LXT313 / LXT316

Low Power E1 PCM Repeaters

General Description

The LXT313 and LXT316 are integrated repeater circuits for E1 carrier systems. The LXT313 is a dual repeater and the LXT316 is a single repeater. The LXT313 and LXT316 are designed to operate as regenerative repeaters for 2.048 Mbit/s data rate PCM lines. Each includes all circuits required for a regenerative repeater 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 design. Compared with traditional tuned coil-type repeaters, 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 +5V power supply.

Features

- Integrated repeater 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 ceramic DIP

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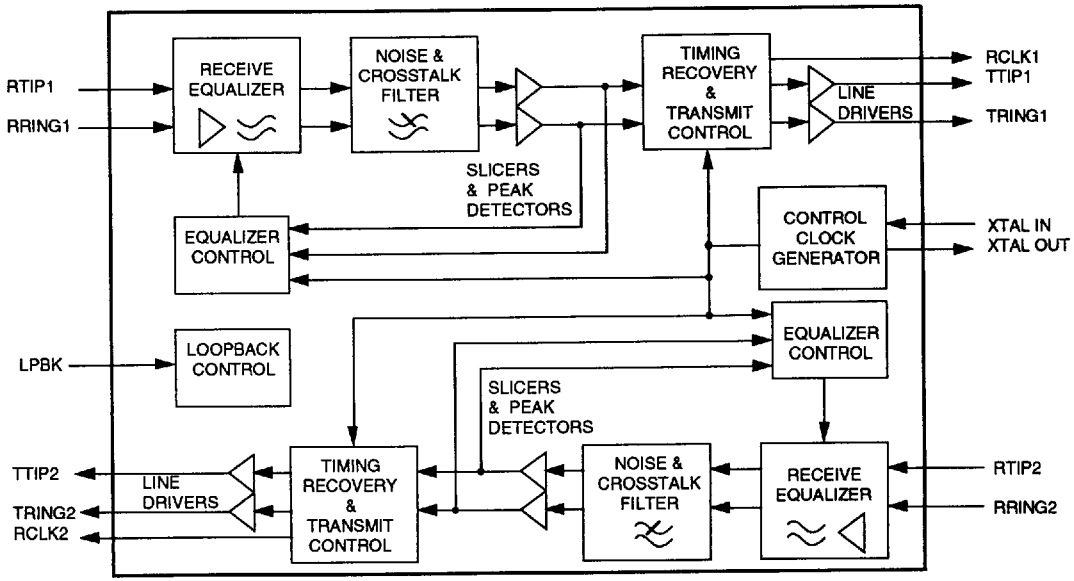
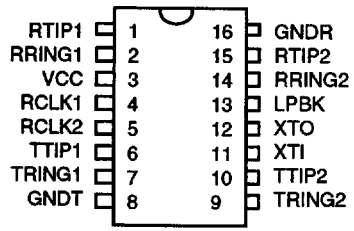
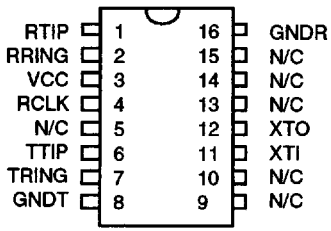
Figure 1: LXT313 Block Diagram





LXT313



LXT316

Pin Descriptions

Pin #	Sym	I/O	Name	Description
1	RTIP1	I	Repeater Tip and	Tip and ring receive inputs for Channel 1.
2	RRING1	I	Ring Inputs	
4	RCLK1	O	Recovered Clock	Clock output recovered from Channel 1 receive input.
6	TTIP1	O	Repeater Tip and	Open drain output drivers for Channel 1.
7	TRING1	O	Ring Outputs	
11	XTI	I	Crystal Oscillator	Either a 8.192 MHz crystal must be connected across these two
12	XTO	O	Input and Output	pins, or a clock must be input at XTI and XTO left floating.
3	VCC	I	Power Supply	Power supply input for all circuits. +5 V (±0.25 V)
8	GNDT	–	Transmit Ground	Ground return for transmit circuits.
16	GNDR	–	Receive Ground	Ground return for receive circuits.
9 [1]	TRING2	O	Repeater Channel 2	On the LXT313 dual repeater, these are open drain output
10 [1]	TTIP2	O	Tip and Ring Outputs	drivers for Channel 2.
14 [1]	RRING2	I	Repeater Channel 2	On the LXT313 dual repeater these are tip and ring receive
15 [1]	RTIP2	I	Ring and Tip Inputs	inputs for Channel 2.
5 [1]	RCLK2	O	Recovered Clock	On the LXT313 dual repeater, this is the recovered clock output for Channel 2.
13 [2]	LPBK	I	Loopback Control	On the LXT313, this pin controls Loopback Selection. High = Loopback side 1 data to side 2. Low = No Loopback.

Notes:
1. On the LXT316 single repeater, these pins are not connected (N/C).
2. On the LXT316 single repeater, this pin must be connected to GND.

Absolute Maximum Ratings*

* 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.

- Supply Voltage V_{CC} -0.3 V to 6 V
- Driver Voltage V_{OH} 18 V
- Receiver Current I_{CC} 100 mA
- Operating temperature T_{OP} -40 °C (min) to +85 °C (max)
- Storage temperature T_{ST} -65 °C (min) to +150 °C (max)

Recommended Operating Conditions (Voltages are with respect to ground unless otherwise specified.)

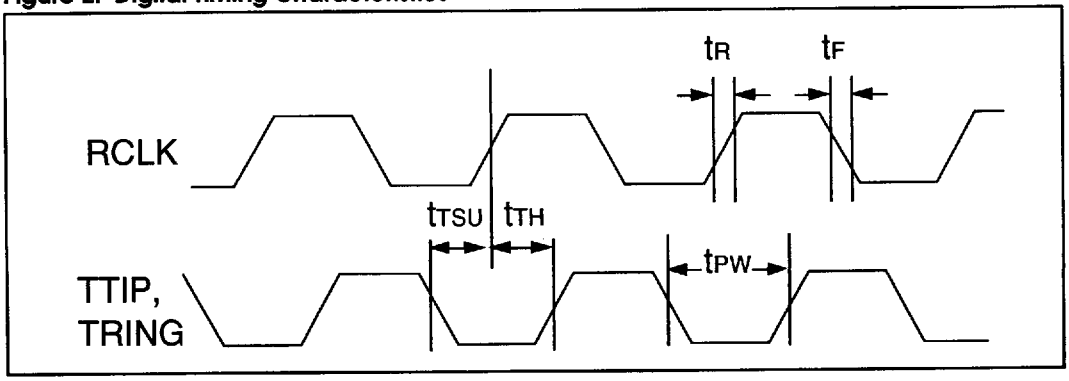
Parameter	Symbol	Min	Typ	Max	Units
Supply voltage	V_{CC}	4.75	5.0	5.25	V
Operating temperature	T_{OP}	-40	–	85	°C

Electrical Characteristics (Ta = -40 to 85 °C, V_{CC} = 5V ±5%)

Parameter		Symbol	Min	Typ[1]	Max	Units
Interference Margin		SNR	-14	–	–	dB
Receiver Dynamic Range		–	-43	–	0	dB
Digital Outputs - Low	(I_{OL} = 1.6 mA)	V_{OL}	–	–	0.4	V
	(I_{OL} = 10 µA)	V_{OL}	–	0.2	–	V
Digital Outputs - High	(I_{OH} = 0.4 mA)	V_{OH}	2.4	–	–	V
	(I_{OH} < 10 µA)	V_{OH}	–	4.5	–	V
Digital Inputs - High		V_{IH}	2.0	–	–	V
Digital Inputs - Low		V_{IL}	–	–	0.8	V
Supply Current	All zeros	I_{CC}	–	15	23	mA
(from VCC supply)[2]	All ones	I_{CC}	–	–	25	mA
Driver Leakage Current (V_{DVR} = 18 V)		I_{LL}	–	–	100	µA
Driver Pulse Amplitude (Driver output I_O = 20 mA)		A_P	0.65	–	0.95	V
Driver Pulse Width		t_{PW}	219	244	269	ns
Driver Pulse Imbalance		–	–	–	15	ns
Rise and Fall Time (any digital output[2])		t_R / t_F	–	–	25	ns
Setup Time - TTIP/TRING to RCLK		t_{TSU}	90	–	–	ns
Hold Time - TTIP/TRING from RCLK		t_{TH}	90	–	–	ns

[1] Typical figures are at 25 °C and are for design aid only; not guaranteed and not subject to production testing.
[2] Measured with $C_{LOAD} \leq 10$ pF, $R_{LOAD} > 100$ kΩ.

Figure 2: Digital Timing Characteristics



General Description

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

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

Functional Description

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 Table 1 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 operates in the normal mode. When the LPBK pin is pulled high, the data is looped back from side 1 to side 2.

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 3, when operated at line losses from 0 to 43 dB. Figure 4 shows the setup used for jitter tolerance testing.

Table 1: LXT313/316 Crystal Specifications

Parameter	Specification
Frequency	8.192 MHz
Frequency [1]	± 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)

Figure 3: Receiver Jitter Tolerance Template

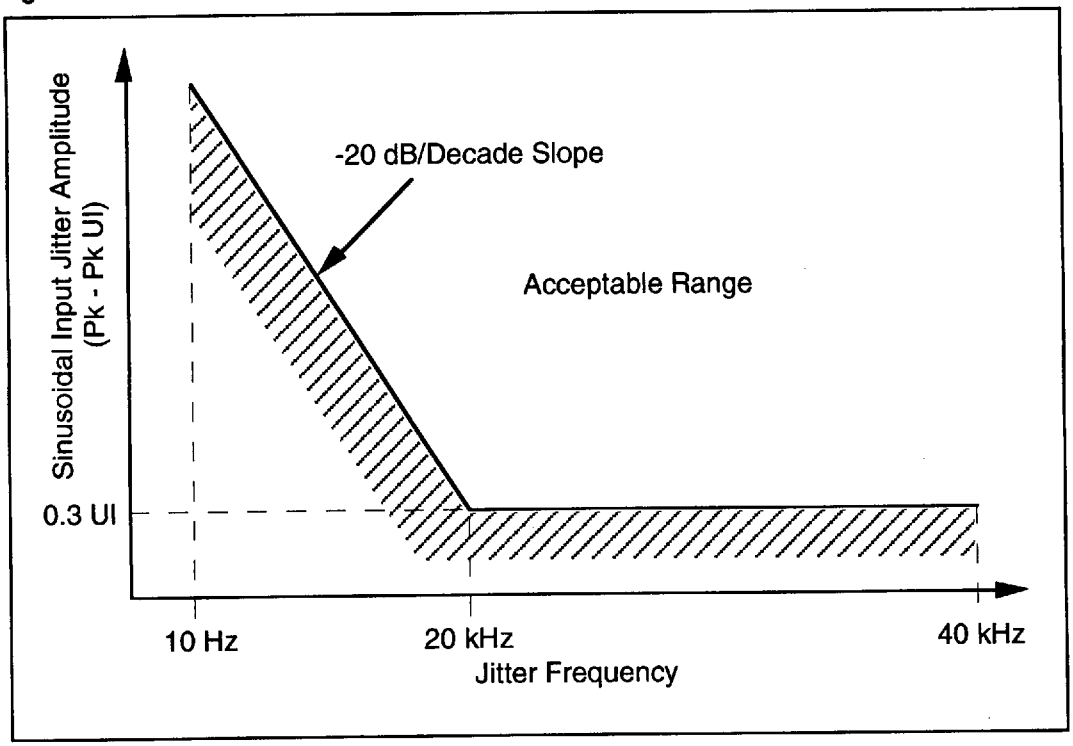
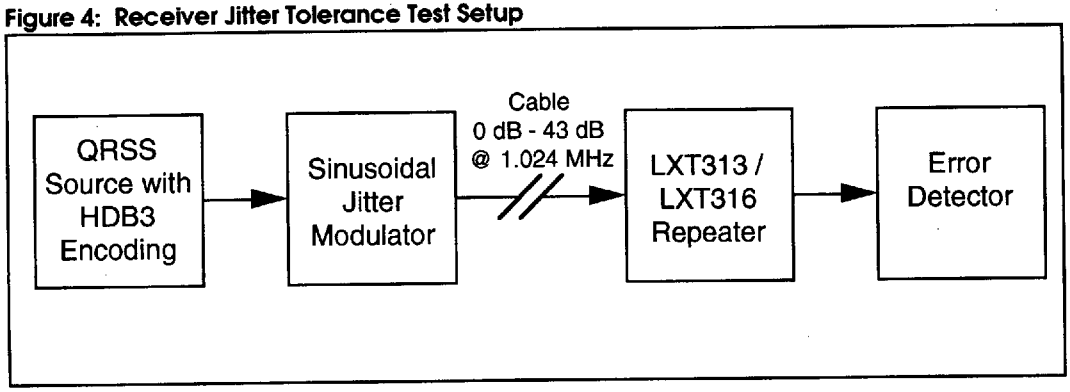


Figure 4: Receiver Jitter Tolerance Test Setup



Receiver Jitter Transfer Testing

Receive jitter transfer meets the template shown in Figure 5, 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 6 shows the setup used for jitter transfer testing.

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 7.

Figure 5: Receiver Jitter Transfer Template

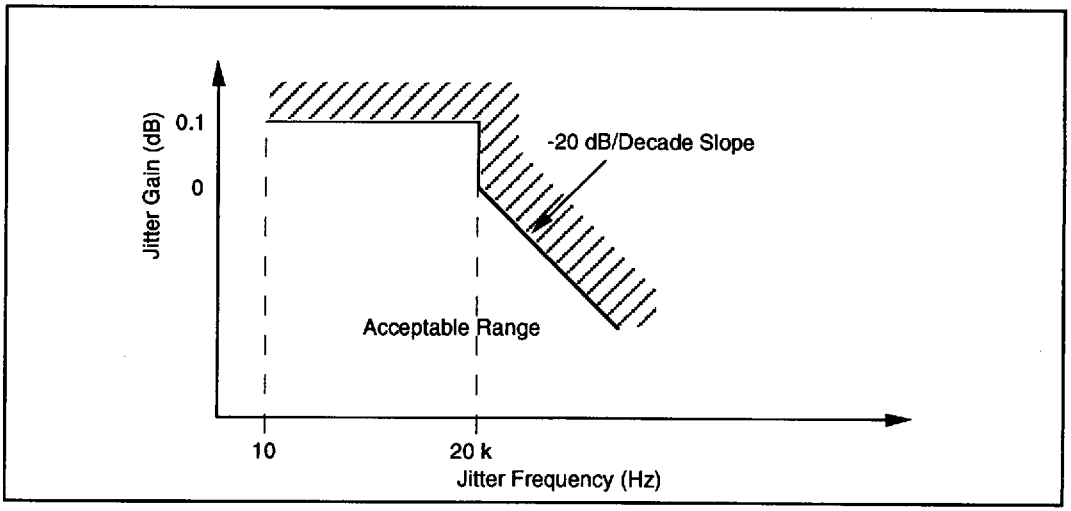


Figure 6: Receiver Jitter Transfer Test Setup

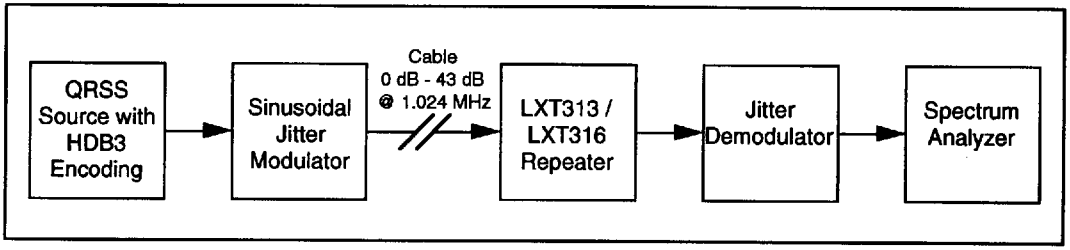
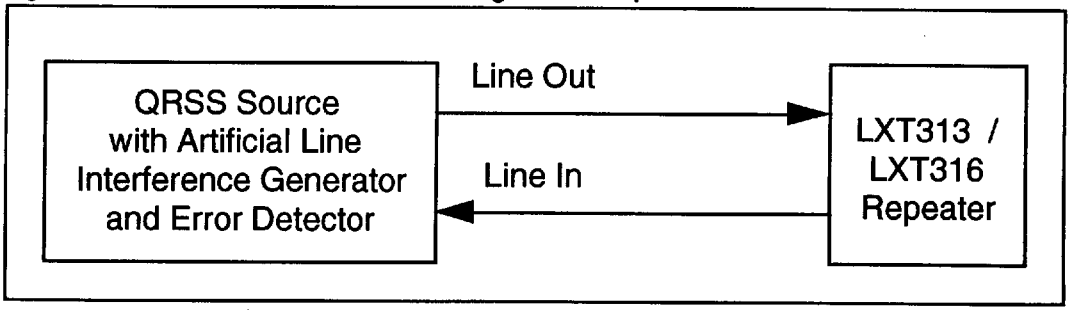


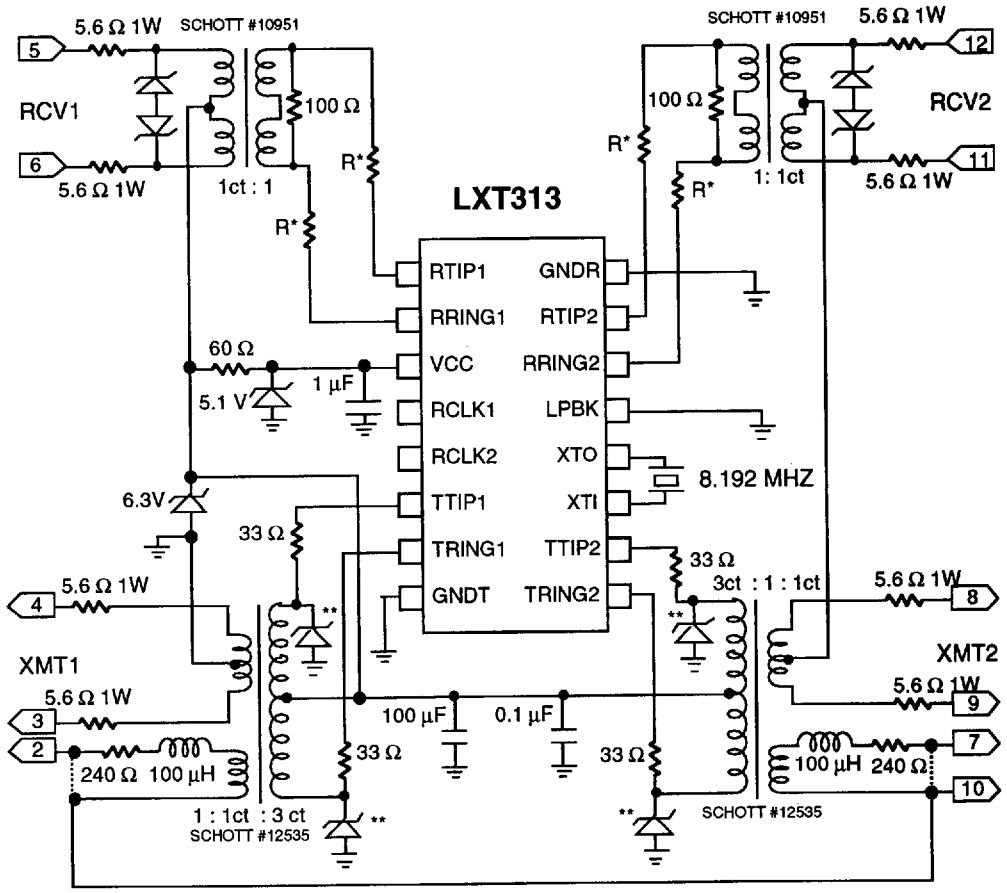
Figure 7: Receiver Noise Interference Margin Test Setup



Applications

Figure 8 is a typical E1 dual repeater application circuit showing standard repeater card edge connections. A jumper selectable shorting option for the fault location circuitry is also shown (dashed lines, connector pins 2 and 7).

Figure 8: Typical E1 Dual Repeater Application Diagram



Notes * RTIP/RRING Resistors are used to provide surge protection.
Values can be 0 - 100 Ω.
** TTIP/TRING Zeners are used to to reduce surge susceptibility.
Values can be 12 - 14 V.