

LXT901A/907A

Universal Ethernet Transceiver

General Description

The LXT901A and LXT907A Universal Ethernet Transceivers are new-generation LXT901 and LXT907 replacements with improved noise immunity and output filtering. The feature set of the LXT901A/907A has been streamlined, removing Remote Signaling capabilities. The LXT901A and LXT907A provide all the active circuitry to interface most standard 802.3 controllers to either the 10BASE-T media or Attachment Unit Interface (AUI).

The LXT901A and LXT907A are identical except for the function of one pin. The LXT901A with selectable termination impedance (STP) allows the use of either shielded or unshielded twisted-pair cable. The LXT907A offers a Signal Quality Error disable (DSQE) function.

LXT901A and LXT907A functions include Manchester encoding/decoding, receiver squelch and transmit pulse shaping, jabber, link testing and reversed polarity detection/correction.

Applications

- 10BASE-T hub and switching products
- Computer/workstation 10BASE-T LAN adapter boards

Features

Functional Features

- Integrated Filters - Simplify FCC Compliance
- Integrated Manchester Encoder/Decoder
- 10BASE-T Transceiver
- AUI Transceiver
- Full-Duplex Capable (20 Mbps)

Convenience Features

- Automatic/Manual AUI/RJ45 Selection
- Automatic Polarity Correction
- DSQE Disable function (*LXT907A*)
- Programmable Impedance Driver (*LXT901A*)
- Power Down Mode and four loopback modes
- Available in 64-pin LQFP and 44-pin PLCC packages

Diagnostic Features

- Four LED Drivers
- AUI/RJ45 Loopback

LXT901A/907A Block Diagram

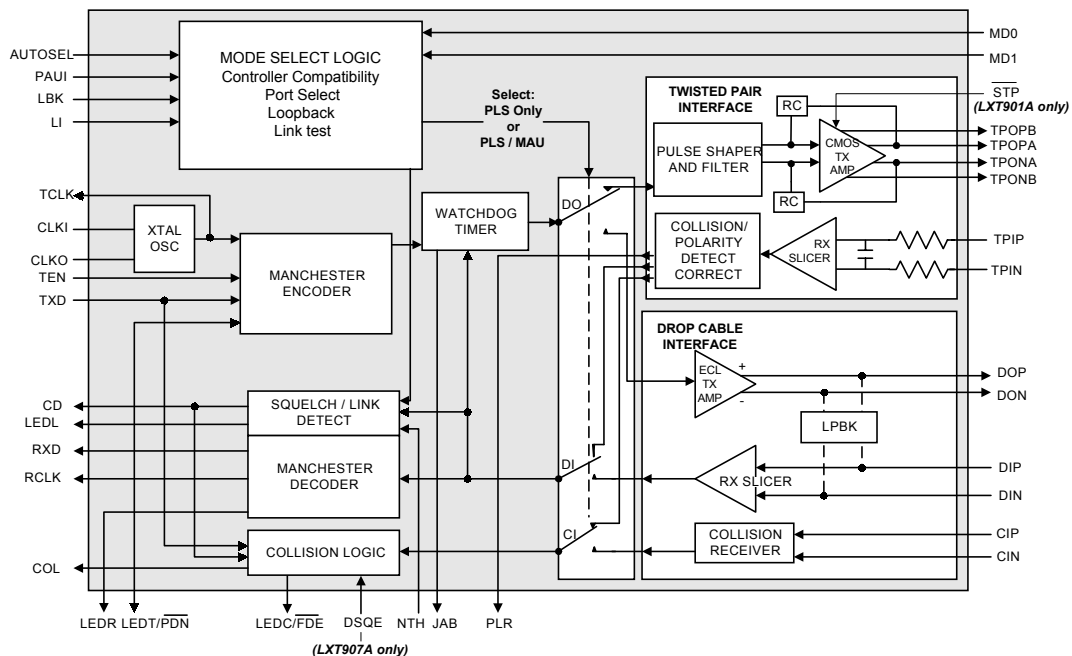


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PIN ASSIGNMENTS AND SIGNAL DESCRIPTIONS

Figure 1: LXT901A/907A Pin Assignments

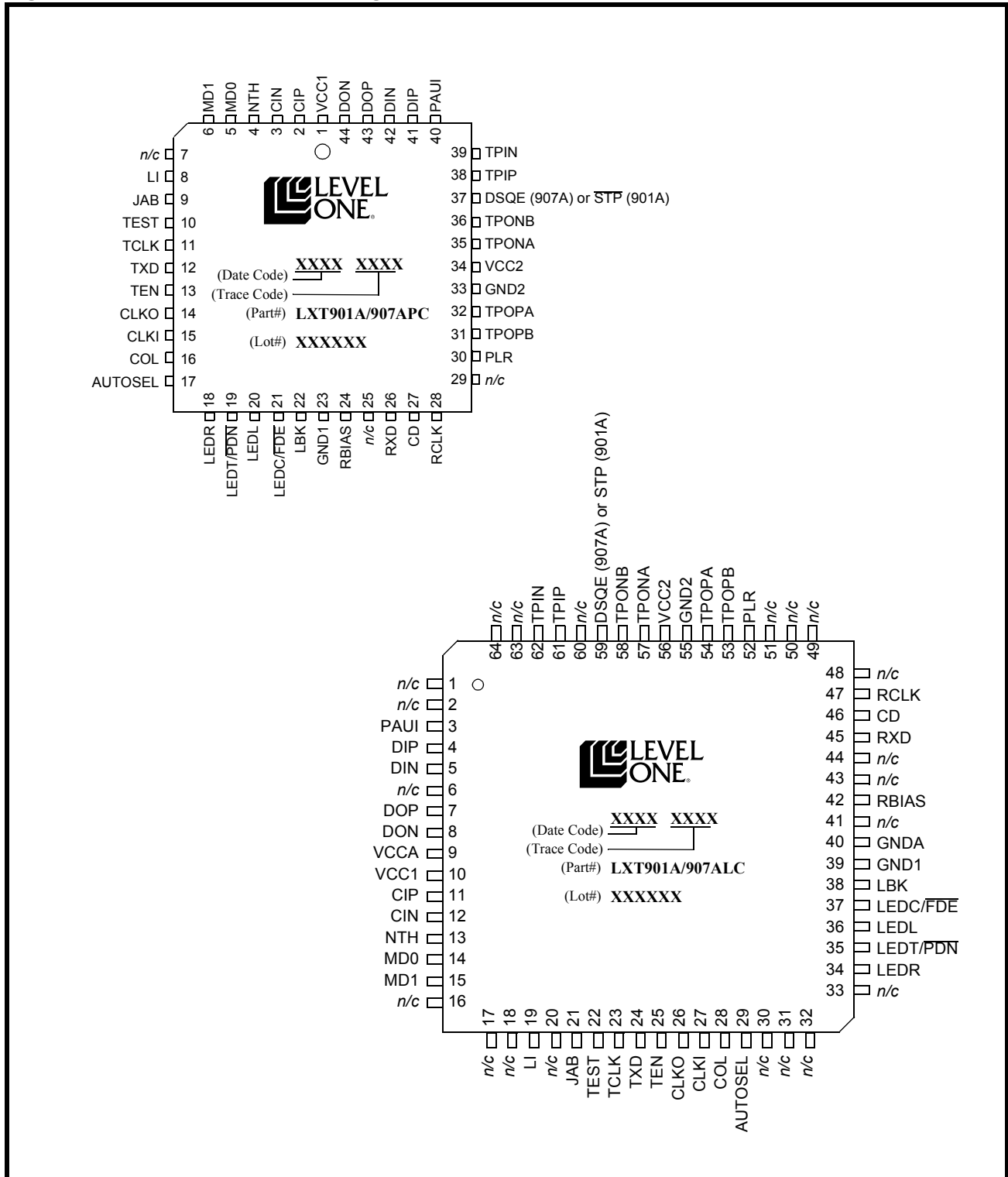


Table 1: LXT901A/907A Signal Descriptions

| Pin # | | Symbol | I/O ¹ | Description |
|----------|----------|--------------|------------------|---|
| PLCC | LQFP | | | |
| 1 34 | 10 56 | VCC1 VCC2 | – – | Power Supply 1 and 2. Power supply inputs of +5 volts. |
| 2 3 | 11 12 | CIP CIN | I I | AUI Collision Pair. Differential input to the AUI transceiver CI circuit. The input is collision signaling or SQE. |
| 4 | 13 | NTH | I | Normal Threshold. Selects normal or reduced threshold. When NTH is High, the normal TP squelch threshold is in effect. When NTH is Low, the normal TP squelch threshold is reduced by 4.5 dB. |
| 5 6 | 14 15 | MD0 MD1 | I I | Mode Select 0 (MD0) and Mode Select 1 (MD1). Mode select pins determine the controller compatibility mode in accordance with Table 2. |
| 8 | 19 | LI | I | Link Test Enable. Controls Link Integrity Test; enabled when LI = High, disabled when LI = Low |
| 9 | 21 | JAB | O | Jabber Indicator. Output goes High to indicate Jabber state. |
| 10 | 22 | TEST | I | Test. For Level One internal use only. It is recommended to tie this pin High externally. |
| 11 | 23 | TCLK | O | Transmit Clock. A 10 MHz clock output. This clock signal should be directly connected to the transmit clock input of the controller. |
| 12 | 24 | TXD | I | Transmit Data. Input signal containing NRZ data to be transmitted on the network. Connect TXD directly to the transmit data output of the controller. |
| 13 | 25 | TEN | I | Transmit Enable. Enables data transmission and starts the watchdog timer. Synchronous to TCLK (see Test Specifications for details). |
| 14 15 | 26 27 | CLKO CLKI | O I | Crystal Oscillator. A 20 MHz crystal must be connected across these pins, or a 20 MHz clock applied at CLKI with CLKO left open. |
| 16 | 28 | COL | O | Collision Detect. Output which drives the collision detect input of the controller. |
| 17 | 29 | AUTOSEL | I | Automatic Port Select. When High, automatic port selection is enabled (the 901A/907A defaults to the AUI port only if TP link integrity = Fail). When Low, manual port selection is enabled (the PAUI pin determines the active port). |
| 18 | 34 | LEDR | OD | Receive LED. Open drain driver for the receive indicator LED. Output is pulled Low during receive. |
| 19 | 35 | LEDT/ PDN | OD | Transmit LED (LEDT)/Power Down (PDN). Open drain driver for the transmit indicator. Output is pulled Low during transmit. If externally pulled Low, the LXT901A/907A goes to power down state. |
| 20 | 36 | LEDL | OD | Link LED. Open drain driver for link integrity indicator. Output is pulled Low during link test pass. If externally tied Low, internal circuitry is forced to “Link Pass” state and the 901A/907A will transmit link test pulses continuously. |

1. I/O Column Coding: I = Input O= Output, OD = Open Drain

LXT901A/907A Pin Assignments and Signal Descriptions

Table 1: LXT901A/907A Signal Descriptions – continued

| Pin # | | Symbol | I/O ¹ | Description |
|----------------------|----------------------|----------------------------------|------------------|---|
| PLCC | LQFP | | | |
| 21 | 37 | LEDC/ FDE | OD | <p>Collision LED (LEDC)/Full Duplex Enable (FDE). Open drain driver for the collision indicator pulls Low during collision. LED “On” (i.e., Low output) time is extended by approximately 100 ms.</p> <p>If externally tied Low, enables full duplex operation by disabling the internal TP loopback and collision detection circuits in anticipation of external TP loopback or full duplex operation.</p> <p>If this pin is not used, tie high or directly to Vcc.</p> |
| 22 | 38 | LBK | I | <p>Loopback. Enables internal loopback mode. Refer to Functional Description for details.</p> |
| 23 33 | 39 40 | GND1 GND2 | – – | <p>Ground Returns 1 and 2. Grounds</p> |
| 24 | 42 | RBIAS | I | <p>Bias Control. A 12.4 kΩ 1% resistor to ground at this pin controls operating circuit bias.</p> |
| 26 | 45 | RXD | O | <p>Receive Data. Output signal. Connect directly to the receive data input of the controller.</p> |
| 27 | 46 | CD | O | <p>Carrier Detect. An output to notify the controller of activity on the network.</p> |
| 28 | 47 | RCLK | O | <p>Receive Clock. A recovered 10 MHz clock which is synchronous to the received data. Connect to the controller receive clock input.</p> |
| 30 | 52 | PLR | O | <p>Polarity Reverse. Output goes High to indicate reversed polarity at the TP input.</p> |
| 31 36 32 35 | 53 58 54 57 | TPOPB TPONB TPOPA TPONA | O O O O | <p>Twisted-Pair Transmit Pairs A & B. Two differential driver pair outputs (A and B) to the twisted-pair cable. The outputs are pre-equalized. Each pair must be shorted together and tied to the transformer through a 24.9 Ω 1% series resistor to match impedance of 100 Ω. Refer to Figure 15 in the Applications Section for information on 150Ω configurations.</p> |
| 37 | 59 | STP | I | <p>STP Select (LXT901A only). When STP is Low, 150 Ω termination for shielded TP is selected. When STP is High, 100 Ω termination for unshielded TP is selected. LXT907A is designed for 100Ω UTP termination (not selectable).</p> |
| | | DSQE | I | <p>Disable SQE (LXT907A only). When DSQE is High, the SQE function is disabled. When DSQE is Low, the SQE function is enabled. SQE must be disabled for normal operation in Hub/Switch applications. LXT901A operates with SQE enabled (not selectable).</p> |

1. I/O Column Coding: I = Input O= Output, OD = Open Drain

Table 1: LXT901A/907A Signal Descriptions – continued

| Pin # | | Symbol | I/O ¹ | Description |
|--------------|---|--------------|------------------|---|
| PLCC | LQFP | | | |
| 38 39 | 61 62 | TPIP TPIN | I I | Twisted-Pair Receive Pair. A differential input pair from the TP cable. Receive filter is integrated on-chip. No external filters are required. |
| 40 | 3 | PAUI | I | Port/AUI Select. In Manual Port Select mode (AUTOSEL Low), PAUI selects the active port. When PAUI is High, the AUI port is selected. When PAUI is Low, the TP port is selected. In Auto Port Select mode, PAUI must be tied to ground. |
| 41 42 | 4 5 | DIP DIN | I I | AUI Receive Pair. Differential input pair from the AUI transceiver DI circuit. The input is Manchester encoded. |
| 43 44 | 7 8 | DOP DON | O O | AUI Transmit Pair. A differential output driver pair for the AUI transceiver cable. The output is Manchester encoded. |
| 7, 25, 29 | 1, 2, 6, 16, 17, 18, 20, 30, 31, 32, 33, 41, 43, 44, 48, 49, 50, 51, 60, 63, 64 | N/C | – | No Connect (Internally tied to ground). |

1. I/O Column Coding: I = Input O= Output, OD = Open Drain

FUNCTIONAL DESCRIPTION

The LXT901A/907A Universal Ethernet Interface Transceivers perform the physical layer signaling (PLS) and Media Attachment Unit (MAU) functions as defined by the IEEE 802.3 specification. They function as a PLS-Only device (for use with 10BASE-2 or 10BASE-5 coaxial cable networks) or as an Integrated PLS/MAU (for use with 10BASE-T twisted-pair networks). In addition to standard 10 Mbps operation, they also support full-duplex 20 Mbps operation.

The LXT901A/907A interfaces a back-end controller to either an AUI drop cable or a twisted-pair (TP) cable. The controller interface includes transmit and receive clock and NRZ data channels, as well as mode control logic and signaling. The AUI interface comprises three circuits: Data Output (DO), Data Input (DI) and Collision (CI). The twisted-pair interface comprises two circuits: Twisted-Pair Input (TPI) and Twisted-Pair Output (TPO). In addition to the three basic interfaces, the LXT901A/907A contains an internal crystal oscillator and four LED drivers for visual status reporting.

Functions are defined from the back-end controller side of the interface. The Transmit function refers to data transmitted by the back-end to the AUI cable (PLS-Only mode) or to the twisted-pair network (Integrated PLS/MAU mode). The Receive function refers to data received by the back-end from the AUI cable (PLS-Only) or from the twisted-pair network (Integrated PLS/MAU mode). In the integrated PLS/MAU mode, the LXT901A/907A performs all required MAU functions defined by the IEEE 802.3 10BASE-T specification such as collision detection, link integrity testing, signal quality error messaging, jabber control and loopback. In the PLS-Only mode, the LXT901A/907A receives incoming signals from the AUI DI circuit with ± 18 ns of jitter and drives the AUI DO circuit.

Controller Compatibility Modes

The LXT901A/907A are compatible with most industry standard controllers including devices produced by Motorola, AMD, Intel, Fujitsu, National Semiconductor, Seeq and Texas Instruments. Four different control signal timing and polarity schemes (Modes 1 through 4) are required to achieve this compatibility. Mode select pins (MD0 and MD1) determine Controller compatibility modes as listed in Table 2. Refer to Test Specifications for a complete set of timing diagrams for each mode.

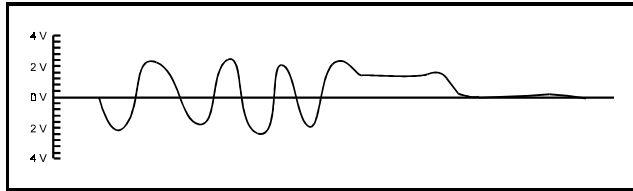
Table 2: Controller Compatibility Modes

| Controller Mode | Setting | |
|---|---------|------|
| | MD1 | MD0 |
| Mode 1 For Motorola 68EN360, MPC860, Advanced Micro Devices AM7990 or compatible controllers | Low | Low |
| Mode 2 For Intel 82596 or compatible controllers ¹ | Low | High |
| Mode 3 For Fujitsu MB86950, MB86960 or compatible controllers (Seeq 8005) ² | High | Low |
| Mode 4 For National Semiconductor 8390 or compatible controllers (TI TMS380C26) | High | High |
| 2. Refer to Level One Application Note 51 when designing with Intel Controllers. 3. SEEQ controllers require inverters on CLK1, LBK, RCLK and COL. | | |

Transmit Function

The LXT901A/907A receives NRZ data from the controller at the TXD input, as shown in the block diagram on the first page of this Data Sheet, and passes it through a Manchester encoder. The encoded data is then transferred to either the AUI cable (the DO circuit) or the twisted-pair network (the TPO circuit). The advanced integrated pulse shaping and filtering network produces the output signal on TPON and TPOP as shown in Figure 2. The TPO output is pre-distorted and prefiltered to meet the 10BASE-T jitter template. An internal continuous resistor-capacitor filter is used to remove any high-frequency clocking noise from the pulse shaping circuitry. Integrated filters simplify the design work required for FCC compliant EMI performance. During idle periods, the LXT901A/907A transmits link integrity test pulses on the TPO circuit (if LI is enabled and integrated PLS/ MAU mode is selected). External resistors control the termination impedance for the LXT907A. External resistors and the STP Pin control termination impedance on the LXT901A.

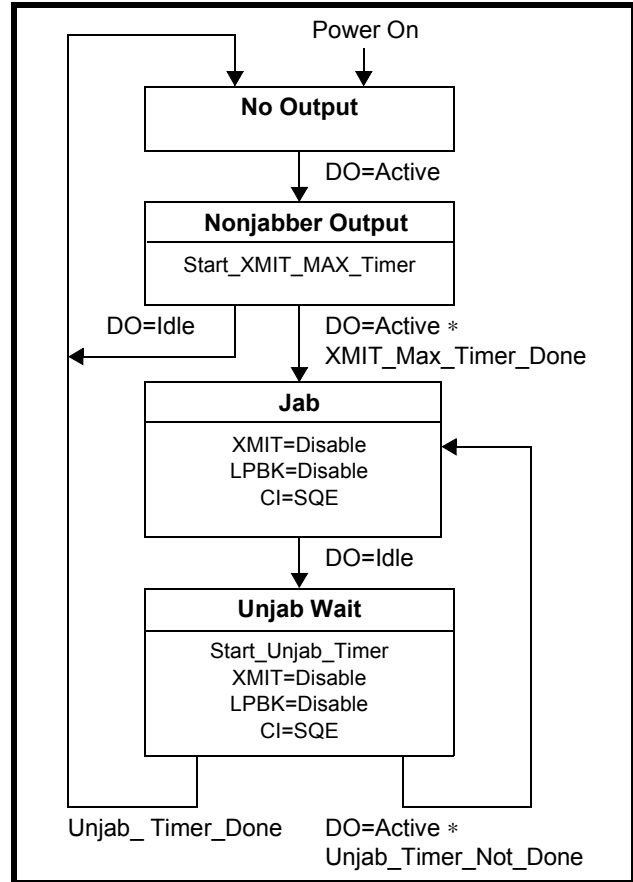
Figure 2: TPO Output Waveform



Jabber Control Function

Figure 3 is a state diagram of the LXT901A/907A Jabber control function. The on-chip watchdog timer prevents the DTE from locking into a continuous transmit mode. When a transmission exceeds the time limit, the watchdog timer disables the transmit and loopback functions, and activates the JAB pin. Once the LXT901A/907A is in the jabber state, the TXD circuit must remain idle for a period of 250 to 750ms before it will exit the jabber state.

Figure 3: Jabber Control Function



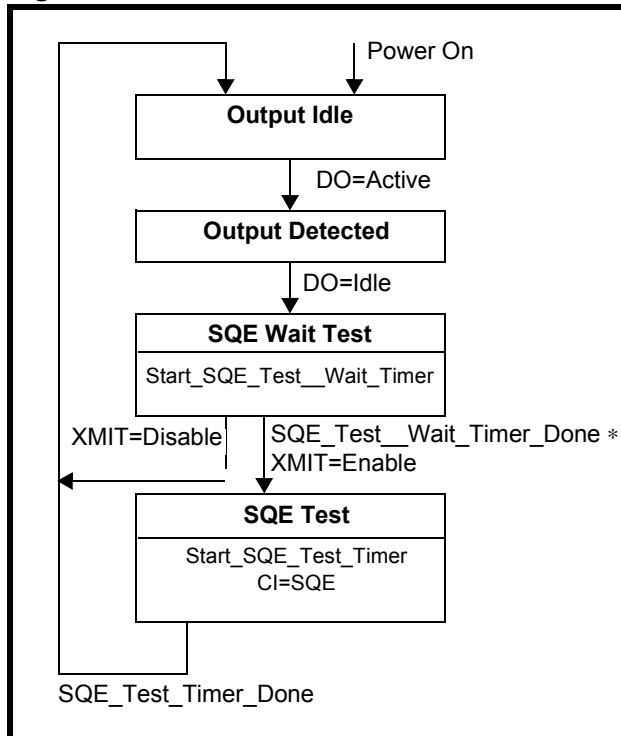
SQE Function

In the integrated PLS/MAU mode, the LXT901A/907A supports the signal quality error (SQE) function as shown in Figure 4, although the SQE function can be disabled on the LXT907A. After every successful transmission on the 10BASE-T network, when SQE is enabled, the LXT901A/907A transmits the SQE signal for $10BT \pm 5BT$ over the internal CI circuit which is indicated on the COL pin of the device. When using the AUI of the LXT901A/907A, the SQE function is determined by the external MAU attached.

SQE Disable Function (LXT907A only)

SQE must be disabled for normal operation in hub and switch applications. The LXT907A is configured with an SQE Disable function. The SQE function is disabled when DSQE is set High, and enabled when DSQE is Low.

Figure 4: SQE Function



Receive Function

The LXT901A/907A receive function acquires timing and data from the twisted-pair network (the TPI circuit) or from the AUI (the DI circuit). Valid received signals are passed through the on-chip filters and Manchester decoder, then output as decoded NRZ data and receive timing on the RXD and RCLK pins, respectively.

An internal RC filter and an intelligent squelch function discriminate noise from link test pulses and valid data streams. The receive function is activated only by valid data streams above the squelch level and with proper timing. If the differential signal at the TPI or the DI circuit inputs falls below 75% of the threshold level (unsquelched) for 8 bit times (typical), the LXT901A/907A receive function enters the idle state. If the polarity of the TPI circuit is reversed, LXT901A/907A detects the polarity reverse and reports it via the PLR output. The LXT901A/907A automatically corrects reversed polarity.

Polarity Reverse Function

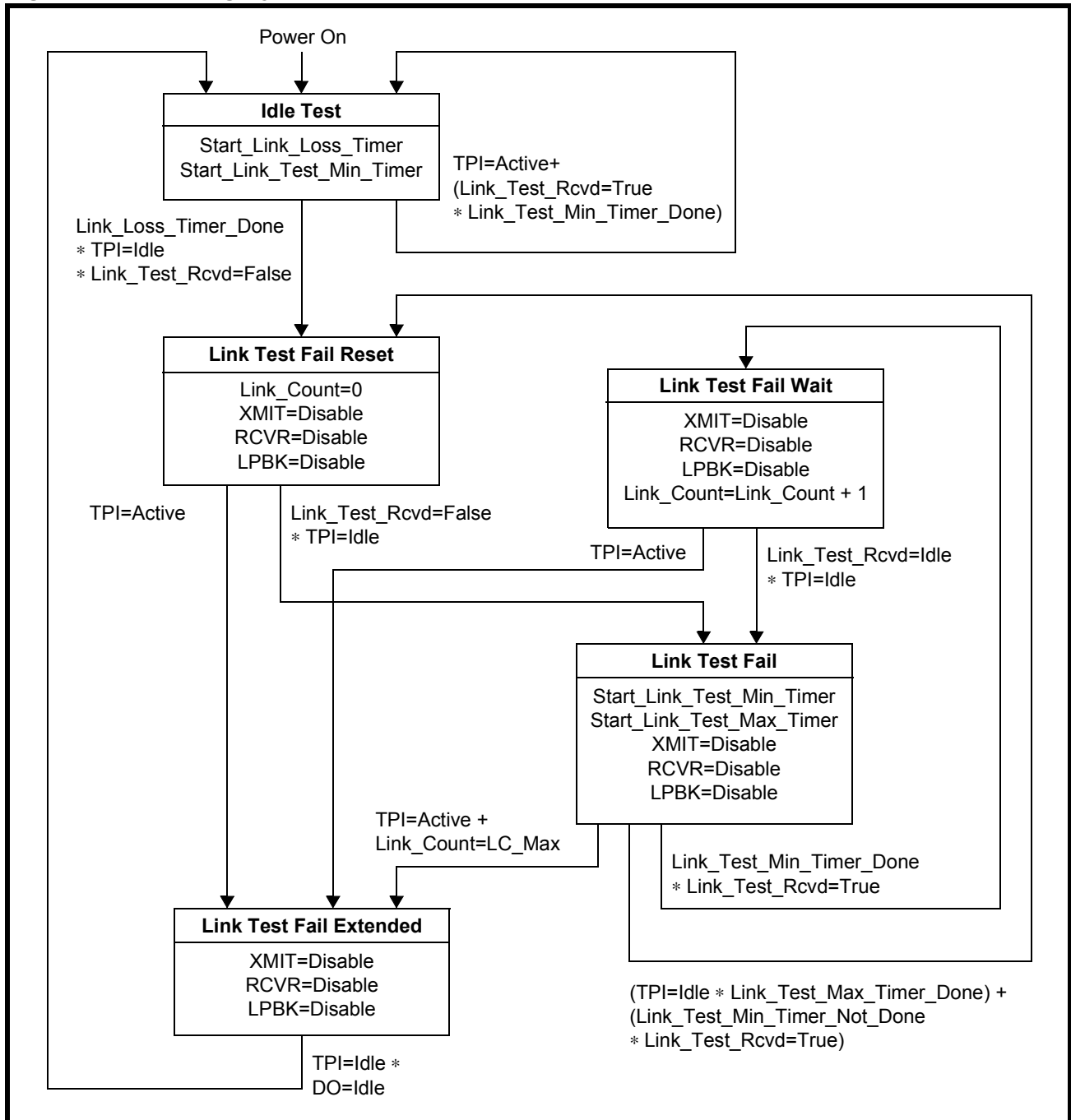
The LXT901A/907A polarity reverse function uses both link pulses and end-of-frame data to determine the polarity of the received signal. A reversed polarity condition is detected when eight opposite receive link pulses are detected without receipt of a link pulse of the expected polarity. Reversed polarity is also detected if four frames are received with a reversed start-of-idle. Whenever a correct polarity frame or a correct link pulse is received, these two counters are reset to zero. If the LXT901A/907A enters the link fail state and no valid data or link pulses are received within 96 to 128 ms, the polarity is reset to the default non-flipped condition. If Link Integrity Testing is disabled, polarity detection is based only on received data. Polarity correction is always enabled.

Link Integrity Test Function

Figure 6 is a state diagram of the LXT901A/907A Link Integrity test function. The link integrity test is used to determine the status of the receive side twisted-pair cable. Link integrity testing is enabled when the LI pin is tied High. When enabled, the receiver recognizes link integrity pulses which are transmitted in the absence of receive traf-

fic. If no serial data stream or link integrity pulses are detected within 50 - 150 ms, the chip enters a link fail state and disables the transmit and normal loopback functions. The LXT901A/907A ignores any link integrity pulse with interval less than 2 - 7 ms. The LXT901A/907A will remain in the link fail state until it detects either a serial data packet or two or more link integrity pulses.

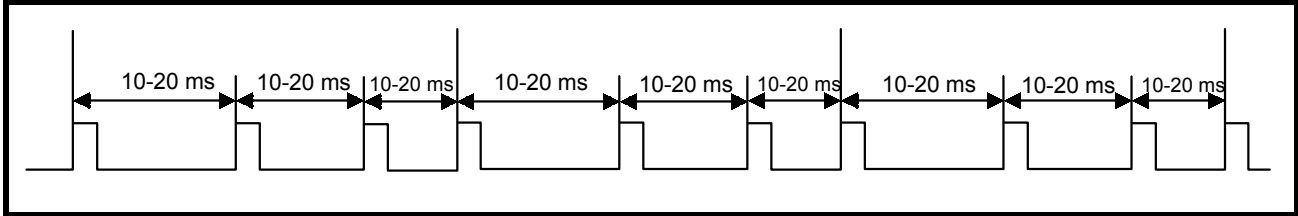
Figure 6: Link Integrity Test Function



Link pulse Transmission

When not transmitting data, the LXT901A/907A transmits 802.3-compliant standard link pulses. Figure 7 shows the link integrity pulse timing.

Figure 7: Transmitted Link Integrity Pulse Timing



APPLICATION INFORMATION

Twisted-Pair Impedance Matching

Resistors must be installed on each input and output pair to match impedance of the network media being used. The LXT907A is configured with 100Ω termination for Unshielded Twisted-Pair (UTP). In this case, the positive and negative sides of both output pairs are shorted together (TPOPA/TPOPB and TPONA/TPONB) and tied to the transformer through a 24.9 Ω 1% series resistor.

The LXT901A is designed with an \overline{STP} Select pin that allows the device to match both 100Ω and 150Ω media. A dual resistor combination can be configured to accommodate either line termination as shown in Figure 15. When 100Ω termination is selected, both A and B pairs are driven in parallel. When 150Ω termination is selected, the B pair is tri-stated and only the A pair is driven.

Crystal Information

Designers should test and validate crystals before committing to a specific component. Based on limited evaluation, Table 3 lists some suitable crystals.

Table 3: Suitable Crystals

| Manufacturer | Part Number |
|--------------|-------------|
| MTRON | MP-1 |
| | MP-2 |

Magnetics Information

The LXT901A and LXT907A require a 1:1 ratio for the receive transformer and a 1:√2 ratio for the transmit transformer on the twisted-pair interface. The AUI Interface requires a 1:1 ratio for both the transmit and receive transformers. Table 4 lists some suitable magnetics.

Table 4: Suitable Magnetics

| | Manufacturer | Part Number |
|--------------|--------------|-------------|
| Twisted-Pair | Fil-Mag | 23Z128 |
| | | 23Z128SM |
| | Valor | PT4069 |
| | | ST7011 |
| | Belfuse | A553-0716 |
| | | S553-0716 |
| | HALO | TD42-2006Q |
| | | TG42-1406N1 |
| AUI | Fil-Mag | 23Z90 |
| | | 23Z90SM |
| | Valor | LT6032 |
| | | ST7032 |
| | HALO | TD01-0756K |
| | | TG01-0756N |

Typical Applications

Figures 8 through 15 show typical LXT901A/907A applications.

Auto Port Select with External Loopback Control

Figure 8 is a typical LXT901A/907A application. The diagram is arranged to group similar pins together; it does not represent the actual LXT901A/907A pinout. The controller interface pins (transmit data, clock and enable; receive data and clock; and the collision detect, carrier detect and loopback control pins) are shown at the top left.

Programmable option pins are grouped center left. The PAUI pin is tied Low and all other option pins are tied High. This setup selects the following options:

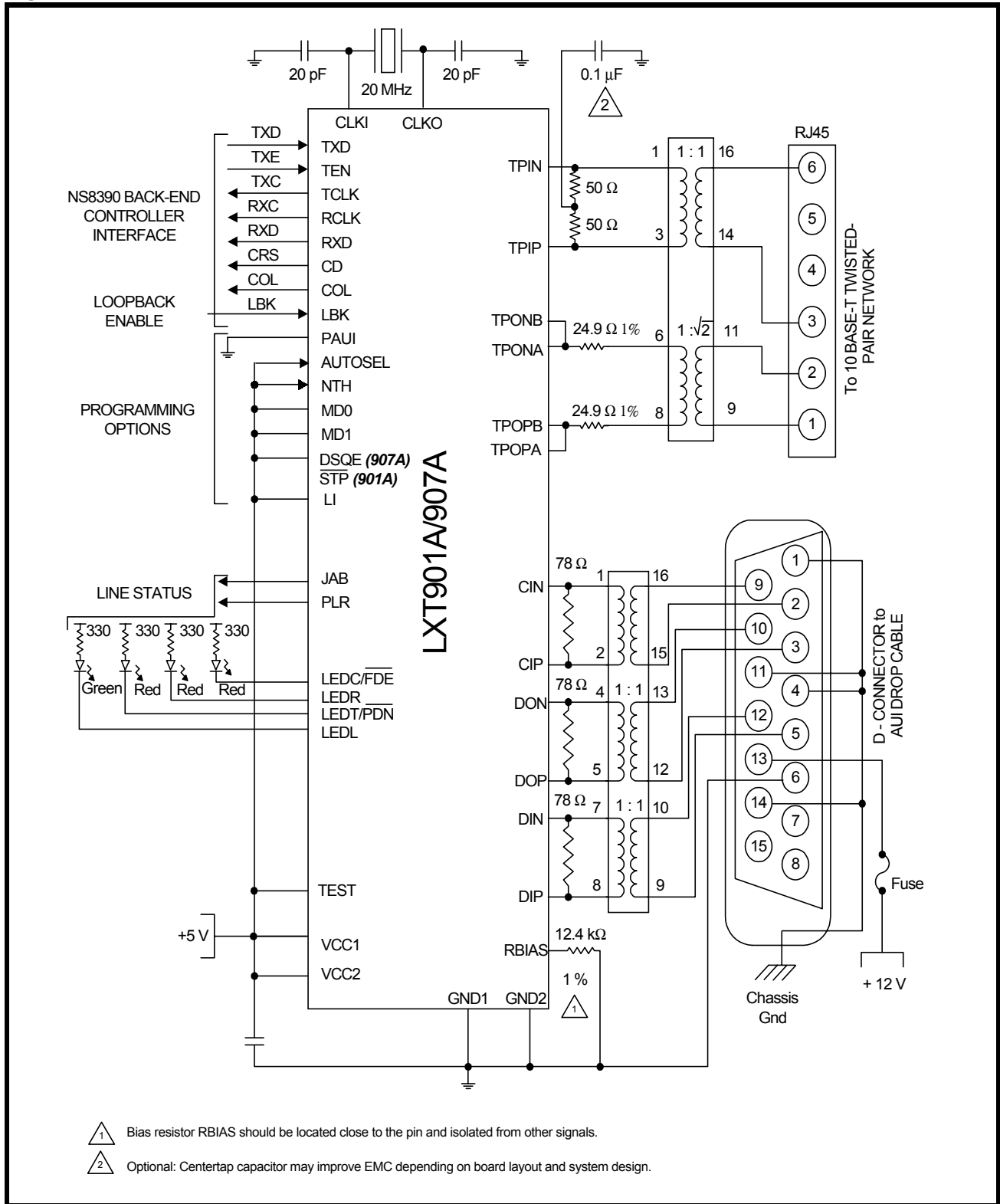
- Automatic Port Selection (PAUI Low and AUTOSEL High)
- Normal Receive Threshold (NTH High)
- Mode 4, compatible with National NS8390 controllers (MD0 High, MD1 High)
- SQE Disabled (DSQE High for LXT907A only)
- UTP is selected (STP High for LXT901A only)
- Link Testing Enabled (LI High)

Status outputs are grouped at lower left. Local status outputs drive LED indicators.

Power and ground pins are shown at the bottom of the diagram. A single power supply is used for both VCC1 and VCC2 with a decoupling capacitor installed between the power and ground busses.

The TP and AUI interfaces are shown at upper and lower right, respectively. Impedance matching resistors for 100 Ω UTP are installed in each I/O pair and no external filters are required.

Figure 8: LAN Adapter Board - Auto Port Select with External LPBK Control

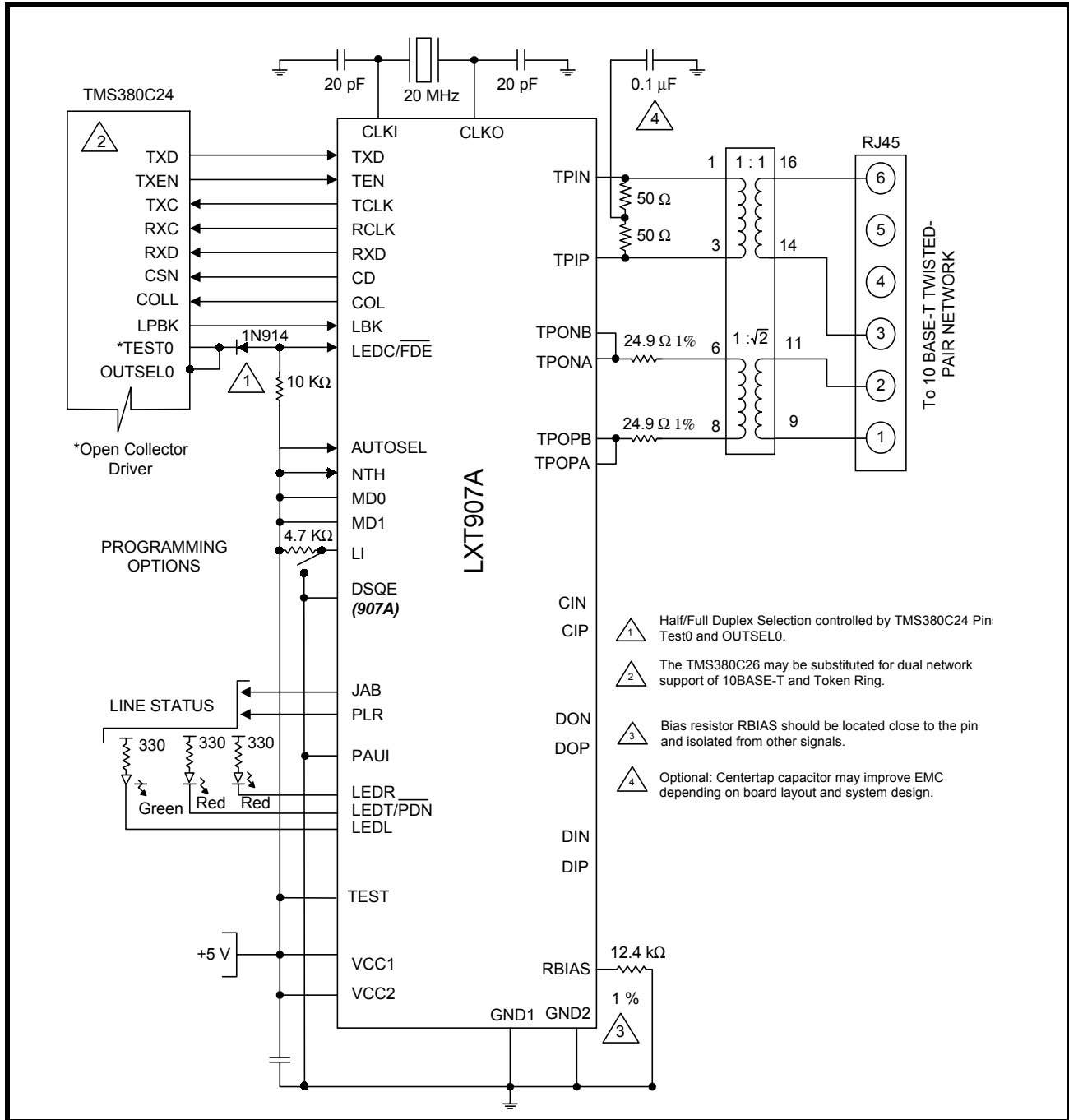


Full Duplex Support

Figure 9 shows the LXT907A with a Texas Instruments 380C24 CommProcessor. The 380C24 is compatible with Mode 4 (MD0 and MD1 both High). When used with the

380C24, or other full duplex-capable controller, the LXT907A supports full-duplex Ethernet, effectively doubling the available bandwidth of the network. In this application the SQE function is enabled (DSQE tied Low), and the AUI port is not used.

Figure 9: Full-Duplex Operation

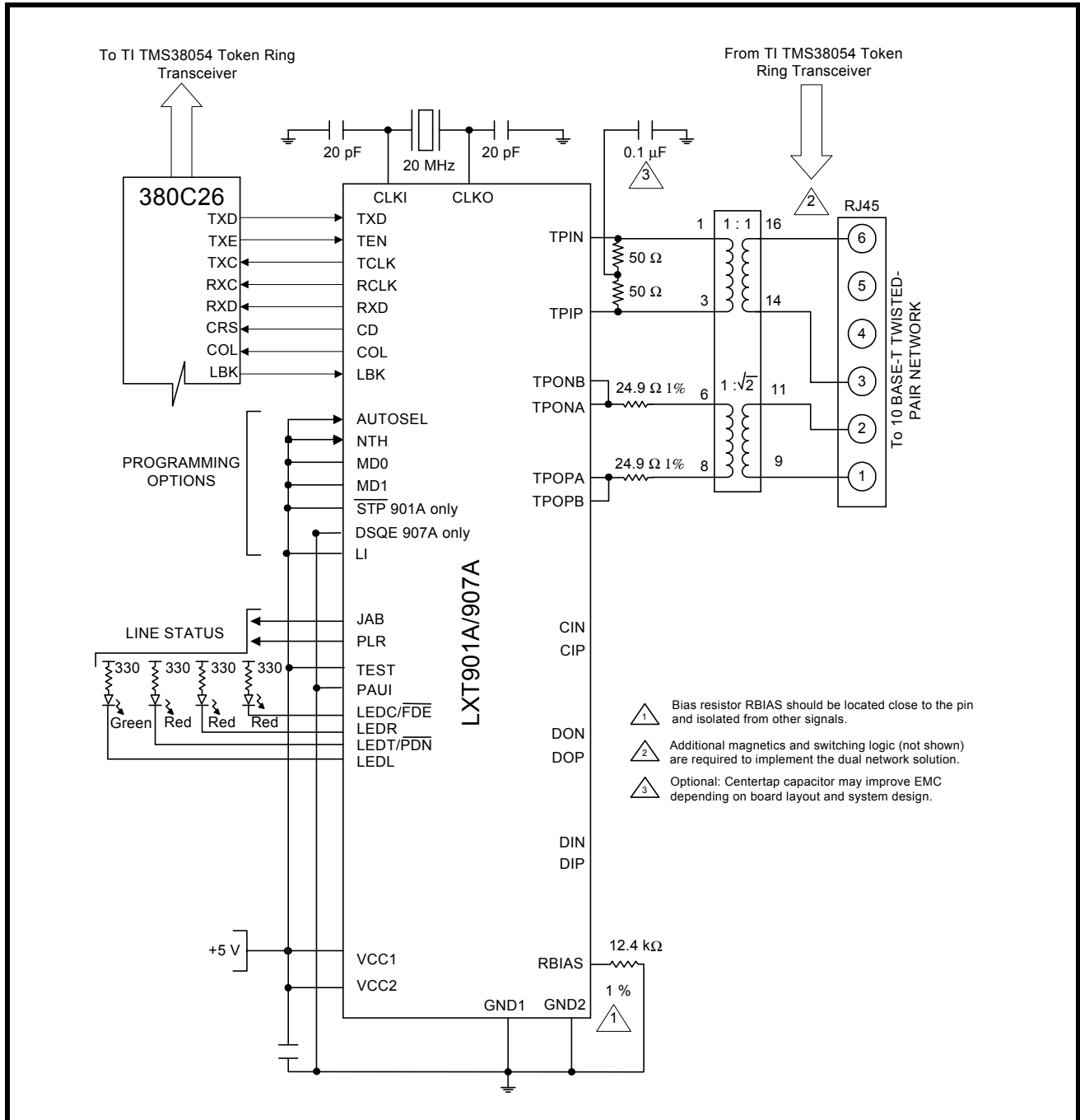


Dual Network Support - 10Base-T and Token Ring

Figure 10 shows the LXT901A/907A with a Texas Instruments 380C26 CommProcessor. The 380C26 is compatible with Mode 4 (MD0 and MD1 both High). When used with

the 380C26, both the LXT901A/907A and a TMS38054 Token Ring transceiver can be tied to a single RJ45 allowing dual network support from a single connector. The LXT901A/907A AUI port is not used. The DSQE pin on the LXT907A is tied Low and the STP pin on the LXT901A is tied High.

Figure 10: 380C26 Interface for Dual Network Support of 10BASE-T and Token Ring



Manual Port Select with Link Test Function

With MD0 tied Low and MD1 tied High, the LXT901A/907A logic and framing are set to Mode 3 (compatible with Fujitsu MB86950 and MB86960, and Seeq 8005 controllers). Figure 11 shows the setup for Fujitsu controllers. Figure 12 shows the four inverters required to interface with

the Seeq 8005 controller. As in Figure 8 both these Mode 3 applications show the LI pin tied High, enabling Link Testing; and the STP (901A only) and NTH pins are both tied High, selecting the standard receiver threshold and 100 Ω termination for unshielded TP cable. However, in these applications AUTOSEL is tied Low, allowing external port selection through the PAUI pin.

Figure 11: LAN Adapter Board - Manual Port Select with Link Test Function

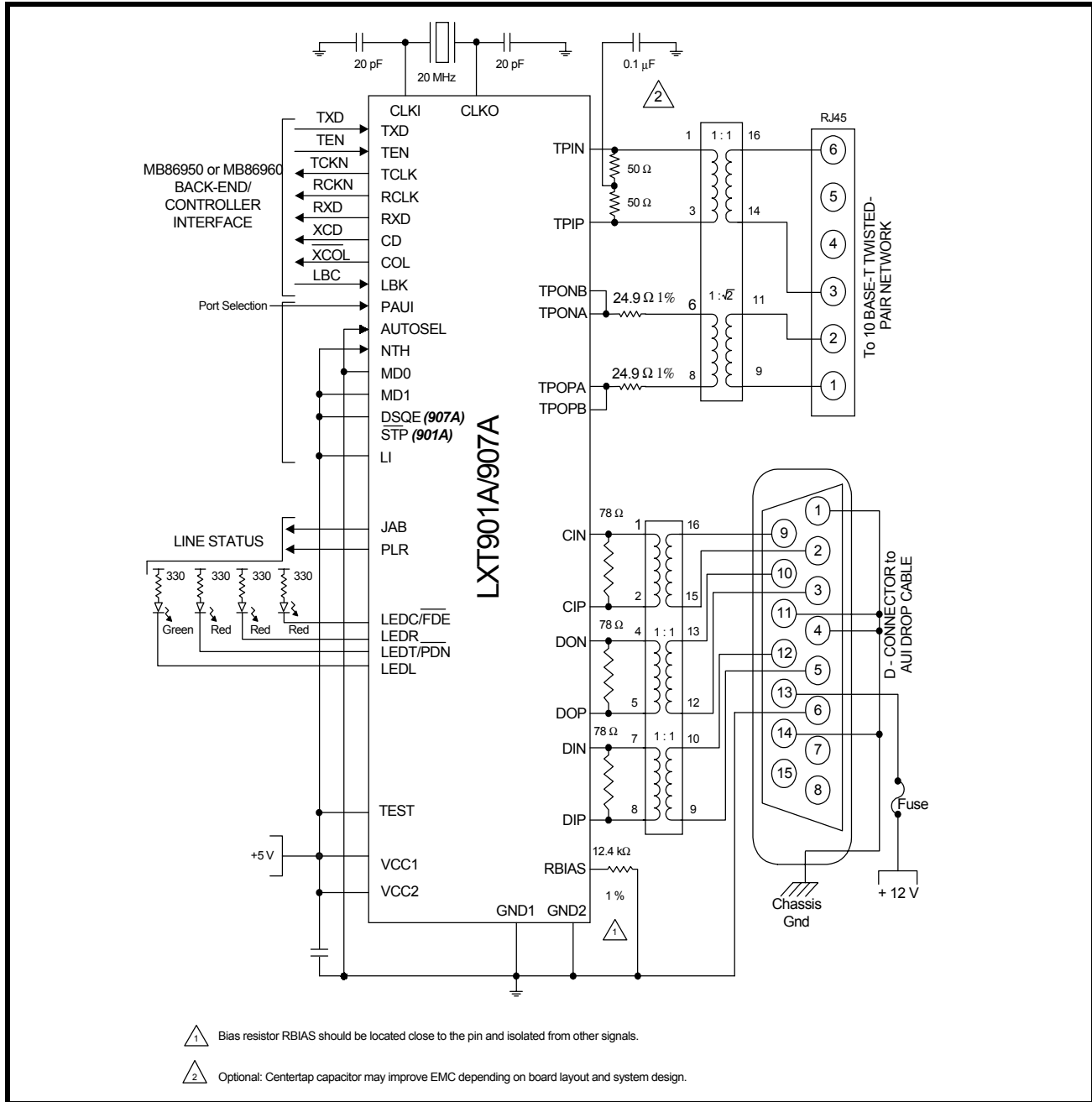
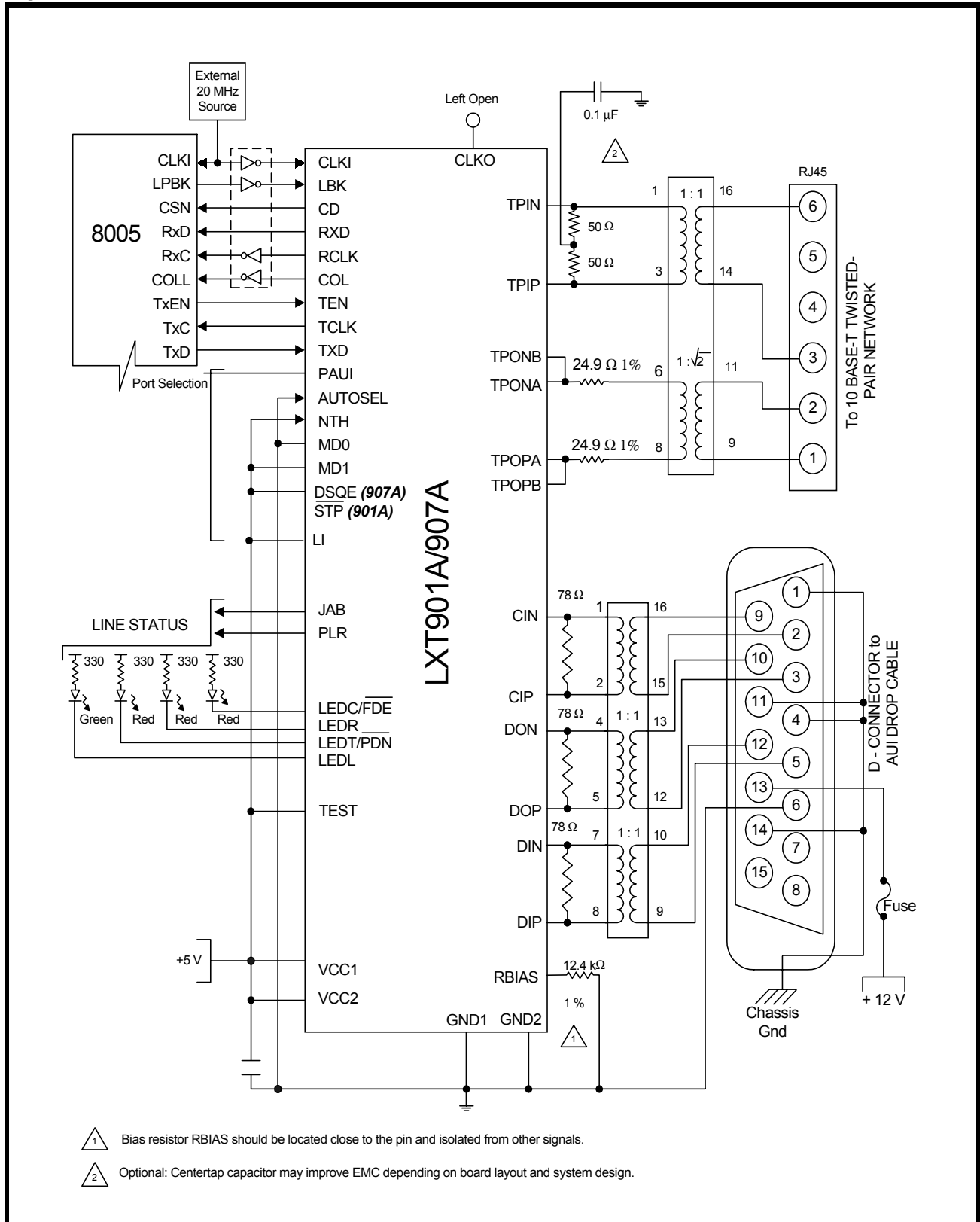


Figure 12: Manual Port Select with Seeq 8005 Controller

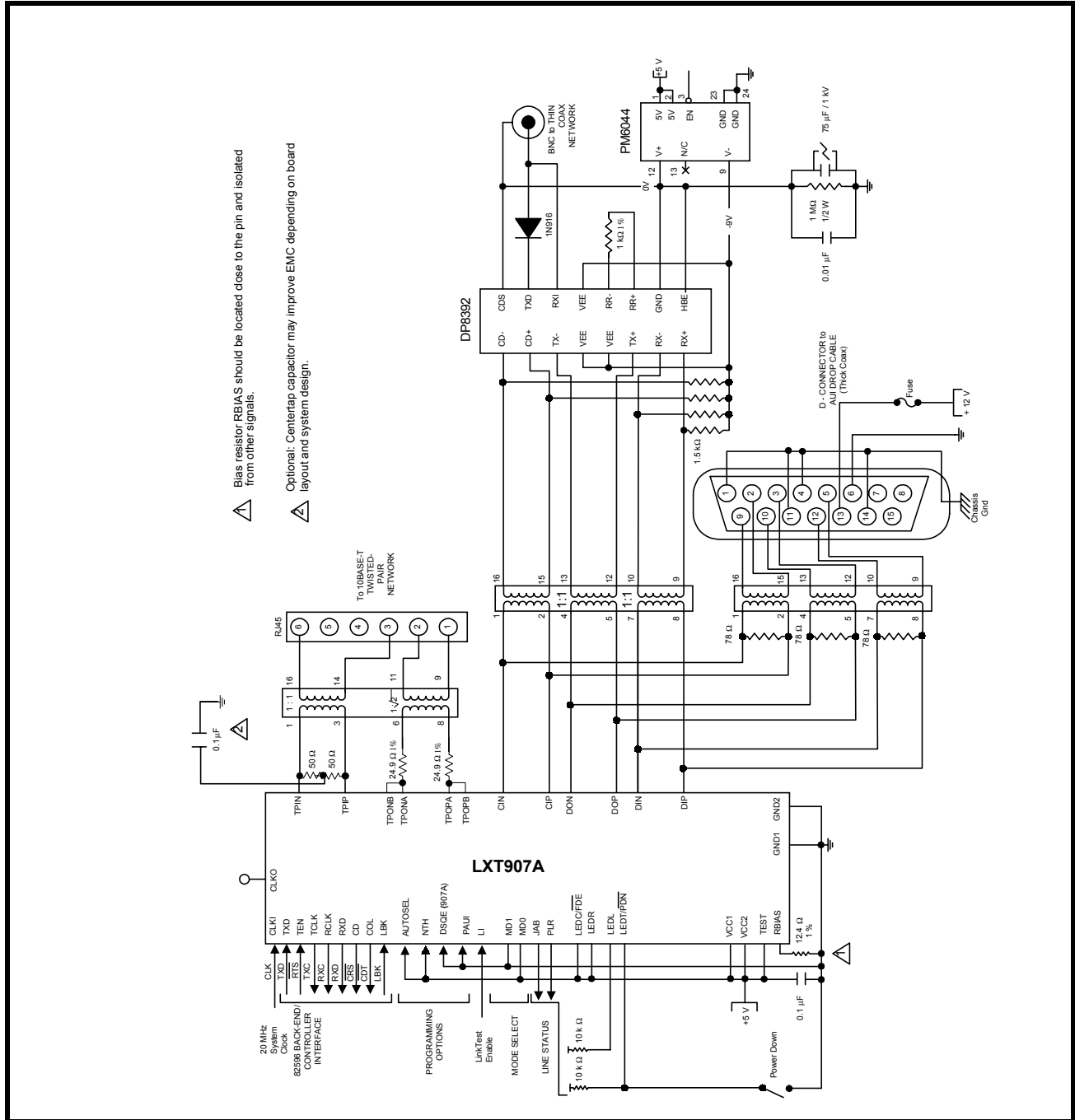


Three Media Application

Figure 13 shows the LXT907A in Mode 2 (compatible with Intel 82596 controllers) with additional media options for the AUI port. Two transformers are used to couple the AUI

port to either a D-connector or a BNC connector. A DP8392 coax transceiver with PM6044 power supply are required to drive the thin coax network through the BNC.

Figure 13: Three Media Application

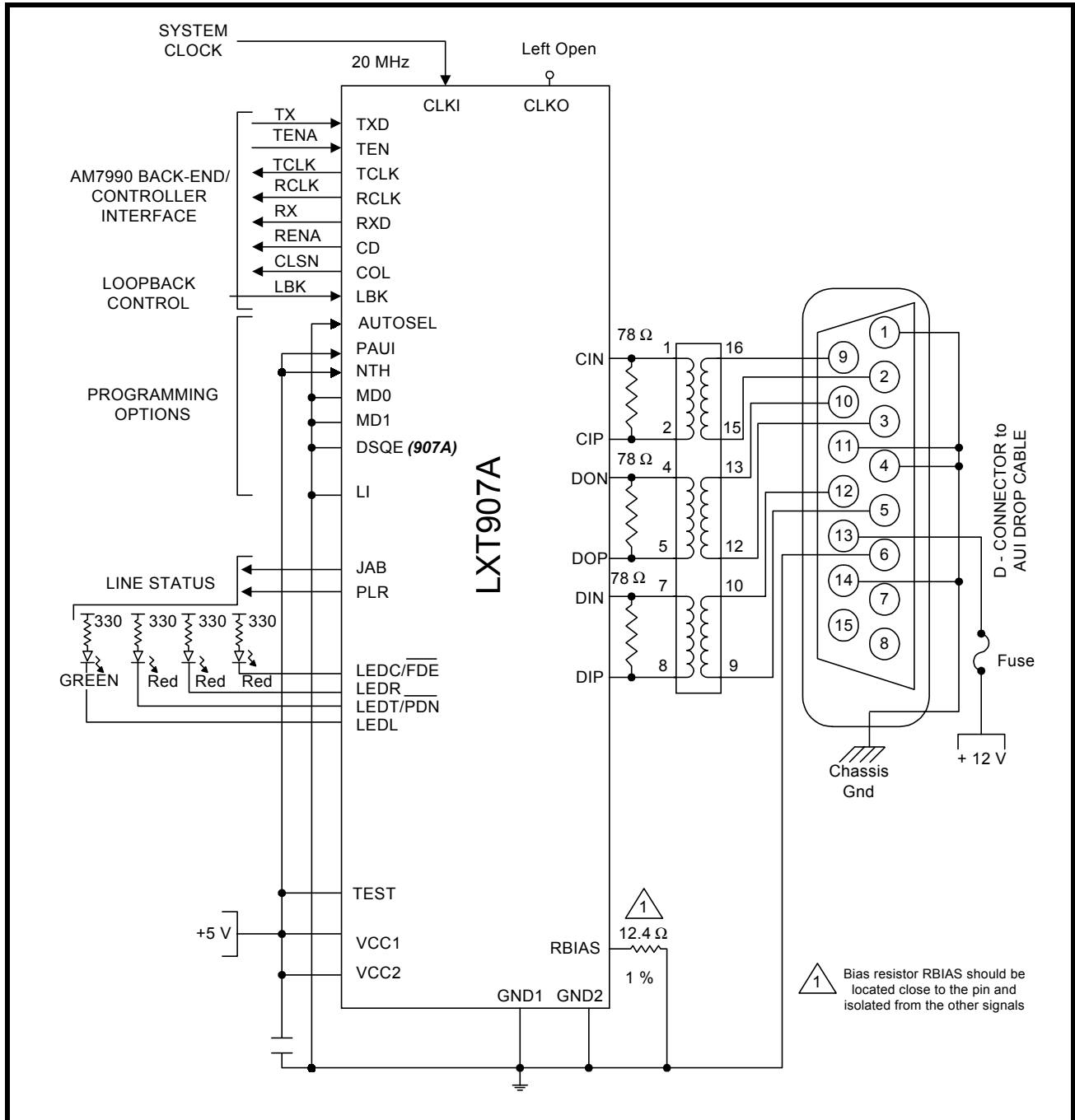


AUI Encoder/Decoder Only

In this application (see Figure 14) the DTE is connected to a coaxial network through the AUI. AUTOSEL is tied Low and PAUI is tied High to manually select the AUI port. The twisted-pair port is not used. With MD1 and MD0 both Low, the logic and framing are set to Mode 1 (compatible

with AMD AM7990 controllers). The LI pin is tied Low, disabling the link test function. The DSQE pin is also Low, enabling the SQE function on the LXT907A. The LBK input controls loopback. A 20 MHz system clock is supplied at CLK1 with CLK0 left open.

Figure 14: AUI Encoder/Decoder Only Application

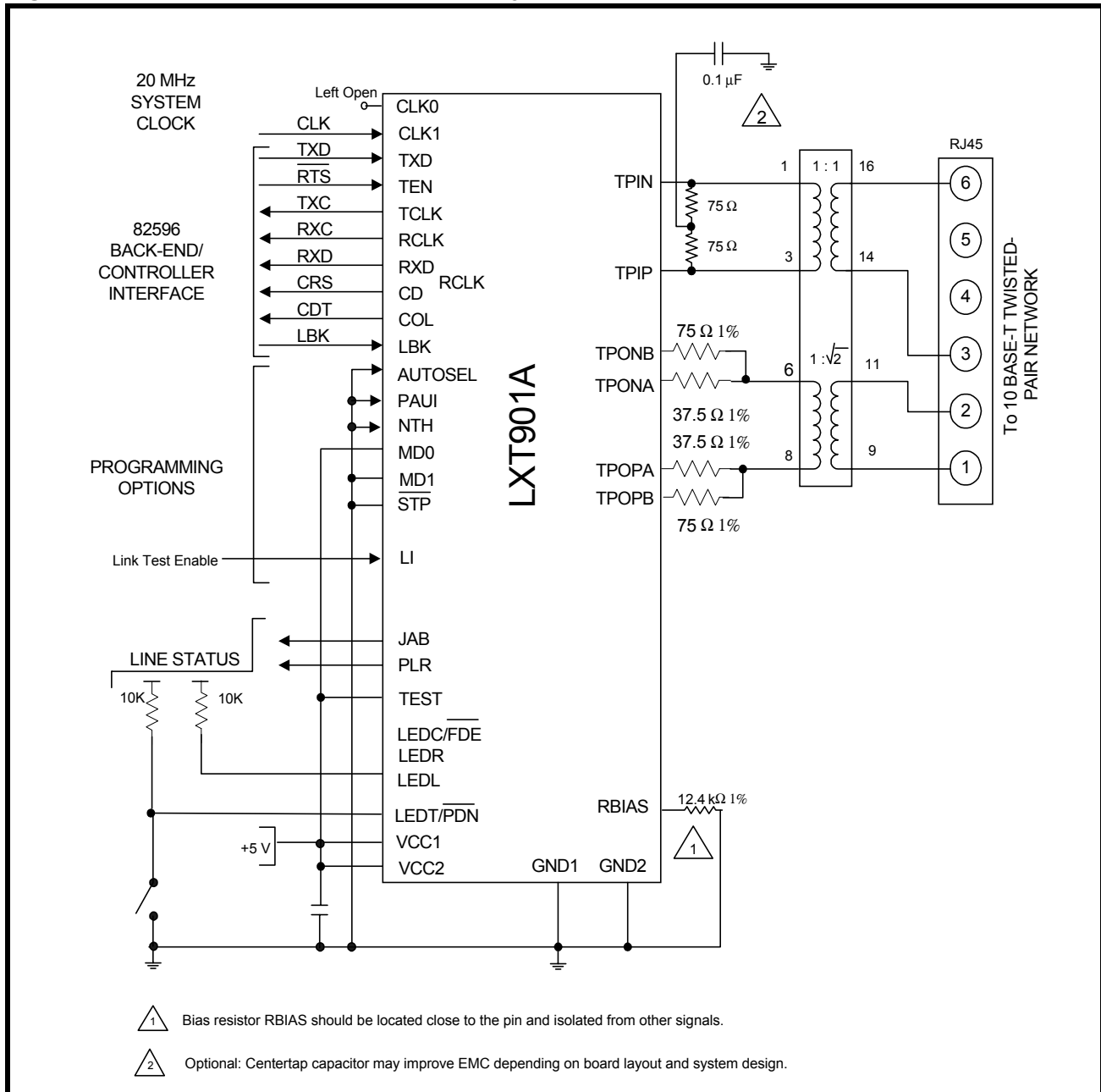


150 Ω Shielded Twisted-pair only (LXT901A only)

Figure 15 shows the LXT901A in a typical twisted-pair only application. The DTE is connected to a 10BASE-T network through the twisted-pair RJ45 connector. Note that the AUI port is not used. With MD0 tied High and MD1 Low, the LXT901A logic and framing are set to Mode 2 (compatible with Intel 82596 controllers).

A 20 MHz system clock input at CLK1 is used in place of the crystal oscillator. (CLK0 is left open). The L1 pin externally controls the link test function. The STP and NTH pins are both tied Low, selecting the reduced receiver threshold and 150 Ω termination for shielded TP cable. The switch at LEDT/PDN manually controls the power down mode.

Figure 15: 150 Ω Shielded Twisted-Pair Only Application (LXT901A)



TEST SPECIFICATIONS

NOTE

The minimum and maximum values in Tables 5 through 14 and Figures 16 through 41 represent the performance specifications of the LXT901A/907A and are guaranteed by test, except where noted by design.

Table 5: Absolute Maximum Values

| Parameter | Symbol | Min | Max | Units |
|-------------------------------|--------|------|------|-------|
| Supply voltage | VCC | -0.3 | 6 | V |
| Ambient operating temperature | TA | 0 | 70 | °C |
| Storage temperature | TSTG | -65 | +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 6: Recommended Operating Conditions

| Parameter | Symbol | Min | Typ | Max | Units |
|---|--------|------|-----|------|-------|
| Recommended supply voltage ¹ | VCC | 4.75 | 5.0 | 5.25 | V |
| Recommended operating temperature | TOP | 0 | – | 70 | °C |

1. Voltages with respect to ground unless otherwise specified. Power supply should be filtered to suppress high frequency transients, consistent with good PCB design.

Table 7: I/O Electrical Characteristics (Over Recommended Range)

| Parameter | | Sym | Min | Typ ¹ | Max | Units | Test Conditions |
|--|-----------------|------------------|-----|------------------|-------|------------------|---------------------------|
| Input Low voltage ² | | V _{IL} | – | – | 0.8 | V | |
| Input High voltage ² | | V _{IH} | 2.0 | – | – | V | |
| Output Low voltage | | V _{OL} | – | – | 0.4 | V | I _{OL} = 1.6 mA |
| | | V _{OL} | – | – | 10 | %V _{CC} | I _{OL} < 10 μA |
| Output Low voltage (Open drain LED driver) | | V _{OLL} | – | – | 0.7 | %V _{CC} | I _{OLL} = 10 mA |
| Output High voltage | | V _{OH} | 2.4 | – | – | V | I _{OH} = 40 μA |
| | | V _{OH} | 90 | – | – | %V _{CC} | I _{OH} < 10 μA |
| Output rise time | CMOS | – | – | 7 | 12 | ns | C _{LOAD} = 20 pF |
| TCLK & RCLK | TTL | – | – | 7 | 8 | ns | |
| Output fall time | CMOS | – | – | 7 | 12 | ns | C _{LOAD} = 20 pF |
| TCLK & RCLK | TTL | – | – | 7 | 8 | ns | |
| CLKI rise time (externally driven) | | – | – | – | 10 | ns | |
| CLKI duty cycle (externally driven) | | – | – | – | 40/60 | % | |
| Supply current | Normal Mode | I _{CC} | – | 65 | 85 | mA | Idle Mode |
| | | I _{CC} | – | 95 | 120 | mA | Transmitting on TP |
| | | I _{CC} | – | 95 | 120 | mA | Transmitting on AUI |
| | Power Down Mode | I _{CC} | – | 0.03 | 2 | mA | |

1. Typical values are at 25 °C and are for design aid only; not guaranteed and not subject to production testing.
 2. Limited functional tests are performed at these input levels. The majority of functional tests are performed at levels of 0V and 3V.

Table 8: AUI Electrical Characteristics (Over Recommended Range)

| Parameter | Symbol | Min | Typ ¹ | Max | Units | Test Conditions |
|--------------------------------|-----------------|------|------------------|-------|-------|-------------------------|
| Input Low current | I _{IL} | – | – | -700 | μA | |
| Input High current | I _{IH} | – | – | 500 | μA | |
| Differential output voltage | V _{OD} | ±550 | – | ±1200 | mV | |
| Differential squelch threshold | V _{DS} | 150 | 250 | 350 | mV | 5 MHz square wave input |

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

Table 9: TP Electrical Characteristics (Over Recommended Range)

| Parameter | | Symbol | Min | Typ ¹ | Max | Units | Test Conditions |
|--|----------------------------|------------------|-----|------------------|------|-------|--|
| Transmit output impedance | | Z _{OUT} | – | 5 | – | Ω | |
| Transmit timing jitter addition ² | | – | – | ±3.3 | ±10 | ns | 0 line length for internal MAU |
| Transmit timing jitter added by the MAU and PLS sections ^{2, 3} | | – | – | ±3.3 | ±5.5 | ns | After line model specified by IEEE 802.3 for 10BASE-T internal MAU |
| Receive input impedance | | Z _{IN} | – | 20 | – | kΩ | Between TPIP/TPIN, CIP/CIN & DIP/DIN |
| Differential squelch Threshold | Normal threshold; NTH = 1 | V _{DS} | 300 | 400 | 585 | mV | 5 MHz square wave input |
| | Reduced threshold; NTH = 0 | V _{DS} | 180 | 250 | 345 | mV | 5 MHz square wave input |

1. Typical values are at 25 °C and are for design aid only; not guaranteed and not subject to production testing.
 2. Parameter is guaranteed by design; not subject to production testing.
 3. IEEE 802.3 specifies maximum jitter additions at 1.5 ns for the AUI cable, 0.5 ns from the encoder, and 3.5 ns from the MAU.

Table 10: Switching Characteristics (Over Recommended Range)

| Parameter | Symbol | Minimum | Typical ¹ | Maximum | Units |
|-----------------------|------------------------|---------|----------------------|---------|--------|
| Jabber Timing | Maximum transmit time | – | 20 | – | 150 ms |
| | Unjab time | – | 250 | – | 750 ms |
| Link Integrity Timing | Time link loss receive | – | 50 | – | 150 ms |
| | Link min receive | – | 2 | – | 7 ms |
| | Link max receive | – | 50 | – | 150 ms |
| | Link transmit period | – | 8 | 10 | 24 ms |

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

Table 11: RCLK/Start-of-Frame Timing (Over Recommended Range)

| Parameter | | Symbol | Minimum | Typical ¹ | Maximum | Units |
|---|------------------|--------|---------|----------------------|---------|-------|
| Decoder acquisition time | AUI | tDATA | – | 900 | 1100 | ns |
| | TP | tDATA | – | 1200 | 1500 | ns |
| CD turn-on delay | AUI | tCD | – | 25 | 200 | ns |
| | TP | tCD | – | 425 | 550 | ns |
| Receive data setup from RCLK | Mode 1 | trDS | 60 | 70 | – | ns |
| | Modes 2, 3 and 4 | trDS | 30 | 45 | – | ns |
| Receive data hold from RCLK | Mode 1 | trDH | 10 | 20 | – | ns |
| | Modes 2, 3 and 4 | trDH | 30 | 45 | – | ns |
| RCLK shut off delay from CD assert (LXT907A only; Mode 3) | | tsws | – | ±100 | – | ns |

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

Table 12: RCLK/End-of-Frame Timing (Over Recommended Range)

| Parameter | Type | Sym | Mode 1 | Mode 2 | Mode 3 | Mode 4 | Units |
|--|------------------|--------|--------|--------|----------|--------|-------|
| RCLK after CD off | Min | tRC | 5 | 1 | 27 | 5 | BT |
| Rev data throughput delay | Max | trD | 400 | 375 | 375 | 375 | ns |
| CD turn off delay ² | Max | tCDOFF | 500 | 475 | 475 | 475 | ns |
| Receive block out after TEN off | Typ ¹ | tIFG | 5 | 50 | – | – | BT |
| RCLK switching delay after CD off (LXT907A only; Mode 3) | Typ ¹ | tsWE | – | – | 120(±80) | – | ns |

1. Typical values are at 25° C and are for design aid only; not guaranteed and not subject to production testing.
 2. CD turn-off delay measured from middle of last bit; timing specification is unaffected by the value of the last bit.

Table 13: Transmit Timing (Over Recommended Range)

| Parameter | Symbol | Minimum | Typical ¹ | Maximum | Units |
|----------------------------------|--------|---------|----------------------|---------|-------|
| TEN setup from TCLK | tEHCH | 22 | – | – | ns |
| TXD setup from TCLK | tDSCH | 22 | – | – | ns |
| TEN hold after TCLK | tCHEL | 5 | – | – | ns |
| TXD hold after TCLK | tCHDU | 5 | – | – | ns |
| Transmit start-up delay - AUI | tSTUD | – | 220 | 450 | ns |
| Transmit start-up delay - TP | tSTUD | – | 430 | 450 | ns |
| Transmit through-put delay - AUI | tTPD | – | – | 300 | ns |
| Transmit through-put delay - TP | tTPD | – | 300 | 350 | ns |

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

Table 14: Collision, COL/CI Output and Loopback Timing (Over Recommended Range)

| Parameter | Symbol | Minimum | Typical ¹ | Maximum | Units |
|-------------------------------|---------|---------|----------------------|---------|-------|
| COL turn-on delay | tCOLD | – | 40 | 500 | ns |
| COL turn-off delay | tCOLOFF | – | 420 | 500 | ns |
| COL (SQE) Delay after TEN off | tSQED | 0.65 | 1.2 | 1.6 | μs |
| COL (SQE) Pulse Duration | tSQEP | 500 | 1000 | 1500 | ns |
| LBK setup from TEN | tKHEH | 10 | 25 | – | ns |
| LBK hold after TEN | tKHEL | 10 | 0 | – | ns |

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

Timing Diagrams for Mode 1 (MD1 = Low, MD0 = Low) Figures 16 through 21

Figure 16: Mode 1 RCLK/Start-of-Frame Timing

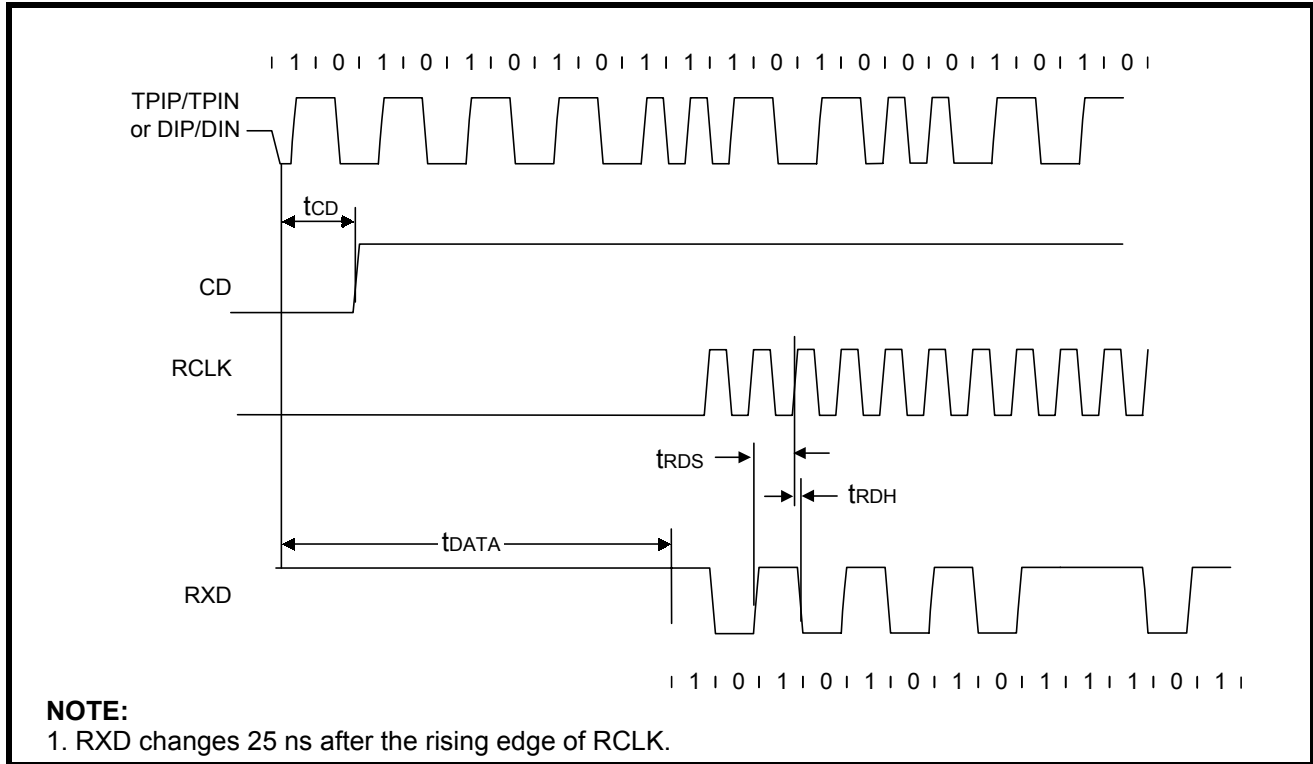


Figure 17: Mode 1 RCLK/End-of-Frame Timing

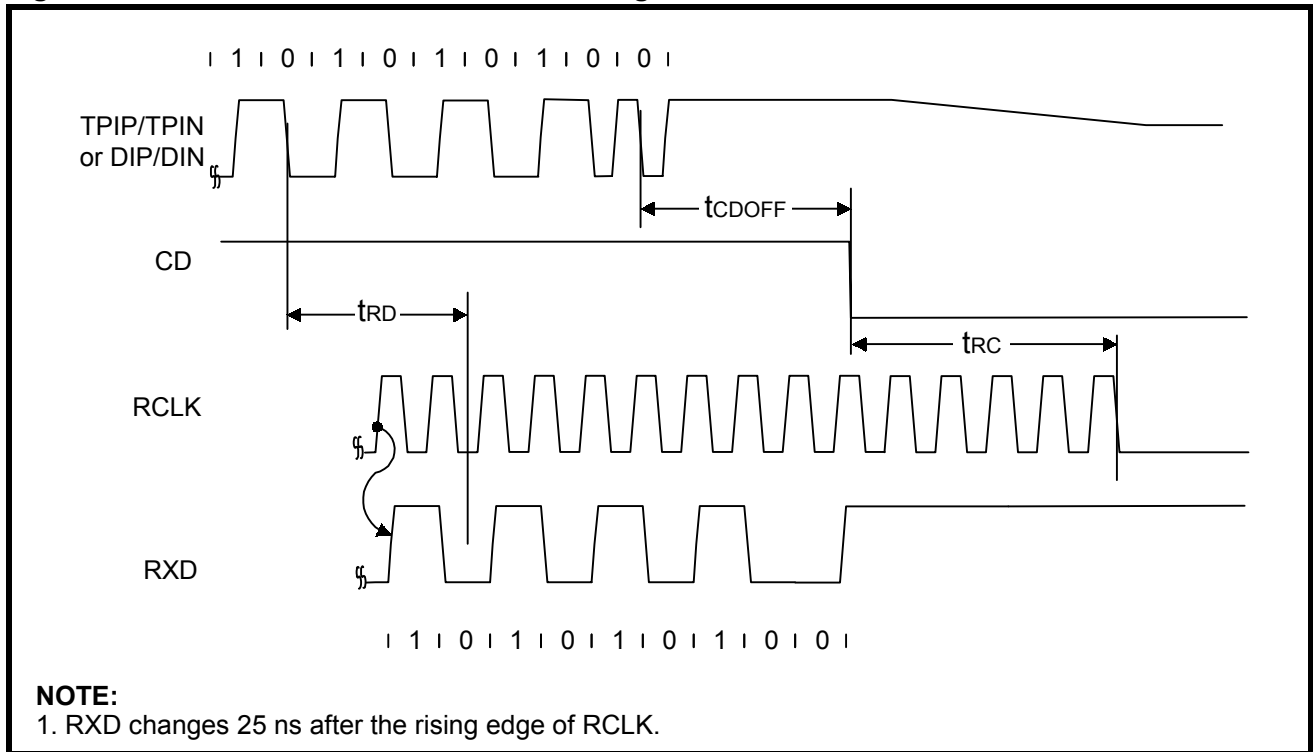


Figure 18: Mode 1 Transmit Timing

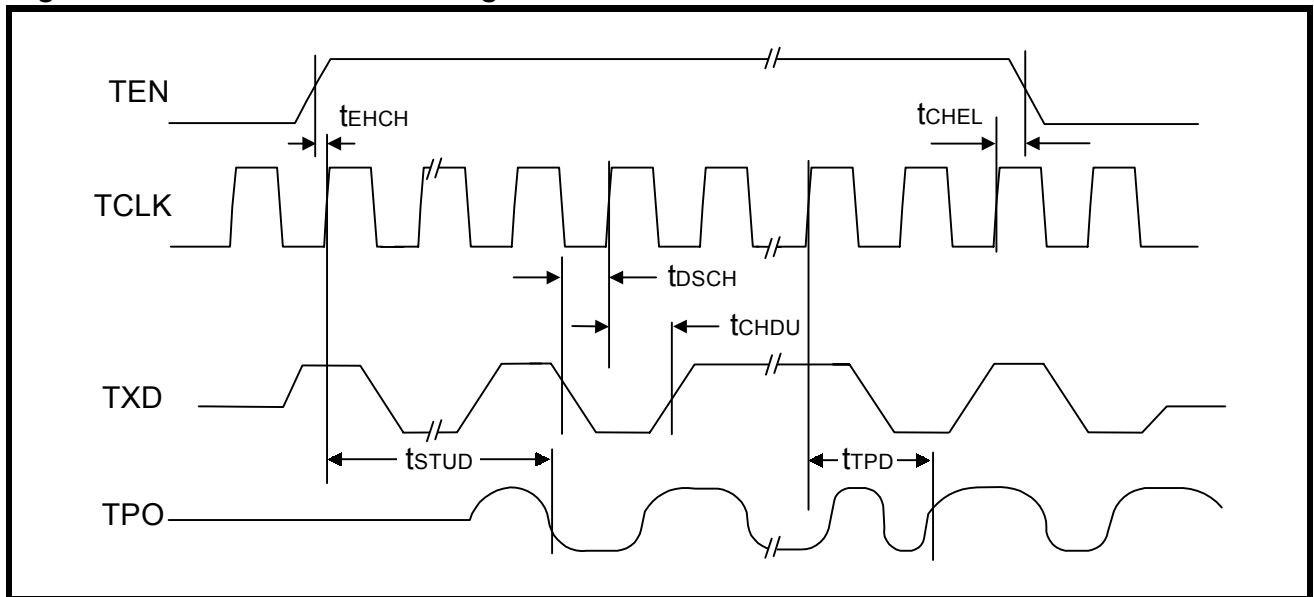


Figure 19: Mode 1 Collision Detect Timing

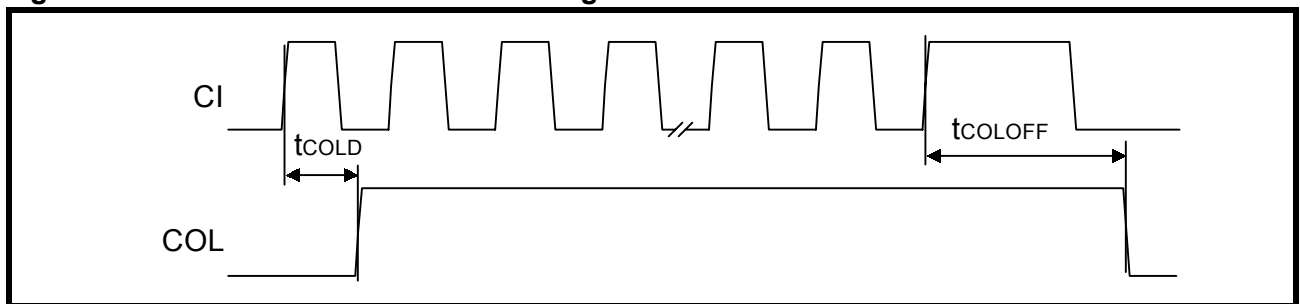


Figure 20: Mode 1 COL/CI Output Timing

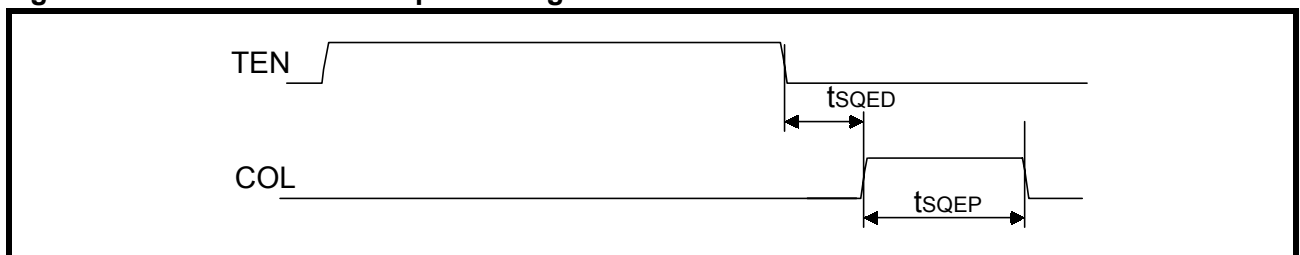
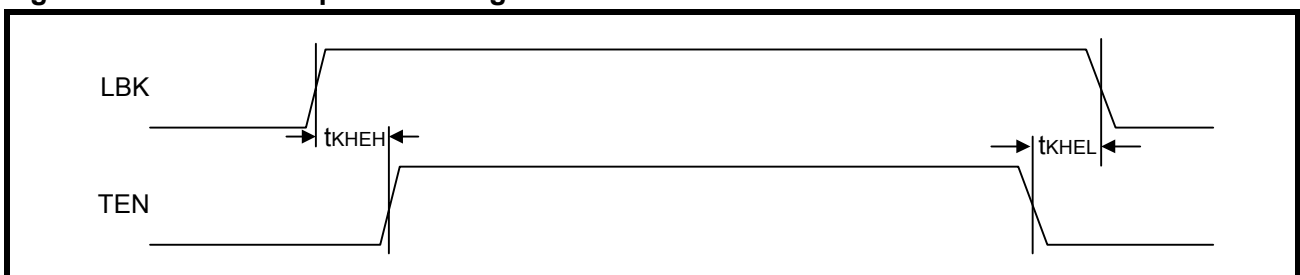


Figure 21: Mode 1 Loopback Timing



Timing Diagrams for Mode 2 (MD1=Low, MD0=High) Figures 22 through 27

Figure 22: Mode 2 RCLK/Start-of-Frame Timing

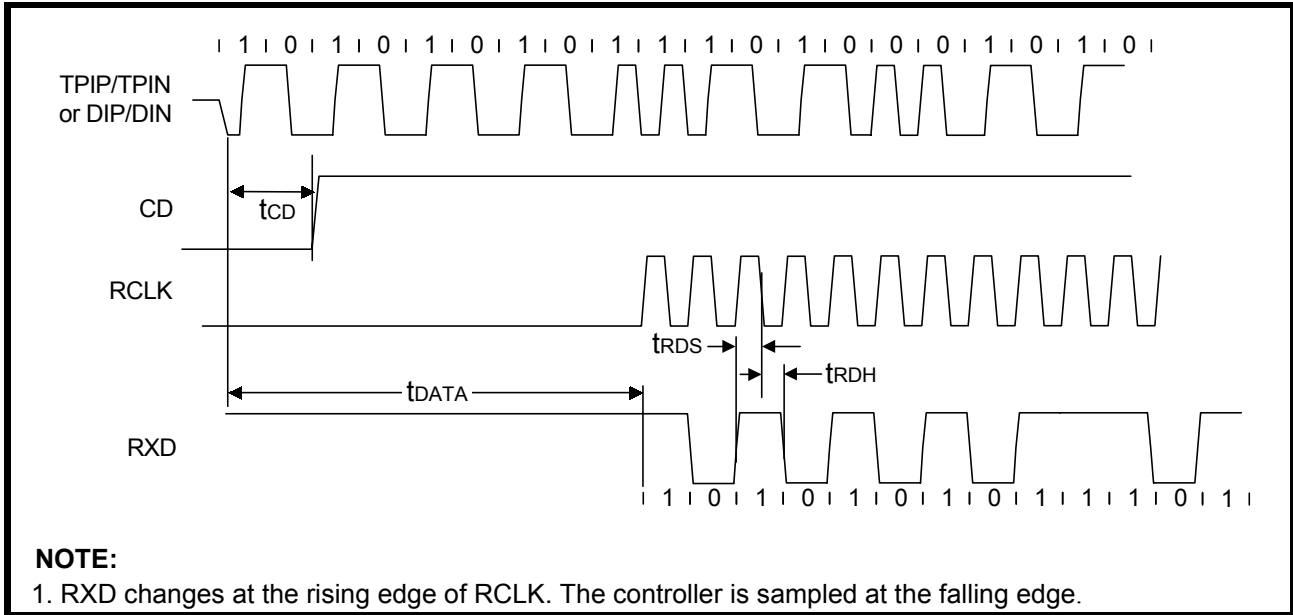


Figure 23: Mode 2 RCLK/End-of-Frame Timing

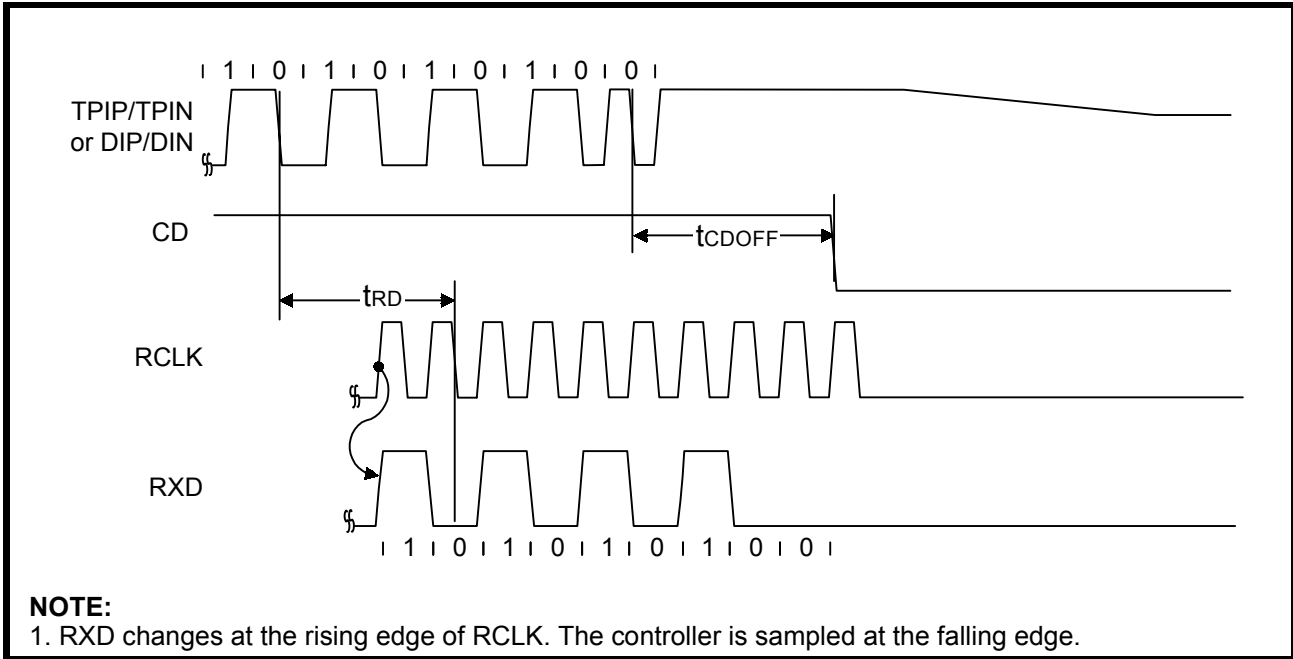


Figure 24: Mode 2 Transmit Timing

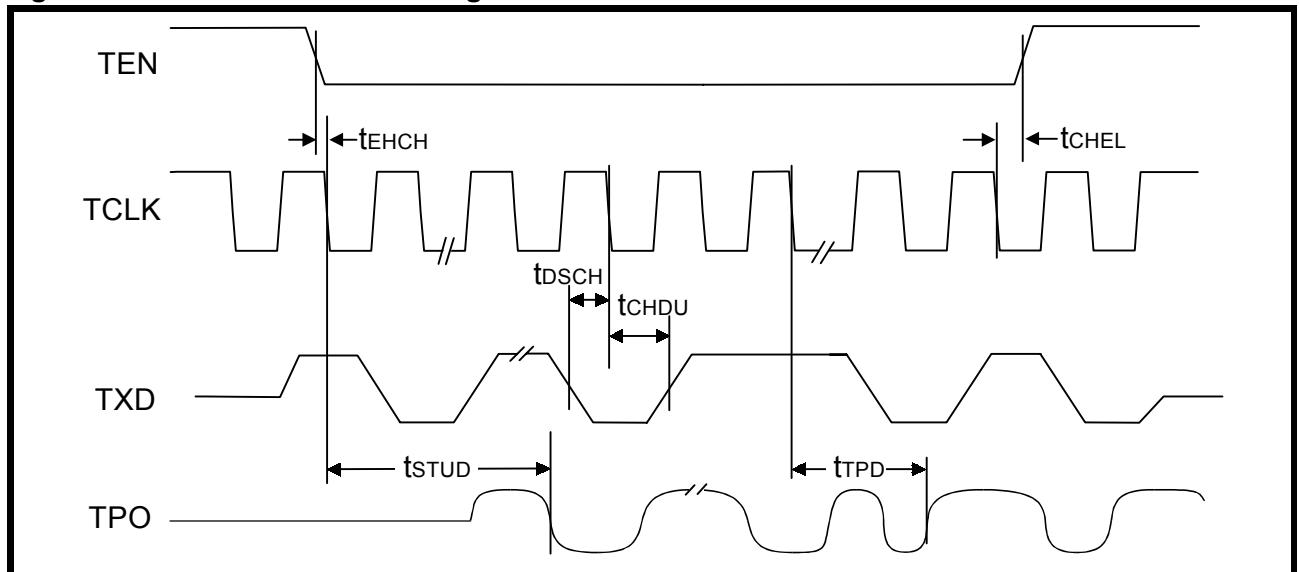


Figure 25: Mode 2 Collision Detect Timing

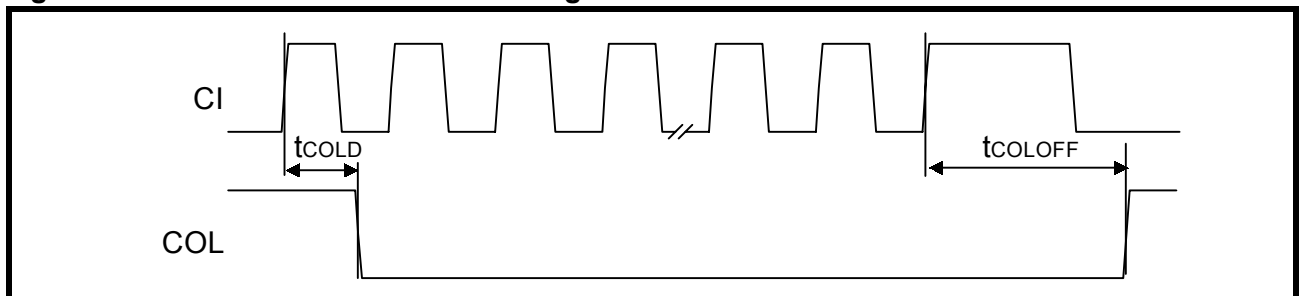


Figure 26: Mode 2 COL/CI Output Timing

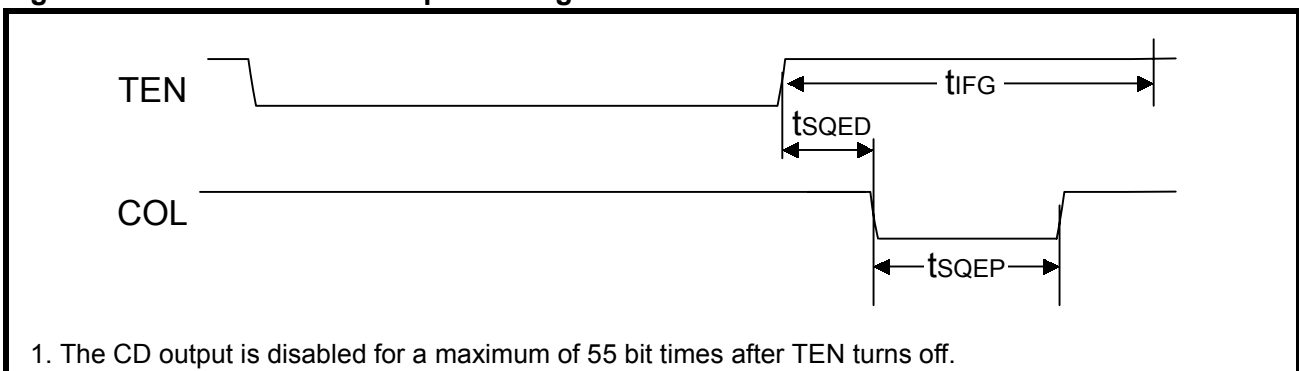
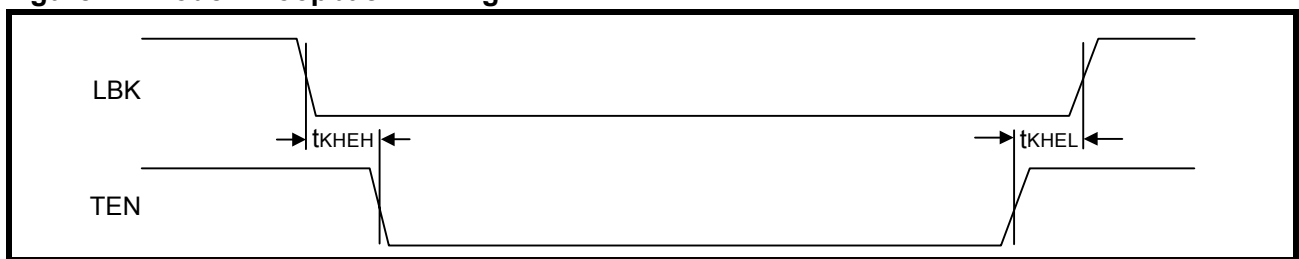


Figure 27: Mode 2 Loopback Timing



Timing Diagrams for Mode 3 (MD1 = High, MD0 = Low) Figures 28 through 35

Figure 28: Mode 3 RCLK/Start-of-Frame Timing (LXT901A)

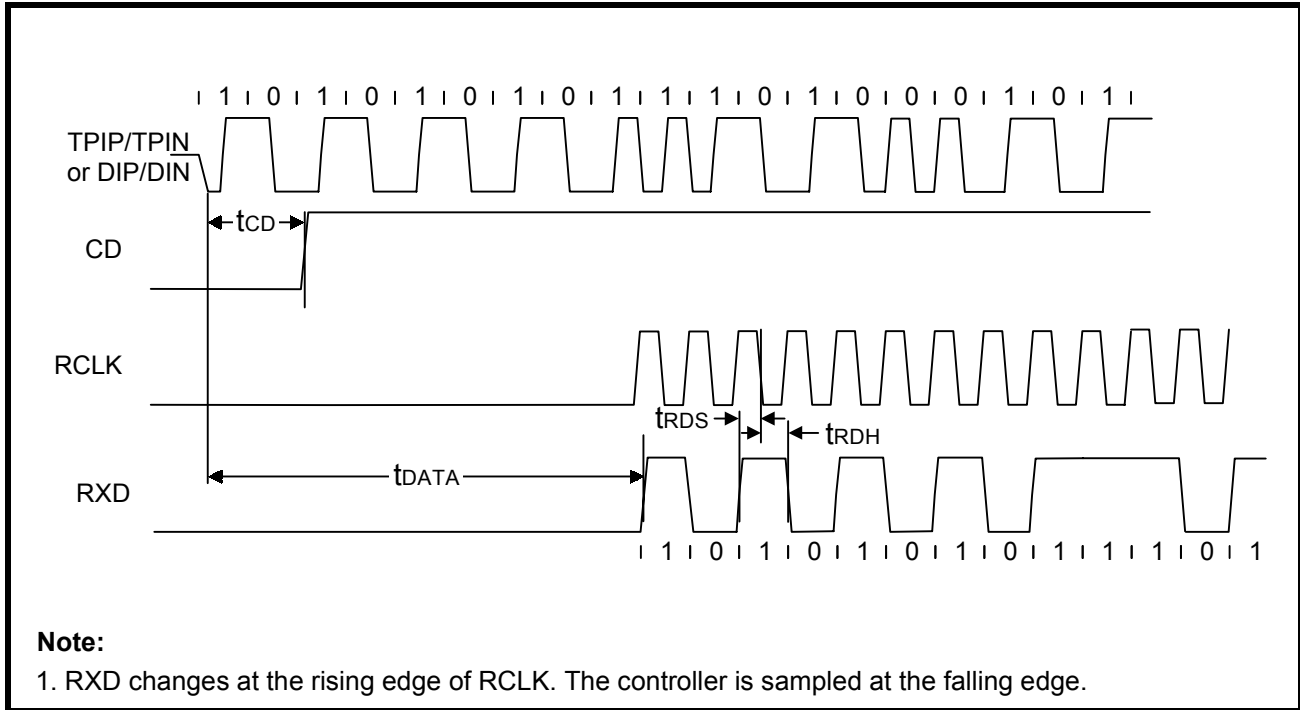


Figure 29: Mode 3 RCLK/End-of-Frame Timing (LXT901A)

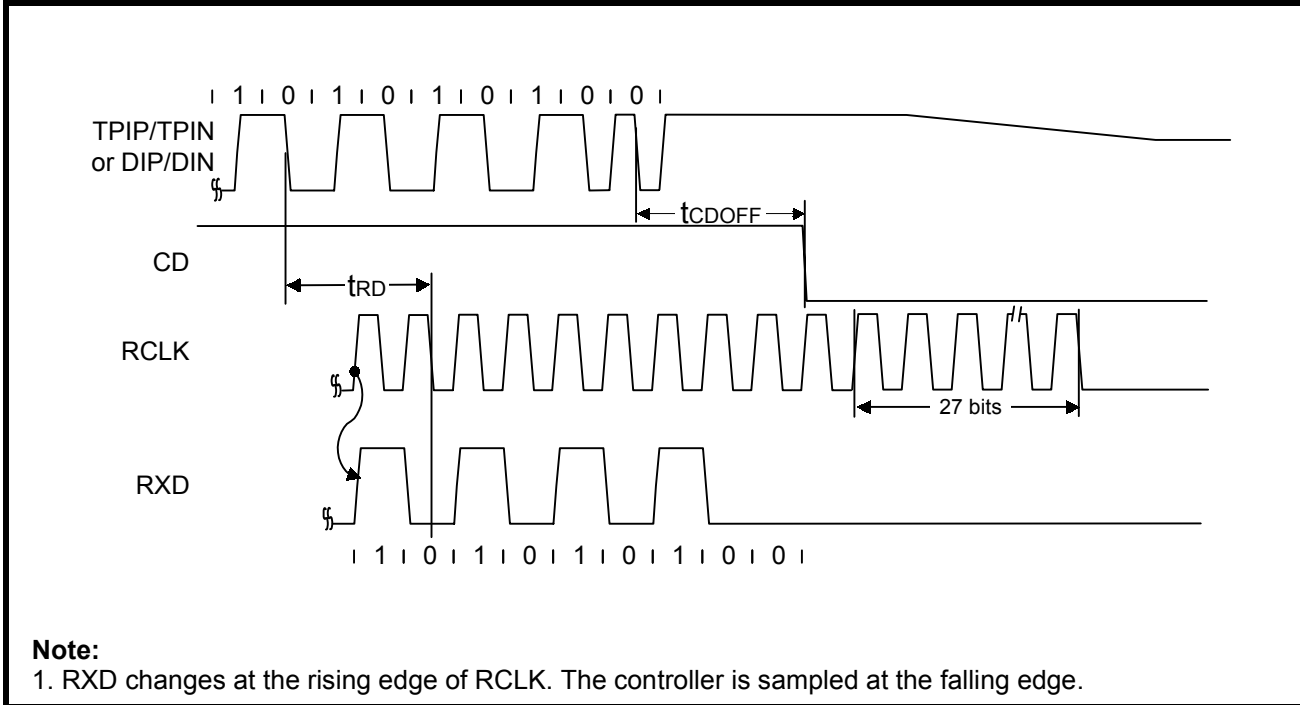


Figure 30: Mode 3 RCLK/Start-of-Frame Timing (LXT907A)

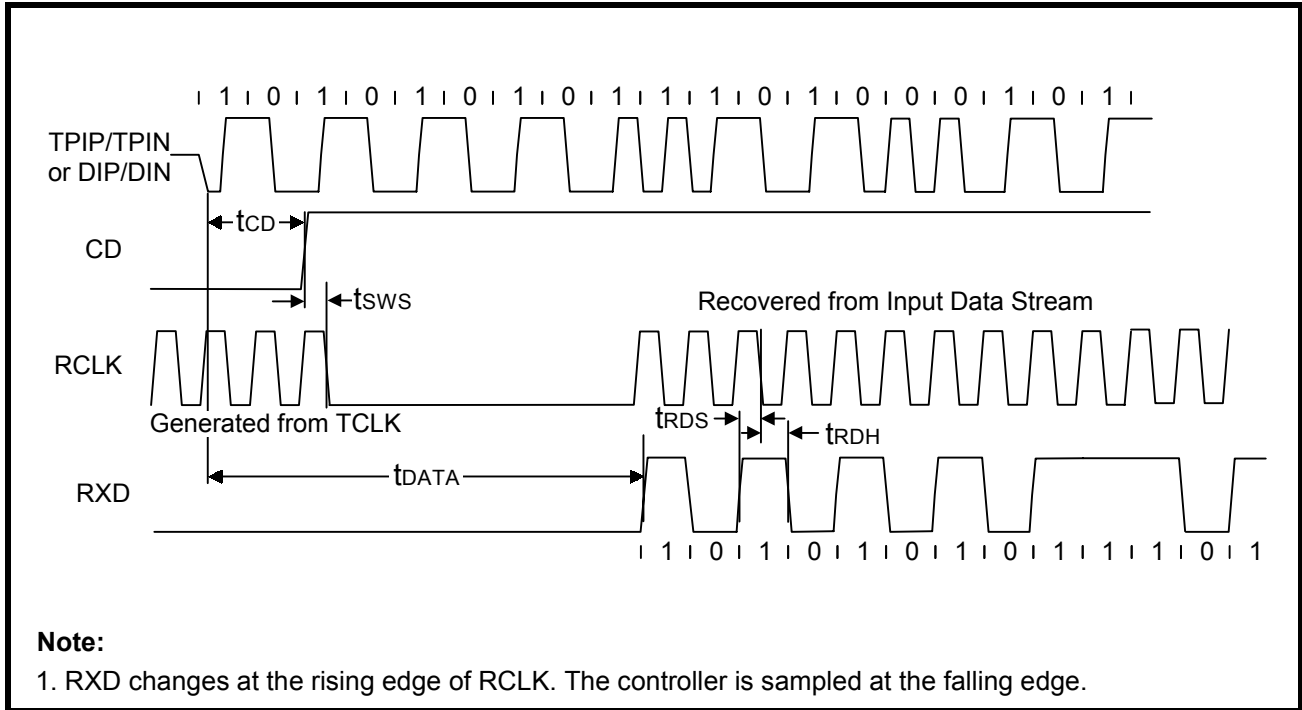


Figure 31: Mode 3 RCLK/End-of-Frame Timing (LXT907A)

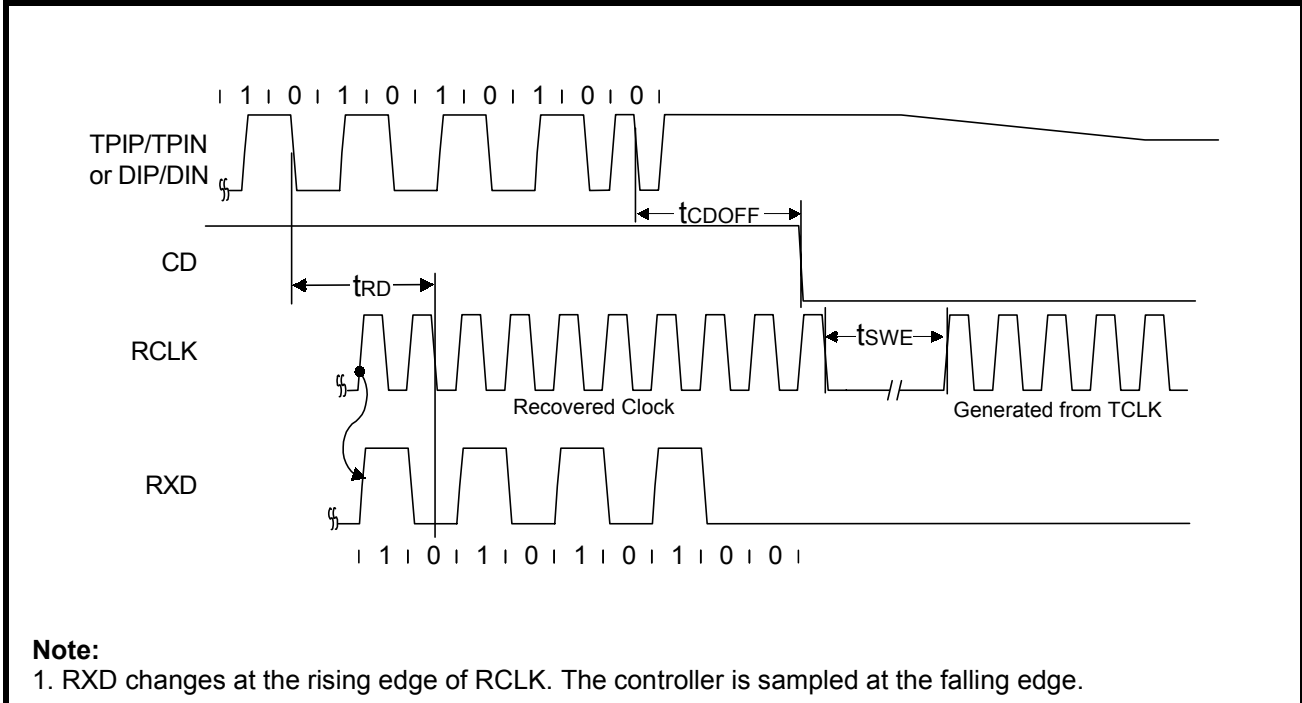


Figure 32: Mode 3 Transmit Timing

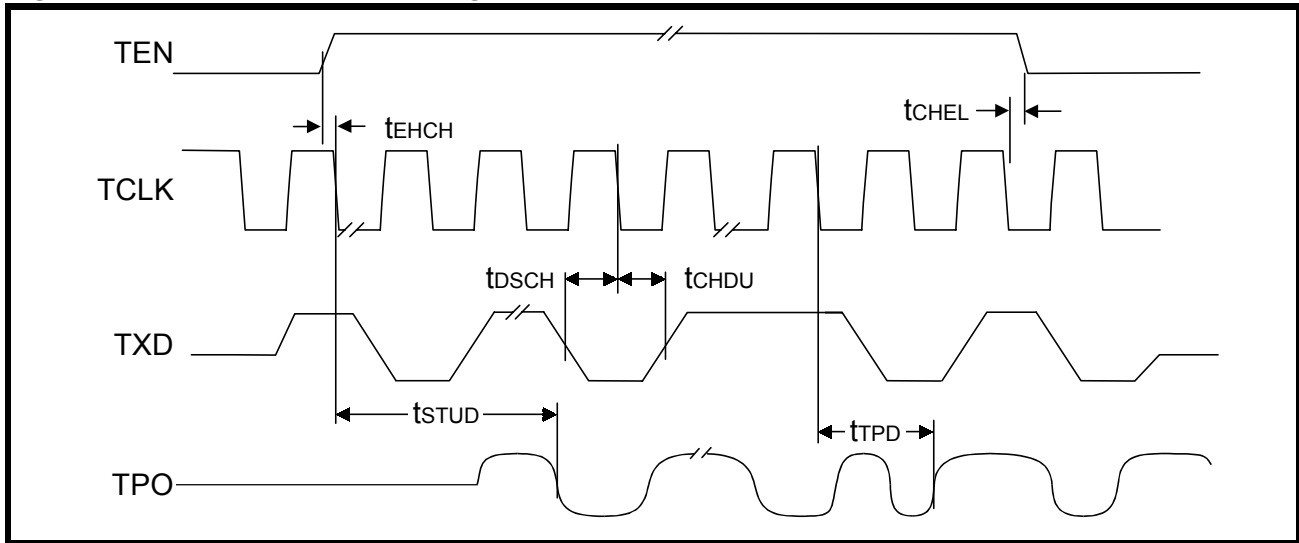


Figure 33: Mode 3 Collision Detect Timing

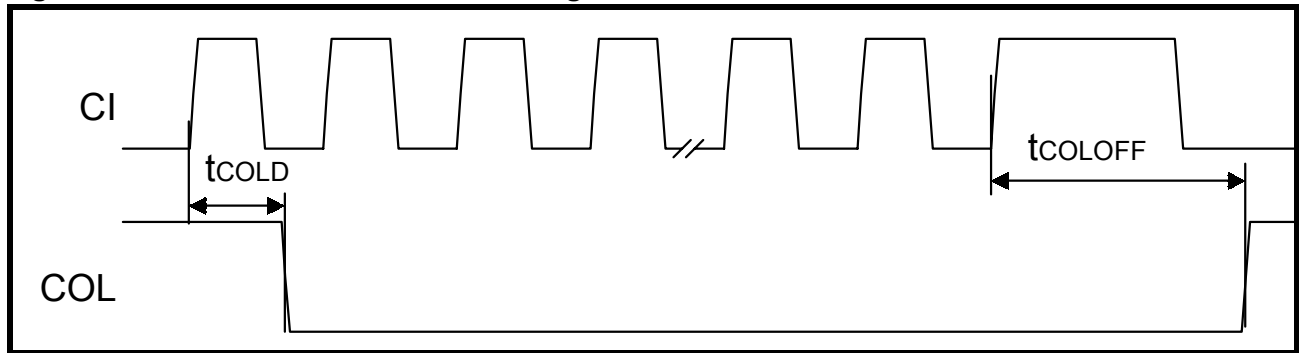


Figure 34: Mode 3 COL/CI Output Timing

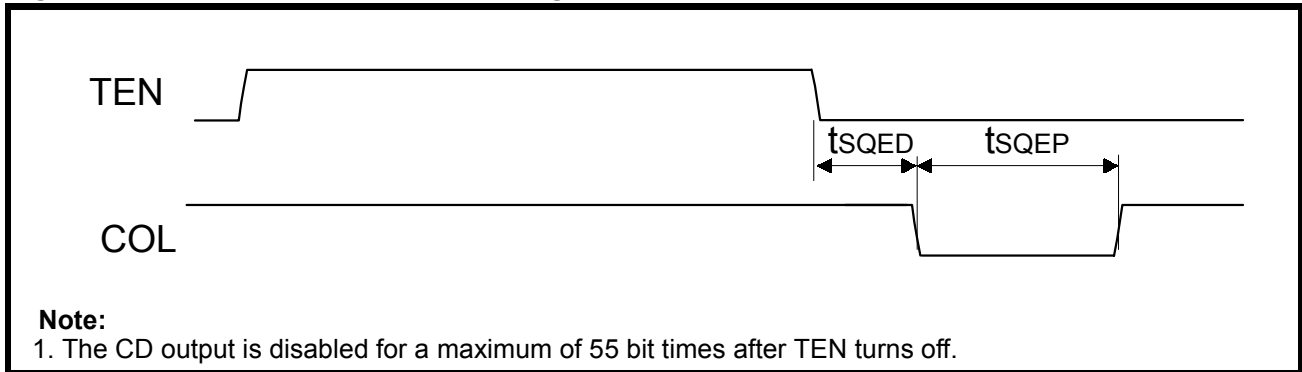
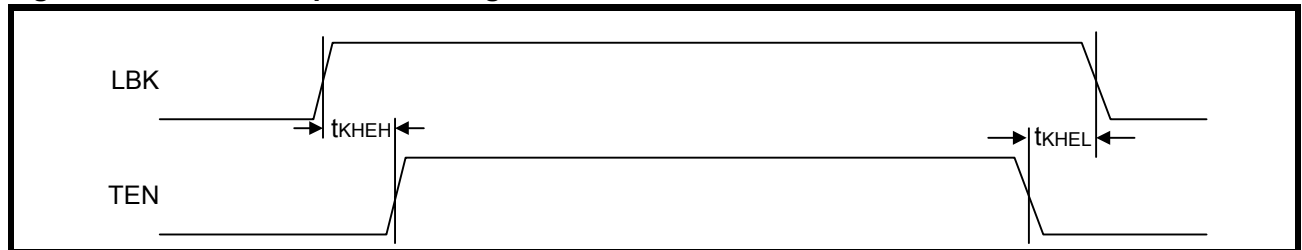


Figure 35: Mode 3 Loopback Timing



Timing Diagrams for Mode 4 (MD1 = High, MD0 = High) Figures 36 through 41

Figure 36: Mode 4 RCLK/Start-of-Frame Timing

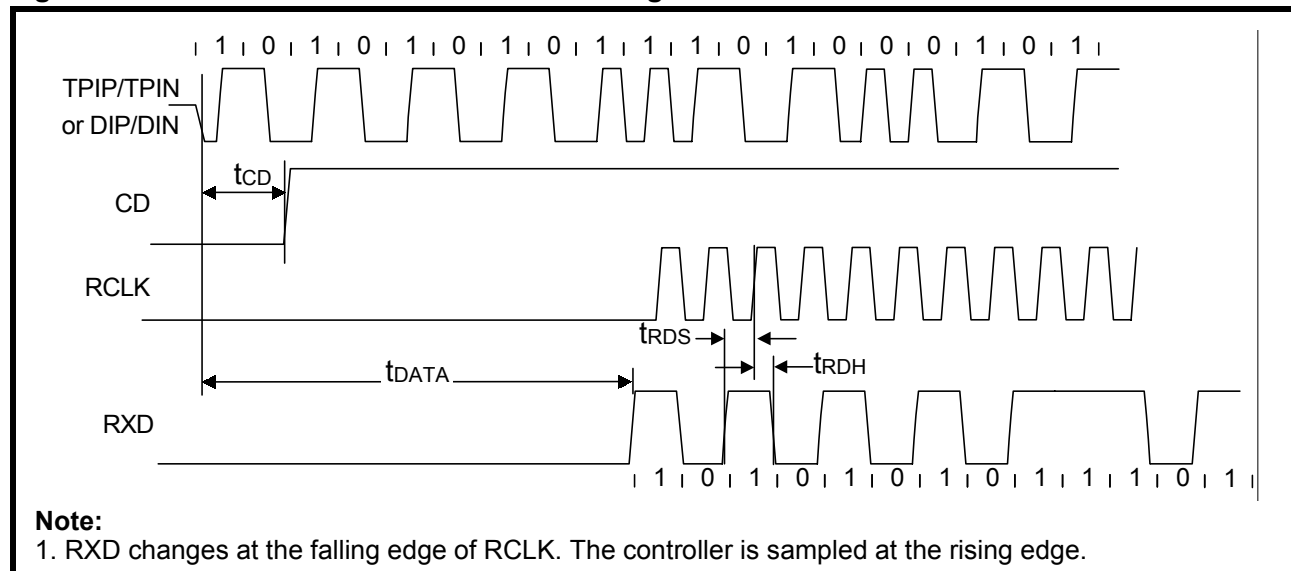


Figure 37: Mode 4 RCLK/End-of-Frame Timing

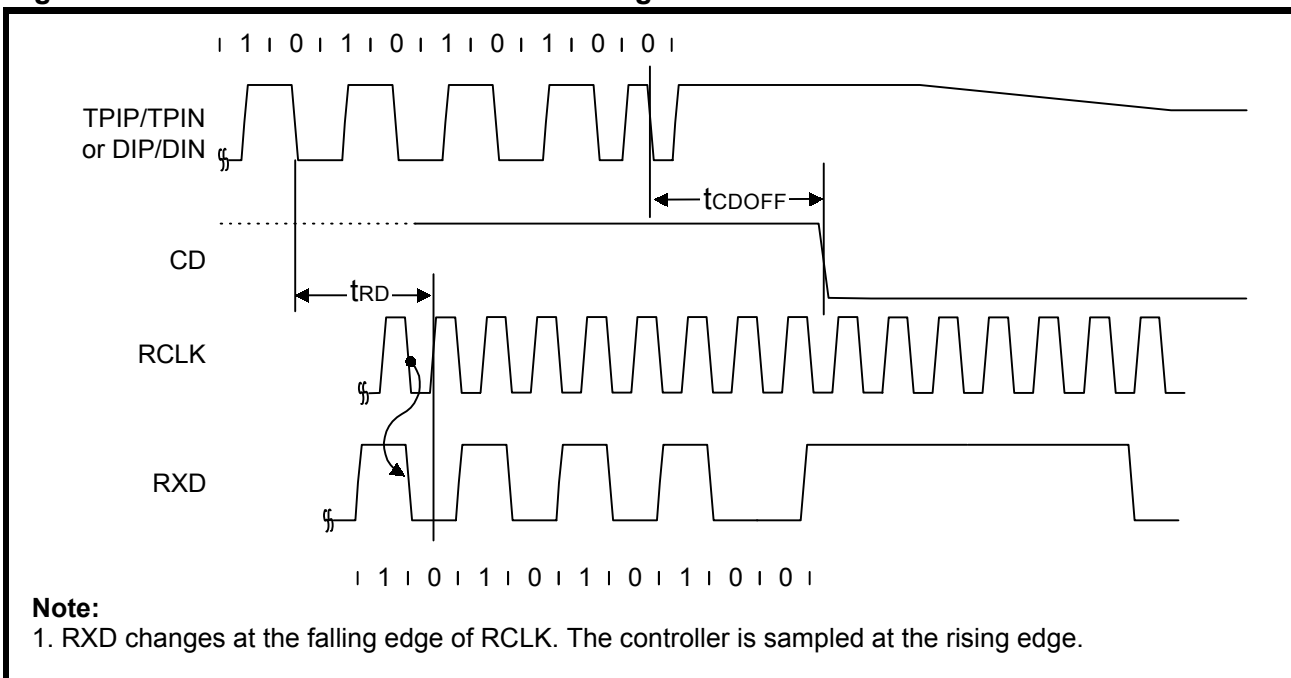


Figure 38: Mode 4 Transmit Timing

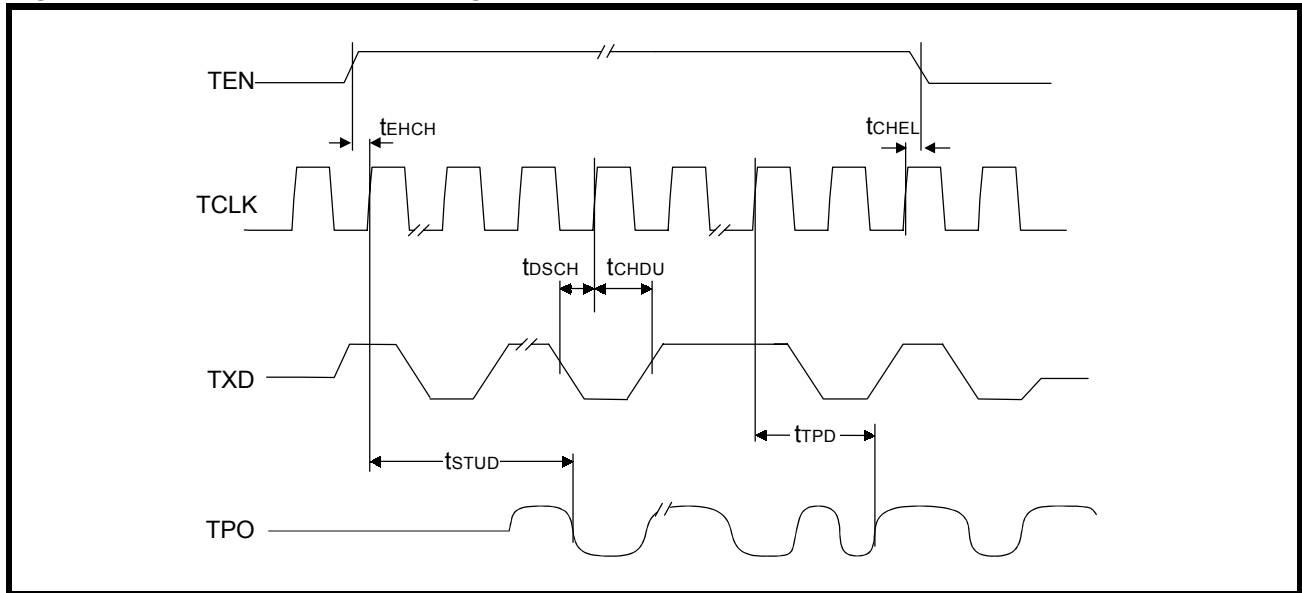


Figure 39: Mode 4 Collision Detect Timing

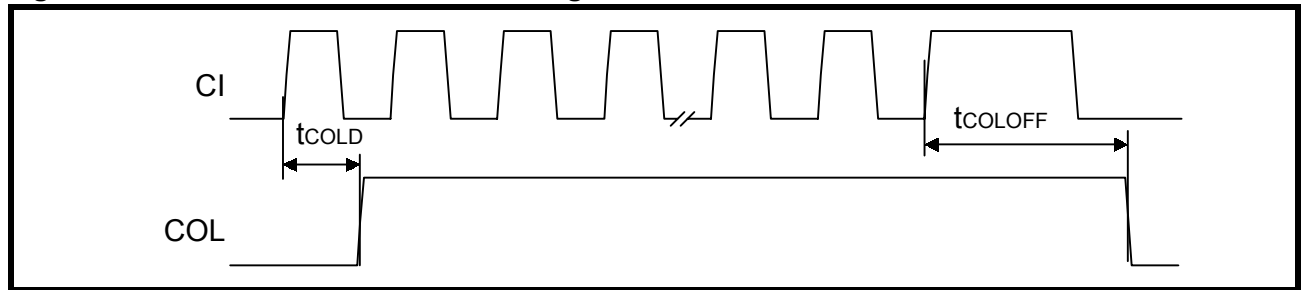


Figure 40: Mode 4 COL/CI Output Timing

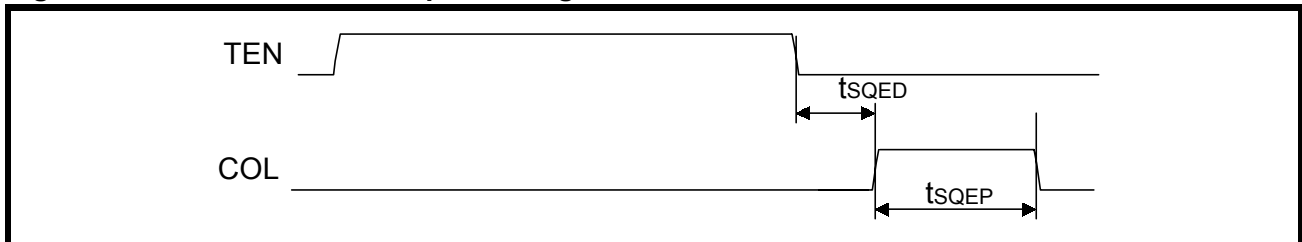
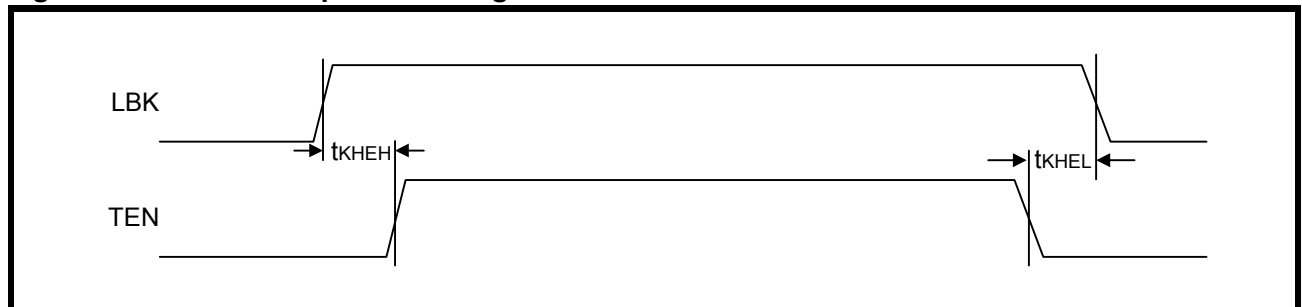


Figure 41: Mode 4 Loopback Timing



NOTES
