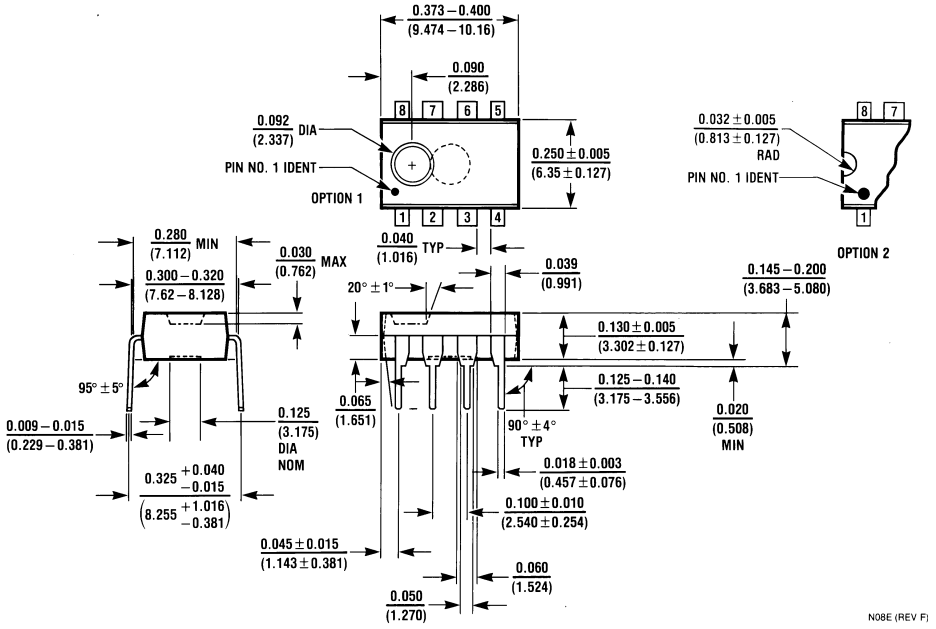
Physical Dimensions inches (millimeters) unless otherwise noted



Lit. # 103669



Molded Dual-In-Line Package (N)
Order Number DS75176BN or DS75176BTN
NS Package Number N08E

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