# Single 5V AppleTalk® Transceiver

January 1994

## 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

## DESCRIPTION

The LTC1323 is a single 5V line transceiver designed to operate on Appletalk or EIA562 networks. The LTC1323 is available in 16-pin or 24-pin versions, each includes a differential RS422 compatible transceiver. A charge pump generates the chip's –5V supply which may also be used to power an external device. The 24-pin LTC1323 includes an additional dedicated EIA562 driver and two EIA562 receivers, one of which features a micropower keep-alive mode which can be used for monitoring 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 will drive either differential AppleTalk loads or EIA562 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.

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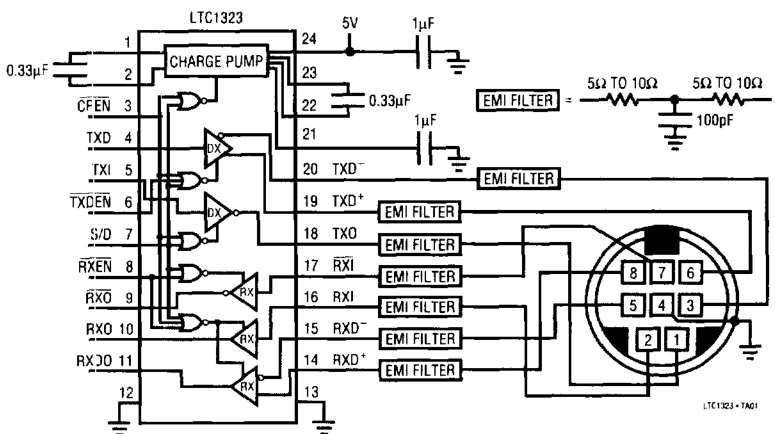
## TYPICAL APPLICATION

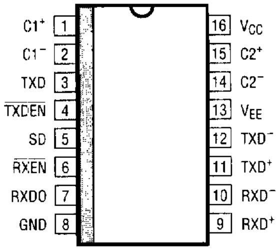


## ABSOLUTE MAXIMUM RATINGS

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

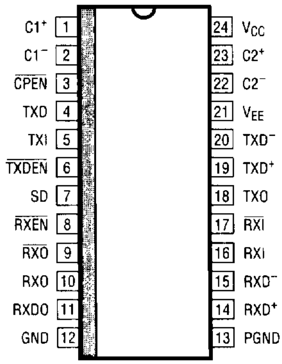



S PACKAGE
16-LEAD PLASTIC SOL

$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 85°C/W

| ORDER PART NUMBER |
| --- |
| LTC1323CS-16 |

TOP VIEW




S PACKAGE
24-LEAD PLASTIC SOL

$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 85°C/W

| ORDER PART NUMBER |
| --- |
| LTC1323CS |

Consult factory for Industrial and Military grade parts

## ELECTRICAL CHARACTERISTICS $V_{CC}$ = 5V ±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, SD = 0V, $\overline{CPEN}$ = 0V, $\overline{TXDEN}$ = 0V, $\overline{RXEN}$ = 0V | ● | | 2.4 | 4 | mA |
| | Receiver Keep-Alive Supply Current | No Load, SD = 0V, $\overline{CPEN}$ = $V_{CC}$, $\overline{TXDEN}$ = 0V, $\overline{RXEN}$ = 0V | ● | | 65 | 100 | µA |
| | Shutdown Supply Current | No Load, SD = $V_{CC}$, $\overline{CPEN}$ = X, $\overline{TXDEN}$ = X, $\overline{RXEN}$ = 0V | ● | | 0.5 | 10 | µA |
| $V_{EE}$ | Negative Supply Output Voltage | $I_{LOAD}$ ≤ 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<br>$R_L$ = 100Ω (Figure 1) | ●<br>● | ±8<br>±2 | | | V |
| $\Delta V_{OD}$ | Change in Magnitude of Differential Output Voltage | $R_L$ = 100Ω (Figure 1) | | | 0.2 | | V |


LINEAR TECHNOLOGY

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

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **Differential Driver** | | | | | | | |
| $V_{OC}$ | Differential Common-Mode Output Voltage | $R_L$ = 100Ω | | | 3 | | V |
| $V_{OS}$ | Single-Ended Output Voltage | No Load<br>$R_L$ = 3k to GND | ●<br>● | ±4.5<br>±3.7 | | | V<br>V |
| $V_{CMR}$ | Common-Mode Range | SD = $V_{CC}$ or $\overline{CPEN}$ = $V_{CC}$ or Power Off | ● | | | ±10 | V |
| $I_{SS}$ | Short-Circuit Current | $-5V \le V_O \le 5V$ | ● | 35 | 120 | 250 | mA |
| $I_{OZ}$ | Three-State Output Current | SD = $V_{CC}$ or $\overline{CPEN}$ = $V_{CC}$ or Power Off, $-10V \le V_O \le 10V$ | ● | | ±2 | ±200 | µA |
| **Single-Ended Driver (Note 5)** | | | | | | | |
| $V_{OS}$ | Single-Ended Output Voltage | No Load<br>$R_L$ = 3k to GND | ●<br>● | ±4.5<br>±3.7 | | | V<br>V |
| $V_{CMR}$ | Common-Mode Range | SD = $V_{CC}$ or $\overline{CPEN}$ = $V_{CC}$ or $\overline{TXDEN}$ = $V_{CC}$ or Power Off | ● | | | ±10 | V |
| $I_{SS}$ | Short-Circuit Current | $-5V \le V_O \le 5V$ | ● | 35 | 220 | 500 | mA |
| $I_{OZ}$ | Three-State Output Current | SD = $V_{CC}$ or $\overline{CPEN}$ = $V_{CC}$ or $\overline{TXDEN}$ = $V_{CC}$ or Power Off, $-10V \le V_O \le 10V$ | ● | | ±2 | ±200 | µA |
| **Receivers** | | | | | | | |
| $R_{IN}$ | Input Resistance | $-7V \le V_{IN} \le 7V$ | ● | 12 | | | kΩ |
| | Differential Receiver Threshold Voltage | $-7V \le V_{CM} \le 7V$ | ● | −200 | | 200 | mV |
| | Differential Receiver Input Hysteresis | $-7V \le V_{CM} \le 7V$ | ● | | 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 | $-5V \le V_O \le 5V$ | ● | 7 | | 85 | mA |
| $I_{OZ}$ | Output Three-State Current | $-5V \le V_O \le 5V$, $\overline{RXEN}$ = $V_{CC}$ | ● | | ±2 | ±100 | µA |
| **Logic Inputs** | | | | | | | |
| VIH | Input High Voltage | All Logic Input Pins | ● | 2.0 | | | V |
| VIL | Input Low Voltage | All Logic Input Pins | ● | | | 0.8 | V |
| IC | Input Current | All Logic Input Pins | ● | | ±1.0 | ±20 | µA |
| **Switching Characteristics** | | | | | | | |
| $t_{PLH}$, $t_{PHL}$ | Differential Driver Propagation Delay | $R_L$ = 100Ω, $C_L$ = 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, SD = 0V, $\overline{CPEN}$ = $V_{CC}$ | $C_L$ = 15pF (Figures 6, 12) (Note 5) | ● | | 150 | 400 | ns |
| $t_{SKEW}$ | Differential Driver Output to Output | $R_L$ = 100Ω, $C_L$ = 100pF (Figures 2, 7) | ● | | 10 | 50 | ns |

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

| SYMBOL | PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** | | | | | | | |
| $t_r$, $t_f$ | Differential Driver Rise/Fall Time | $R_L$ = 100Ω, $C_L$ = 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) | ● | | 50 | 150 | 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) | ● | | 50 | 150 | 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.

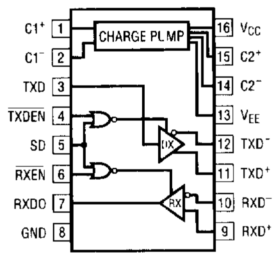
**Note 3:** All typicals are given at $V_{CC}$ = 5V, $T_A$ = 25°C.

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

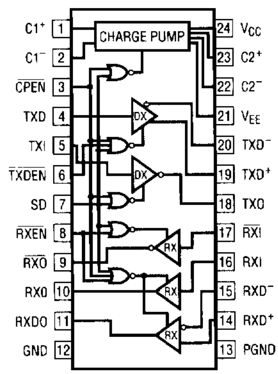
**Note 5:** These specifications apply to the 24-pin package only.

## PIN FUNCTIONS

**LTC1323CS-16**




**LTC1323CS**




### (16-Pin/24-Pin)

**C1⁺ (Pin 1/Pin 1):** C1 Positive Input. Connect a 0.33μF capacitor between C1⁺ and C1⁻.

**C1⁻ (Pin 2/Pin 2):** C1 Negative Input. Connect a 0.33μF capacitor between C1⁺ and C1⁻.

**$\overline{\text{CPEN}}$ (NA/Pin 3):** 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 ($\overline{\text{RXI}}$) 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 S/D pin high.

## PIN FUNCTIONS

**TXD (Pin 3/Pin 4):** Differential Driver Input (TTL compatible).

**TXI (NA/Pin 5):** Single-Ended Driver Input ( TTL compatible).

**$\overline{\text{TXDEN}}$ (Pin 4/Pin 6):** 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.

**S/D (Pin 5/Pin 7):** 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.

**$\overline{\text{RXEN}}$ (Pin 6/Pin 8):** 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.

**$\overline{\text{RXO}}$ (NA/Pin 9):** Inverting Single-Ended Receiver Output. Remains active in the receiver keep-alive mode.

**RXO (NA/Pin 10):** Noninverting Single-Ended Receiver Output.

**RXDO (Pin 7/Pin 11):** Differential Receiver Output.

**GND (Pin 8/Pin 12):** Signal Ground. Connect to PGND with 24-pin package.

**PGND (NA/Pin 13):** Power ground is connected internally to the charge pump and differential driver. Connect to the GND pin.

**$RXD^+$ (Pin 9/Pin 14):** 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.

**$RXD^-$ (Pin 10/Pin 15):** Differential Receiver Inverting Input.

**RXI (NA/Pin 16):** Noninverting Receiver Input. This input controls the RXO output.

**$\overline{\text{RXI}}$ (NA/Pin 17):** Inverting Receiver Input. This input controls the $\overline{\text{RXO}}$ output. In receiver keep-alive mode ($\overline{\text{CPEN}}$ high, S/D low), this receiver can be used to monitor a wake-up control signal.

**TXO (NA/Pin 18):** Single-Ended Driver Output.

**$TXD^+$ (Pin 11/Pin 19):** Differential Driver Noninverting Output.

**$TXD^-$ (Pin 12/Pin 20):** Differential Driver Inverting Output.

**$V_{EE}$ (Pin 13/Pin 21):** The 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.

**$C2^-$ (Pin 14/Pin 22):** C2 Negative Input. Connect a 0.33μF capacitor between $C2^+$ and $C2^-$.

**$C2^+$ (Pin 15/Pin 23):** C2 Positive Input. Connect a 0.33μF capacitor between $C2^+$ and $C2^-$.

**$V_{CC}$ (Pin 16/Pin 24):** The Positive Supply Input. $4.5V \le V_{CC} \le 5.5V$. Requires a 1μF bypass capacitor to ground.

## TEST CIRCUITS

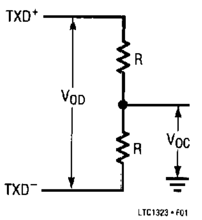



**Figure 1**

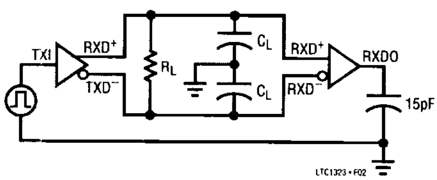



**Figure 2**

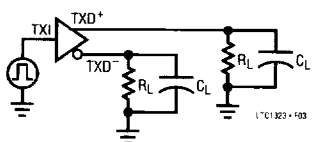



**Figure 3**

## TEST CIRCUITS

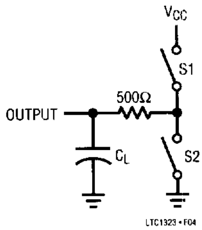



Figure 4

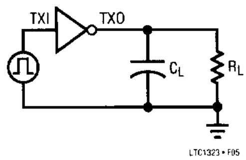



Figure 5

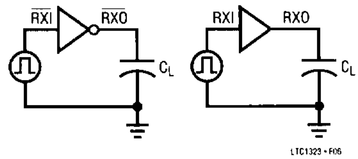



Figure 6

## SWITCHING WAVEFORMS

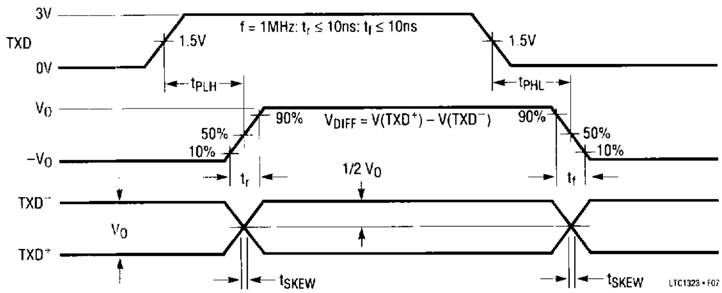



**Figure 7. Differential Driver**

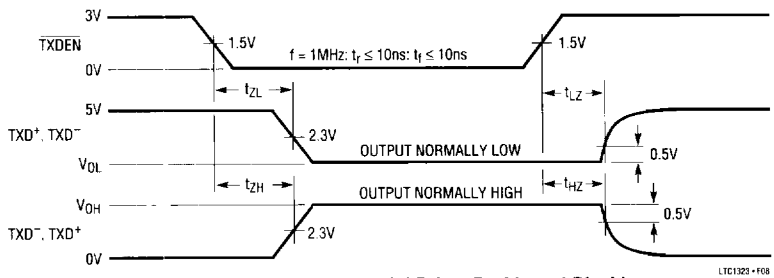



**Figure 8. Differential Driver Enable and Disable**

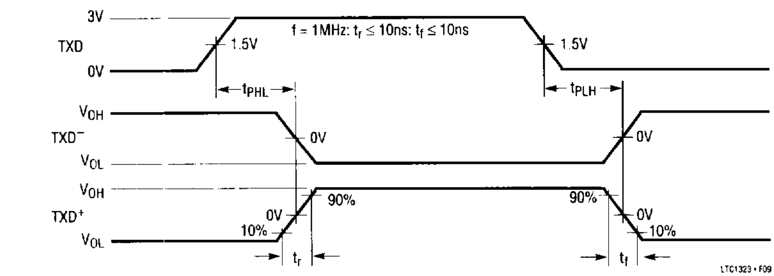



**Figure 9. Differential Driver With Single-Ended Load**

# SWITCHING WAVEFORMS

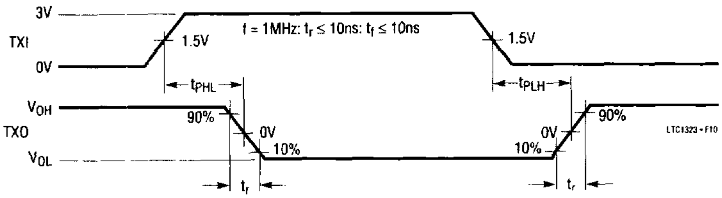



**Figure 10. Single-Ended Driver**

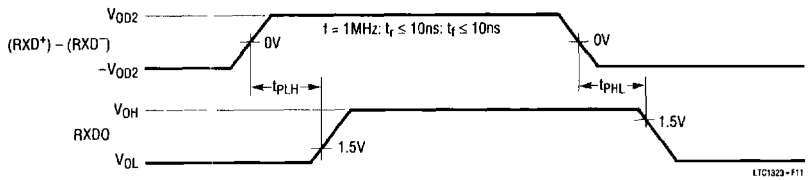



**Figure 11. Differential Receiver**

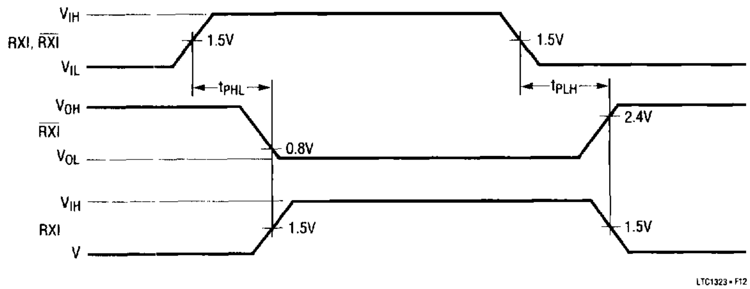



**Figure 12. Single-Ended Receiver**

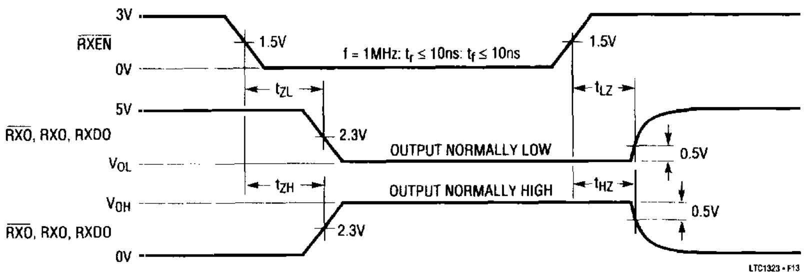



**Figure 13. Receiver Enable and Disable**

# APPLICATIONS INFORMATION

### 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 250mA. When the die temperature rises above 150°C, the thermal shutdown circuit turns off the driver outputs. When the die cools to about 130°C, the outputs re-enable. 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 S/D 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.

### Supply Bypassing

The LTC1323 requires that both $V_{CC}$ and $V_{EE}$ are well bypassed to 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.

### Driving an External Load from $V_{EE}$

An external load may be connected between ground and the $V_{EE}$ pin as shown in Figure 14.

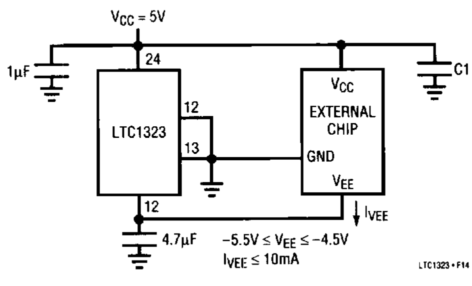



Figure 14

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 chips should have separate $V_{CC}$ bypass capacitors but can share the $V_{EE}$ capacitor.

### Driving 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. With a differential AppleTalk load, $TXD^+$ and $TXD^-$ will typically swing between 1.2V and 3.5V (Figure 15a). With a single-ended 3k load such as a printer, $TXD^+$ or $TXD^-$ will meet the EIA562 voltage swing requirement of ±3.7V (Figure 15b).

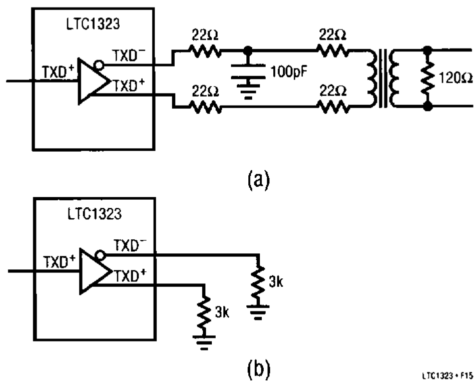



Figure 15

### Receiver Keep-Alive Mode (24-Pin Package Only)

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 ($\overline{RXI}$) 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.

# APPLICATIONS INFORMATION

## 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 driver's signal applied to the cable. Because the LTC1323 uses a single supply driver, the resistor values should be reduced to 5Ω to 10Ω to insure enough voltage swing on the cable (Figure 16). In most applications, removing the resistors completely does not cause an increase in EMI as long as a shielded connector and cable are used. With the resistors removed the only DC load becomes the primary of the LocalTalk transformer. This will increase the DC standby current when the drivers are active, but does not adversely affect the drivers because they can handle a direct short circuit indefinitely. For maximum swing and EMI immunity, a ferrite bead and capacitor could be used.

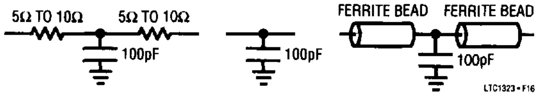



**Figure 16. EMI Filters**