

## FEATURES

- Single Chip Provides Complete LocalTalk®/AppleTalk Port
- Operates From a Single 5V Supply
- ESD Protection to  $\pm 10\text{kV}$  on Receiver Inputs and Driver Outputs
- Low Power:  $I_{CC} = 2.4\text{mA Typ}$
- Shutdown Pin Reduces  $I_{CC}$  to  $0.5\mu\text{A Typ}$
- Receiver Keep-Alive Function:  $I_{CC} = 65\mu\text{A Typ}$
- Differential Driver Drives Either Differential AppleTalk or Single-Ended EIA562 Loads
- Drivers Maintain High Impedance in Three-State or with Power Off
- Thermal Shutdown Protection
- Drivers are Short-Circuit Protected

## APPLICATIONS

- LocalTalk Peripherals
- Notebook/Palmtop Computers
- Battery-Powered Systems

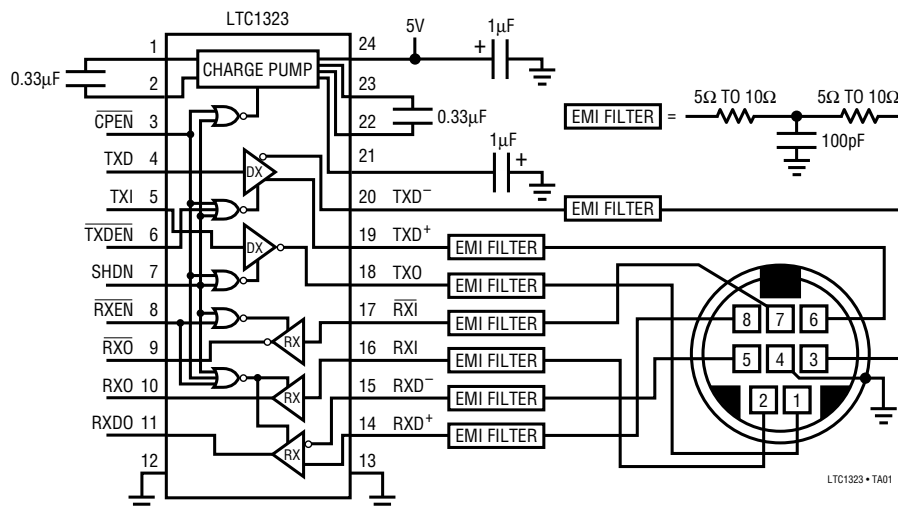
## DESCRIPTION

The LTC<sup>®</sup>1323 is a multi-protocol line transceiver designed to operate on AppleTalk or EIA562-compatible single-ended networks while operating from a single 5V supply. There are two versions of the LTC1323 available: a 16-pin version designed to connect to an AppleTalk network, and a 24-pin version which also includes the additional single-ended drivers and receivers necessary to create an Apple-compatible serial port. An on-board charge pump generates a  $-5\text{V}$  supply which can be used to power external devices. Additionally, the 24-pin LTC1323 features a micropower keep-alive mode during which one of the single-ended receivers is kept active to monitor external wake-up signals. The LTC1323 draws only  $2.4\text{mA}$  quiescent current when active,  $65\mu\text{A}$  in receiver keep-alive mode, and  $0.5\mu\text{A}$  in shutdown, making it ideal for use in battery-powered systems.

The differential driver can drive either differential AppleTalk loads or conventional single-ended loads. The driver outputs three-state when disabled, during shutdown, in receiver keep-alive mode, or when the power is off. The driver outputs will maintain high impedance even with output common-mode voltages beyond the power supply rails. Both the driver outputs and receiver inputs are protected against ESD damage to  $\pm 10\text{kV}$ .

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 AppleTalk and LocalTalk are registered trademarks of Apple Computer, Inc.

## TYPICAL APPLICATION



## ABSOLUTE MAXIMUM RATINGS

Supply Voltage ( $V_{CC}$ ) ..... 7V  
 Input Voltage  
     Logic Inputs .....  $-0.3V$  to  $V_{CC} + 0.3V$   
     Receiver Inputs .....  $\pm 15V$   
 Driver Output Voltage (Forced) .....  $\pm 15V$

Driver Short-Circuit Duration ..... Indefinite  
 Operating Temperature Range .....  $0^{\circ}C$  to  $70^{\circ}C$   
 Storage Temperature Range .....  $-65^{\circ}C$  to  $150^{\circ}C$   
 Lead Temperature (Soldering, 10 sec) .....  $300^{\circ}C$

## PACKAGE/ORDER INFORMATION

<p style="text-align: center;">TOP VIEW</p> <p style="text-align: center;">G PACKAGE 28-LEAD PLASTIC SSOP <math>T_{JMAX} = 150^{\circ}C, \theta_{JA} = 96^{\circ}C/W</math></p>	<p style="text-align: center;">ORDER PART NUMBER</p> <p style="text-align: center;">LTC1323CG</p>	<p style="text-align: center;">TOP VIEW</p> <p style="text-align: center;">S PACKAGE 16-LEAD PLASTIC SO <math>T_{JMAX} = 125^{\circ}C, \theta_{JA} = 85^{\circ}C/W</math></p>	<p style="text-align: center;">ORDER PART NUMBER</p> <p style="text-align: center;">LTC1323CS</p>
<p style="text-align: center;">TOP VIEW</p> <p style="text-align: center;">SW PACKAGE 24-LEAD PLASTIC SO WIDE <math>T_{JMAX} = 125^{\circ}C, \theta_{JA} = 85^{\circ}C/W</math></p>	<p style="text-align: center;">ORDER PART NUMBER</p> <p style="text-align: center;">LTC1323CSW</p>		

Consult factory for Industrial and Military grade parts.

## ELECTRICAL CHARACTERISTICS $V_{CC} = 5V \pm 10\%$ , $T_A = 0^\circ C$ to $70^\circ C$ (Notes 2, 3)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
<b>Supplies</b>							
$I_{CC}$	Normal Operation Supply Current	No Load, SHDN = 0V, $\overline{CPEN} = 0V$ , $\overline{TXDEN} = 0V$ , $\overline{RXEN} = 0V$	●	2.4	4	mA	
	Receiver Keep-Alive Supply Current	No Load, SHDN = 0V, $\overline{CPEN} = V_{CC}$ , $\overline{TXDEN} = 0V$ , $\overline{RXEN} = 0V$	●	65	100	$\mu A$	
	Shutdown Supply Current	No Load, SHDN = $V_{CC}$ , $\overline{CPEN} = X$ , $\overline{TXDEN} = X$ , $\overline{RXEN} = 0V$	●	0.5	10	$\mu A$	
$V_{EE}$	Negative Supply Output Voltage	$I_{LOAD} \leq 10mA$ (Note 4), $V_{CC} = 5V$ , $R_L = 100\Omega$ (Figure 1), $TXI = V_{CC}$ , $R_{TXO} = 3k$ (Figure 5)	●	-5.5	-5	-4.5	V
$f_{OSC}$	Charge Pump Oscillator Frequency			200		kHz	
<b>Differential Driver</b>							
$V_{OD}$	Differential Output Voltage	No Load $R_L = 100\Omega$ (Figure 1)	● ●	$\pm 8$ $\pm 2$		V	
$\Delta V_{OD}$	Change in Magnitude of Differential Output Voltage	$R_L = 100\Omega$ (Figure 1)		0.2		V	
<b>Differential Driver</b>							
$V_{OC}$	Differential Common-Mode Output Voltage	$R_L = 100\Omega$		3		V	
$V_{OS}$	Single-Ended Output Voltage	No Load $R_L = 3k$ to GND	●	$\pm 4.0$		V	
			●	$\pm 3.7$		V	
$V_{CMR}$	Common-Mode Range	SHDN = $V_{CC}$ or $\overline{CPEN} = V_{CC}$ or Power Off	●		$\pm 10$	V	
$I_{SS}$	Short-Circuit Current	$-5V \leq V_O \leq 5V$	●	35	120	500	mA
$I_{OZ}$	Three-State Output Current	SHDN = $V_{CC}$ or $\overline{CPEN} = V_{CC}$ or Power Off, $-10V \leq V_O \leq 10V$	●		$\pm 2$	$\pm 200$	$\mu A$
<b>Single-Ended Driver (Note 5)</b>							
$V_{OS}$	Single-Ended Output Voltage	No Load $R_L = 3k$ to GND	●	$\pm 4.5$		V	
			●	$\pm 3.7$		V	
$V_{CMR}$	Common-Mode Range	SHDN = $V_{CC}$ or $\overline{CPEN} = V_{CC}$ or $\overline{TXDEN} = V_{CC}$ or Power Off	●		$\pm 10$	V	
$I_{SS}$	Short-Circuit Current	$-5V \leq V_O \leq 5V$	●	35	220	500	mA
$I_{OZ}$	Three-State Output Current	SHDN = $V_{CC}$ or $\overline{CPEN} = V_{CC}$ or $\overline{TXDEN} = V_{CC}$ or Power Off, $-10V \leq V_O \leq 10V$	●		$\pm 2$	$\pm 200$	$\mu A$
<b>Receivers</b>							
$R_{IN}$	Input Resistance	$-7V \leq V_{IN} \leq 7V$	●	12		k $\Omega$	
	Differential Receiver Threshold Voltage	$-7V \leq V_{CM} \leq 7V$	●	-200	200	mV	
	Differential Receiver Input Hysteresis	$-7V \leq V_{CM} \leq 7V$	●		70	mV	
	Single-Ended Input, Low Voltage	(Note 5)	●		0.8	V	
	Single-Ended Input, High Voltage	(Note 5)	●	2		V	
$V_{OH}$	Output High Voltage	$I_O = -4mA$	●	3.5		V	
$V_{OL}$	Output Low Voltage	$I_O = 4mA$	●		0.4	V	
$I_{SS}$	Output Short-Circuit Current	$-5V \leq V_O \leq 5V$	●	7	85	mA	
$I_{OZ}$	Output Three-State Current	$-5V \leq V_O \leq 5V$ , $\overline{RXEN} = V_{CC}$	●		$\pm 2$	$\pm 100$	$\mu A$

**ELECTRICAL CHARACTERISTICS**  $V_{CC} = 5V \pm 10\%$ ,  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$  (Notes 2 and 3)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
<b>Logic Inputs</b>							
$V_{IH}$	Input High Voltage	All Logic Input Pins	●	2.0			V
$V_{IL}$	Input Low Voltage	All Logic Input Pins	●			0.8	V
$I_C$	Input Current	All Logic Input Pins	●		$\pm 1.0$	$\pm 20$	$\mu\text{A}$
<b>Switching Characteristics</b>							
$t_{PLH}, t_{PHL}$	Differential Driver Propagation Delay	$R_L = 100\Omega, C_L = 100\text{pF}$ (Figures 2, 7)	●		40	120	ns
	Differential Driver Propagation Delay with Single-Ended Load	$R_L = 3k, C_L = 100\text{pF}$ (Figures 3, 9)	●		120	180	ns
	Single-Ended Driver Propagation Delay	$R_L = 3k, C_L = 100\text{pF}$ , (Figures 5, 10) (Note 5)	●		40	120	ns
	Differential Receiver Propagation Delay	$C_L = 15\text{pF}$ (Figures 2, 11)	●		70	160	ns
	Single-Ended Receiver Propagation Delay	$C_L = 15\text{pF}$ (Figures 6, 12) (Note 5)	●		70	160	ns
	Inverting Receiver Propagation Delay in Keep-Alive Mode, $\text{SHDN} = 0V, \text{CPEN} = V_{CC}$	$C_L = 15\text{pF}$ (Figures 6, 12) (Note 5)	●		150	600	ns
$t_{SKEW}$	Differential Driver Output to Output	$R_L = 100\Omega, C_L = 100\text{pF}$ (Figures 2, 7)	●		10	50	ns
$t_r, t_f$	Differential Driver Rise/Fall Time	$R_L = 100\Omega, C_L = 100\text{pF}$ (Figures 2, 7)	●		50	150	ns
	Differential Driver Rise/Fall Time with Single-Ended Load	$R_L = 3k, C_L = 100\text{pF}$ (Figures 3, 9)	●		50	150	ns
	Single-Ended Driver Rise/Fall Time	$R_L = 3k, C_L = 100\text{pF}$ (Figures 5, 10) (Note 5)	●		15	80	ns
$t_{HDIS}, t_{LDIS}$	Differential Driver Output Active to Disable	$C_L = 15\text{pF}$ (Figures 4, 8)	●		180	250	ns
	Any Receiver Output Active to Disable	$C_L = 15\text{pF}$ (Figures 4, 13)	●		30	100	ns
$t_{ENH}, t_{ENL}$	Differential Driver Enable to Output Active	$C_L = 15\text{pF}$ (Figures 4, 8)	●		180	250	ns
	Any Receiver, Enable to Output Active	$C_L = 15\text{pF}$ (Figures 4, 13)	●		30	100	ns
$V_{EER}$	Supply Rise Time from Shutdown or Receiver Keep-Alive	$C1 = C2 = 0.33\mu\text{F}, C_{VEE} = 1\mu\text{F}$	●		0.2		ms

The ● denotes specifications which apply over the full operating temperature range.

**Note 1:** Absolute maximum ratings are those values beyond which the life of a device may be impaired.

**Note 2:** All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to ground unless otherwise specified.

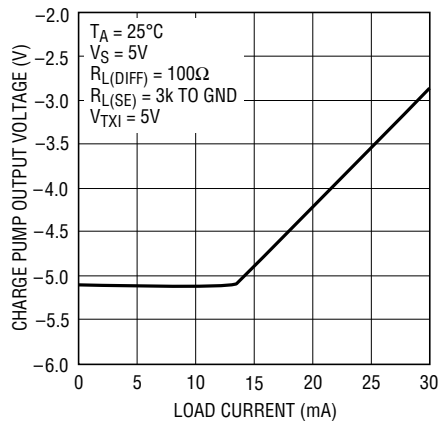
**Note 3:** All typicals are given at  $V_{CC} = 5V, T_A = 25^\circ\text{C}$ .

**Note 4:**  $I_{LOAD}$  is an external current being sunk into the  $V_{EE}$  pin.

**Note 5:** These specifications apply to the 24-pin SO Wide package only.

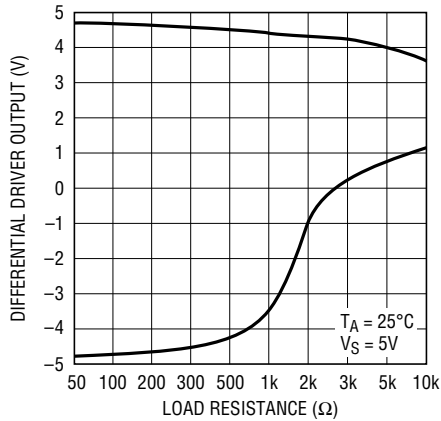
# TYPICAL PERFORMANCE CHARACTERISTICS

**Charge Pump Output Voltage vs Load Current**



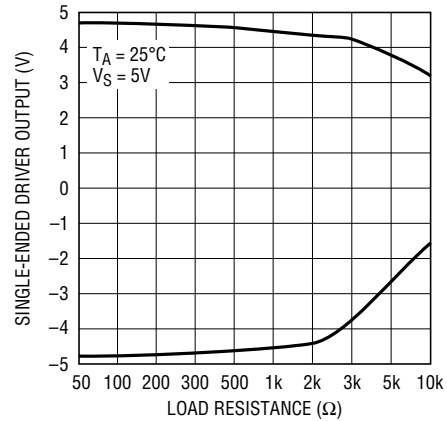
LTC1323 • TPC01

**Differential Driver Swing vs Load Resistance**



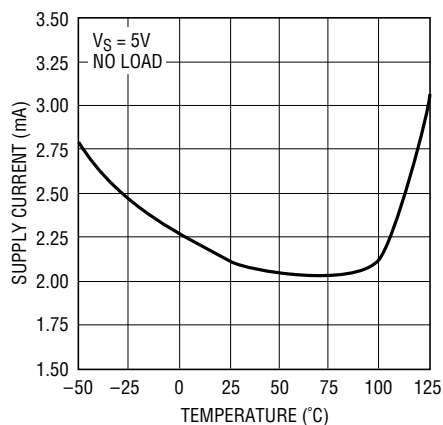
LTC1323 • TPC02

**Single-Ended Driver Swing vs Load Resistance**



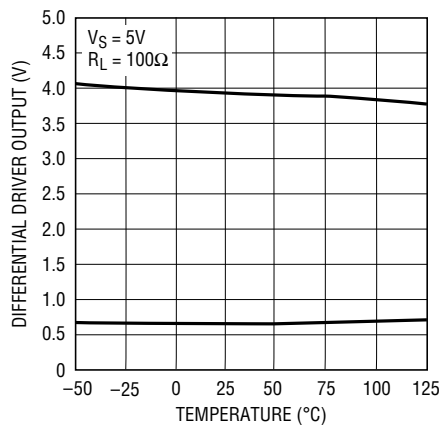
LTC1323 • TPC03

**Supply Current vs Temperature**



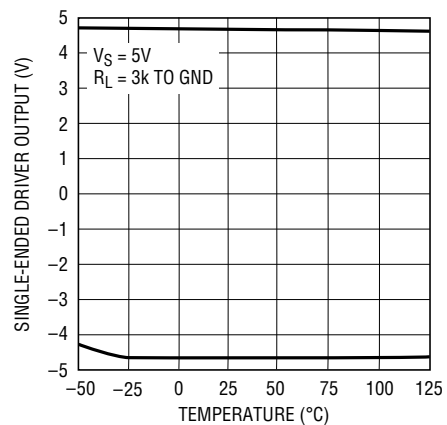
LTC1323 • TPC04

**Differential Driver Swing vs Temperature**



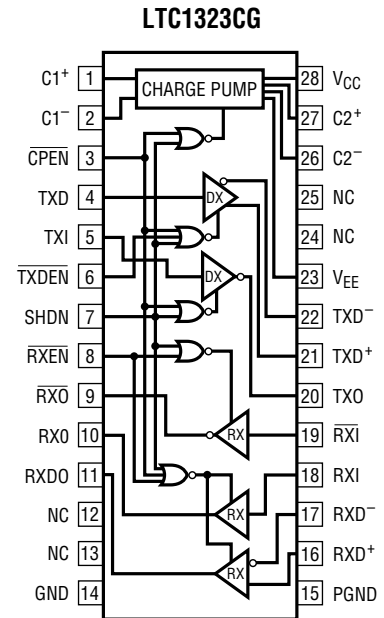
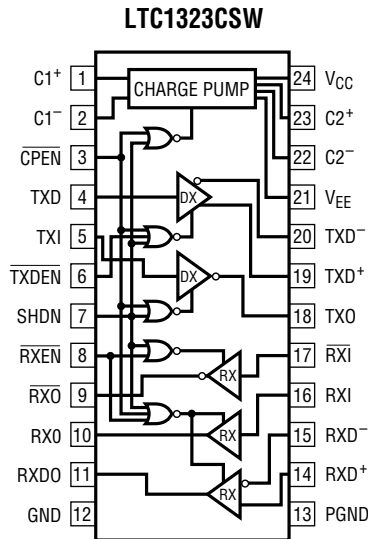
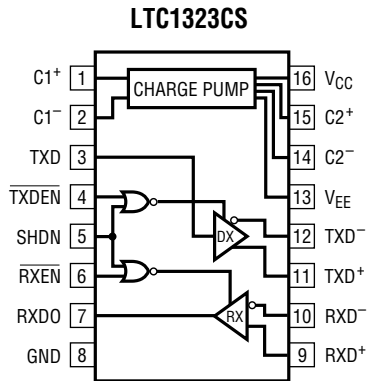
LTC1323 • TPC05

**Single-Ended Driver Swing vs Temperature**



LTC1323 • TPC06

## PIN FUNCTIONS



**C1<sup>+</sup>**: C1 Positive Input. Connect a 0.33 $\mu$ F capacitor between C1<sup>+</sup> and C1<sup>-</sup>.

**C1<sup>-</sup>**: C1 Negative Input. Connect a 0.33 $\mu$ F capacitor between C1<sup>+</sup> and C1<sup>-</sup>.

**CPEN**: TTL Level Charge Pump Enable Input. With  $\overline{\text{CPEN}}$  held low, the charge pump is enabled and the chip operates normally. When  $\overline{\text{CPEN}}$  is pulled high, the charge pump is disabled as well as both drivers, the noninverting single-ended receiver, and the differential receiver. The inverting single-ended receiver (RXI) is kept alive to monitor the control line and  $I_{\text{CC}}$  drops to 65 $\mu$ A. To turn off the receiver and drop  $I_{\text{CC}}$  to 0.5 $\mu$ A, pull the SHDN pin high.

**TXD**: Differential Driver Input (TTL compatible).

**TXI**: Single-Ended Driver Input (TTL compatible).

**TXDEN**: Differential Driver Output Enable (TTL compatible). A high level on this pin forces the differential driver into three-state; a low level enables the driver. This input does not affect the single-ended driver.

**SHDN**: Shutdown Input (TTL compatible). When this pin is high, the chip is shut down. All driver and receiver outputs are three-state, the charge pump turns off, and the supply current drops to 0.5 $\mu$ A. A low level on this pin allows normal operation.

**RXEN**: Receiver Enable (TTL compatible). A high level on this pin disables the receivers and three-states the logic outputs; a low level allows normal operation.

**RXO**: Inverting Single-Ended Receiver Output. Remains active in the receiver keep-alive mode.

**RXO**: Noninverting Single-Ended Receiver Output.

**RXDO**: Differential Receiver Output.

**GND**: Signal Ground. Connect to PGND with 24-pin package.

**PGND**: Power ground is connected internally to the charge pump and differential driver. Connect to the GND pin.

**RXD<sup>+</sup>**: Differential Receiver Noninverting Input. When this pin is  $\geq 200\text{mV}$  above  $\text{RXD}^-$ ,  $\text{RXDO}$  will be high; when this pin is  $\geq 200\text{mV}$  below  $\text{RXD}^-$ ,  $\text{RXDO}$  will be low.

**RXD<sup>-</sup>**: Differential Receiver Inverting Input.

**RXI**: Noninverting Receiver Input. This input controls the  $\text{RXO}$  output.

**RXI**: Inverting Receiver Input. This input controls the  $\overline{\text{RXO}}$  output. In receiver keep-alive mode ( $\overline{\text{CPEN}}$  high, SHDN low), this receiver can be used to monitor a wake-up control signal.

## PIN FUNCTIONS

**TXO:** Single-Ended Driver Output.

**TXD<sup>+</sup>:** Differential Driver Noninverting Output.

**TXD<sup>-</sup>:** Differential Driver Inverting Output.

**V<sub>EE</sub>:** Negative Supply Charge Pump Output. Requires a 1μF bypass capacitor to ground. If an external load is connected to the V<sub>EE</sub> pin, the bypass capacitor value should be increased to 4.7μF.

**C2<sup>-</sup>:** C2 Negative Input. Connect a 0.33μF capacitor between C2<sup>+</sup> and C2<sup>-</sup>.

**C2<sup>+</sup>:** C2 Positive Input. Connect a 0.33μF capacitor between C2<sup>+</sup> and C2<sup>-</sup>.

**V<sub>CC</sub>:** Positive Supply Input. 4.5V ≤ V<sub>CC</sub> ≤ 5.5V. Requires a 1μF bypass capacitor to ground.

## TEST CIRCUITS

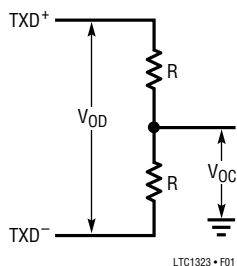


Figure 1

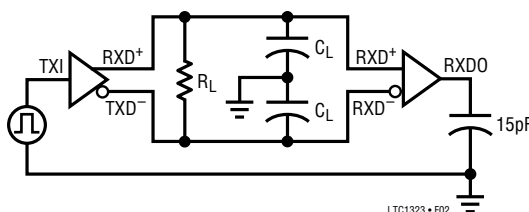


Figure 2

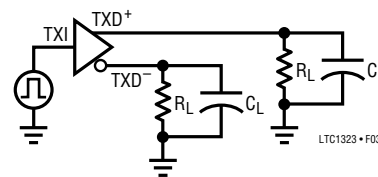


Figure 3

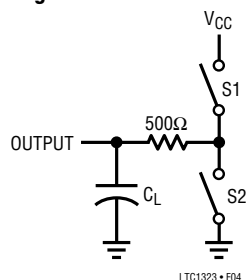


Figure 4

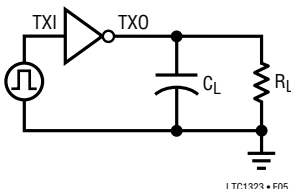


Figure 5

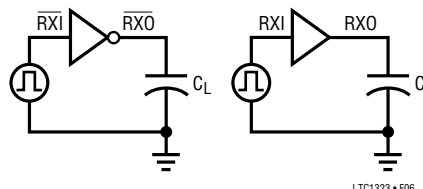


Figure 6

## SWITCHING WAVEFORMS

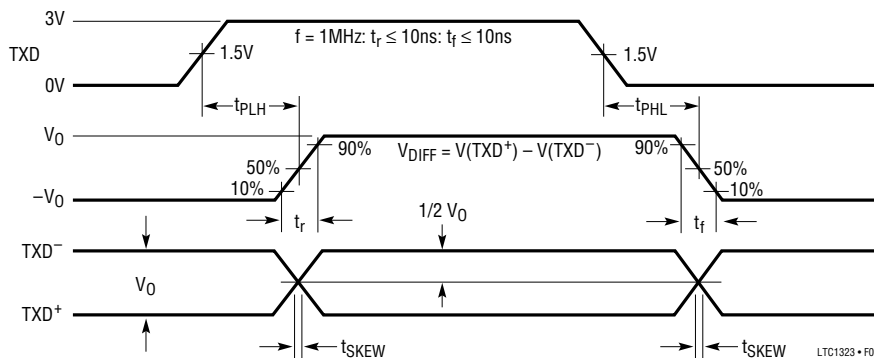


Figure 7. Differential Driver

# SWITCHING WAVEFORMS

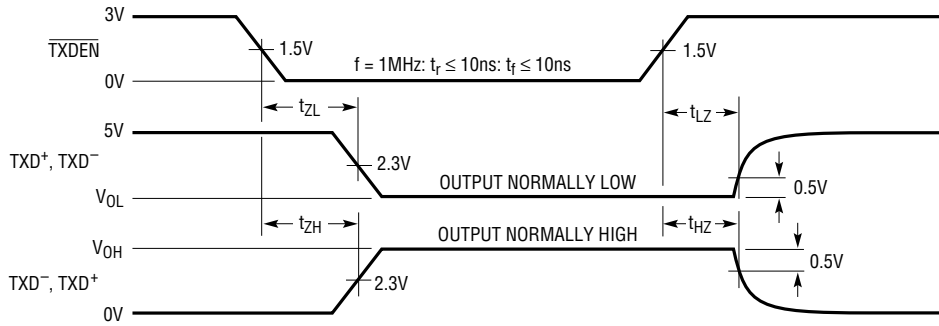


Figure 8. Differential Driver Enable and Disable

LTC1323 • F08

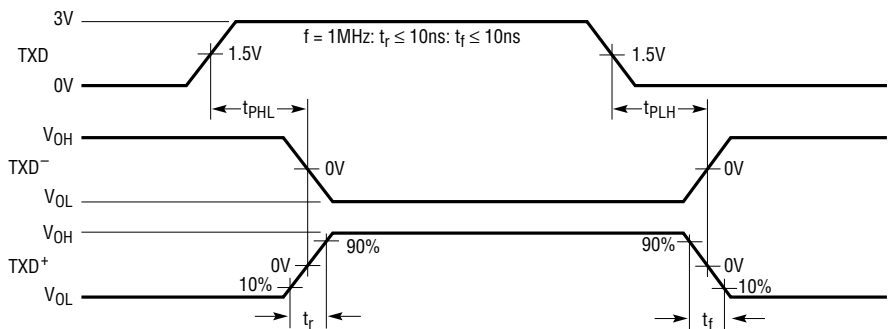


Figure 9. Differential Driver With Single-Ended Load

LTC1323 • F09

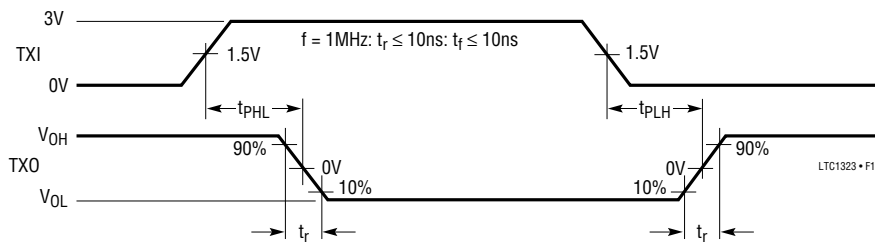


Figure 10. Single-Ended Driver

LTC1323 • F10

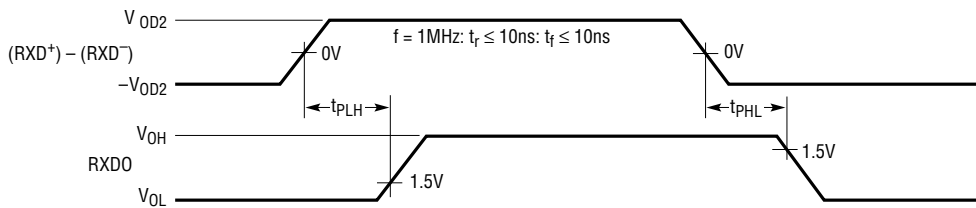


Figure 11. Differential Receiver

LTC1323 • F11





## APPLICATIONS INFORMATION

### Driving Differential AppleTalk or Single-Ended Loads

The differential driver is able to drive either an AppleTalk load or a single-ended load such as a printer or modem. With a differential AppleTalk load, TXD<sup>+</sup> and TXD<sup>-</sup> will typically swing between 1.2V and 3.5V (Figure 14a). With a single-ended 3k load such as a printer, either TXD<sup>+</sup> or TXD<sup>-</sup> will meet the single-ended voltage swing requirement of  $\pm 3.7V$  (Figure 14b). An automatic switching circuit prevents the differential driver from overloading the charge pump if the outputs are shorted to ground while driving single-ended signals. This allows the second single-ended driver to continue to operate normally when the first is shorted, and allows external circuitry attached to the charge pump output to continue to operate even if there are faults at the driver outputs.

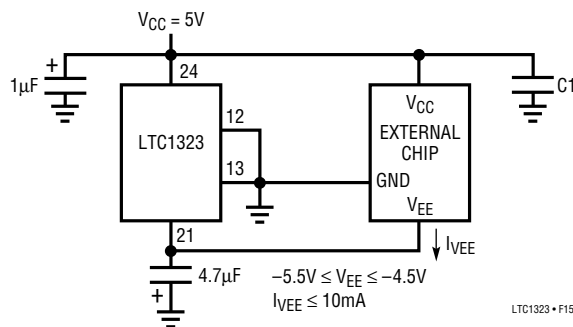


Figure 14

### Thermal Shutdown Protection

The LTC1323 includes a thermal shutdown circuit which protects against prolonged shorts at the driver outputs. If a driver output is shorted to another output or to the power supply, the current will be initially limited to a maximum of 500mA. When the die temperature rises above 150°C, the thermal shutdown circuit disables the driver outputs. When the die cools to about 130°C, the outputs are re-enabled. If the short still exists, the part will heat again and the cycle will repeat. This oscillation occurs at about 10Hz and prevents the part from being damaged by excessive power dissipation. When the short is removed, the part will return to normal operation.

### Power Shutdown

The power shutdown feature of the LTC1323 is designed for battery-powered systems. When SHDN is forced high the part enters shutdown mode. In shutdown the supply current typically drops from 2.4mA to 0.5µA, the charge pump turns off, and the driver and receiver outputs are three-stated.

### Receiver Keep-Alive Mode (24-Pin SO Wide Only)

The 24-pin SO Wide version of the LTC1323 also features a power saving receiver keep-alive mode. When  $\overline{CPEN}$  is pulled high the charge pump is turned off and the outputs of both drivers, the noninverting single-ended receiver and the differential receiver are forced into three-state. The inverting single-ended receiver (RXI) is kept alive with  $I_{CC}$  dropping to 65µA and the receiver delay time increasing to a maximum of 400ns. The receiver can then be used to monitor a wake-up control signal.

### Charge Pump Capacitors and Supply Bypassing

The LTC1323 requires two external 0.33µF capacitors for the charge pump to operate: one from C1<sup>+</sup> to C1<sup>-</sup> and one from C2<sup>+</sup> to C2<sup>-</sup>. These capacitors should be low ESR types and should be mounted as close as possible to the LTC1323. Monolithic ceramic capacitors work well in this application. Do not use capacitors greater than 2µF at the charge pump pins or internal peak currents can rise to destructive levels. The LTC1323 also requires that both V<sub>CC</sub> and V<sub>EE</sub> be well bypassed to ensure proper charge pump operation and prevent data errors. A 1µF capacitor from V<sub>CC</sub> to ground is adequate. A 1µF capacitor is required from V<sub>EE</sub> to ground and should be increased to 4.7µF if an external load is connected to the V<sub>EE</sub> pin. Ceramic or tantalum capacitors are adequate for power supply bypassing; aluminum electrolytic capacitors should only be used if their ESR is low enough for proper charge pump operation. Inadequate bypass or charge pump capacitors will cause the charge pump output to go out of regulation prematurely, degrading the output swing at the SINGLE-ENDED driver outputs.

## APPLICATIONS INFORMATION

### Driving an External Load from V<sub>EE</sub>

An external load may be connected between ground and the V<sub>EE</sub> pin as shown in Figure 15. The LTC1323 V<sub>EE</sub> pin will sink up to a maximum of 10mA while maintaining the pin voltage between -4.5V and -5.5V. If an external load is connected, the V<sub>EE</sub> bypass capacitor should be increased to 4.7μF. Both LTC1323 and the external chip should have separate V<sub>CC</sub> bypass capacitors but can share the V<sub>EE</sub> capacitor.

### EMI Filter

Most LocalTalk applications use an electromagnetic interference (EMI) filter consisting of a resistor-capacitor T network between each driver and receiver and the connector. Unfortunately, the resistors significantly attenuate the drivers output signals before they reach the cable. Because

the LTC1323 uses a single supply differential driver, the resistor values should be reduced to 5Ω to 10Ω to guarantee adequate voltage swing on the cable (Figure 16a). In most applications, removing the resistors completely does not cause an increase in EMI as long as a shielded connector and cable are used (Figure 16b). With the resistors removed the only DC load is the primary resistance of the LocalTalk transformer. This will increase the DC standby current when the driver outputs are active, but does not adversely affect the drivers because they can handle a direct indefinite short circuits without damage. Transformer primary resistance should be above 15Ω to keep the LTC1323 operating normally and prevent it from entering thermal shutdown. For maximum swing and EMI immunity, a ferrite bead and capacitor T network can be used (Figure 16c).

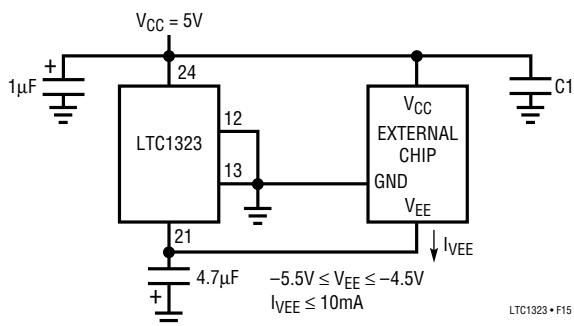


Figure 15

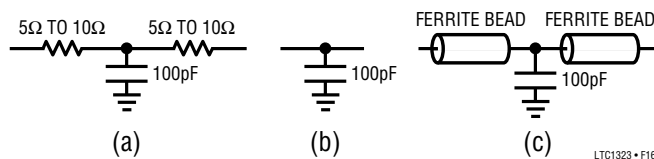
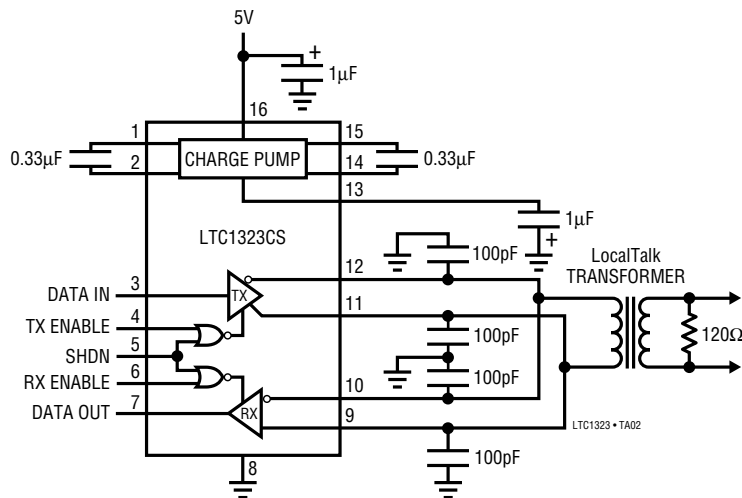


Figure 16. EMI Filters

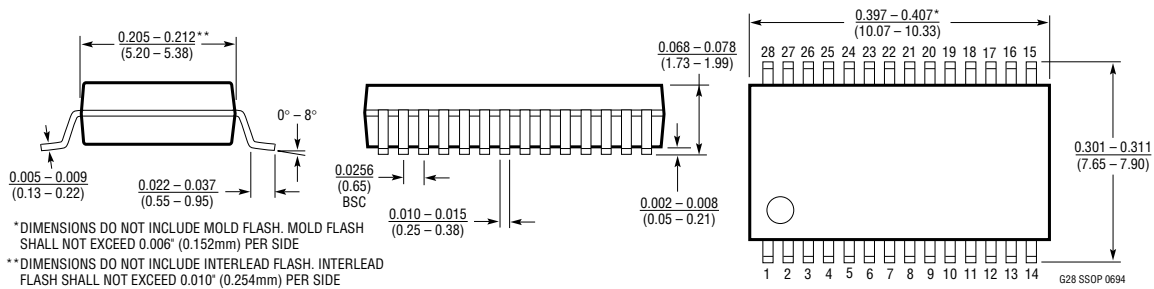
## TYPICAL APPLICATIONS

### Typical LocalTalk Connection

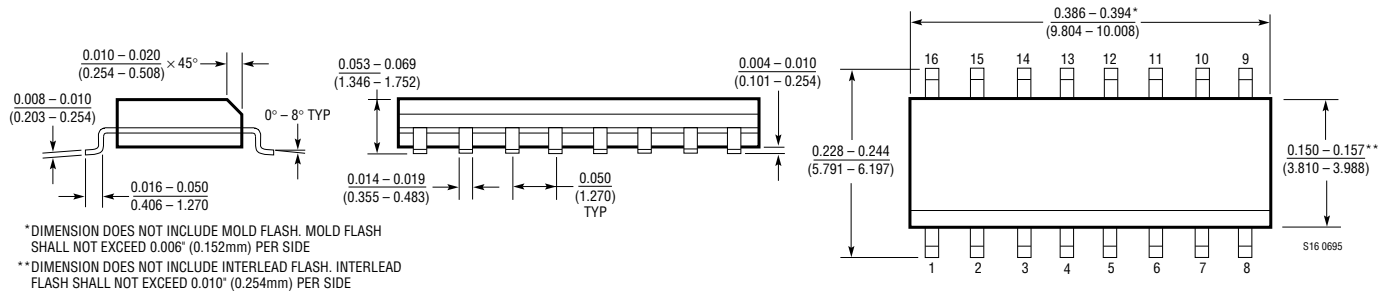


**PACKAGE DESCRIPTION** Dimensions in inches (millimeters) unless otherwise noted.

**G Package**  
**28-Lead Plastic SSOP (0.209)**  
 (LTC DWG # 05-08-1640)



**S Package**  
**16-Lead Plastic Small Outline (Narrow 0.150)**  
 (LTC DWG # 05-08-1610)



**SW Package**  
**24-Lead Plastic Small Outline (Wide 0.300)**  
 (LTC DWG # 05-08-1620)

