Single 5V AppleTalk® Transceiver

FEATURES

- **Single Chip Provides Complete LocalTalk®/AppleTalk Port**
- **Operates From a Single 5V Supply**
- ESD Protection to ±10kV on Receiver Inputs and Driver Outputs
- **Low Power: I_{CC} = 2.4mA Typ**
- Shutdown Pin Reduces I_{CC} to 0.5µA Typ
- Receiver Keep-Alive Function: I_{CC} = 65µA 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

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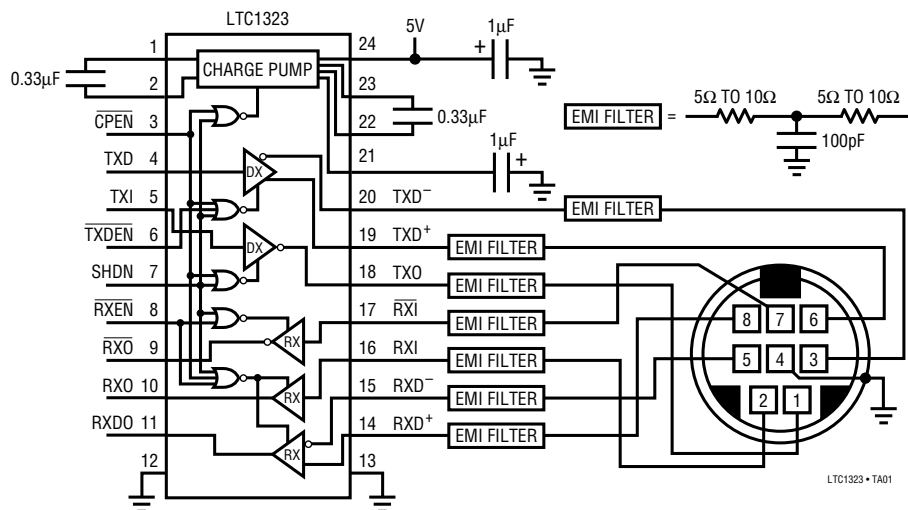AppleTalk and LocalTalk are registered trademarks of Apple Computer, Inc.

DESCRIPTION

The LTC®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 –5V 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 2.4mA quiescent current when active, 65µA in receiver keep-alive mode, and 0.5µA 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 ±10kV.

TYPICAL APPLICATION

LTC1323 • TA01

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC}) 7V
Input Voltage
    Logic Inputs .... −0.3V to V_{CC} + 0.3V
    Receiver Inputs .... ±15V
Driver Output Voltage (Forced) .... ±15V

Driver Short-Circuit Duration .... Indefinite
Operating Temperature Range .... 0°C to 70°C
Storage Temperature Range .... −65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION

TOP VIEW

C1$^+$	1		28	V_{CC}
C2$^-$	2		27	C2$^+$
$\overline{CPEN}$	3		26	C2$^-$
TXD	4		25	NC
TXI	5		24	NC
$\overline{TXDEN}$	6		23	V_{EE}
SHDN	7		22	TXD$^-$
$\overline{RXEN}$	8		21	TXD$^+$
$\overline{RXO}$	9		20	TXO
RXO	10		19	$\overline{RXI}$
RXDO	11		18	RXI
NC	12		17	RXD$^-$
NC	13		16	RXD$^+$
GND	14		15	PGND

G PACKAGE
28-LEAD PLASTIC SSOP
T_{JMAX} = 150°C, θ_{JA} = 96°C/W

ORDER PART NUMBER

LTC1323CG

TOP VIEW

C1$^+$	1		16	V_{CC}
C1$^-$	2		15	C2$^+$
TXD	3		14	C2$^-$
$\overline{TXDEN}$	4		13	V_{EE}
SHDN	5		12	TXD$^-$
$\overline{RXEN}$	6		11	TXD$^+$
RXDO	7		10	RXD$^-$
GND	8		9	RXD$^+$

S PACKAGE
16-LEAD PLASTIC SO
T_{JMAX} = 125°C, θ_{JA} = 85°C/W

ORDER PART NUMBER

LTC1323CS

TOP VIEW

C1$^+$	1		24	V_{CC}
C1$^-$	2		23	C2$^+$
$\overline{CPEN}$	3		22	C2$^-$
TXD	4		21	V_{EE}
TXI	5		20	TXD$^-$
$\overline{TXDEN}$	6		19	TXD$^+$
SHDN	7		18	TXO
$\overline{RXEN}$	8		17	$\overline{RXI}$
$\overline{RXO}$	9		16	RXI
RXO	10		15	RXD$^-$
RXDO	11		14	RXD$^+$
GND	12		13	PGND

SW PACKAGE
24-LEAD PLASTIC SO WIDE
T_{JMAX} = 125°C, θ_{JA} = 85°C/W

ORDER PART NUMBER

LTC1323CSW

Consult factory for Industrial and Military grade parts.

LINEAR
TECHNOLOGY

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

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Supplies							
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	µA
	Shutdown Supply Current	No Load, SHDN = V_{CC}, $\overline{CPEN}$ = X, $\overline{TXDEN}$ = X, $\overline{RXEN}$ = 0V	●		0.5	10	µA
V_{EE}	Negative Supply Output Voltage	$I_{LOAD} \leq$ 10mA (Note 4), V_{CC} = 5V, R_L = 100Ω (Figure 1), TXI = V_{CC}, R_{TXO} = 3k (Figure 5)	●	−5.5	−5	−4.5	V
f_{OSC}	Charge Pump Oscillator Frequency				200		kHz
Differential Driver							
V_{OD}	Differential Output Voltage	No Load R_L = 100Ω (Figure 1)	● ●	$\pm$8 $\pm$2			V
ΔV_{OD}	Change in Magnitude of Differential Output Voltage	R_L = 100Ω (Figure 1)			0.2		V
Differential Driver							
V_{OC}	Differential Common-Mode Output Voltage	R_L = 100Ω			3		V
V_{OS}	Single-Ended Output Voltage	No Load R_L = 3k to GND	● ●	$\pm$4.0 $\pm$3.7			V 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	µA
Single-Ended Driver (Note 5)							
V_{OS}	Single-Ended Output Voltage	No Load R_L = 3k to GND	● ●	$\pm$4.5 $\pm$3.7			V 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	µA
Receivers							
R_{IN}	Input Resistance	−7V $\leq V_{IN} \leq$ 7V	●	12			kΩ
	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	µA

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

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Logic Inputs							
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	●		±1.0	±20	µA
Switching Characteristics							
t_{PLH}, t_{PHL}	Differential Driver Propagation Delay	$R_L = 100\Omega$, $C_L = 100pF$ (Figures 2, 7)	●		40	120	ns
	Differential Driver Propagation Delay with Single-Ended Load	$R_L = 3k$, $C_L = 100pF$ (Figures 3, 9)	●		120	180	ns
	Single-Ended Driver Propagation Delay	$R_L = 3k$, $C_L = 100pF$, (Figures 5, 10) (Note 5)	●		40	120	ns
	Differential Receiver Propagation Delay	$C_L = 15pF$ (Figures 2, 11)	●		70	160	ns
	Single-Ended Receiver Propagation Delay	$C_L = 15pF$ (Figures 6, 12) (Note 5)	●		70	160	ns
	Inverting Receiver Propagation Delay in Keep-Alive Mode, $\overline{SHDN} = 0V$, $CPEN = V_{CC}$	$C_L = 15pF$ (Figures 6, 12) (Note 5)	●		150	600	ns
t_{SKEW}	Differential Driver Output to Output	$R_L = 100\Omega$, $C_L = 100pF$ (Figures 2, 7)	●		10	50	ns
t_r, t_f	Differential Driver Rise/Fall Time	$R_L = 100\Omega$, $C_L = 100pF$ (Figures 2, 7)	●		50	150	ns
	Differential Driver Rise/Fall Time with Single-Ended Load	$R_L = 3k$, $C_L = 100pF$ (Figures 3, 9)	●		50	150	ns
	Single-Ended Driver Rise/Fall Time	$R_L = 3k$, $C_L = 100pF$ (Figures 5, 10) (Note 5)	●		15	80	ns
t_{HDIS}, t_{LDIS}	Differential Driver Output Active to Disable	$C_L = 15pF$ (Figures 4, 8)	●		180	250	ns
	Any Receiver Output Active to Disable	$C_L = 15pF$ (Figures 4, 13)	●		30	100	ns
t_{ENH}, t_{ENL}	Differential Driver Enable to Output Active	$C_L = 15pF$ (Figures 4, 8)	●		180	250	ns
	Any Receiver, Enable to Output Active	$C_L = 15pF$ (Figures 4, 13)	●		30	100	ns
V_{EER}	Supply Rise Time from Shutdown or Receiver Keep-Alive	$C1 = C2 = 0.33µF$, $C_{VEE} = 1µF$	●		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.
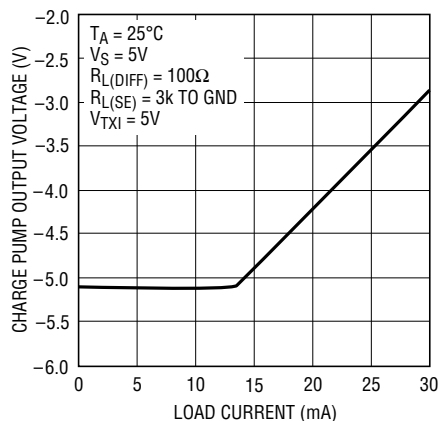
Note 3: All typicals are given at $V_{CC} = 5V$, $T_A = 25°C$.

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

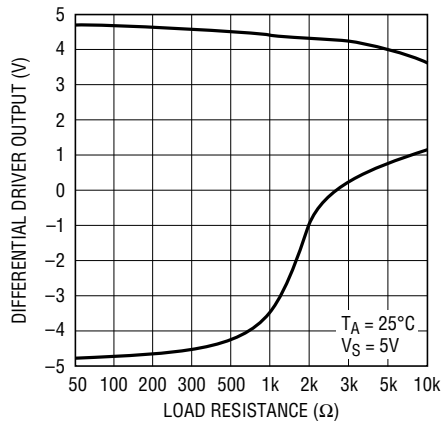**Note 5:** These specifications apply to the 24-pin SO Wide package only.

LINEAR TECHNOLOGY

TYPICAL PERFORMANCE CHARACTERISTICS
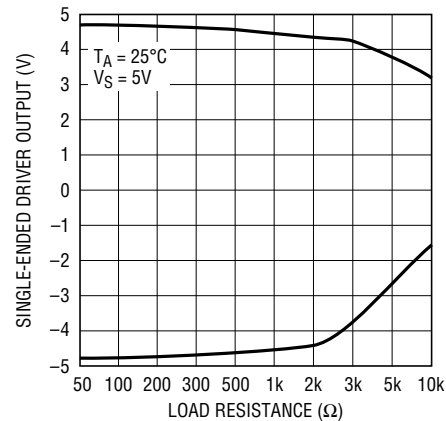
Charge Pump Output Voltage vs Load Current

T_A = 25°C
V_S = 5V
R_L(DIFF) = 100Ω
R_L(SE) = 3k TO GND
V_TXI = 5V

LTC1323 • TPC01

Differential Driver Swing vs Load Resistance

T_A = 25°C
V_S = 5V

LTC1323 • TPC02

Single-Ended Driver Swing vs Load Resistance

T_A = 25°C
V_S = 5V

LTC1323 • TPC03

Supply Current vs Temperature

V_S = 5V
NO LOAD
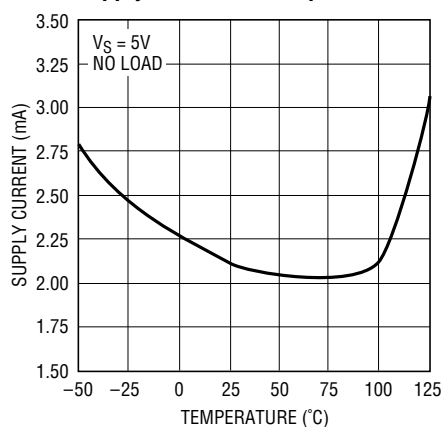
LTC1323 • TPC04

Differential Driver Swing vs Temperature

V_S = 5V
R_L = 100Ω
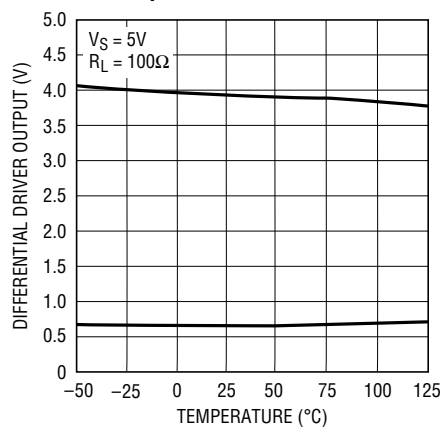
LTC1323 • TPC05

Single-Ended Driver Swing vs Temperature

V_S = 5V
R_L = 3k TO GND
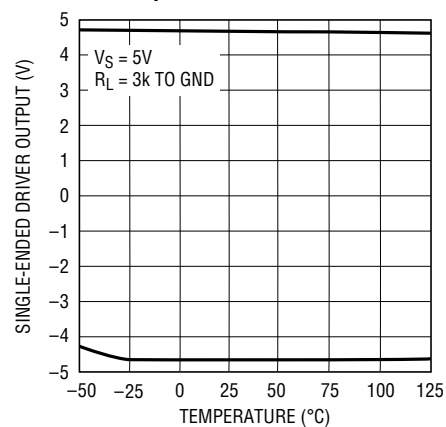
LTC1323 • TPC06

PIN FUNCTIONS

LTC1323CS

```
C1⁺    [1]  ┌─ CHARGE PUMP ─┐  [16]  V_CC
C1⁻    [2]  │               │  [15]  C2⁺
TXD    [3]  │               │  [14]  C2⁻
TXDEN  [4]  │               │  [13]  V_EE
SHDN   [5]  │          DX   │  [12]  TXD⁻
RXEN   [6]  │               │  [11]  TXD⁺
RXDO   [7]  │          RX   │  [10]  RXD⁻
GND    [8]  └───────────────┘  [9]   RXD⁺
```

LTC1323CSW

```
C1⁺    [1]   ┌─ CHARGE PUMP ─┐  [24]  V_CC
C1⁻    [2]   │               │  [23]  C2⁺
CPEN   [3]   │          DX   │  [22]  C2⁻
TXD    [4]   │               │  [21]  V_EE
TXI    [5]   │          DX   │  [20]  TXD⁻
TXDEN  [6]   │               │  [19]  TXD⁺
SHDN   [7]   │               │  [18]  TXO
RXEN   [8]   │          RX   │  [17]  RXI
RXO    [9]   │               │  [16]  RXI
RX0    [10]  │          RX   │  [15]  RXD⁻
RXDO   [11]  │          RX   │  [14]  RXD⁺
GND    [12]  └───────────────┘  [13]  PGND
```

LTC1323CG

```
C1⁺    [1]   ┌─ CHARGE PUMP ─┐  [28]  V_CC
C1⁻    [2]   │               │  [27]  C2⁺
CPEN   [3]   │          DX   │  [26]  C2⁻
TXD    [4]   │               │  [25]  NC
TXI    [5]   │          DX   │  [24]  NC
TXDEN  [6]   │               │  [23]  V_EE
SHDN   [7]   │               │  [22]  TXD⁻
RXEN   [8]   │               │  [21]  TXD⁺
RXO    [9]   │               │  [20]  TXO
RX0    [10]  │          RX   │  [19]  RXI
RXDO   [11]  │               │  [18]  RXI
NC     [12]  │          RX   │  [17]  RXD⁻
NC     [13]  │          RX   │  [16]  RXD⁺
GND    [14]  └───────────────┘  [15]  PGND
```

C1⁺: C1 Positive Input. Connect a 0.33µF capacitor between C1⁺ and C1⁻.

C1⁻: C1 Negative Input. Connect a 0.33µF capacitor between C1⁺ and C1⁻.

CPEN: TTL Level Charge Pump Enable Input. With CPEN held low, the charge pump is enabled and the chip operates normally. When 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_{CC} drops to 65µA. To turn off the receiver and drop I_{CC} to 0.5µA, 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 0.5µA. 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⁺: Differential Receiver Noninverting Input. When this pin is ≥200mV above RXD⁻, RXDO will be high; when this pin is ≥200mV below RXD⁻, RXDO will be low.

RXD⁻: Differential Receiver Inverting Input.

RXI: Noninverting Receiver Input. This input controls the RXO output.

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

PIN FUNCTIONS

TXO: Single-Ended Driver Output.

TXD⁺: Differential Driver Noninverting Output.

TXD⁻: Differential Driver Inverting Output.

V_{EE}: Negative Supply Charge Pump Output. Requires a 1μF bypass capacitor to ground. If an external load is connected to the V_{EE} pin, the bypass capacitor value should be increased to 4.7μF.

C2⁻: C2 Negative Input. Connect a 0.33μF capacitor between C2⁺ and C2⁻.

C2⁺: C2 Positive Input. Connect a 0.33μF capacitor between C2⁺ and C2⁻.

V_{CC}: Positive Supply Input. $4.5V \leq V_{CC} \leq 5.5V$. Requires a 1μF bypass capacitor to ground.
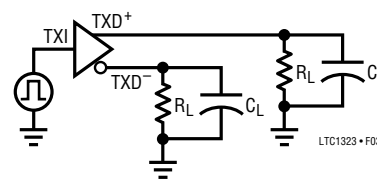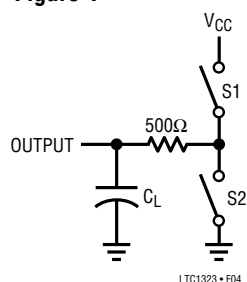
TEST CIRCUITS
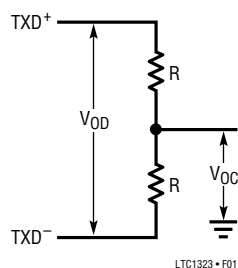
Figure 1
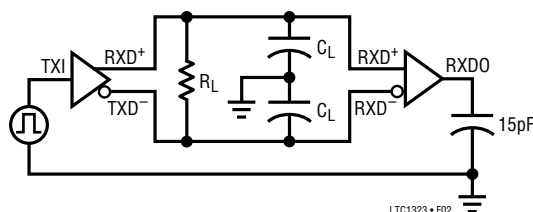
Figure 2

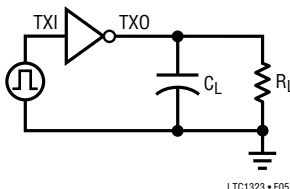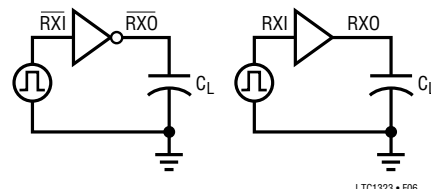

Figure 3

Figure 4

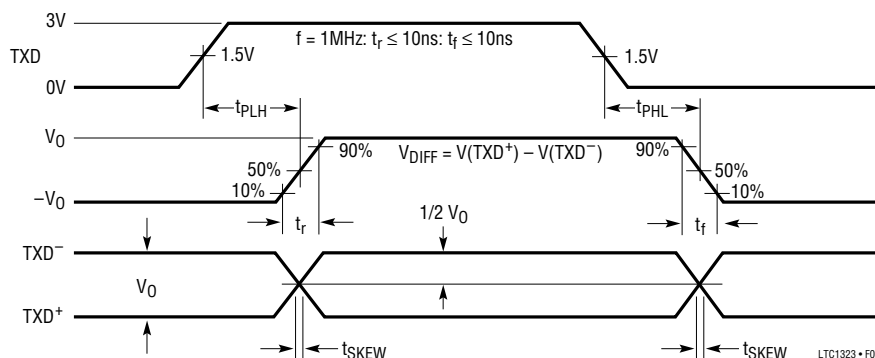**Figure 5**

Figure 6

SWITCHING WAVEFORMS

Figure 7. Differential Driver

SWITCHING WAVEFORMS

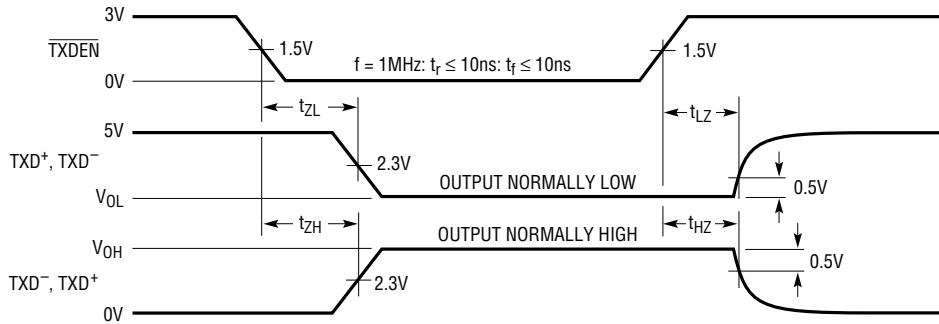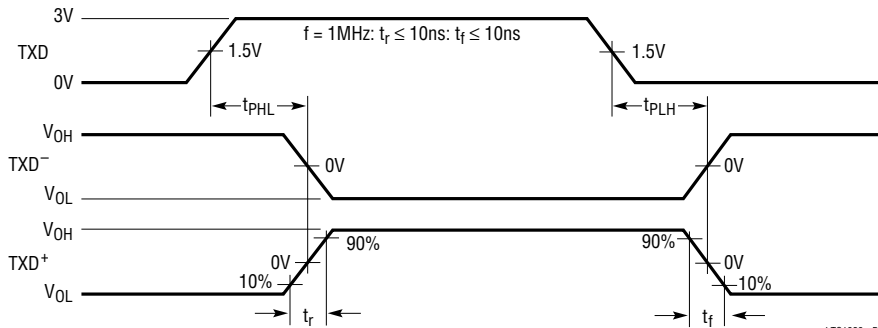**Figure 8. Differential Driver Enable and Disable**

Figure 9. Differential Driver With Single-Ended Load

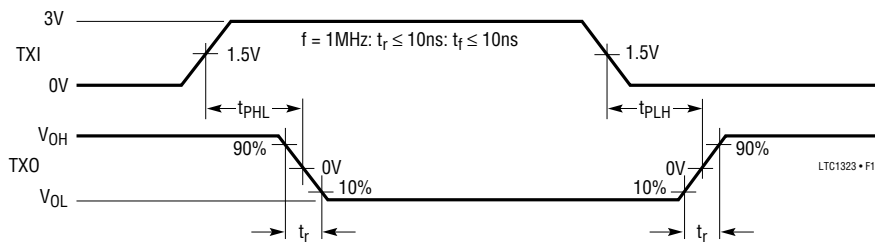**Figure 10. Single-Ended Driver**
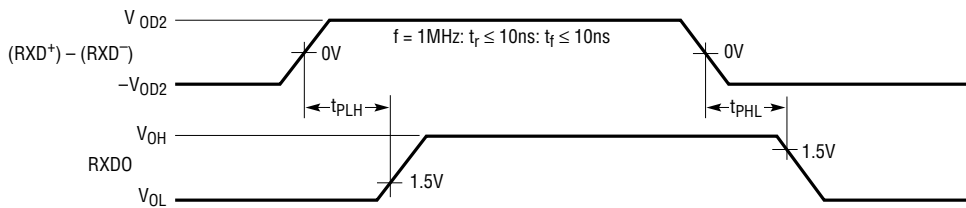
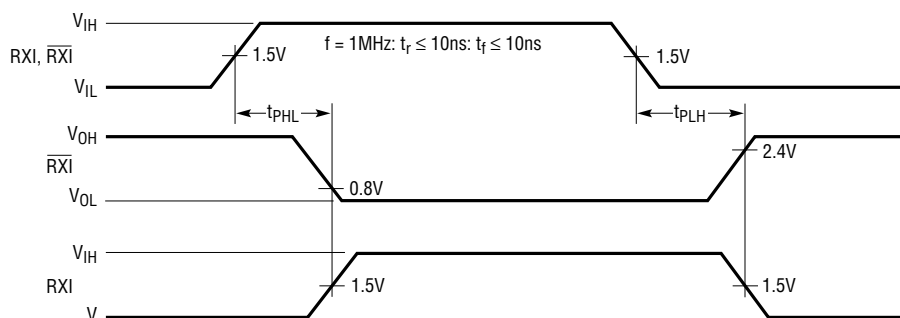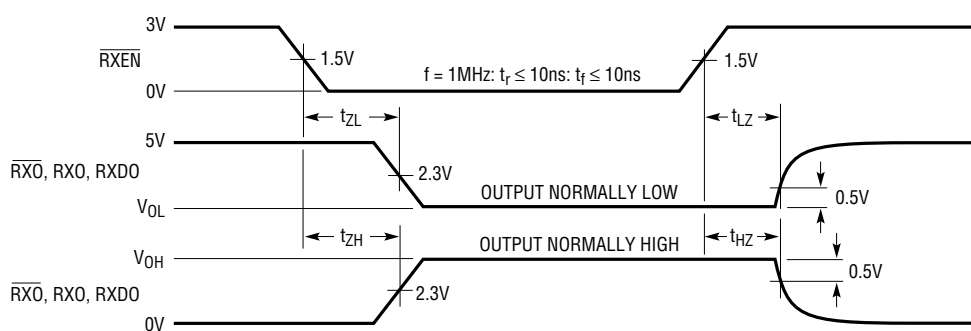**Figure 11. Differential Receiver**

SWITCHING WAVEFORMS

Figure 12. Single-Ended Receiver

Figure 13. Receiver Enable and Disable

APPLICATIONS INFORMATION

Functional Description

The "serial port" on the back of an Apple-compatible computer or peripheral is a fairly versatile "multi-protocol" connector. It must be able to connect to a wide bandwidth LAN (an AppleTalk/LocalTalk network), which requires a high speed differential transceiver to meet the AppleTalk specification, and it must also be able to connect directly to a printer or modem through a short RS232 style link. The LTC1323 is designed to provide all the functions necessary to implement such a port on a single chip. Two versions of the LTC1323 are available: a 16-pin SO version which provides the minimum solution for interfacing to an AppleTalk network in a smaller package, and a larger 24-pin SO Wide version which additionally includes all the handshaking lines required to implement a complete AppleTalk/modem/printer serial port. All LTC1323s run from a single 5V power supply while providing true single-ended compatibility, and include a 0.5µA low power shutdown mode

to improve lifetime in battery-powered devices. The 24-pin SO Wide version also includes a receiver keep-alive mode for monitoring external signals while drawing 65µA typically.

The LTC1323 includes an RS422-compatible differential driver/receiver pair for data transmission, with the driver specified to drive 2V into the 100Ω primary of a typical LocalTalk interface transformer/RFI interference network. Either output of the differential RS422 driver can also act as an single-ended driver, allowing the LTC1323 to communicate over a standard serial connection. The 24-pin SO Wide LTC1323 also includes an extra single ended only driver and two extra RS232-compatible single-ended receivers for handshaking lines. All versions include an on-board charge pump to provide a regulated −5V supply required for the single-ended drivers. The charge pump can also provide up to 10mA of external load current to power other circuitry.

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$^+$ and TXD$^-$ will typically swing between 1.2V and 3.5V (Figure 14a). With a single-ended 3k load such as a printer, either TXD$^+$ or TXD$^-$ will meet the single-ended voltage swing requirement of $\pm3.7V$ (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.
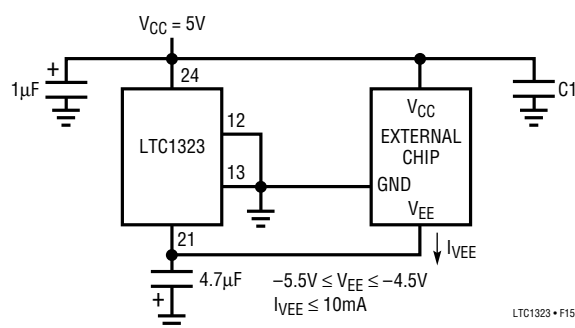

Figure 14

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 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$^+$ to C1$^-$ and one from C2$^+$ to C2$^-$. 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_{CC} and V_{EE} be well bypassed to ensure proper charge pump operation and prevent data errors. A 1μF capacitor from V_{CC} to ground is adequate. A 1μF capacitor is required from V_{EE} to ground and should be increased to 4.7μF if an external load is connected to the V_{EE} 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_{EE}

An external load may be connected between ground and the V_{EE} pin as shown in Figure 15. The LTC1323 V_{EE} 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_{EE} bypass capacitor should be increased to 4.7μF. Both LTC1323 and the external chip should have separate V_{CC} bypass capacitors but can share the V_{EE} 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 16. EMI Filters

Figure 15

TYPICAL APPLICATIONS
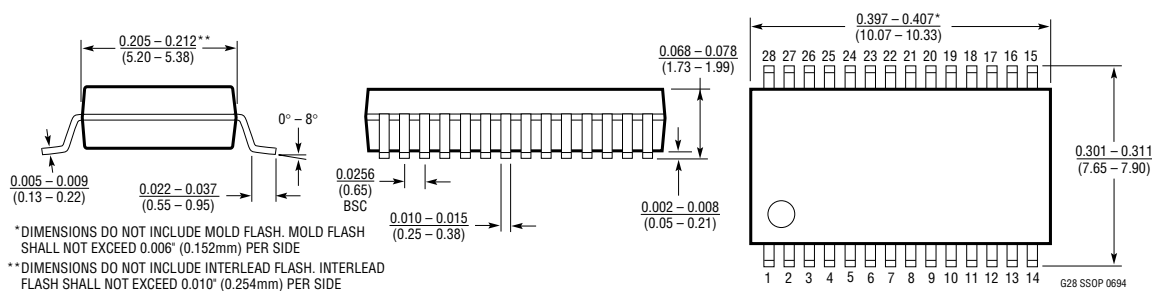
Typical LocalTalk Connection

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

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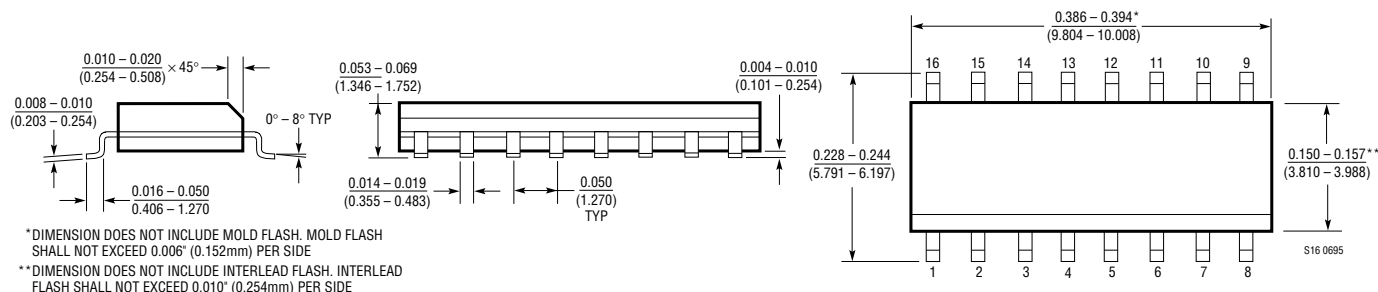

*DIMENSIONS DO NOT INCLUDE MOLD FLASH. MOLD FLASH
SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE
**DIMENSIONS DO NOT INCLUDE INTERLEAD FLASH. INTERLEAD
FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

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

*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH
SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE
**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD
FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

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

NOTE:
1. PIN 1 IDENT, NOTCH ON TOP AND CAVITIES ON THE BOTTOM OF PACKAGES ARE THE MANUFACTURING OPTIONS
   THE PART MAY BE SUPPLIED WITH OR WITHOUT ANY OF THE OPTIONS.
   *DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE
   **DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

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