

LXT305A

Integrated T1/E1 Short-Haul Transceiver with Transmit JA

General Description

The LXT305A is a fully integrated transceiver for both North American 1.544 Mbps (T1) and International 2.048 Mbps (E1) applications. Transmit pulse shapes (T1 or E1) are selectable for various line lengths and cable types.

The LXT305A provides transmit jitter attenuation starting at 3 Hz, and is microprocessor controllable through a serial interface. It is especially well suited for applications in which the T1/E1 signals are demultiplexed from a higher rate service such as DS3 or SONET/SDH. This demultiplexing results in a gapped clock which the 305A smooths out.

The LXT305A, an advanced double-poly, double-metal CMOS device, requires only a single 5-volt power supply.

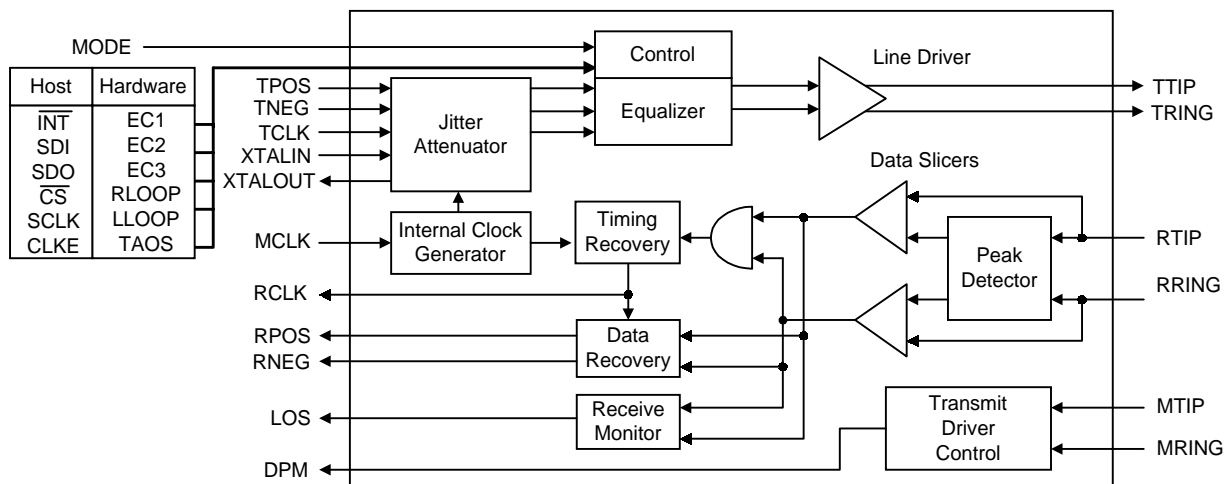
Applications

- SDH / SONET Equipment
- M13 Multiplexers
- Digital microwave Radio
- PCM / Voice Channel Banks
- Data Channel Bank / Concentrator
- T1 / E1 multiplexer
- Digital Access and Cross-connect Systems (DACs)
- Computer to PBX interface (CPI & DMI)
- High-speed data transmission lines
- Interfacing Customer Premises Equipment to a CSU
- Digital Loop Carrier (DLC) terminals

Features

- Low power consumption (400 mW maximum)
- Constant low output impedance transmitter, regardless of data pattern (3 Ω typical)
- High transmit and receive return loss exceeds ETS 300166 and G.703
- Compatible with most popular PCM framers
- Line driver, data recovery and clock recovery functions
- Minimum receive signal of 500 mV
- Selectable slicer levels (T1/E1) improve SNR
- Programmable transmit equalizer shapes pulses to meet DSX-1 pulse template from 0 to 655 ft
- Local and remote loopback functions
- Transmit Driver Performance Monitor (DPM) output
- Receive monitor with analog/digital Loss of Signal (LOS) output per G.775
- Receiver jitter tolerance 0.4 UI from 40 kHz to 100 kHz
- Transmit jitter attenuation starting at 3 Hz
- Serial control interface
- Available in 28-pin DIP and PLCC

LXT305A Block Diagram



PIN ASSIGNMENTS AND SIGNAL DESCRIPTIONS

Figure 1: Pin Assignments

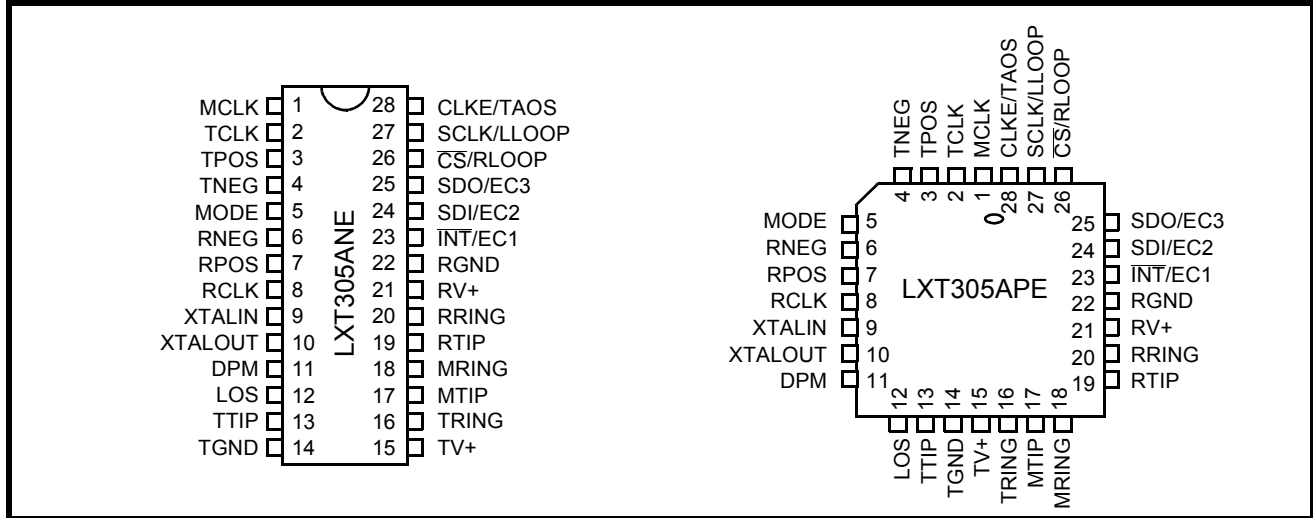


Table 1: Pin Descriptions

| Pin # | Sym | I/O ¹ | Description |
|-------|------|------------------|--|
| 1 | MCLK | DI | Master Clock. A 1.544 or 2.048 MHz clock input used to generate internal clocks. Upon Loss of Signal (LOS), RCLK is derived from MCLK. If MCLK is not applied, this pin should be grounded. |
| 2 | TCLK | DI | Transmit Clock. Transmit clock input. TPOS and TNEG are sampled on the falling edge of TCLK. |
| 3 | TPOS | DI | Transmit Positive Data. Input for positive pulse to be transmitted on the twisted-pair line. |
| 4 | TNEG | DI | Transmit Negative Data. Input for negative pulse to be transmitted on the twisted-pair line. |
| 5 | MODE | DI | Mode Select. Setting MODE High puts the LXT305A in the Host Mode. In the Host Mode, the serial interface is used to control the LXT305A and determine its status. Setting MODE Low puts the LXT305A in the Hardware (H/W) Mode. In the Hardware Mode, the serial interface is disabled and hard-wired pins are used to control configuration and report status. |
| 6 | RNEG | DO | Receive Negative Data; Receive Positive Data. Received data outputs. A signal on RNEG corresponds to receipt of a negative pulse on RTIP and RRING. A signal on RPOS corresponds to receipt of a positive pulse on RTIP and RRING. RNEG and RPOS outputs are Non-Return-to-Zero (NRZ). Both outputs are stable and valid on the rising edge of RCLK. In the Host Mode, CLKE determines the clock edge at which these outputs are stable and valid. In the Hardware Mode both outputs are stable and valid on the rising edge of RCLK. |
| 7 | RPOS | DO | |

1. Entries in I/O column are: DI = Digital Input; DO = Digital Output; AI = Analog Input; AO = Analog Output; S = Supply.

Table 1: Pin Descriptions – continued

| Pin # | Sym | I/O ¹ | Description |
|-------|---------|------------------|--|
| 8 | RCLK | DO | Recovered Clock. This is the clock recovered from the signal received at RTIP and RRING. |
| 9 | XTALIN | AI | Crystal Input; Crystal Output. An external crystal operating at four times the bit rate (6.176 MHz for DSX-1, 8.192 MHz for E1 applications with an 18.7pF load) is required to enable the jitter attenuation function of the LXT305A. These pins may also be used to disable the jitter attenuator by connecting the XTALIN pin to the positive supply through a resistor, and tying the XTALOUT pin to ground. |
| 10 | XTALOUT | AO | |
| 11 | DPM | DO | Driver Performance Monitor. DPM goes High when the transmit monitor loop (MTIP and MRING) does not detect a signal for 63 ± 2 clock periods. DPM remains High until a signal is detected. |
| 12 | LOS | DO | Loss of Signal. LOS goes High when 175 consecutive spaces have been detected. LOS returns Low when the received signal reaches 12.5% ones density (based on 4 ones in any 32-bit period) with no more than 15 consecutive zeros. |
| 13 | TTIP | AO | Transmit Tip; Transmit Ring. Differential Driver Outputs. These low impedance outputs achieve maximum power savings through a 1:1.15 transformer (T1), or a 1:1 (75 Ω) or 1:1.26 (120 Ω) transformer (E1) without additional components. To provide higher return loss, resistors may be used in series with a transformer as specified in Application Information. |
| 16 | TRING | AO | |
| 14 | TGND | S | Transmit Ground. Ground return for the transmit drivers power supply TV+. |
| 15 | TV+ | S | Transmit Power Supply. +5 VDC power supply input for the transmit drivers. TV+ must not vary from RV+ by more than ± 0.3 V. |
| 17 | MTIP | AI | Monitor Tip; Monitor Ring. These pins are used to monitor the tip and ring transmit outputs. The transceiver can be connected to monitor its own output or the output of another LXT305A on the board. Host Mode only: To prevent false interrupts in the Host Mode if the monitor is not used, apply a clock signal to one of the monitor pins and tie the other monitor pin to approximately the clock's mid-level voltage. The monitor clock can range from 100 kHz to the TCLK frequency. |
| 18 | MRING | AI | |
| 19 | RTIP | AI | Receive Tip; Receive Ring. The AMI signal received from the line is applied at these pins. A center-tapped, center-grounded, 2:1 step-up transformer is required on these pins. Data and clock from the signal applied at these pins are recovered and output on the RPOS/RNEG and RCLK pins. |
| 20 | RRING | AI | |
| 21 | RV+ | S | Receive Power Supply. +5 VDC power supply for all circuits except the transmit drivers. (Transmit drivers are supplied by TV+.) |
| 22 | RGND | S | Receive Ground. Ground return for power supply RV+. |

1. Entries in I/O column are: DI = Digital Input; DO = Digital Output; AI = Analog Input; AO = Analog Output; S = Supply.

Table 1: Pin Descriptions – continued

| Pin # | Sym | I/O ¹ | Description |
|-------|------------------------|------------------|--|
| 23 | INT | DO | Interrupt (Host Mode). This LXT305A Host Mode output goes Low to flag the host processor when LOS or DPM go active. $\overline{\text{INT}}$ is an open-drain output and should be tied to power supply RV+ through a resistor. $\overline{\text{INT}}$ is reset by clearing the respective register bit (LOS and/or DPM). |
| | EC1 | DI | Equalizer Control 1 (H/W Mode). The signal applied at this pin in the LXT305A Hardware Mode is used in conjunction with EC2 and EC3 inputs to determine shape and amplitude of AMI output transmit pulses. |
| 24 | SDI | DI | Serial Data In (Host Mode). The serial data input stream is applied to this pin when the LXT305A operates in the Host Mode. SDI is sampled on the rising edge of SCLK. |
| | EC2 | DI | Equalizer Control 2 (H/W Mode). The signal applied at this pin in the LXT305A Hardware Mode is used in conjunction with EC1 and EC3 inputs to determine shape and amplitude of AMI output transmit pulses. |
| 25 | SDO | DO | Serial Data Out (Host Mode). The serial data from the on-chip register is output on this pin in the LXT305A Host Mode. If CLKE is High, SDO is valid on the rising edge of SCLK. If CLKE is Low SDO is valid on the falling edge of SCLK. This pin goes to a high-impedance state when the serial port is being written to and when $\overline{\text{CS}}$ is High. |
| | EC3 | DI | Equalizer Control 3 (H/W Mode). The signal applied at this pin in the LXT305A Hardware Mode is used in conjunction with EC1 and EC2 inputs to determine shape and amplitude of AMI output transmit pulses. |
| 26 | $\overline{\text{CS}}$ | DI | Chip Select (Host Mode). This input is used to access the serial interface in the LXT305A Host Mode. For each read or write operation, $\overline{\text{CS}}$ must transition from High to Low, and remain Low. |
| | RLOOP | DI | Remote Loopback (H/W Mode). This input controls loopback functions in the LXT305A Hardware Mode. Setting RLOOP High enables the Remote Loopback Mode. Setting both RLOOP and LLOOP High causes a Reset. |
| 27 | SCLK | DI | Serial Clock (Host Mode). This clock is used in the LXT305A Host Mode to write data to or read data from the serial interface registers. |
| | LLOOP | DI | Local Loopback (H/W Mode). This input controls loopback functions in the LXT305A Hardware Mode. Setting LLOOP High enables the Local Loopback Mode. |
| 28 | CLKE | DI | Clock Edge (Host Mode). Setting CLKE High causes RPOS and RNEG to be valid on the falling edge of RCLK, and SDO to be valid on the rising edge of SCLK. When CLKE is Low, RPOS and RNEG are valid on the rising edge of RCLK, and SDO is valid on the falling edge of SCLK. |
| | TAOS | DI | Transmit All Ones (H/W Mode). When set High, TAOS causes the LXT305A (Hardware Mode) to transmit a continuous stream of marks at the MCLK frequency. Activating TAOS causes TPOS and TNEG inputs to be ignored. TAOS is inhibited during Remote Loopback. |

1. Entries in I/O column are: DI = Digital Input; DO = Digital Output; AI = Analog Input; AO = Analog Output; S = Supply.

FUNCTIONAL DESCRIPTION

The LXT305A is a fully integrated PCM transceiver for both 1.544 Mbps (DSX-1) and 2.048 Mbps (E1) applications. It allows full-duplex transmission of digital data over existing twisted-pair installations.

The first page of this data sheet shows a simplified block diagram of the LXT305A. The LXT305A transceiver interfaces with two twisted-pair lines (one twisted-pair for transmit, one twisted-pair for receive) through standard pulse transformers and appropriate resistors.

Power Requirements

The LXT305A is a low-power CMOS device. It operates from a single +5 V power supply which can be connected externally to both the transmitter and receiver. However, the two inputs must be within $\pm .3V$ of each other, and decoupled to their respective grounds separately. Refer to Application Information for typical decoupling circuitry. Isolation between the transmit and receive circuits is provided internally.

The transmitter powers down to conserve power when the required clock input is not supplied. The LXT305A enters the power down mode during normal operation and local loopback if TCLK is not supplied, and during TAOS if MCLK is not supplied.

Reset Operation

Upon power up, the transceiver is held static until the power supply reaches approximately 3 V. Upon crossing this threshold, the device begins a 32 ms reset cycle to calibrate the transmit and receive delay lines and lock the Phase Lock Loop to the receive line. A reference clock is required to calibrate the delay lines. MCLK provides the receiver reference. The crystal oscillator provides the transmitter reference. If the crystal oscillator is grounded, MCLK is used as the transmitter reference clock.

The transceiver can also be reset from the Host or Hardware Mode. In Host Mode, reset is commanded by simultaneously writing RLOOP and LLOOP to the register. In Hardware Mode, reset is commanded by holding RLOOP and LLOOP High simultaneously for 200 ns. Reset is initiated on the falling edge of the reset request. In either mode, reset clears and sets all registers to 0 and then begins calibration.

Receiver

The LXT305A receives the signal input from one twisted-pair line on each side of a center-grounded transformer. Positive pulses are received at RTIP and negative pulses are received at RRING. Recovered data is output at RPOS and RNEG, and the recovered clock is output at RCLK. Refer to Test Specifications for LXT305A receiver timing.

The signal received at RPOS and RNEG is processed through the peak detector and data slicers. The peak detector samples the inputs and determines the maximum value of the received signal. A percentage of the peak value is provided to the data slicers as a threshold level to ensure optimum signal-to-noise ratio. For T1 applications (determined by Equalizer Control inputs EC1 - EC3 \neq 000 or 001) the threshold is set to 70% of the peak value. This threshold is maintained above 65% for up to 15 successive zeros over the range of specified operating conditions. For E1 applications (EC inputs = 000 or 001) the threshold is 50%.

The receiver is capable of accurately recovering signals with up to -13.6 dB of attenuation (from 2.4 V), corresponding to a received signal level of approximately 500 mV. Maximum line length is 1500 feet of ABAM cable (approximately 6 dB of attenuation). Regardless of received signal level, the peak detectors are held above a minimum level of .3 V to provide immunity from impulsive noise.

After processing through the data slicers, the received signal is routed to the data and clock recovery sections, and to the receive monitor. The data and clock recovery circuits are highly tolerant with an input jitter tolerance significantly better than required by Pub 62411. Refer to Test Specifications for additional information.

The receiver monitor loads a digital counter at the RCLK frequency. The count is incremented each time a zero is received, and reset to zero each time a one (mark) is received. Upon receipt of 175 consecutive zeros the LOS pin goes High, and a smooth transition replaces the RCLK output with the MCLK. Received marks are output regardless of the LOS status, but the LOS pin will not reset until the ones density reaches 12.5%. This level is based on receipt of at least 4 ones in any 32-bit period with no more than 15 consecutive zeros.

Transmitter

Data received for transmission onto the line is clocked serially into the device at TPOS and TNEG. Input synchronization is supplied by the transmit clock (TCLK). The transmitted pulse shape is determined by Equalizer Control signals EC1 through EC3 as shown in Table 4. Refer to Test Specifications for master and transmit clock timing characteristics. Shaped pulses are applied to the AMI line driver for transmission onto the line at TTIP and TRING. Equalizer Control signals may be hardwired in the Hardware Mode, or input as part of the serial data stream (SDI) in the Host Mode

Pulses can be shaped for either 1.544 or 2.048 Mbps applications. 1.544 Mbps pulses for DSX-1 applications can be programmed to match line lengths from 0 to 655 feet of ABAM cable. The LXT305A also matches FCC and EISA specifications for CSU applications. 2.048 Mbps pulses can drive coaxial or shielded twisted-pair lines.

Jitter Attenuation

Jitter attenuation of the LXT305A transmit outputs is provided by a Jitter Attenuation Loop (JAL) and an Elastic Store (ES). An external crystal oscillating at 4 times the bit rate provides clock stabilization. Refer to Application Information for crystal specifications. The ES is a 32 x 2-bit register. Transmit data is clocked into the ES with the transmit clock (TCLK) signal, and clocked out of the ES with the dejittered clock from the JAL. When the bit count in the ES is within two bits of overflowing or underflowing, the ES adjusts the output clock by 1/8 of a bit period. The ES produces an average delay of 16 bits in the receive path.

Driver Performance Monitor

The transceiver incorporates a Driver Performance Monitor (DPM) in parallel with TTIP and TRING at the output transformer. The DPM output goes High upon detection of 63 consecutive zeros. It is reset when a one is detected on the transmit line, or when a reset command is received.

Line Code

The LXT305A transmits data as a 50% AMI line code as shown in Figure 2. The output driver maintains a constant low output impedance regardless of whether it is driving marks or spaces. This well controlled output impedance provides excellent return loss (> 18 dB) when used with external 9.1 " precision ($\pm 1\%$ accuracy) in series with a transmit transformer with a turns ratio of 1:2.3 ($\pm 2\%$ accu-

racy). Series resistors also provide increased surge protection and reduced short circuit current flow.

Figure 2: 50% AMI Coding

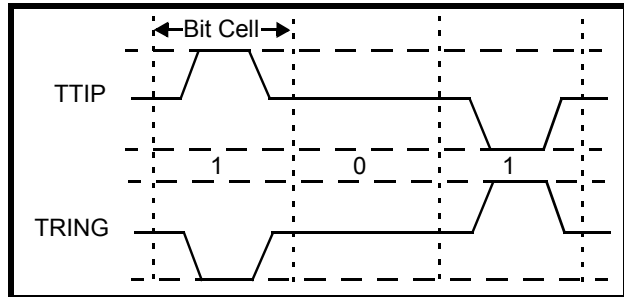


Table 2: LXT305A Serial Data Output Bits (See Figure 4)

| Bit D5 | Bit D6 | Bit D7 | Status |
|--------|--------|--------|--|
| 0 | 0 | 0 | Reset has occurred, or no program input. |
| 0 | 0 | 1 | TAOS is active. |
| 0 | 1 | 0 | Local Loopback is active. |
| 0 | 1 | 1 | TAOS and Local Loopback are active. |
| 1 | 0 | 0 | Remote Loopback is active. |
| 1 | 0 | 1 | DPM has changed state since last Clear DPM occurred. |
| 1 | 1 | 0 | LOS has changed state since last Clear LOS occurred. |
| 1 | 1 | 1 | LOS and DPM have both changed state since last Clear DPM and Clear LOS occurred. |

Operating Modes

The LXT305A can be controlled through hard-wired pins (Hardware Mode) or by a microprocessor through a serial interface (Host Mode). The mode of operation is set by the MODE pin logic level. The LXT305A can also be commanded to operate in one of several diagnostic modes.

Host Mode Operation

To allow a host microprocessor to access and control the LXT305A through the serial interface, MODE is set High.

The serial interface (SDI/SDO) uses a 16-bit word consisting of an 8-bit Command/Address byte and an 8-bit Data byte. Figure 3 shows the serial interface data structure and relative timing.

The Host Mode provides a latched Interrupt output (INT) which is triggered by a change in the Loss of Signal (LOS) and/or Driver Performance Monitor (DPM) bits. The Interrupt is cleared when the interrupt condition no longer exists, and the host processor enables the respective bit in the serial input data byte. Host Mode also allows control of

the serial data and receive data output timing. The Clock Edge (CLKE) signal determines when these outputs are valid, relative to the Serial Clock (SCLK) or RCLK as listed in Table 3.

Table 3: Valid CLKE Settings

| CLKE | Output | Clock | Valid Edge |
|------|---------------------|----------------------|------------------------------|
| Low | RPOS RNEG SDO | RCLK RCLK SCLK | Rising Rising Falling |
| High | RPOS RNEG SDO | RCLK RCLK SCLK | Falling Falling Rising |

Figure 3: LXT305A Serial Interface Data Structure

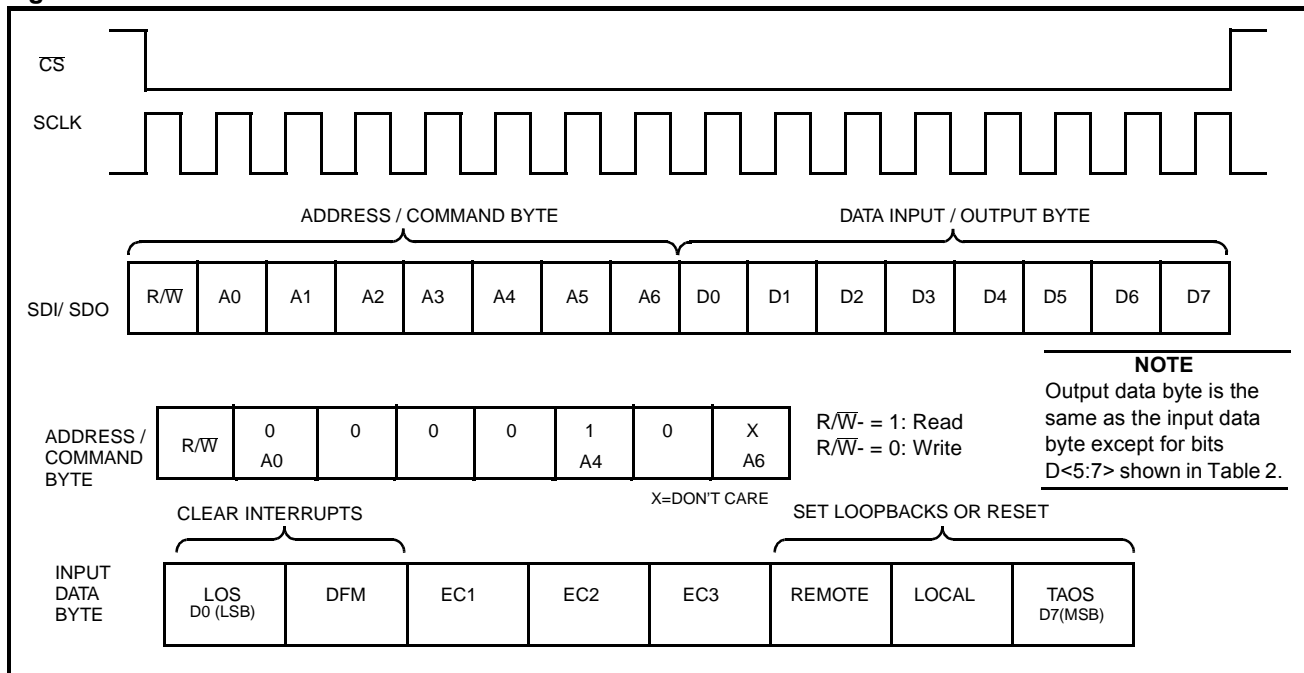


Table 4: Equalizer Control Inputs

| EC3 | EC2 | EC1 | Line Length ¹ | Cable Loss ² | Application | Bit Rate |
|-----|-----|-----|--------------------------|-------------------------|---------------------------|------------|
| 0 | 1 | 1 | 0 ~ 133 ft ABAM | 0.6 dB | DSX-1 | 1.544 Mbps |
| 1 | 0 | 0 | 133 ~ 266 ft ABAM | 1.2 dB | | |
| 1 | 0 | 1 | 266 ~ 399 ft ABAM | 1.8 dB | | |
| 1 | 1 | 0 | 399 ~ 533 ft ABAM | 2.4 dB | | |
| 1 | 1 | 1 | 533 ~ 655 ft ABAM | 3.0 dB | | |
| 0 | 0 | 0 | ITU Recommendation G.703 | | E1 - Coax (75 Ω) | 2.048 Mbps |
| 0 | 0 | 1 | | | E1 - Twisted-pair (120 Ω) | |
| 0 | 1 | 0 | FCC Part 68, Option A | | CSU (DS-1) | 1.544 Mbps |

The LXT305A serial port is addressed by setting bit A4 in the Address/Command byte, corresponding to address 16. The LXT305A contains only a single output data register so no complex chip addressing scheme is required. The register is accessed by causing the Chip Select (CS) input to transition from High to Low. Bit 1 of the serial Address/Command byte provides Read/Write control when the chip is accessed. A logic 1 indicates a read operation, and a logic 0 indicates a write operation. Table 2 lists serial data output bit combinations for each status. Serial data I/O timing characteristics are shown in the Test Specifications section.

Hardware Mode Operation

In Hardware Mode the transceiver is accessed and controlled through individual pins. With the exception of the INT and CLKE functions, Hardware Mode provides all the functions provided in the Host Mode. In the Hardware Mode RPOS and RNEG outputs are valid on the rising edge of RCLK.

To operate in Hardware Mode, MODE must be set Low. Equalizer Control signals (EC1 through EC3) are input on the Interrupt, Serial Data In and Serial Data Out pins. Diagnostic control for Remote Loopback (RLOOP), Local Loopback (LLOOP), and Transmit All Ones (TAOS) modes is provided through the individual pins used to control serial interface timing in the Host Mode.

Diagnostic Mode Operation

Transmit All Ones

In Transmit All Ones (TAOS) Mode the TPOS and TNEG inputs to the transceiver are ignored. The transceiver transmits a continuous stream of ones when the TAOS mode is activated. TAOS can be commanded simultaneously with Local Loopback, but is inhibited during Remote Loopback. During TAOS, the transmitter is locked to MCLK. If MCLK is not supplied, the transmitter powers down.

Remote Loopback

In Remote Loopback (RLOOP) Mode, the transmit data and clock inputs (TPOS, TNEG and TCLK) are ignored. The RPOS and RNEG outputs are looped back through the transmit circuits and output on TTIP and TRING at the RCLK frequency. Receiver circuits are unaffected by the RLOOP command and continue to output the RPOS, RNEG and RCLK signals received from the twisted-pair line.

Local Loopback

In Local Loopback (LLOOP) Mode, the receiver circuits are inhibited. The transmit data and clock inputs (TPOS, TNEG and TCLK) are looped back onto the receive data and clock outputs (RPOS, RNEG and RCLK). The transmitter circuits are unaffected by the LLOOP command. The TPOS and TNEG inputs (or a stream of ones if the TAOS command is active) will be transmitted normally. During local loopback if TCLK is not supplied, the transmitter powers down. If LOS and LLOOP are both active, LLOOP takes precedence, forcing RCLK = TCLK.

Table 5: LXT305A Crystal Specifications (External)

| Parameter | T1 | E1 |
|-----------------------------|--|--|
| Frequency | 6.176 MHz | 8.192 MHz |
| Frequency stability | ± 20 ppm @ 25 °C ± 25 ppm from -40 °C to 85 °C (Ref 25 °C reading) | ± 20 ppm @ 25 °C ± 25 ppm from -40 °C to 85 °C (Ref 25 °C reading) |
| Pullability | CL = 11 pF to 18.7 pF, +ΔF = 175 to 195 ppm CL = 18.7 pF to 34 pF, -ΔF = 175 to 195 ppm | CL = 11 pF to 18.7 pF, +ΔF = 95 to 115 ppm CL = 18.7 pF to 34 pF, -ΔF = 95 to 115 ppm |
| Effective series resistance | 40 Ω Maximum | 30 Ω Maximum |
| Crystal cut | AT | AT |
| Resonance | Parallel | Parallel |
| Maximum drive level | 2.0 mW | 2.0 mW |
| Mode of operation | Fundamental | Fundamental |
| Crystal holder | HC49 (R3W), C ₀ = 7 pF maximum C _M = 17 fF typical | HC49 (R3W), C ₀ = 7 pF maximum C _M = 17 fF typical |

APPLICATION INFORMATION

1.544 Mbps T1 Interface Applications

Figure 4 is a typical 1.544 Mbps T1 interface application. Use a 1:1.15 transmit transformer without in-line resistors for maximum power savings. The LXT305A is shown in the Host Mode with a T1/ESF Framer providing the digital interface with the host controller. An LXP600A Clock Adapter (CLAD) provides the 2.048 MHz system backplane clock, locked to the recovered 1.544 MHz clock signal. The power supply inputs are tied to a common bus with appropriate decoupling capacitors installed (68 μ F on the transmit side, 1.0 μ F and 0.1 μ F on the receive side).

For DSX-1 applications, series resistors can be used in line with the transmit transformer to provide higher return loss.

2.048 Mbps E1 Interface Applications

Figure 5 is a typical 2.048 Mbps E1 application. The LXT305A is shown in Hardware Mode with an E1/CRC4 Framer. As in the DSX-1 application Figure 4, this configuration is illustrated with a crystal in place to enable the LXT305A Jitter Attenuation Loop, and a single power supply bus. The hard-wired control lines for TAOS, LLOOP and RLOOP are individually controllable, and the LLOOP and RLOOP lines are also tied to a single control for the Reset function. With the 1:1 transformer ratio and code 000 selected on the EC inputs, the LXT305A outputs the ITU specified 2.37 V pulse onto 75 " coaxial cable. Simply changing the EC code to 001 allows the LXT305A to match the 3.0 V pulse specification for 120 " shielded twisted-pair cable. No transformer change is required. For situations where a 1:1.26 transformer is desired, EC code 000 selects the correct output for 120 " twisted-pair cable.

To achieve higher return loss, increased surge protection and lower output short circuit current, series resistors can be used in line with the transmit transformer.

Table 6: T1/E1 Input/Output Configurations

| Bit Rate (Mbps) | Crystal XTAL | Cable (Ω) | Rr ² (Ω) | EC3/2/1 | Transmit Transformer ¹ (Tr) | Rt ² (Ω) | Typical TX Return Loss ³ (dB) | Cc (μ F) |
|-----------------|--------------|--------------------|------------------------------|---------------|--|------------------------------|--|---------------|
| 1.544 (T1) | LXC6176 | 100 | 200 | 0/1/1 - 1/1/1 | 1:1.15 | 0 | 0.5 | 0.47 |
| | | | | | 1:2 | 9.1 | 18 | 0 |
| | | | | | 1:2.3 | 9.1 | 18 | 0 |
| 2.048 (E1) | LXC8192 | 120 | 240 | 0/0/0 | 1:1.26 | 0 | 0.5 | 0.47 |
| | | | | 0/0/0 | 1:2 | 9.1 | 12 | 0 |
| | | | | 0/0/1 | 1:1 | 0 | 0.5 | 0.47 |
| | | | | 0/0/1 | 1:2 | 15 | 18 | 0 |
| | | 75 | 150 | 0/0/0 | 1:1 | 0 | 0.5 | 0.47 |
| | | | | 0/0/0 | 1:2 | 9.1 | 18 | 0 |
| | | 0/0/1 | 1:1 | 10 | 5 | 0 | | |
| | | 0/0/1 | 1:2 | 14.3 | 10 | 0 | | |

1. Transformer turns ratio accuracy is $\pm 2\%$.
 2. Rr and Rt values are $\pm 1\%$.
 3. Typical return loss, 51 kHz to 3.072 MHz band.

Figure 4: Typical LXT305A 1.544 Mbps T1 Application (Host Mode)

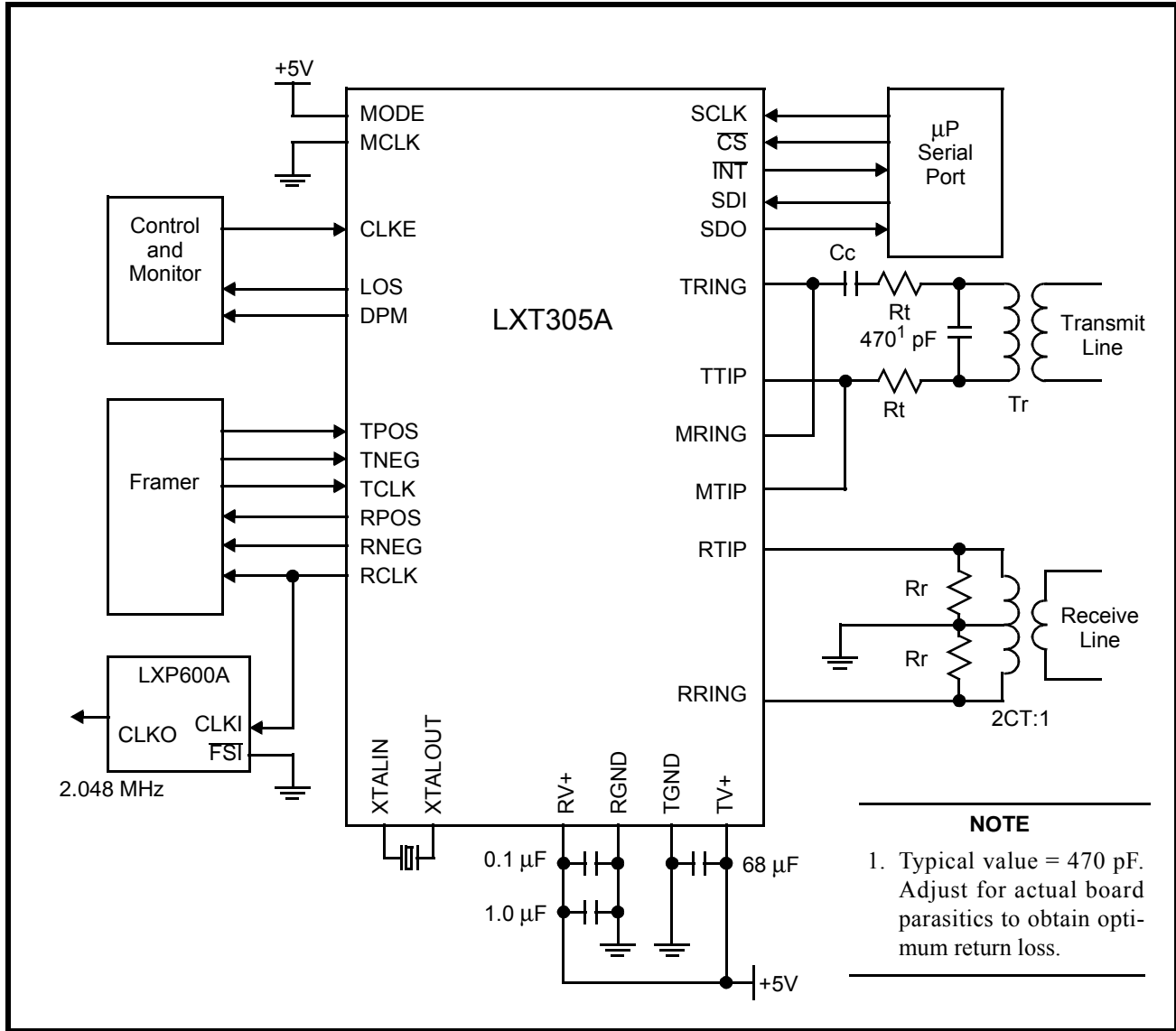
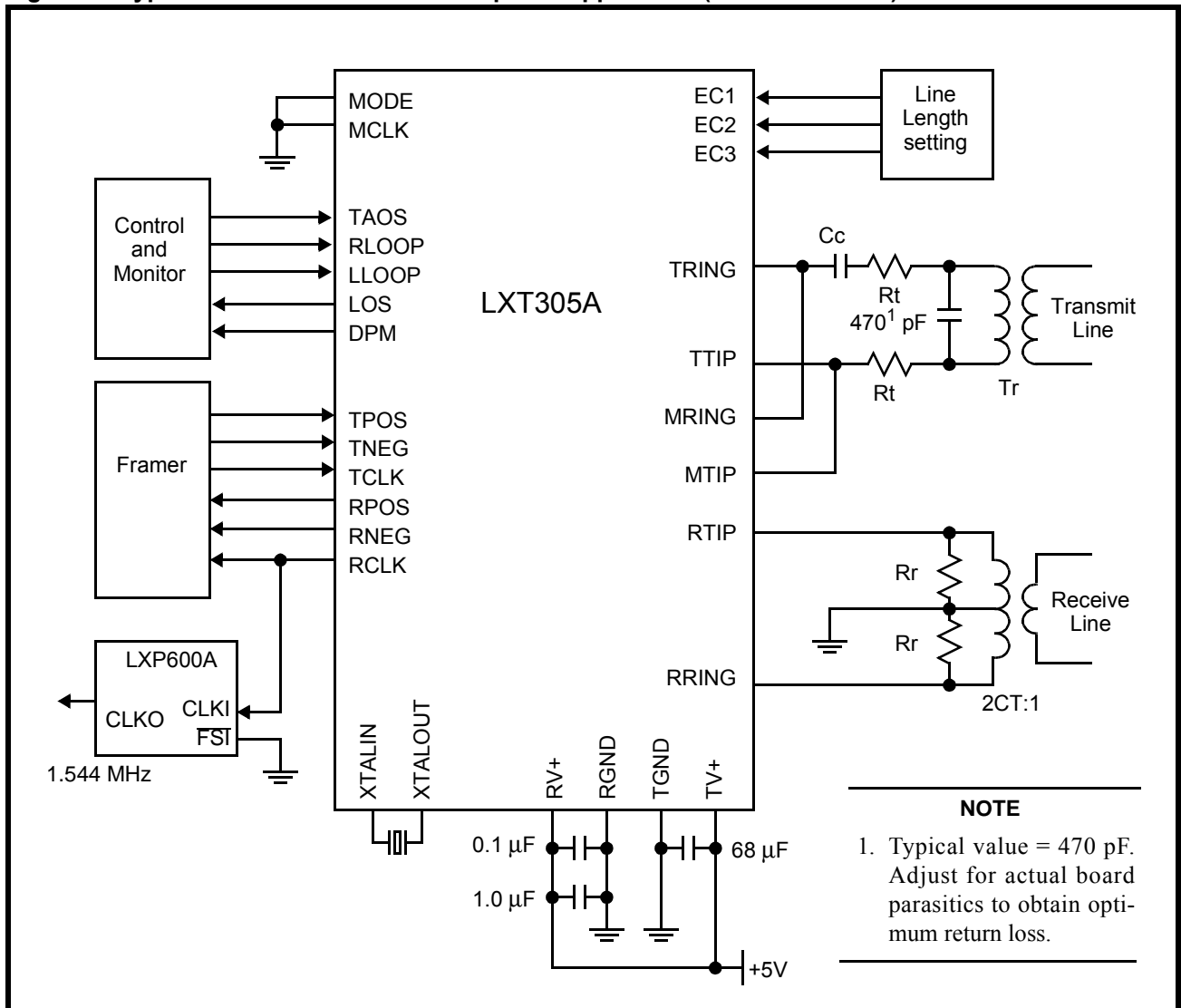


Figure 5: Typical LXT305A 120 Ω 2.048 Mbps E1 Application (Hardware Mode)



TEST SPECIFICATIONS

NOTE

The minimum and maximum values in Tables 7 through 13 and Figures 6 through 11 represent the performance specifications of the LXT305A and are guaranteed by test, except where noted by design.

Table 7: Absolute Maximum Ratings

| Parameter | Sym | Min | Max | Units |
|-------------------------------------|------------------|------------|-----------|-------|
| DC supply (referenced to GND) | RV+, TV+ | -0.3 | 6.0 | V |
| Input voltage, any pin ¹ | V _{IN} | RGND - 0.3 | RV+ + 0.3 | V |
| Input current, any pin ² | I _{IN} | -10 | 10 | mA |
| Storage temperature | T _{STG} | -65 | 150 | °C |

CAUTION
Operations at or beyond these limits may result in permanent damage to the device.
Normal operation is not guaranteed at these extremes.

1. Excluding RTIP and RRING which must stay between -6V and (RV+ + 0.3) V.
2. Transient currents of up to 100 mA will not cause SCR latch up. TTIP, TRING, TV+ and TGND can withstand a continuous current of 100 mA.

Table 8: Recommended Operating Conditions and Characteristics

| Parameter | Sym | Min | Typ | Max | Units |
|-------------------------------|----------------|------|-----|------|-------|
| DC supply ¹ | RV+, TV+ | 4.75 | 5.0 | 5.25 | V |
| Ambient operating temperature | T _A | -40 | 25 | 85 | °C |

1. TV+ must not exceed RV+ by more than 0.3 V.

Table 9: Electrical Characteristics (Under Recommended Operating Conditions)

| Parameter | Sym | Min | Max | Units | Test Conditions |
|---|-----------------|-----|-----|-------|--|
| Total power dissipation ¹ | P _D | – | 400 | mW | 100% ones density & maximum line length @ 5.25 V |
| High level input voltage ^{2,3} (pins 1-5, 10, 23-28) | V _{IH} | 2.0 | – | V | |
| Low level input voltage ^{2,3} (pins 1-5, 10, 23-28) | V _{IL} | – | 0.8 | V | |
| High level output voltage ^{2,3} (pins 6-8, 11, 12, 23, 25) | V _{OH} | 2.4 | – | V | I _{OUT} = -400 μA |
| Low level output voltage ^{2,3} (pins 6-8, 11, 12, 23, 25) | V _{OL} | – | 0.4 | V | I _{OUT} = 1.6 mA |
| Input leakage current ⁴ | I _{LL} | 0 | ±10 | μA | |
| Three-state leakage current ² (pin 25) | I _{3L} | 0 | ±10 | μA | |

1. Power dissipation while driving 75 Ω load over operating temperature range. Includes device and load. Digital input levels are within 10% of the supply rails and digital outputs are driving a 50 pF capacitive load.
2. Functionality of pins 23 and 25 depends on mode. See Host/Hardware Mode descriptions.
3. Output drivers will output CMOS logic levels into CMOS loads.
4. Except MTIP and MRING I_{II} = ± 50 μA.

Table 10: Analog Characteristics (Under Recommended Operating Conditions)

| Parameter | | Min | Typ ¹ | Max | Units | Test Conditions |
|--|-----------------------|-------------------------|------------------|------------------------|------------|-----------------------|
| AMI output pulse amplitudes | DSX-1 | 2.4 | 3.0 | 3.6 | V | measured at the DSX |
| | E1 | 2.7 | 3.0 | 3.3 | V | measured at line side |
| Recommended output load at TTIP and TRING | | – | 75 | – | Ω | |
| Jitter added by the transmitter ² | 10 Hz - 8 kHz | – | – | 0.01 | UI | |
| | 8 kHz - 40 kHz | – | – | 0.025 | UI | |
| | 10 Hz - 40 kHz | – | – | 0.025 | UI | |
| | Broad Band | – | – | 0.05 | UI | |
| Sensitivity below DSX (0 dB = 2.4 V) | | 13.6 | – | – | dB | |
| | | 500 | – | – | mV | |
| Loss of Signal threshold | | – | 0.3 | – | V | |
| Data decision threshold | DSX-1 | 63 | 70 | 77 | % peak | |
| | E1 | 43 | 50 | 57 | % peak | |
| Allowable consecutive zeros before LOS | | 160 | 175 | 190 | – | |
| Input jitter tolerance | 10 kHz - 100 kHz | 0.4 | – | – | UI | |
| Jitter attenuation curve corner frequency ³ | | – | 3 | – | Hz | |
| Minimum return loss ^{4,5} | | Transmit Min | Typ | Receive Min | Typ | dB |
| | 51 kHz - 102 kHz | 18 | – | 20 | – | dB |
| | 102 kHz - 2.048 kHz | 18 | – | 20 | – | dB |
| | 2.048 kHz - 3.072 kHz | 18 | – | 20 | – | dB |

1. Typical values are measured at 25 °C and are for design aid only; not guaranteed and not subject to production testing.
2. Input signal to TCLK is jitter-free.
3. Circuit attenuates jitter at 20 dB/decade above the corner frequency.
4. In accordance with ITU G.703/ETS 300166 return loss specifications when wired per Figure 5 (E1).
5. Guaranteed by design.

Figure 6: Typical Receive Jitter Tolerance

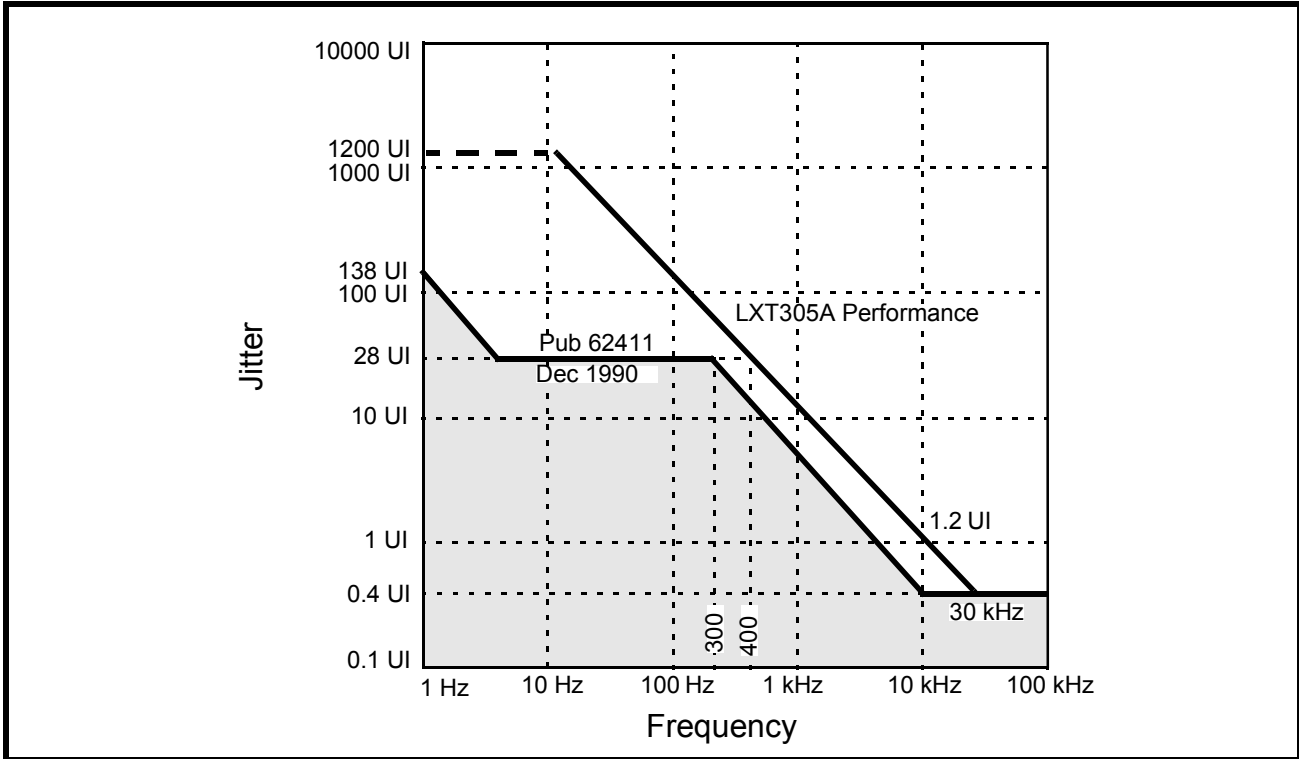


Figure 7: LXT305A Transmit Jitter Transfer Performance (Typical)

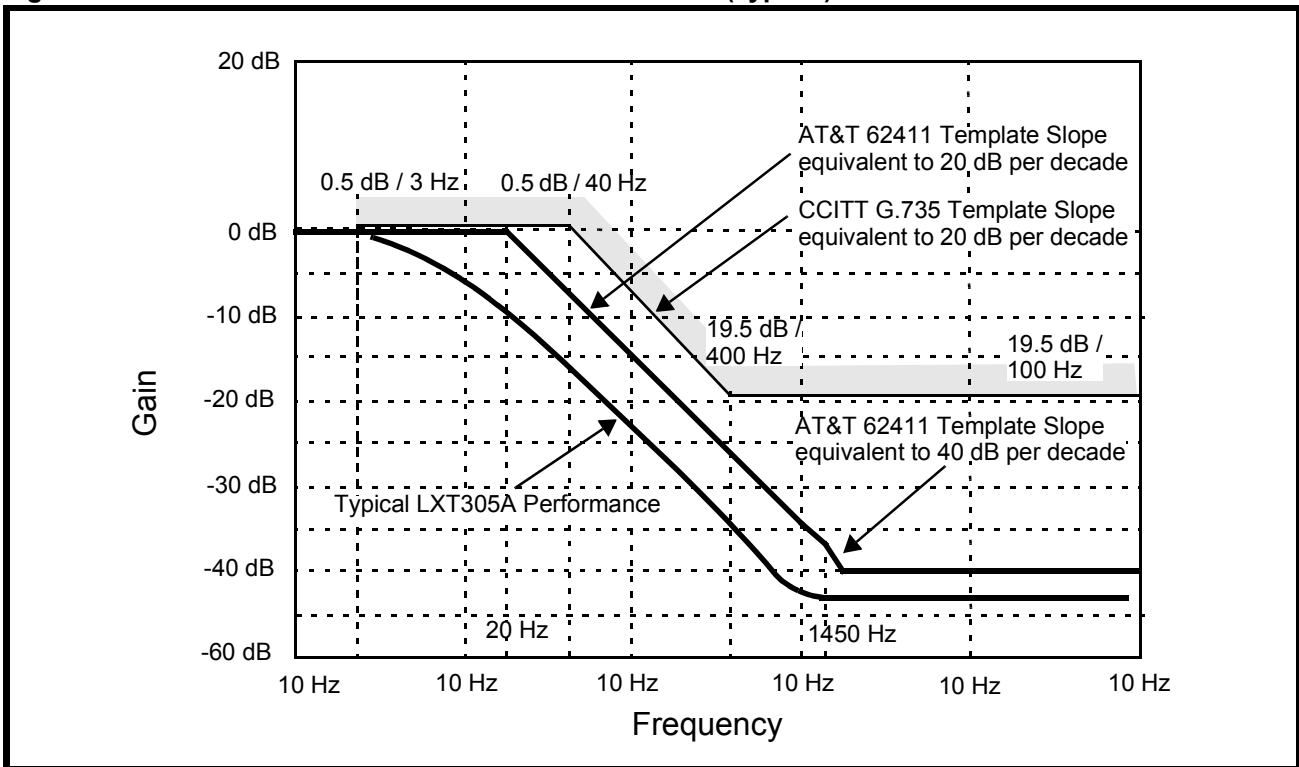
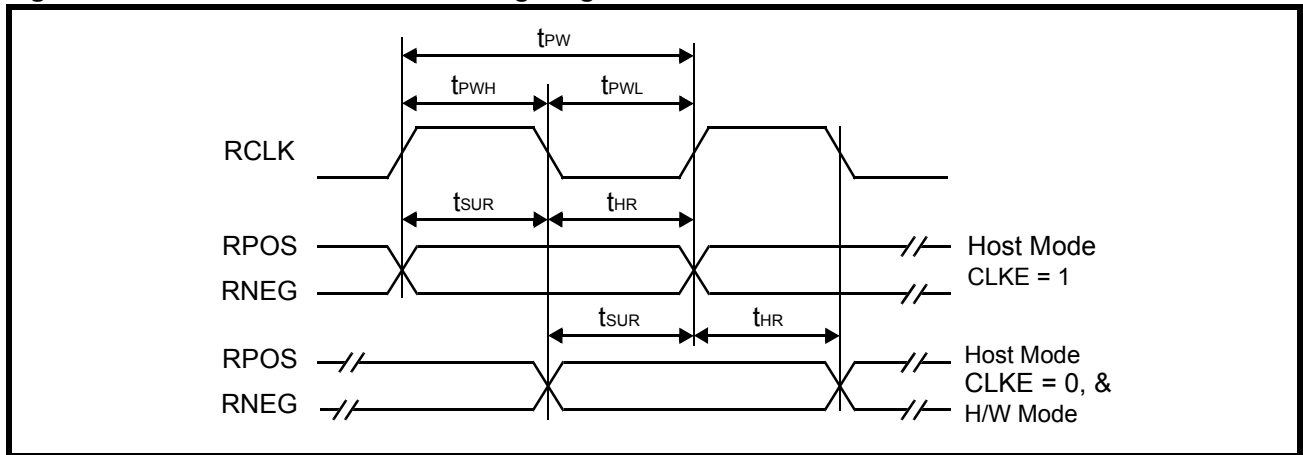


Table 11: LXT305A Receive Timing Characteristics (See Figure 8)

| Parameter | | Sym | Min | Typ ¹ | Max | Units | Test Conditions |
|--|----|-------|-----|------------------|-----|-------|-----------------|
| Receive clock duty cycle ² | T1 | RCLKd | 40 | 50 | 60 | % | |
| | E1 | RCLKd | 40 | 50 | 60 | % | |
| Receive clock pulse width ² | T1 | tpw | 594 | 648 | 702 | ns | |
| | E1 | tpw | 447 | 488 | 529 | ns | |
| Receive clock pulse width high | T1 | tpWH | – | 324 | – | ns | |
| | E1 | tpWH | – | 244 | – | ns | |
| Receive clock pulse width low | T1 | tpWL | 270 | 324 | 378 | ns | |
| | E1 | tpWL | 203 | 244 | 285 | ns | |
| RPOS/RNEG to RCLK rising setup time | T1 | tsUR | 50 | 270 | – | ns | |
| | E1 | tsUR | 50 | 203 | – | ns | |
| RCLK rising to RPOS/RNEG hold time | T1 | tHR | 50 | 270 | – | ns | |
| | E1 | tHR | 50 | 203 | – | ns | |

1. Typical values are at 25 °C and are for design aid only; they are not guaranteed and not subject to production testing.
 2. RCLK duty cycle widths will vary depending on extent of received pulse jitter displacement. Max and Min RCLK duty cycles are for worst case jitter conditions (0.4 UI clock displacement for 1.544 MHz, 0.2 UI clock displacement for 2.048 MHz).

Figure 8: LXT305A Receive Clock Timing Diagram



LXT305A Integrated T1/E1 Short-Haul Transceiver with Transmit JA

Table 12: LXT305A Master Clock and Transmit Timing Characteristics (See Figure 9)

| Parameter | | Sym | Min | Typ ¹ | Max | Units |
|------------------------------|-------|------------------|-----|------------------|-----|-------|
| Master clock frequency | DSX-1 | MCLK | – | 1.544 | – | MHz |
| | E1 | MCLK | – | 2.048 | – | MHz |
| Master clock tolerance | | MCLKt | – | ±100 | – | ppm |
| Master clock duty cycle | | MCLKd | 40 | – | 60 | % |
| Crystal frequency | DSX-1 | fc | – | 6.176 | – | MHz |
| | E1 | fc | – | 8.192 | – | MHz |
| Transmit clock frequency | DSX-1 | TCLK | – | 1.544 | – | MHz |
| | E1 | TCLK | – | 2.048 | – | MHz |
| Transmit clock tolerance | | TCLKt | – | ±50 | – | ppm |
| Transmit clock duty cycle | | TCLKd | 10 | – | 90 | % |
| TPOS/TNEG to TCLK setup time | | t _{SUT} | 25 | – | – | ns |
| TCLK to TPOS/TNEG hold time | | t _{HT} | 25 | – | – | ns |

1. Typical values are at 25 °C and are for design aid only; they are not guaranteed and not subject to production testing.

Figure 9: LXT305A Transmit Clock Timing Diagram

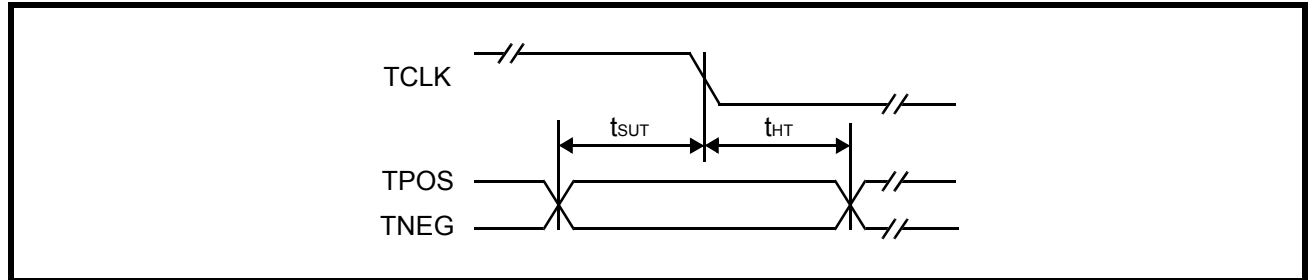


Table 13: LXT305A Serial I/O Timing Characteristics (See Figures 10 and 11)

| Parameter | Sym | Min | Typ ¹ | Max | Units | Test Conditions |
|--|------------|-----|------------------|-----|-------|--------------------|
| Rise/Fall time - any digital output | t_{RF} | – | – | 100 | ns | Load 1.6 mA, 50 pF |
| SDI to SCLK setup time | t_{DC} | 50 | – | – | ns | |
| SCLK to SDI hold time | t_{CDH} | 50 | – | – | ns | |
| SCLK low time | t_{CL} | 240 | – | – | ns | |
| SCLK high time | t_{CH} | 240 | – | – | ns | |
| SCLK rise and fall time | t_r, t_f | – | – | 50 | ns | |
| \overline{CS} to SCLK setup time | t_{CC} | 50 | – | – | ns | |
| SCLK to \overline{CS} hold time | t_{CCH} | 50 | – | – | ns | |
| \overline{CS} inactive time | t_{CWH} | 250 | – | – | ns | |
| SCLK to SDO valid | t_{CDV} | – | – | 200 | ns | |
| SCLK falling edge or \overline{CS} rising edge to SDO high Z | t_{CDZ} | – | 100 | – | ns | |

1. Typical values are at 25° C and are for design aid only; they are not guaranteed and not subject to production testing.

Figure 10: LXT305A Serial Data Input Timing Diagram

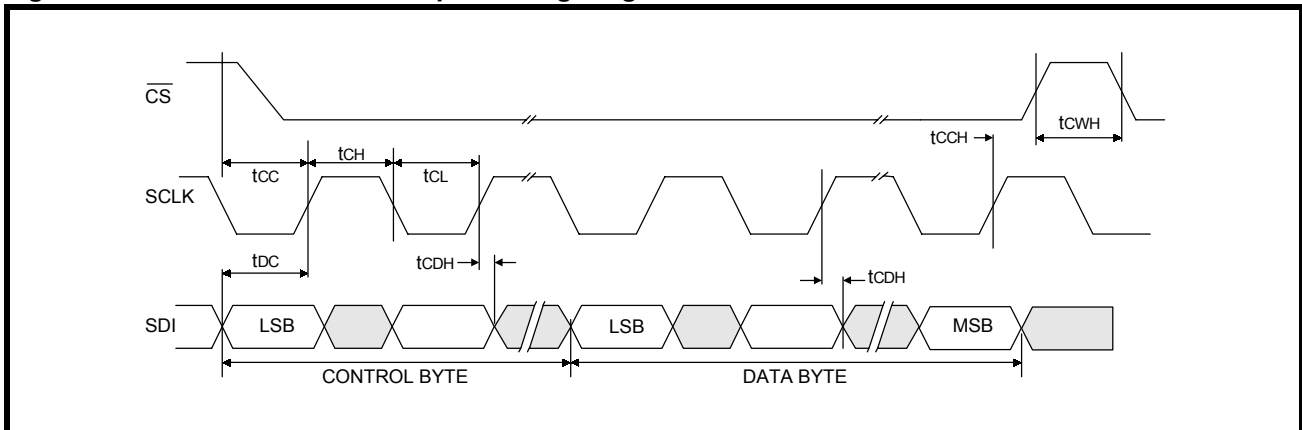
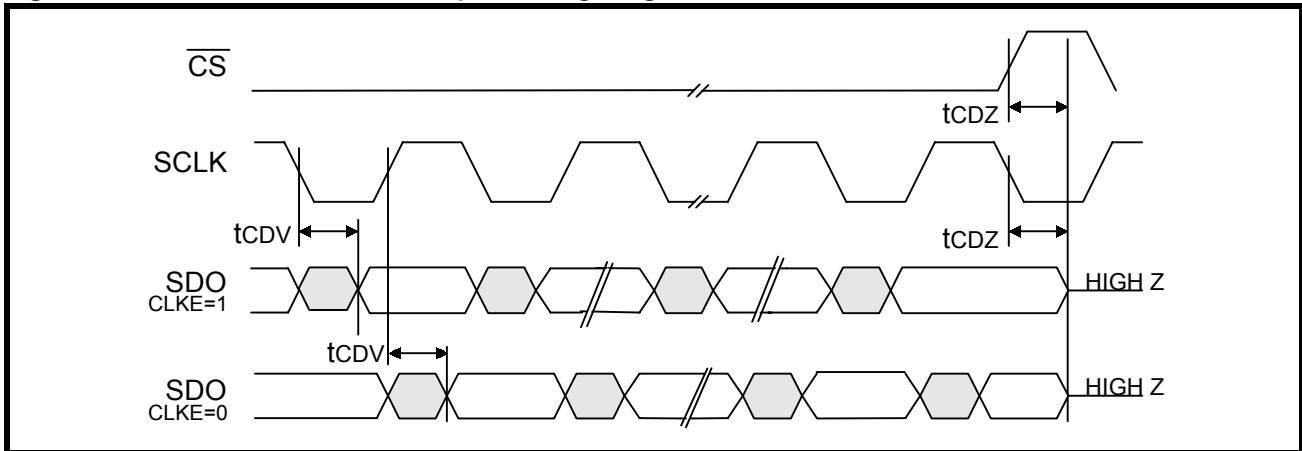


Figure 11: LXT305A Serial Data Output Timing Diagram



NOTES
