

## DS3893A BTL TURBOTRANSCEIVER™

### General Description

The TURBOTRANSCEIVER is designed for use in very high speed bus systems. The bus terminal characteristics of the TURBOTRANSCEIVER are referred to as "Backplane Transceiver Logic" (BTL). BTL is a new logic signaling standard that has been developed to enhance the performance of backplane buses. BTL compatible transceivers feature low output capacitance drivers to minimize bus loading, a 1V nominal signal swing for reduced power consumption and receivers with precision thresholds for maximum noise immunity. This new standard eliminates the settling time delays, that severely limit the TTL bus performance, to provide significantly higher bus transfer rates.

The TURBOTRANSCEIVER is compatible with the requirements of the proposed IEEE 896 Futurebus draft standard. It is similar to the DS3896/97 BTL TRAPEZOIDAL™ Transceivers but the trapezoidal feature has been removed to improve the propagation delay. A stripline backplane is therefore required to reduce the crosstalk induced by the faster rise and fall times. This device can drive a 10Ω load with a typical propagation delay of 3.5 ns for the driver and 5 ns for the receiver.

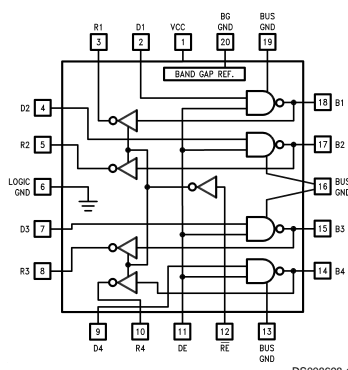
When multiple devices are used to drive a parallel bus, the driver enables can be tied together and used as a common control line to get on and off the bus. The driver enable delay is designed to be the same as the driver propagation delay in order to provide maximum speed in this configuration. The low input current on the enable pin eases the drive required for the common control line.

The bus driver is an open collector NPN with a Schottky diode in series to isolate the transistor output capacitance from the bus when the driver is in the inactive state. The active output low voltage is typically 1V. The bus is intended to be operated with termination resistors (selected to match the bus impedance) to 2.1V at both ends. Each of the resistors can be as low as 20Ω.

### Features

- Fast single ended transceiver (typical driver enable and receiver propagation delays are 3.5 ns and 5 ns)
- Backplane Transceiver Logic (BTL) levels (1V logic swing)
- Less than 5 pF bus-port capacitance
- Drives densely loaded backplanes with equivalent load impedances down to 10Ω
- 4 transceivers in 20 pin PCC package
- Specially designed for stripline backplanes
- Separate bus ground returns for each driver to minimize ground noise
- High impedance, MOS and TTL compatible inputs
- TRI-STATE™ control for receiver outputs
- Built-in bandgap reference provides accurate receiver threshold
- Glitch free power up/down protection on all outputs
- Oxide isolated bipolar technology

### Connection and Logic Diagram



Order Number DS3893AV  
See NS Package Number V20A

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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	6.5V
Control Input Voltage	5.5V
Driver Input and Receiver Output	5.5V
Driver Output Receiver Input Clamp Current	±15 mA
Power Dissipation at 70°C	900 mW

Storage Temperature Range                    -65°C to +150°C  
Lead Temperature (Soldering, 3 sec.)        260°C

**Recommended Operating Conditions**

	Min	Max	Units
Supply Voltage, $V_{CC}$	4.5	5.5	V
Bus Termination Voltage ( $V_T$ )	2.0	2.2	V
Operating Free Air Temperature	0	70	°C

**Electrical Characteristics** (Notes 2, 3, 4)

$T_A = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 5\text{V} \pm 10\%$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DRIVER AND CONTROL INPUT: (DE, <math>\overline{RE}</math>, Dn)</b>						
$V_{IH}$	Input High Voltage		2.0			V
$V_{IL}$	Input Low Voltage				0.8	V
$I_I$	Input Leakage Current	$DE = \overline{RE} = Dn = V_{CC}$			100	μA
$I_{IH}$	Input High Current	$DE = \overline{RE} = Dn = 2.5\text{V}$			20	μA
$I_{IL}$	Dn Input Low Current	$Dn = 0.5\text{V}$ , $DE = V_{CC} = \text{Max}$			-200	μA
	DE Input Low Current	$DE = 0.5\text{V}$ , $Dn = V_{CC} = \text{Max}$			-500	μA
	$\overline{RE}$ Input Low Current	$\overline{RE} = 0.5\text{V}$ , $V_{CC} = \text{Max}$			-100	μA
$V_{CL}$	Input Diode Clamp Voltage	$I_{clamp} = -12\text{ mA}$			-1.2	V
<b>DRIVER OUTPUT/RECEIVER INPUT: (Bn)</b>						
$V_{OLB}$	Output Low Bus Voltage	$Dn = DE = V_{IH}$ (Figure 2) $R_T = 10\Omega$ , $V_T = 2.2\text{V}$	0.75	1.0	1.2	V
		$Dn = DE = V_{IH}$ (Figure 2) $R_T = 18.5\Omega$ , $V_T = 2.14$	0.75	1.0	1.1	V
$I_{ILB}$	Output Bus Current (Power On)	$Dn = DE = 0.8\text{V}$ , $V_{CC} = \text{Max}$ $Bn = 0.75\text{V}$	-250		100	μA
$I_{IHB}$	Output Bus Current (Power Off)	$Dn = DE = 0.8\text{V}$ , $V_{CC} = 0\text{V}$ $Bn = 1.2\text{V}$			100	μA
$V_{OCB}$	Driver Output Positive Clamp	$V_{CC} = \text{Max}$ or $0\text{V}$ , $Bn = 1\text{ mA}$			2.9	V
		$V_{CC} = \text{Max}$ or $0\text{V}$ , $Bn = 10\text{ mA}$			3.2	V
$V_{OHB}$	Output High Bus Voltage	$V_{CC} = \text{Max}$ , $Dn = 0.8\text{V}$ (Figure 2) $V_T = 2.0\text{V}$ , $R_T = 10\Omega$	1.90			V
$V_{TH}$	Receiver Input Threshold		1.47	1.55	1.62	V
<b>RECEIVER OUTPUT: (Rn)</b>						
$V_{OH}$	Voltage Output High	$Bn = 1.2\text{V}$ , $I_{oh} = -3\text{ mA}$ , $\overline{RE} = 0.8\text{V}$	2.5V			V
$V_{OL}$	Voltage Output Low	$Bn = 2\text{V}$ , $I_{ol} = 6\text{ mA}$ , $\overline{RE} = 0.8\text{V}$		0.35	0.5	V
$I_{OZ}$	TRI-STATE Leakage	$V_o = 2.5\text{V}$ , $\overline{RE} = 2\text{V}$			20	μA
		$V_o = 0.5\text{V}$ , $\overline{RE} = 2\text{V}$			-20	μA
$I_{OS}$	Output Short Circuit Current (Note 5)	$Bn = 1.2\text{V}$ , $V_o = 0\text{V}$ $\overline{RE} = 0.8\text{V}$ , $V_{CC} = \text{Max}$	-80	-120	-200	mA
$I_{CC}$	Supply Current	$Dn = DE = \overline{RE} = V_{IH}$ , $V_{CC} = \text{Max}$		70	95	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 table 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  $V_{CC} = 5\text{V}$  and  $T_A = 25^\circ\text{C}$ .

**Note 4:** Unused inputs should not be left floating. Tie unused inputs to either  $V_{CC}$  or GND thru a resistor.

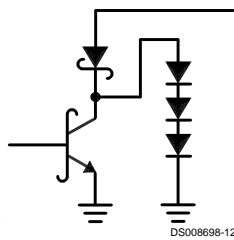
**Note 5:** Only one output at a time should be shorted.

## Switching Characteristics

$T_A = 0$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 5\text{V} \pm 10\%$

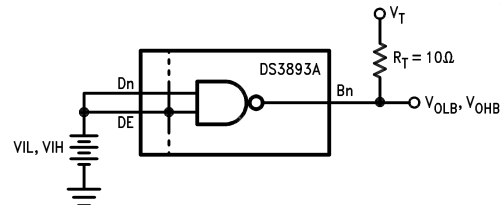
Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DRIVER:</b> (Figure 3 and Figure 6)						
$t_{PHL}$	Driver Input to Output	$V_T = 2\text{V}$ , $R_T = 10\Omega$ , $C_L = 30\text{ pF}$ , $DE = 3\text{V}$	1	3.5	7	ns
$t_{PLH}$	Driver Input to Output	$V_T = 2\text{V}$ , $R_T = 10\Omega$ , $C_L = 30\text{ pF}$ , $DE = 3\text{V}$	1	3.5	7	ns
$t_r$	Output Rise time	$V_T = 2\text{V}$ , $R_T = 10\Omega$ , $C_L = 30\text{ pF}$ , $DE = 3\text{V}$	1	2	5	ns
$t_f$	Output Fall Time	$V_T = 2\text{V}$ , $R_T = 10\Omega$ , $C_L = 30\text{ pF}$ , $DE = 3\text{V}$	1	2	5	ns
$t_{skew}$	Skew Between Drivers in Same Package	(Note 6)		1		ns
<b>DRIVER ENABLE:</b> (Figure 3 and Figure 6)						
$t_{PHL}$	Enable Delay	$V_T = 2\text{V}$ , $R_T = 10\Omega$ , $C_L = 30\text{ pF}$ , $Dn = 3\text{V}$	1	3.5	7	ns
$t_{PLH}$	Disable Delay	$V_T = 2\text{V}$ , $R_T = 10\Omega$ , $C_L = 30\text{ pF}$ , $Dn = 3\text{V}$	1	3.5	7	ns
<b>RECEIVER:</b> (Figure 4 and Figure 7)						
$t_{PHL}$	Receiver Input to Output	$C_L = 50\text{ pF}$ , $\overline{RE} = DE = 0.3\text{V}$ , $S3$ Closed	2	5	8	ns
$t_{PLH}$	Receiver Input to Output	$C_L = 50\text{ pF}$ , $\overline{RE} = DE = 0.3\text{V}$ , $S3$ Open	2	5	8	ns
$t_{skew}$	Skew Between Receivers in Same Package	(Note 6)		1		ns
<b>RECEIVER ENABLE:</b> (Figure 5 and Figure 8)						
$t_{ZL}$	Receiver Enable to Output Low	$C_L = 50\text{ pF}$ , $R_L = 500$ , $DE = 0.3\text{V}$ $S2$ Open $Bn = 2\text{V}$	2	6	12	ns
$t_{ZH}$	Receiver Enable to Output High	$C_L = 50\text{ pF}$ , $R_L = 500$ , $DE = 0.3\text{V}$ $S1$ Open $Bn = 1\text{V}$	2	5	12	ns
$t_{LZ}$	Receiver Disable From Output Low	$C_L = 50\text{ pF}$ , $R_L = 500$ , $DE = 0.3\text{V}$ $S2$ Open $Bn = 2\text{V}$	1	5	8	ns
$t_{HZ}$	Receiver Disable From Output High	$C_L = 50\text{ pF}$ , $R_L = 500$ , $DE = 0.3\text{V}$ $S1$ Open $Bn = 1\text{V}$	1	4	8	ns

**Note 6:**  $t_D$  and  $t_R$  skew is an absolute value, defined as differences seen in propagation delays between each of the drivers or receivers in the same package of the same delay,  $V_{CC}$ , temperature and load conditions.



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FIGURE 1. Equivalent Bus Output

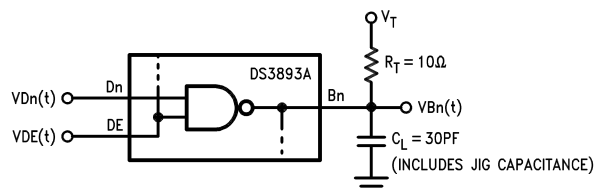


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Note:  $n = 1, 2, 3, 4$

FIGURE 2. Driver Output Voltage

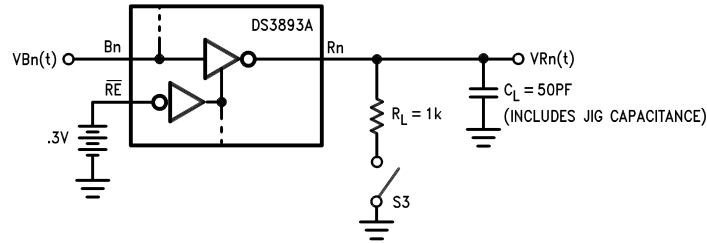
## AC Test Circuits



DS008698-3

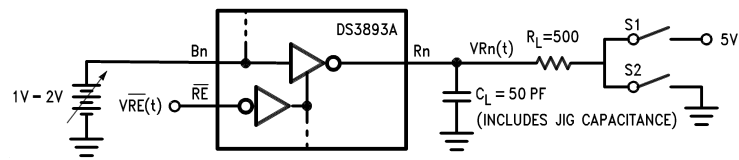
FIGURE 3.

## AC Test Circuits (Continued)



DS008698-4

FIGURE 4.

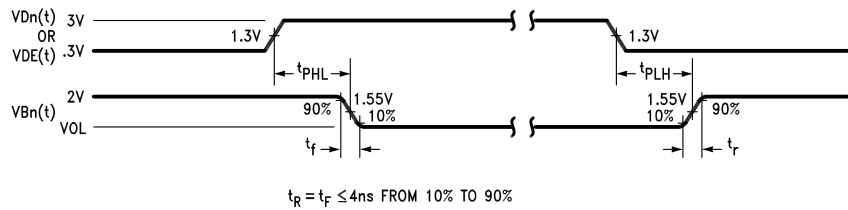


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**Note:**  
Unless Otherwise Specified  
The Switches are Closed

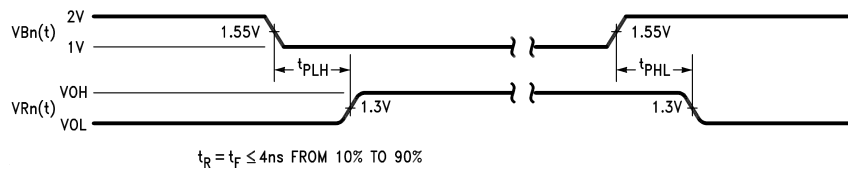
FIGURE 5.

## Switching Time Waveforms



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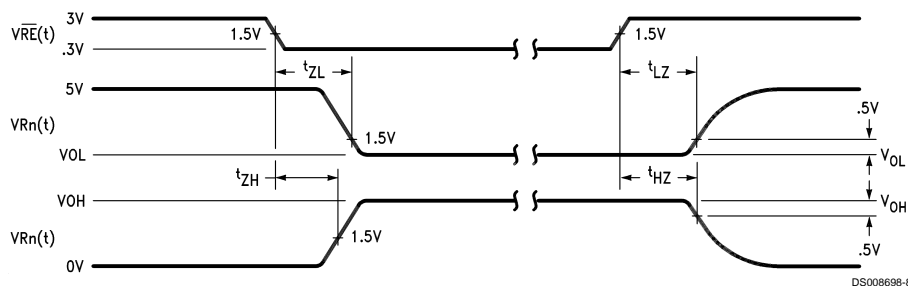
FIGURE 6. Driver Propagation Delay



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FIGURE 7. Receiver Propagation Delay

## Switching Time Waveforms (Continued)

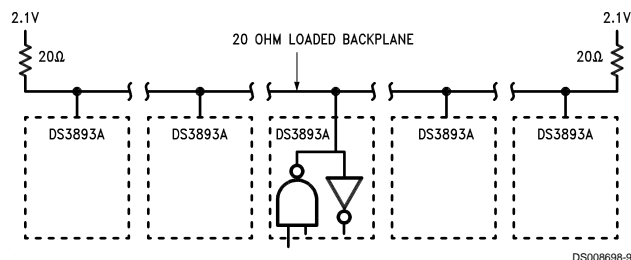


Note:  $t_R = t_F \leq 4$  ns From 10% to 90%

Note:  $n = 1, 2, 3, 4$

FIGURE 8. Receiver Enable and Disable Times

## Typical Application



## Application Information

Due to the high current and very high speed capability of the TURBOTRANSCEIVER's driver output stage, circuit board layout and bus grounding are critical factors that affect the system performance.

Each of the TURBOTRANSCEIVER's bus ground pins should be connected to the nearest backplane ground pin with the shortest possible path. The ground pins on the connector should be distributed evenly through its length.

Although the bandgap reference receiver threshold provides sufficient DC noise margin (Figure 9), ground noise and ringing on the data paths could easily exceed this margin if the series inductance of the traces and connectors are not kept to a minimum. The bandgap ground pin should be returned to the connector through a separate trace that does not carry transient switching currents. The transceivers should be mounted as close as possible to the connector. It should be noted that even one inch of trace can add a significant amount of ringing to the bus signal.

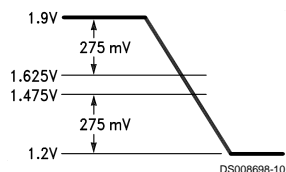


FIGURE 9. Noise Margin

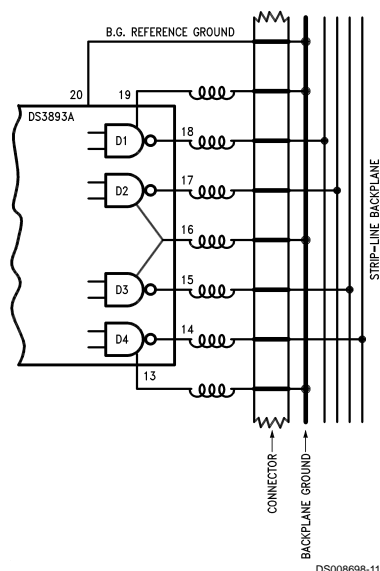
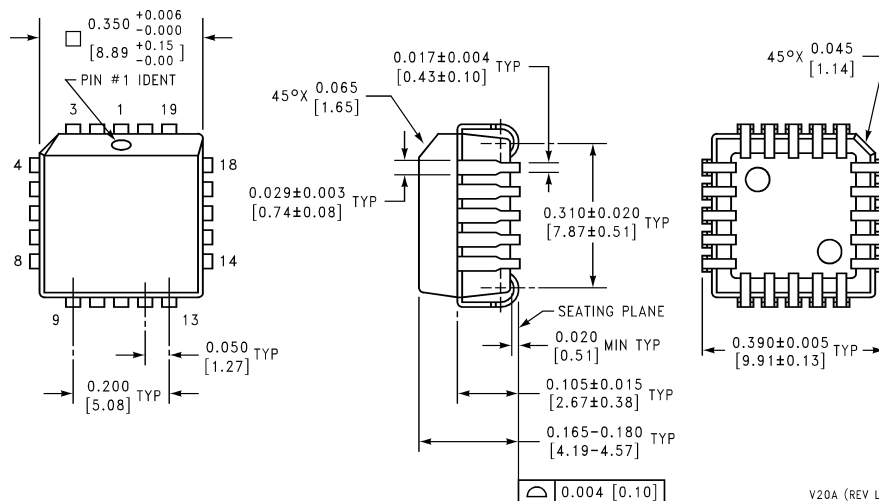


FIGURE 10.

## Physical Dimensions inches (millimeters) unless otherwise noted



**Plastic Chip Carrier (V)**  
**Order Number DS3893AV**  
**NS Package Number V20A**

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**National Semiconductor Corporation**  
Americas  
Tel: 1-800-272-9959  
Fax: 1-800-737-7018  
Email: support@nsc.com

www.national.com

**National Semiconductor Europe**

Fax: +49 (0) 1 80-530 85 86  
Email: europe.support@nsc.com  
Deutsch Tel: +49 (0) 1 80-530 85 85  
English Tel: +49 (0) 1 80-532 78 32  
Français Tel: +49 (0) 1 80-532 93 58  
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**National Semiconductor Asia Pacific Customer Response Group**

Tel: 65-2544466  
Fax: 65-2504466  
Email: sea.support@nsc.com

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