

# LXT313 / LXT316

## Low-Power E1 PCM Repeaters/Transceivers

### General Description

The LXT313 and LXT316 are integrated repeater/transceiver circuits for E1 carrier systems. The LXT313 is a dual repeater/transceiver and the LXT316 is a single repeater/transceiver. The LXT313 and LXT316 are designed to operate as regenerative repeaters/transceivers for 2.048 Mbps data rate PCM lines. Each includes all circuits required for a regenerative repeater/transceiver system including the equalization network, automatic line build-out (ALBO), and a state-of-the-art analog/digital clock extraction network tuned by an external crystal.

The key feature of the LXT313 family is that it requires only a crystal and a minimum of other components to complete a repeater/transceiver design. Compared with traditional tuned coil-type repeaters/transceivers, they offer significant savings in component and labor costs, along with reduced voltage drop/power consumption, and improved reliability. To ensure performance for all loop lengths, the LXT313 and LXT316 are 100% AC/DC tested using inputs generated by Level One's proprietary transmission line and network simulator.

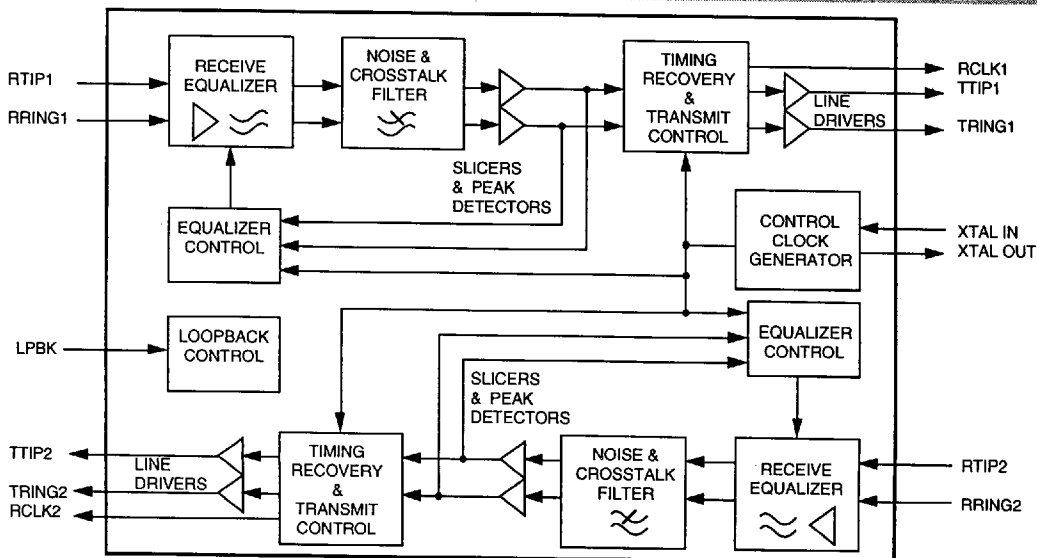
The LXT313 and LXT316 are advanced CMOS devices which require only a single 5-volt power supply.

### Features

- Integrated repeater/transceiver circuit on a single CMOS chip
- On-chip equalization network
- On-chip ALBO
- Low power consumption
- No tuning coil
- On-chip Loopback
- Recovered Clock Output
- 0 to 43 dB dynamic range
- -14 dB interference margin
- Single 5 V only CMOS technology
- Available in 16-pin PDIP and 44-pin PLCC

4

### LXT313 Block Diagram



### Figure 1: LXT313/316 Repeater/Transceiver Pin Assignments

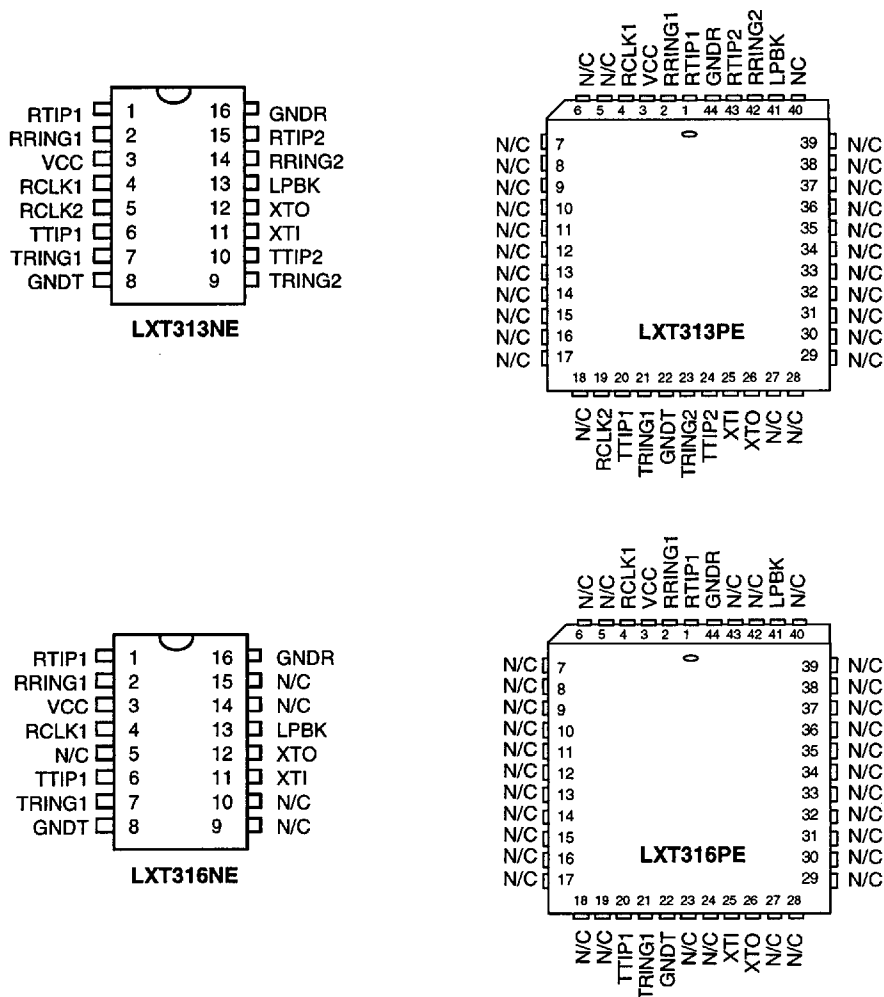


Table 1: Pin Descriptions

| Pin #<br>DIP / PLCC  | Sym             | I/O    | Name | Description         |   |
|--|-----------------|--------|------|---------------------|---|
| 1  | 1               | RTIP1  | I    | Repeater Tip and    | Tip and ring receive inputs for Channel 1.  |
| 2  | 2               | RRING1 | I    | Ring Inputs         |   |
| 4  | 4               | RCLK1  | O    | Recovered Clock     | Clock output recovered from Channel 1 receive input.  |
| 6  | 20              | TTIP1  | O    | Repeater Tip and    | Open-drain output drivers for Channel 1.  |
| 7  | 21              | TRING1 | O    | Ring Outputs        |   |
| 11   | 25              | XTI    | I    | Crystal Oscillator  | A 8.192 MHz crystal must be connected across these two pins.  |
| 12   | 26              | XTO    | O    | Pins                |   |
| 3  | 3               | VCC    | I    | Power Supply        | Power supply input for all circuits. +5 V (±0.25 V)   |
| 8  | 22              | GNDT   | –    | Transmit Ground     | Ground return for transmit circuits.  |
| 16   | 44              | GNDR   | –    | Receive Ground      | Ground return for receive circuits.   |
| 9 <sup>1</sup>   | 23 <sup>1</sup> | TRING2 | O    | Side 2 Tip and Ring | On the LXT313 dual repeater/transceiver, these are open-drain output drivers for Channel 2.   |
| 10 <sup>1</sup>  | 24 <sup>1</sup> | TTIP2  | O    | Outputs             |   |
| 14 <sup>1</sup>  | 42 <sup>1</sup> | RRING2 | I    | Side 2 Ring and Tip | On the LXT313 dual repeater/transceiver these are tip and ring receive inputs for Channel 2.  |
| 15 <sup>1</sup>  | 43 <sup>1</sup> | RTIP2  | I    | Inputs              |   |
| 5 <sup>1</sup>   | 19 <sup>1</sup> | RCLK2  | O    | Recovered Clock     | On the LXT313 dual repeater/transceiver, this is the recovered clock output for Channel 2.  |
| 13   | 41              | LPBK   | I    | Loopback Control    | On the LXT313, this pin controls Loopback Selection. High = Loopback side 1 data to side 2. Low = No Loopback. <b>On the LXT316 single repeater/transceiver, this pin must be connected to GND.</b> |
| 1. On the LXT316NE and LXT316PE single repeater/transceiver, these pins are not connected (N/C). |                 |        |      |                     |   |
| 2. On the LXT313PE and LXT316PE pins 5 through 18 and 27 through 40 are not connected (N/C).     |                 |        |      |                     |   |

### FUNCTIONAL DESCRIPTION

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#### NOTE

This information is for design aid only.

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PCM signals are attenuated and dispersed in time as they travel down a transmission line. Repeaters/transceivers are required to amplify, reshape, regenerate and retiming the PCM signal, then retransmit it.

The LXT313 and LXT316 each contain all the circuits required to build a complete PCM repeater/transceiver. The operational range of the repeaters/transceivers is 0 to 43 dB of cable loss at 1.024 MHz (equal to 2 km of 22 gauge pulsed insulated cable between repeaters/transceivers).

#### RECEIVE FUNCTION

The signal is received through a 1 : 1 transformer at RTIP and RRING and equalized for up to 43 dB of cable loss. The receive equalizer uses a proprietary on-chip adaptive filter technique which is equivalent to a 3-port ALBO equalizer design. The monolithic structure of the filter and the absence of external components provide excellent ISI and dispersion elimination, and accurate data transfer over temperature.

Receiver noise immunity is optimized by a proprietary crosstalk elimination filter which eliminates the unneeded high frequency components of the received signal.

#### Timing Recovery Function

The equalized signal is full wave rectified and used to generate information for the timing recovery circuit. This circuit uses a mixed analog/digital technique to provide a low-jitter PLL similar to a tuned tank with excellent jitter tracking ability. But unlike a tuned tank, the free running frequency of the PLL clock is accurately controlled by the external reference crystal. No adjustment is required. Refer to Application Information for crystal specifications.

Recovered clock signals are available on the RCLK pins for applications that require synchronization to the bit stream.

#### TRANSMIT FUNCTION

Recovered data is resynchronized to the recovered clock signal by the timing recovery and transmit control section. The data is then retransmitted to the network via two open-drain, high-voltage transistors.

#### LOOPBACK FUNCTION (LXT313 ONLY)

The LXT313 includes a loopback function for network diagnostics. With the LPBK pin Low, the repeater/transceiver operates in the normal mode. When the LPBK pin is pulled High, the data is looped back from side 1 to side 2.

## APPLICATION INFORMATION

### NOTE

This information is for design aid only.

Figure 2 shows a typical E1 dual repeater/transceiver application circuit using standard repeater/transceiver card edge connections. It includes a jumper-selectable shorting option for the fault location circuitry (dashed lines at connector pins 2 and 7). Table 2 gives the specifications for a typical crystal used with the LXT313 or LXT316 repeater/transceiver.

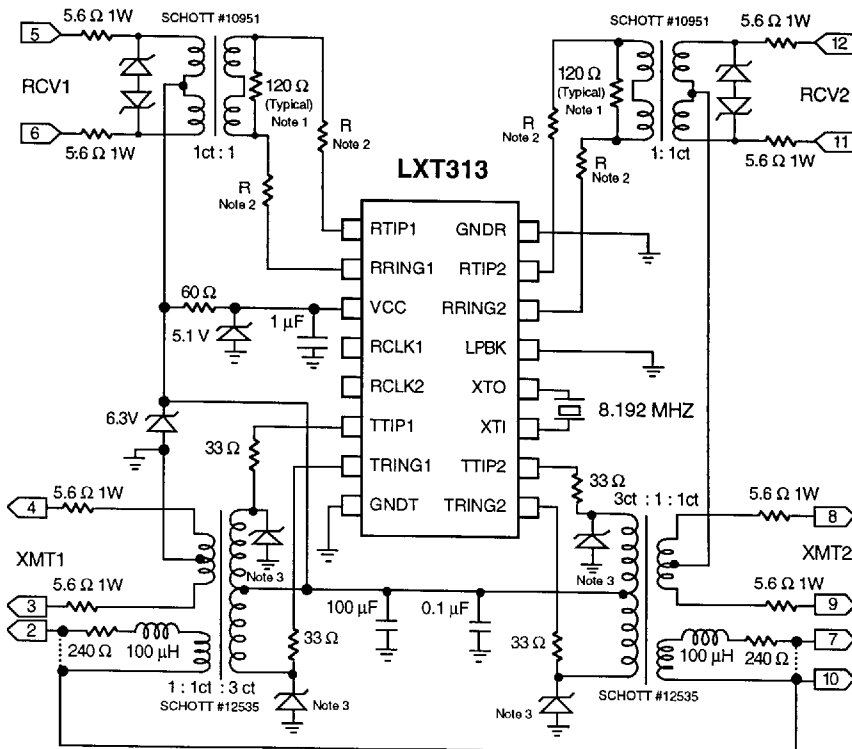
**Table 2: LXT313/316 Crystal Specifications**

| Parameter                        | Specification |
|----------------------------------|---------------|
| Frequency                        | 8.192 MHz     |
| Frequency tolerance <sup>1</sup> | ± 50 ppm      |
| Effective series resistance      | 30 Ω Maximum  |
| Crystal cut                      | AT            |
| Resonance                        | Parallel      |
| Maximum drive level              | 2.0 mW        |
| Mode of operation                | Fundamental   |

1. @ 25 °C, C Load = 10 pF; and from -40 °C to + 85 °C (Ref 25 °C reading)

4

**Figure 2: Typical E1 Dual Repeater/Transceiver Application Diagram**



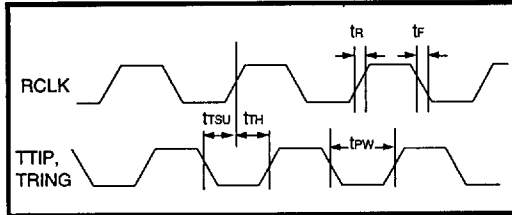
- NOTES:**
1. Check cable impedance required by the approving telecom agency.
  2. RTIP/RRING Resistors are used to provide surge protection. Values can be 0 - 100 Ω.
  3. TTIP/TRING Zeners are used to reduce surge susceptibility. Values can be 12 - 14 V.

## TEST SPECIFICATIONS

### NOTE

Minimum and maximum values in Tables 3 through 5 and Figures 3 through 8 represent the performance specifications of the LXT313/316 repeaters/transceivers and are guaranteed by test except, as noted, by design.

**Figure 3: Digital Timing Characteristics**



**Table 3: Absolute Maximum Ratings**

| Parameter                          | Sym | Value             |
|------------------------------------|-----|-------------------|
| Supply Voltage (min to max)        | VCC | -0.3 V to +6 V    |
| Driver Voltage                     | VOH | 18 V              |
| Receiver Current                   | ICC | 100 mA            |
| Operating temperature (min to max) | TOP | -40 °C to +85 °C  |
| Storage temperature (min to max)   | TST | -65 °C to +150 °C |

### CAUTION

Exceeding these values may cause permanent damage. Functional operation under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

**Table 4: Recommended Operating Conditions (Voltages are with respect to ground.)**

| Parameter             | Symbol | Min  | Typ | Max  | Units |
|-----------------------|--------|------|-----|------|-------|
| Supply voltage        | VCC    | 4.75 | 5.0 | 5.25 | V     |
| Operating temperature | TOP    | -40  | —   | 85   | °C    |

**Table 5: Electrical Characteristics (Over Recommended Range)**

| Parameter   | Symbol             | Min  | Typ <sup>1</sup> | Max  | Units   |
|---|--------------------|------|------------------|------|---------|
| Interference Margin                                   | SNR                | -14  | —                | —    | dB      |
| Receiver Dynamic Range                                | —                  | -43  | —                | 0    | dB      |
| Digital Outputs - Low                                 | (IOL = 1.6 mA)     | VOL  | —                | 0.4  | V       |
|   | (IOL = 10 $\mu$ A) | VOL  | —                | 0.2  | V       |
| Digital Outputs - High                                | (IOH = 0.4 mA)     | VOH  | 2.4              | —    | V       |
|   | (IOH < 10 $\mu$ A) | VOH  | —                | 4.5  | V       |
| Digital Inputs - High                                 | VIH                | 2.0  | —                | —    | V       |
| Digital Inputs - Low                                  | VIL                | —    | —                | 0.8  | V       |
| Supply Current (from VCC supply) <sup>2</sup>         | All zeros          | ICC  | —                | 15   | mA      |
|   | All ones           | ICC  | —                | 25   | mA      |
| Driver Leakage Current (V <sub>DVR</sub> = 18 V)      | ILL                | —    | —                | 100  | $\mu$ A |
| Driver Pulse Amplitude (Driver output Io = 20 mA)     | AP                 | 0.65 | —                | 0.95 | V       |
| Driver Pulse Width                                    | tpw                | 219  | 244              | 269  | ns      |
| Driver Pulse Imbalance                                | —                  | —    | —                | 15   | ns      |
| Rise and Fall Time (any digital output <sup>2</sup> ) | tr / tf            | —    | —                | 25   | ns      |
| Setup Time - TTIP/TRING to RCLK                       | ttsu               | 90   | —                | —    | ns      |
| Hold Time - TTIP/TRING from RCLK                      | tth                | 90   | —                | —    | ns      |

- Typical values are at 25 °C and are for design aid only; not guaranteed and not subject to production testing.
- Measured with CLOAD  $\leq$  10 pF, RLOAD > 100 k $\Omega$ .

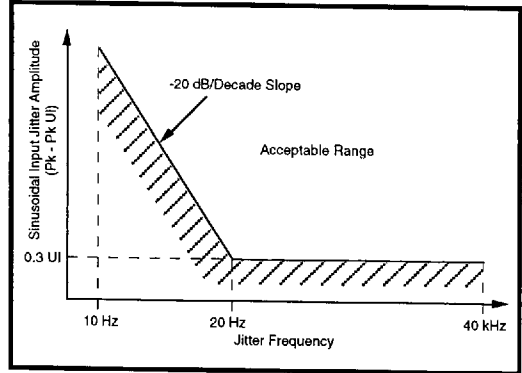
## TEST SETUPS

Both the LXT313 and LXT316 are fully tested (100% AC and DC parameters) using inputs generated by Level One's proprietary transmission line and network simulator. Device testing includes receiver jitter tolerance, jitter transfer and interference margin for line losses from 0 dB to 43 dB @ 1.024 MHz. Specifications and bench test setups are shown in Figures 3 through 7.

### Receiver Jitter Tolerance Testing

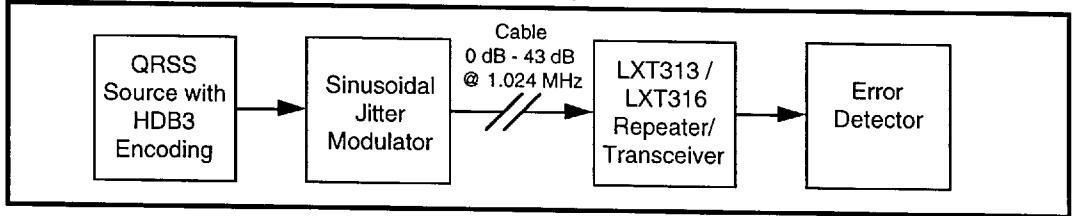
Receiver jitter tolerance meets the template shown in Figure 4, when operated at line losses from 0 to 43 dB. Figure 5 shows the setup used for jitter tolerance testing.

Figure 4: Receiver Jitter Tolerance Template



4

Figure 5: Receiver Jitter Tolerance Test Setup



### Receiver Jitter Transfer Testing

Receiver jitter transfer meets the template shown in Figure 6, when operated with line losses from 0 to 43 dB and input jitter amplitude of 0.15 UI peak-to-peak. Jitter gain at a given frequency is defined as the difference between intrinsic jitter and additive jitter at the measurement frequency, divided by the amplitude of the input jitter. Figure 7 shows the setup used for jitter transfer testing.

Figure 6: Receiver Jitter Transfer Template

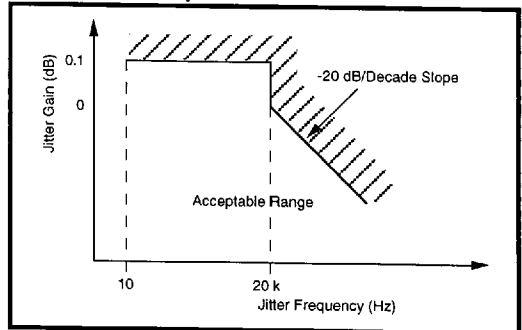
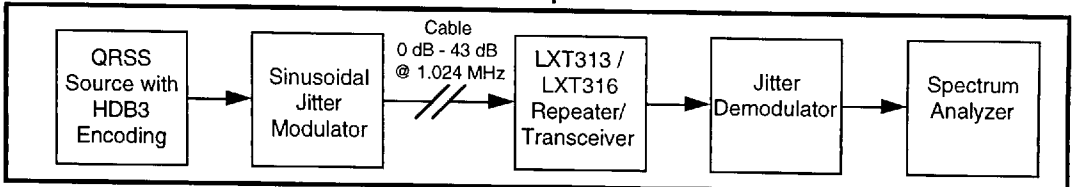


Figure 7: Receiver Jitter Transfer Test Setup



Interference Margin Testing

The LXT313 and LXT316 receiver noise interference margin is specified at a minimum of -14 dB for line losses from 0 dB to 43 dB. The test setup used to measure noise margin is shown in Figure 8.

Figure 8: Receiver Noise Interference Margin Test Setup

