

DP83959 8-Port Lite Ethernet Repeater Interface Controller

General Description

The DP83959 8-Port Lite Ethernet Repeater Interface Controller (LERIC8) is a single chip solution for unmanaged 10BASE-T Ethernet repeater (hub) products. By integrating electronics needed to support eight 10BASE-T ports, a full level/drive compatible AUI port for a backbone connection, and an internal power on reset circuit, a LERIC8 based design requires only the addition of a few passive components: crystal, transformers, connectors and a power source.

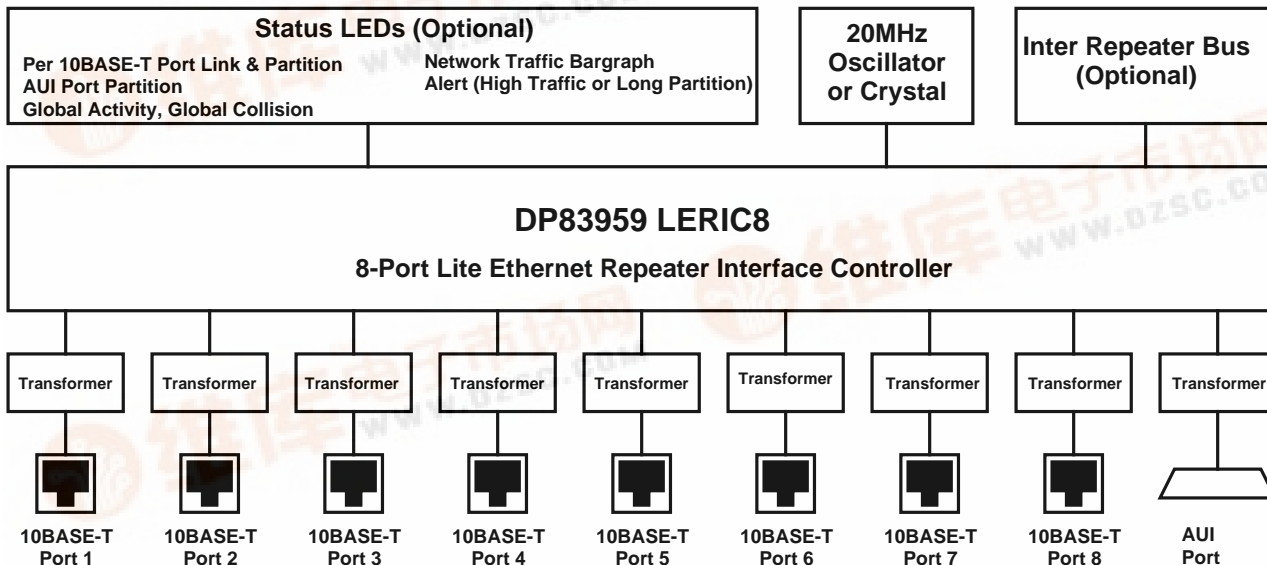
The LERIC8 provides on-chip LED drivers that connect directly to LEDs via series resistors. In addition to the Link OK, Port Partition, Global Activity and Global Collision LED outputs, the LERIC8 provides an on chip network traffic level monitor circuit with 8 LED outputs to drive a bargraph type display.

The LERIC8 also provides an LED and Inter Repeater Bus interface that is compatible with the DP83955/6 LERIC™ products.

Features

- Fully IEEE 802.3 Ethernet Repeater compliant
- Eight IEEE 802.3 10BASE-T compliant ports with on-chip transmit filters
- One IEEE 802.3 compatible AUI port
- Direct drive status LED outputs
- Network traffic level monitor with direct drive LED outputs
- Automatic internal power-on reset function. External TTL compatible reset pin provided for device testing if required
- Inter-LERIC™ bus for cascading up to 3 devices on a single board
- Register/LED status interface compatible with DP83955/6 LERIC™ products
- Single 20 MHz crystal or external 20 MHz oscillator module operation
- Single 5V supply
- 160 pin PQFP package

1.0 System Diagram



DP83959 8-Port Lite Ethernet Repeater Interface Controller



2.0 Block Diagram

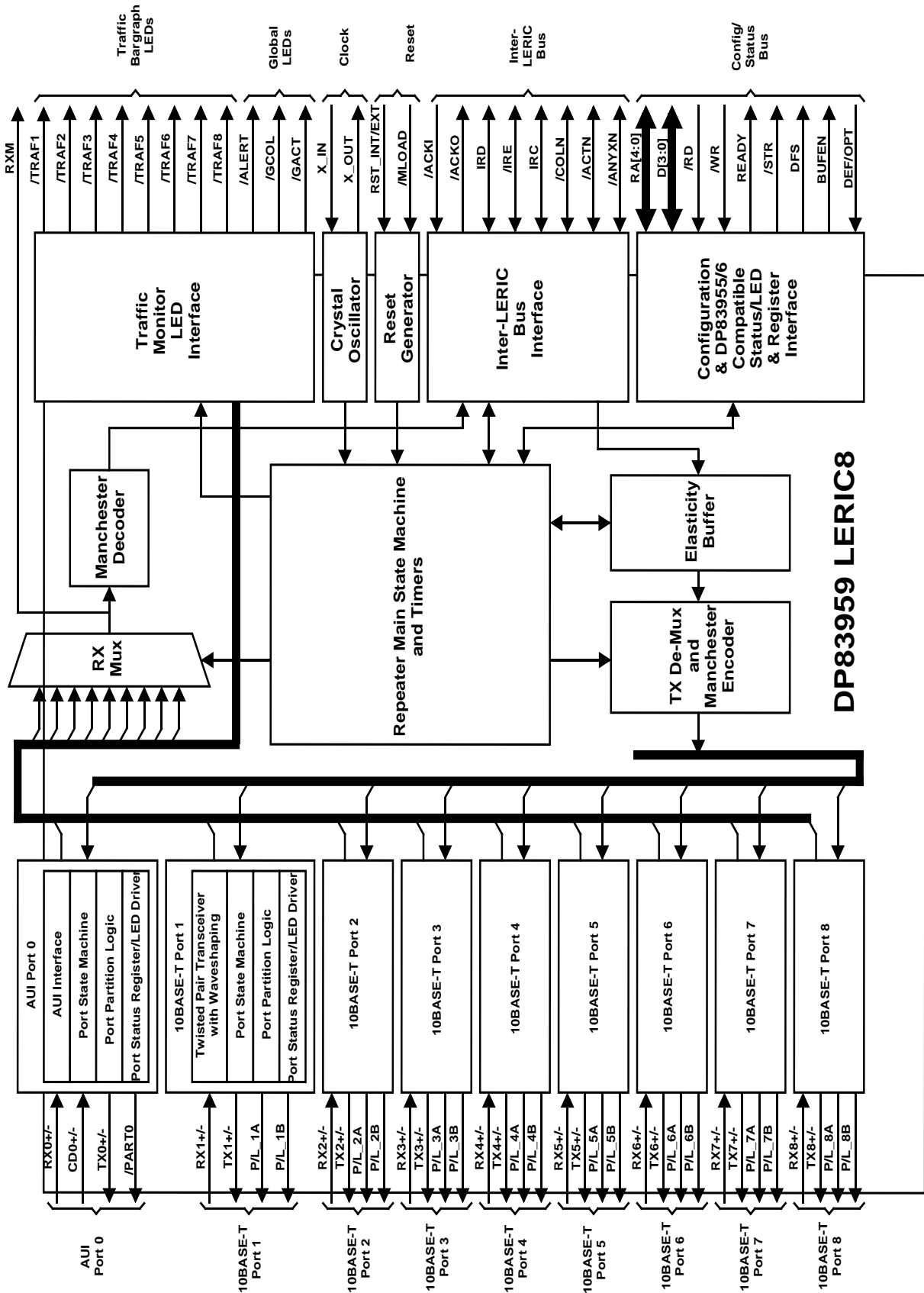
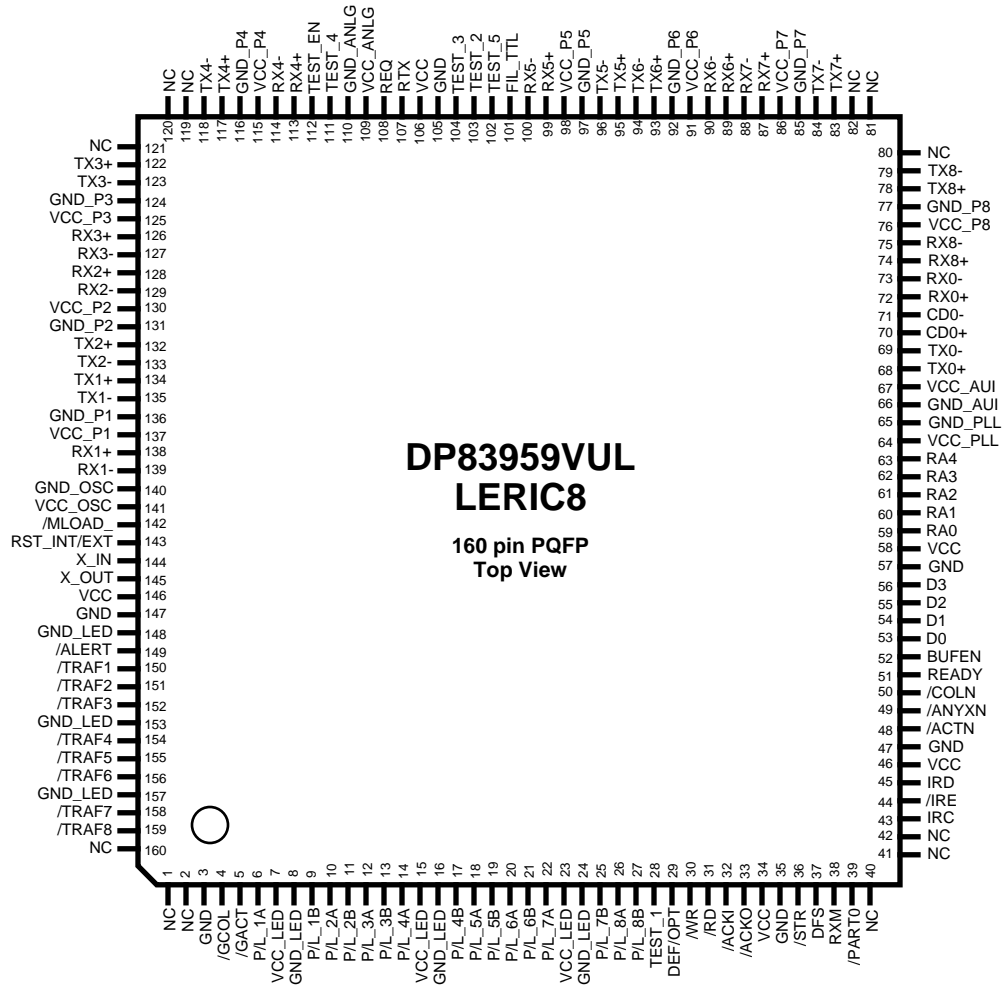


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3.0 Pin Connection Diagram



**Order Number DP83959VUL
See NS Package Number VUL160A**

4.0 Pin Descriptions

Key to Pin Type:

O = TTL Compatible Output

O (ECL) = ECL Compatible Output

I = TTL Compatible Input

I (ECL) = ECL Compatible Input

OZ = TTL Compatible TRI-STATE® Output

O (O.D.) = Open Drain Output

I/O = TTL Compatible Input/Output

I/O (O.D.) = TTL Compatible Input/Open Drain Output

TPO = Twisted Pair Interface Compatible Output

TPI = Twisted Pair Interface Compatible Input

AI = Analog Input

4.1 AUI PORT (PORT 0)

Signal Name	Type	Pin #	Description
TX0+	O (ECL)	68	AUI Transmit +: The AUI transmit path includes National Semiconductor's patented low power dissipation differential drivers that do not need external load resistors. This output should be connected directly to the AUI isolation transformer.
TX0-	O (ECL)	69	AUI Transmit -: The AUI transmit path includes National Semiconductor's patented low power dissipation differential drivers that do not need external load resistors. This output should be connected directly to the AUI isolation transformer.
RX0+	I (ECL)	72	AUI Receive +: This input should be terminated with 39Ω to GND via a series DC blocking capacitor (shared with RX0-). Refer to Figure 8.
RX0-	I (ECL)	73	AUI Receive -: This input should be terminated with 39Ω to GND via a series DC blocking capacitor (shared with RX0+). Refer to Figure 8.
CD0+	I (ECL)	70	AUI Collision Detect +: This input should be terminated with 39Ω to GND via a series DC blocking capacitor (shared with CD0-). Refer to Figure 8.
CD0-	I (ECL)	71	AUI Collision Detect -: This input should be terminated with 39Ω to GND via a series DC blocking capacitor (shared with CD0+). Refer to Figure 8.

4.2 TWISTED PAIR PORTS (PORTS 1 - 8)

Signal Name	Type	Pin #	Description
REQ	AI	108	Equalization Resistor: A resistor connected between this pin and GND or V_{CC} adjusts the equalization step amplitude on the 10BASE-T Manchester encoded transmit data for all eight 10BASE-T ports. No resistor is required for operation with cable length of up to 100 meters.
RTX	AI	107	Extended Cable Resistor: A resistor connected between this pin and GND or V_{CC} adjusts the amplitude of the differential transmit outputs for all eight 10BASE-T ports. No resistor is required for operation with cable length of up to 100 meters.

4.0 Pin Descriptions (Continued)

The values of the resistor/capacitor parallel source impedance matching networks connected to each of the 10BASE-T transmit outputs will depend upon PCB layout factors (such as track length, width, route etc.) and will have to be determined for each design. Preliminary laboratory

work suggests that values of 13.5Ω and 820 pF are appropriate in order to meet IEEE 802.3 specifications and EMI requirements - these values should be taken as a starting point for investigation. Refer to Figure 9.

Signal Name	Type	Pin #	Description
TX1 \pm	TPO	134, 135	Port 1 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX1 \pm	TPI	138, 139	Port 1 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.
TX2 \pm	TPO	132, 133	Port 2 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX2 \pm	TPI	128, 129	Port 2 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.
TX3 \pm	TPO	122, 123	Port 3 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX3 \pm	TPI	126, 127	Port 3 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.
TX4 \pm	TPO	117, 118	Port 4 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX4 \pm	TPI	113, 114	Port 4 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.
TX5 \pm	TPO	95, 96	Port 5 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX5 \pm	TPI	99, 100	Port 5 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.
TX6 \pm	TPO	93, 94	Port 6 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX6 \pm	TPI	89, 90	Port 6 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.
TX7 \pm	TPO	83, 84	Port 7 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX7 \pm	TPI	87, 88	Port 7 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.
TX8 \pm	TPO	78, 79	Port 8 Transmit: 10BASE-T transmitter output - requires a series source impedance matching network consisting of a resistor and capacitor in parallel. The values of these components will be application specific.
RX8 \pm	TPI	74, 75	Port 8 Receive: 10BASE-T receiver input - requires a 50Ω receive termination.

4.0 Pin Descriptions (Continued)

4.3 STATUS LED INTERFACE

All the DP83959's direct drive LED outputs can drive up to 14mA maximum. The LED outputs are intended to drive an external LED with a series current limiting resistor. The Partition/Link OK LED outputs can sink or source current and are thus suitable for driving single or bi-color LEDs directly. Bi-color LEDs can be connected between the A and B outputs (with series current limiting resistors) (see section 5.11).

The direct drive LED outputs are asserted during power-on/reset (either internal or external reset) and remain as-

serted for 1 second (nominal) following the trailing edge of the internal/external reset signal. During the LED test at power-on/reset, the Partition/Link OK 'A' outputs will all be logic '1' and the 'B' outputs logic '0'.

DP83955/6 compatible LED drive outputs are only asserted for the duration of the 1 second LED test following the trailing edge of the internal/external reset (they are not asserted during reset). The DP83955/6 compatible status LED scheme is described in the functional description (Section 5.13) as it requires external circuitry to latch the status and drive the LEDs.

Signal Name	Type	Pin #	Description																				
P/L_1A P/L_1B	O (14mA max.)	6 9	<p>Partition/Link OK LED 1 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				
P/L_2A P/L_2B	O (14mA max.)	10 11	<p>Partition/Link OK LED 2 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				
P/L_3A P/L_3B	O (14mA max.)	12 13	<p>Partition/Link OK LED 3 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				
P/L_4A P/L_4B	O (14mA max.)	14 17	<p>Partition/Link OK LED 4 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				
P/L_5A P/L_5B	O (14mA max.)	18 19	<p>Partition/Link OK LED 5 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				

4.0 Pin Descriptions (Continued)

Signal Name	Type	Pin #	Description																				
P/L_6A P/L_6B	O (14mA max.)	20 21	<p>Partition/Link OK LED 6 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				
P/L_7A P/L_7B	O (14mA max.)	22 25	<p>Partition/Link OK LED 7 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				
P/L_8A P/L_8B	O (14mA max.)	26 27	<p>Partition/Link OK LED 8 - A and B: LED outputs (for use with single or bi-color LEDs) with the following function:</p> <table border="1"> <thead> <tr> <th>Link Status</th> <th>Partition Status</th> <th>A Output</th> <th>B Output</th> </tr> </thead> <tbody> <tr> <td>/OK</td> <td>/PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>/OK</td> <td>PART</td> <td>1</td> <td>1</td> </tr> <tr> <td>OK</td> <td>/PART</td> <td>0</td> <td>1</td> </tr> <tr> <td>OK</td> <td>PART</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Link Status	Partition Status	A Output	B Output	/OK	/PART	1	1	/OK	PART	1	1	OK	/PART	0	1	OK	PART	1	0
Link Status	Partition Status	A Output	B Output																				
/OK	/PART	1	1																				
/OK	PART	1	1																				
OK	/PART	0	1																				
OK	PART	1	0																				
/TRAF1	O (14mA max.)	150	<p>Traffic Monitor LED 1 (1%): 0 = 1% Traffic Level reached or exceeded 1 = Traffic Level less than 1%</p>																				
/TRAF2	O (14mA max.)	151	<p>Traffic Monitor LED 2 (2%): 0 = 2% Traffic Level reached or exceeded 1 = Traffic Level less than 2%</p>																				
/TRAF3	O (14mA max.)	152	<p>Traffic Monitor LED 3 (3%): 0 = 3% Traffic Level reached or exceeded 1 = Traffic Level less than 3%</p>																				
/TRAF4	O (14mA max.)	154	<p>Traffic Monitor LED 4 (6%): 0 = 6% Traffic Level reached or exceeded 1 = Traffic Level less than 6%</p>																				
/TRAF5	O (14mA max.)	155	<p>Traffic Monitor LED 5 (12%): 0 = 12% Traffic Level reached or exceeded 1 = Traffic Level less than 12%</p>																				
/TRAF6	O (14mA max.)	156	<p>Traffic Monitor LED 6 (25%): 0 = 25% Traffic Level reached or exceeded 1 = Traffic Level less than 25%</p>																				
/TRAF7	O (14mA max.)	158	<p>Traffic Monitor LED 7 (50%): 0 = 50% Traffic Level reached or exceeded 1 = Traffic Level less than 50%</p>																				
/TRAF8	O (14mA max.)	159	<p>Traffic Monitor LED 8 (>80%): 0 = >80% Traffic Level reached or exceeded 1 = Traffic Level less than 80%</p>																				
/ALERT	O (14mA max.)	149	<p>Alert LED: This LED output indicates that greater than 80% traffic level for one second or more has occurred, or a 10BASE-T port partition has occurred. The output remains active until the current event condition ceases or, if the event condition is shorter than 30ms, for a minimum of 30ms (nominal value). Active low.</p>																				

4.0 Pin Descriptions (Continued)

Signal Name	Type	Pin #	Description
/PART0	O (14mA max.)	39	Partition LED 0: Partition LED output for the AUI port. Active low.
/GCOL	O (14mA max.)	4	Global Collision LED: Global collision status LED output. Indicates collision activity on any port. Active low. This output will be asserted low until the start of the next network event or for a maximum of 30ms (nominal value).
/GACT	O (14mA max.)	5	Global Activity LED: Global Activity LED output. Indicates receive activity (carrier sense active) on any port. Active low. This output will be asserted low until the start of the next network event or for a maximum of 30ms (nominal value).

4.4 INTER-LERIC BUS INTERFACE

Signal Name	Type	Pin #	Description
/ACKI	I	32	Acknowledge Input: to the network ports' arbitration chain. If the Inter-LERIC bus is not being used or if this LERIC8 is at the top of the /ACKI - /ACKO chain or is the only repeater chip in the system, this pin should be connected to V_{CC} either directly or via a pull-up resistor ($\approx 4.7\text{ k}\Omega$). Otherwise, this input should be driven from the previous LERIC8's /ACKO output.
/ACKO	O	33	Acknowledge Output: from the network ports' arbitration chain, connected to the /ACKI of the next repeater chip in the /ACKI - /ACKO chain. If this LERIC8 is not chained to any other repeater chips, this pin should be left unconnected.
IRD	I/O	45	Inter-LERIC Data: When asserted as an output this signal provides a serial data stream in NRZ format. The signal is asserted by a LERIC8 when it is receiving data from one of its network segments. The default condition of this signal is to be an input. In this state it may be driven by other devices on the Inter-LERIC bus. If the Inter-LERIC bus is not being used, this pin should be left unconnected (it has an internal pull-up resistor of $14\text{ k}\Omega$) or pulled up to V_{CC} via an external resistor.
/IRE	I/O	44	Inter-LERIC Enable: When asserted as an output this signal provides an activity framing enable for the serial data stream. The signal is asserted by a LERIC8 when it is receiving data from one of its network segments. The default condition of this signal is to be an input. In this state it may be driven by other devices on the Inter-LERIC bus. If the Inter-LERIC bus is not being used, this pin should be left unconnected (it has an internal pull-up resistor of $14\text{ k}\Omega$) or pulled up to V_{CC} via an external resistor. If the Inter-LERIC bus is to be used, this signal should have an external 680Ω pull-up resistor to ensure fast de-assertion.
IRC	I/O	43	Inter-LERIC Clock: When asserted as an output this signal provides a clock signal for the serial data stream. Data (IRD) is changed on the falling edge of the clock. The signal is asserted by a LERIC8 when it is receiving data from one of its network segments. The default condition of this signal is to be an input. When an input, IRD is sampled on the rising edge of the clock. In this state it may be driven by other devices on the Inter-LERIC bus. If the Inter-LERIC bus is not being used, this pin should be left unconnected (it has an internal pull-up resistor of $14\text{ k}\Omega$) or pulled up to V_{CC} via an external resistor.
/COLN	I/O	50	Collision on Port N: This denotes that a collision is occurring on the port receiving the data packet (Port N). The default condition of this signal is to be an input. In this state it may be driven by other devices on the Inter-LERIC bus. If the Inter-LERIC bus is not being used, this pin should be left unconnected (it has an internal pull-up resistor of $3.5\text{ k}\Omega$) or pulled up to V_{CC} via an external resistor. If the Inter-LERIC bus is to be used, this signal should have an external 680Ω pull-up resistor to ensure fast de-assertion.

4.0 Pin Descriptions (Continued)

Signal Name	Type	Pin #	Description
/ACTN	I/O (O.D.)	48	Activity on Port N: The LERIC8 asserts this signal when data or collision information is received from one of its network segments. The LERIC8 senses this signal when this or another LERIC8 in a multi-LERIC system is receiving data or collision information. If the Inter-LERIC bus is not being used, this pin should be left unconnected (it has an internal pull-up resistor of 3.5 k Ω) or pulled up to V_{CC} via an external resistor. If the Inter-LERIC bus is to be used, this signal should have an external 680 Ω pull-up resistor to ensure fast de-assertion.
/ANYXN	I/O (O.D.)	49	Activity on Any Port Except Port N: The LERIC8 asserts this signal when a transmit collision is experienced or multiple ports have active collisions on their network segments. The LERIC8 senses this signal when this or another LERIC8 in a multi-LERIC system is experiencing transmit collisions or multiple ports have active collisions on their network segments. If the Inter-LERIC bus is not being used, this pin should be left unconnected (it has an internal pull-up resistor of 14 k Ω) or pulled up to V_{CC} via an external resistor. If the Inter-LERIC bus is to be used, this signal should have an external 680 Ω pull-up resistor to ensure fast de-assertion.

4.5 CLOCK INTERFACE

Signal Name	Type	Pin #	Description
X_IN	I	144	20 MHz Crystal Oscillator Input: This pin can be used to connect an external 20MHz crystal (between X_IN and X_OUT) as shown in Figure 2, or as an external TTL compatible 20MHz oscillator module input as shown in Figure 3.
X_OUT	O	145	20 MHz Crystal Oscillator Output: This pin is used to connect to an external 20 MHz crystal (between X_IN and X_OUT) as shown in Figure 2. When using an external 20 MHz crystal oscillator module connected to the X_IN input, this pin should be left unconnected as shown in Figure 3.

4.0 Pin Descriptions (Continued)

4.6 REGISTER/CONFIGURATION INTERFACE

Signal Name	Type	Pin #	Description
RA4 RA3 RA2 RA1 RA0	I/O	63 62 61 60 59	Register Address [4:0]: Address input value for the current register access. These pins also provide DP83955/6 compatible LED status: during display update cycles these pins become outputs that provide port address and data for LED display purposes. Pins RA[1:4] cycle values from 0h to 9h while RA0 provides Bad Polarity status for the 10BASE-T ports. See Section 5.13 for more details. If the DP83955/6 compatible LEDs and register interface are not being used, these pins should be left unconnected. In Option mode (see DEF/OPT), the logic levels present on RA[4:0] at reset (set by pull-up or pull-down resistors) are latched into the configuration registers. See section 5.12 for more information.
D3 D2 D1 D0	I/O	56 55 54 53	Data [3:0]: Bi-directional register data. /RD and /WR control the data direction. With /RD low and /WR high, D[3:0] are outputs and with /RD high and /WR low, D[3:0] are inputs. These pins also provide the DP83955/6 compatible status outputs for latching to LEDs. See Section 5.13 for more details. If the DP83955/6 compatible LEDs and register interface are not being used, these pins should be left unconnected. In Option mode (see DEF/OPT), the logic levels present on D[3:0] at reset (set by pull-up or pull-down resistors) are latched into the configuration registers. See Section 5.12 for more information.
/RD	I	31	Read Strobe: When strobed low, this input schedules a register read access to the register addressed by the RA[4:0] pins. If the register interface is not being used, this pin should be connected to V _{CC} either directly or via a pull-up resistor (≈ 4.7 k Ω).
/WR	I	30	Write Strobe: When strobed low, this input schedules a register write access to the register addressed by the RA[4:0] pins. If the register interface is not being used, this pin should be connected to V _{CC} either directly or via a pull-up resistor (≈ 4.7 k Ω).
/READY	O	51	Ready Handshake: The falling edge of this active low signal during a read cycle indicates that data is stable and valid for sampling. In write cycles, the falling edge of /READY denotes that the write data has been latched by the LeRIC8. Therefore, data must have been available and stable for this operation to be successful.
/STR	O	36	Display Update Strobe: When using the DP83955/6 compatible status LEDs, this active low signal controls the latching of display data for network ports into the external display latches. If not required, this pin should be left unconnected.
DFS	O	37	Display Frozen Strobe: Asserted high when the display data for each packet is frozen at the end of the repeater transmission of the packet until the start of the next network event or for a maximum of 30ms (nominal value). This ensures DP83955/6 compatible status LEDs are visible even for single network events.
BUFEN	O	52	Buffer Enable: Used to control an external buffer (if required) for the data bus, D[3:0]. External buffer will be necessary in systems having a register interface.
/MLOAD	I	142	Mode Load/Reset: TTL level reset input (not Schmitt) for external reset or test purposes. If not required, this pin should be connected to V _{CC} either directly or via a pull-up resistor (≈ 4.7 k Ω). On the rising (trailing) edge of /MLOAD, the logic levels present on the D[3:0] and RA[4:0] inputs (set by pull-up or pull-down resistors) are latched into the configuration registers.

4.0 Pin Descriptions (Continued)

Signal Name	Type	Pin #	Description
RST_INT/EXT	I	143	<p>RESET Internal or External: This pin is used to select either internal (automatic) or external reset mode. External reset pulses should be applied to the /MLOAD pin. If not used, this pin should be connected to V_{CC} either directly or via a pull-up resistor (≈4.7 kΩ).</p> <p>0 = External reset selected 1 = Internal reset selected</p> <p>The rising edge of the external (/MLOAD) or internal reset signal starts the 1 second display test operation.</p>

4.7 MISCELLANEOUS PINS

Signal Name	Type	Pin #	Description
DEF/OPT	I	29	<p>Default/Optional Configuration Mode: This input is used to select the LERIC8 configuration mode:</p> <p>1 = Default Mode - The default LERIC8 configuration is used. To select this mode the DEF/OPT pin should be pulled up to V_{CC} with a 4.7 kΩ resistor. See Section 5.12 for a description of the default parameters.</p> <p>0 = Optional Mode - The LERIC8's configuration is loaded into the device at the trailing edge of reset from values set on the D[3:0] and RA[4:0] pins. These values are set using 10 kΩ pull-up or pull-down resistors. For normal default mode, no resistors are required.</p>
TEST_1	I	28	Test 1: This pin should be connected to V _{CC} for normal operation.
TEST_2	I	103	Test 2: This pin should be connected to GND for normal operation.
TEST_3	O	104	Test 3: This pin should be left unconnected for normal operation.
TEST_4	I	111	Test 4: This pin should be connected to GND for normal operation.
TEST_5	I	102	Test 5: This pin should be connected to GND for normal operation.
TEST_EN	I	112	<p>Test Enable: This pin selects between normal and factory test operation modes:</p> <p>0 = Normal operation - tie the TEST_EN pin to GND for normal operation. 1 = LERIC8 factory test mode - do not use.</p>
RXM	O	38	Receive Manchester Data: This pin should be left unconnected for normal operation. It is the receive Manchester data output and is supplied for evaluation and testing purposes.
FIL_TTL	I	101	<p>Filter /TTL Transmit Data: This pin selects between pre-filter TTL transmit data and normal filtered analog transmit data. Connect this pin to GND for normal operation.</p> <p>0 = Normal Analog Transmit Data - Transmit outputs are normal 10BASE-T. 1 = Pre-Filter TTL Transmit Data - Transmit outputs become TTL level.</p>
NC	-	1, 2, 40, 41, 42, 80, 81, 82, 119, 120, 121, 160	No Connect: These pins are not connected internally to the DP83959. They should be connected directly to the PCB ground plane. This will help decrease the thermal resistance between the device and its environment.

4.0 Pin Descriptions (Continued)

4.8 POWER AND GROUND PINS

The LERIC8 has power and ground (V_{CC} and GND) pins for each of the major functional blocks of the device. This section describes the pairing and decoupling requirements of the power and ground pins.

4.8.1 Bi-Color LED Power and Ground Pins

These are labeled V_{CC_LED} and GND_LED and are adjacent to each other in the following pairs:

V_{CC}/GND_LED 7/8
 V_{CC}/GND_LED 15/16
 V_{CC}/GND_LED 23/24

Each pair of V_{CC_LED}/GND_LED pins supplies source and sink current for either 3 or 4 bi-color LED drivers. These power and ground pins should be decoupled with 0.1 μ F capacitors to reduce noise.

Special Considerations Regarding I_{cc}

Since the drivers source the current required to turn on the LEDs, the total I_{cc} required by the device will fluctuate depending on network traffic conditions. This should be taken into consideration when calculating the power requirements of the system.

4.8.2 Single LED Ground Pins

These are labeled GND_LED and are interspersed amongst the single LED output driver pins which only have to sink current to ground. These pins are:

GND_LED 148, 153 and 157

4.8.3 PLL Power and Ground Pins

The LERIC8's receive PLL supply pins (V_{CC_PLL} pin 64 and GND_PLL pin 65) should be filtered from noise on the normal +5V V_{CC} supply. The recommended method is with a 10 μ F capacitor in parallel with a 0.01 μ F capacitor and fed from V_{CC} via a 22 Ω resistor as shown in Figure 1.

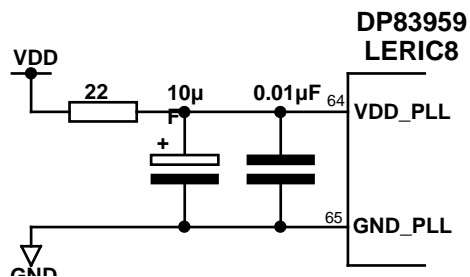


Figure 1. DP83959 PLL Power Supply Decoupling

4.8.4 AUI and 10BASE-T Port Power and Ground Pins

The AUI port and eight 10BASE-T ports each have their own power and ground pair. These should be decoupled with a 0.1 μ F capacitor per pair as close to the power/ground pins as possible.

The AUI and 10BASE-T port power and ground designations are:

Port	Power/Ground Names	Pin Numbers
AUI	V_{CC_AUI}	67
	GND_AUI	66
10BASE-T Port 1	V_{CC_P1}	137
	GND_P1	136
10BASE-T Port 2	V_{CC_P2}	130
	GND_P2	131
10BASE-T Port 3	V_{CC_P3}	125
	GND_P3	124
10BASE-T Port 4	V_{CC_P4}	115
	GND_P4	116
10BASE-T Port 5	V_{CC_P5}	98
	GND_P5	97
10BASE-T Port 6	V_{CC_P6}	91
	GND_P6	92
10BASE-T Port 7	V_{CC_P7}	86
	GND_P7	85
10BASE-T Port 8	V_{CC_P8}	76
	GND_P8	77

4.8.5 Analog Power and Ground Pins

The transmit wave shaping analog circuitry of the LERIC8 has its own power and ground pair:

V_{CC_ANLG} pin 109
 GND_ANLG pin 110

This pair should be decoupled with a 10 μ F capacitor as close as possible to the pins. The power and ground feed to these pins should be kept as quiet as possible.

4.8.6 Crystal Oscillator Power and Ground Pins

The crystal oscillator has its own power and ground pins (V_{CC_OSC} pin 141 and GND_OSC pin 140). This pair should be kept relatively noise free and decoupled with a 0.1 μ F capacitor as close to the pins as possible.

4.8.7 Digital Power and Ground Pins

The DP83959's digital core logic power supply pins should be decoupled in pairs with 0.1 μ F capacitors as close to the pins as possible. The digital power and ground pin pairs are as follows:

V_{CC}	GND
-	3
34	35
46	47
58	57
106	105
146	147

5.0 Functional Description

The DP83959 LERIC8 consists of the following functional blocks, each of which is described in the sections that follow:

- Repeater Main State Machine & Timers
- Port State Machines
- Receive Multiplexer
- Manchester Decoder
- Elasticity Buffer
- Transmit De-Multiplexer & Manchester Encoder
- Inter-LERIC Bus Interface
- Clock Interface
- Reset Interface
- Traffic Monitor LED Interface
- Port Status LEDs
- Configuration/Register Interface
- Min/Max Mode LED Interface
- AUI Port 0
- 10BASE-T Ports 1 - 8

5.1 REPEATER MAIN STATE MACHINE & TIMERS

The main state machine (MSM) has an associated set of timers that ensure the various IEEE 802.3 section 9 repeater specification times (referred to as TW1 to TW6) are fulfilled. Some of the major functions of the MSM and Timers are shown in Table 1.

The MSM is the heart of the DP83959. It controls the operation of most of the functional blocks and performs the majority of the data and collision propagation operations as defined by the IEEE specification.

The MSM requires status inputs from each of the DP83959's ports. Each port has its own port state machine that controls the port and maintains its status. The interaction of the main and port state machines is visible, in part, by observation of the Inter-LERIC bus.

5.2 PORT STATE MACHINES

Each of the nine LERIC8 ports has its own port state machine (PSM). PSMs have two main functions:

1. Control the transmission of repeated data and jam signals over the attached segment.

2. Decide if the port should be the current source of data or collision information to be repeated over the network. This repeater port is known as port N.

An arbitration process is required to enable the repeater to transition from the idle state to the send preamble pattern or receive collision states. This process is used to locate the port which will be port N for that particular packet.

The data received from this port is directed to the PLL decoder and transmitted over the Inter-LERIC bus. If the repeater enters the transmit collision state a further arbitration operation is performed to determine which port is port M. Port M is differentiated from the repeater's other ports if the repeater enters the one port left state. In this state port M does not transmit to its segment; where as all other ports are still required to transmit to their segments.

5.3 RECEIVE MULTIPLEXER

The receive multiplexer routes data from whichever port receives network traffic first (port N) to the Manchester decoder. The receive multiplexer also notifies the main state machine of any collision activity that may be present on the repeater's ports.

5.4 MANCHESTER DECODER

Manchester encoded receive data from the receive multiplexer is routed to the Manchester decoder. The Manchester decoder contains a sophisticated PLL that locks onto the receive packet's preamble signal. This ensures the accumulated jitter is removed from the incoming data. The Manchester data is then decoded into a NRZ receive data stream with a synchronous clock. The DP83959 has a pin (the RXM pin) to enable external Manchester decoders to be used if required.

5.5 ELASTICITY BUFFER

An elasticity buffer is required to allow for any difference in the frequencies between the local clock and the clock of the device that originated the packet, and for any preamble bits lost in the physical layer(s) in a packet's path prior to being repeated.

Table 1 Repeater Main State Machine & Timer Functions

Function	Action
Preamble Regeneration	Restore the length of the preamble pattern to the defined size.
Fragment Extension	Extend received data or collision fragments to meet the minimum fragment length of 96 bits.
Elasticity Buffer Control	A portion of the received packet may require storage in an Elasticity Buffer to accommodate preamble regeneration.
Jam / Preamble Pattern Generation	In cases of receive or transmit collisions, a LERIC8 is required to transmit a jam pattern (1010...). Note: This pattern is the same as that used for preamble regeneration.
Transmit Collision Enforcement	Once the <i>TRANSMIT COLLISION</i> state is entered a repeater is required to stay in this state for at least 96 network bit times.
Data Encoding Control	NRZ format data from the elasticity buffer must be encoded into Manchester format data prior to re-transmission.
<i>T_{w1}</i> Enforcement	Enforce the Transmit Recovery Time specification.
<i>T_{w2}</i> Enforcement	Enforce Carrier Recovery Time specification on all ports with active collisions.

5.0 Functional Description (Continued)

The DP83959 has a 32 bit elasticity buffer (FIFO) in the transmit path prior to the transmit de-multiplexer. This enables the DP83959 to synchronize data packets to its own local clock prior to transmission and regenerate preamble as required.

Soon after the network segment receiving the data packet has been identified, the DP83959 begins to transmit the preamble pattern (1010...) to the other network segments. While the preamble is being transmitted, the elasticity buffer monitors the decoded receive clock and data signals (this is done via the inter-LERIC bus as described later). When the start of frame delimiter (SFD) is detected, the receive data stream is written to the elasticity buffer. Removal of data from the elasticity buffer for re-transmission is not allowed until a valid length preamble pattern has been transmitted.

5.6 TRANSMIT DE-MULTIPLEXER & MANCHESTER ENCODER

The transmit de-multiplexer routes data from the Manchester decoder to all ports other than the one receiving data (all ports not N). The NRZ data is then encoded into a Manchester transmit data stream with a synchronous clock.

5.7 INTER-LERIC BUS INTERFACE

LERIC8 devices may be cascaded to form single logical 10BASE-T repeaters with more ports if required. This is done using the Inter-LERIC Bus. This bus consists of eight signals (see Section 4.4).

Because the LERIC8 was designed for cost conscious stand-alone 8 port repeater applications, the drive strength of some of the Inter-LERIC bus signals is too weak to allow proper operation with LERIC8's on separate boards. External Inter-LERIC bus transceivers cannot be used with the LERIC8 since no signal to enable the transceivers is provided. The maximum number of cascaded LERIC8's on one PCB is 3, using short, low capacitance traces. Note that external 680Ω pull-up resistors are required on the /COLN and /ACTN signals, if the Inter-LERIC bus is used, because of the reduced drive capability of these signals. These are required to ensure fast de-assertion of these signals.

Although the LERIC8 has internal pull-up resistors on the IRD, /IRE, IRC, and /ANYXN signals, it is still recommended that external pull-ups be used. Refer to section 7.0 System Considerations for more information.

5.8 CLOCK INTERFACE

The DP83959 LERIC8 requires a single 20 MHz ±100 ppm reference clock source. This can either be provided by a crystal (with two small padding capacitors, typically 27 pF) connected to the X_IN and X_OUT pins. This arrangement is shown in Figure 2.

The value of the load padding capacitors depends upon the crystal specification. They can be calculated knowing the stray input and output capacitance's and the crystal manufacturer's recommended shunt load capacitance. Typical input capacitance (C_{in}) is 5 pF and typical output capacitance (C_{out}) is 6 pF.

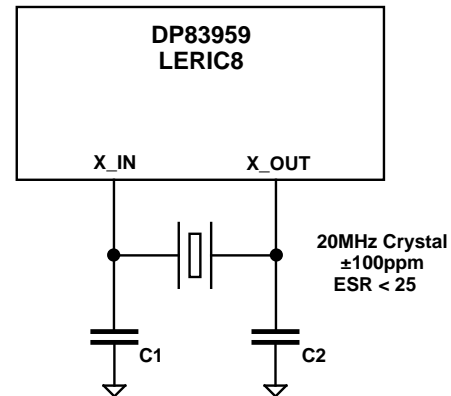


Figure 2. Clock Using a Crystal

The total shunt load capacitance is given by the equation:

$$C_L = \frac{C_{in} \times C_{out}}{C_{in} + C_{out}} + \frac{C_1 \times C_2}{C_1 + C_2}$$

The load padding capacitors C1 and C2 should be made equal in value. Typically, these capacitors are in the order of 27pF.

Alternatively, an external 20 MHz oscillator module (mounted close to the device) feeding TTL clock directly into the X_IN input (with X_OUT left unconnected) can be used. This arrangement is shown in Figure 3.

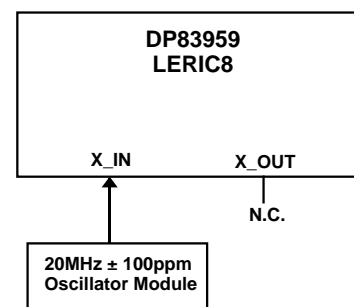


Figure 3. Clock Using an Oscillator Module

5.9 RESET INTERFACE

The DP83959 LERIC8 has an internal power-on reset function that requires no external components for it to power up correctly and begin repeater operation automatically.

A TTL compatible reset input is also provided (/MLOAD). Note that the /MLOAD input is not a Schmitt input: an externally generated pulse must be supplied to this input if it is to be used. If not required, the /MLOAD input can be left unconnected. A representational logic diagram of the reset function is given in Figure 4. The RES_INT/EXT pin selects either internal or external reset.

5.0 Functional Description (Continued)

Optionally, configuration information can be loaded into the device at reset from values set by pull-up and/or pull-down resistors on the D[3:0] and RA[4:0] pins. See Section 5.12 for more details.

The rising edge of the selected reset signal is used to start the 1 second LED test operation.

As a power-on test feature, the DP83959 will assert all single ended LED outputs, the DP83955/6 compatible LED outputs and the 'B' outputs of the bi-color LED outputs. The direct drive LED outputs are asserted during reset as well as for 1 second following the trailing edge of reset, whereas the DP83955/6 compatible LEDs will only be asserted for the 1 second test, not during reset. See the pin descriptions for the LEDs in Section 4.3 for more details.

5.10 TRAFFIC MONITOR LED INTERFACE

The Network Traffic Level Monitor function displays the network utilization as a percentage on 8 LEDs connected in bargraph format. LEDs connected to the /TRAF[1:8] outputs will indicate the following network traffic levels 1%, 2%, 3%, 6%, 12%, 25%, 50%, and >80% respectively. These are chosen in order to provide for an ergonomic display.

The Network Traffic Level Monitor function uses a sum of the internal carrier sense signals from each of the ports to assess the amount of repeater activity in any given sample pe-

riod. Network activity is sampled at 6.25Hz. The activity level is decoded into a percentage of the theoretical maximum and output to the /TRAF[1:8] pins for display on the bargraph style LEDs. That is, all LED outputs up to and including the currently determined network traffic LED level will be asserted. Figure 5 shows how to connect the traffic LEDs.

Additionally, three global LEDs are provided:

An Alert LED output indicates when traffic level exceeds 80% for 1 second or more or when any of the eight 10BASE-T ports is partitioned for 1 second or more. The output will remain active until the excess traffic or long partition event ends or for a minimum of 30ms (nominal value) to ensure LED visibility.

A global activity LED output (/GACT) indicates the presence of any receive activity, while a global collision LED output (/GCOL) indicates the presence of collisions on any port. These LED outputs have the capability to lengthen the time the LED is active. At the end of each event, the output is held asserted for 30 ms, or until another such event occurs. Thus, at low levels of network activity (for /GACT) or network collisions (for /GCOL), the LED is lit long enough to make it discernible to the human eye. At higher rates of events, the relative brightness of the LEDs indicate high or low activity.

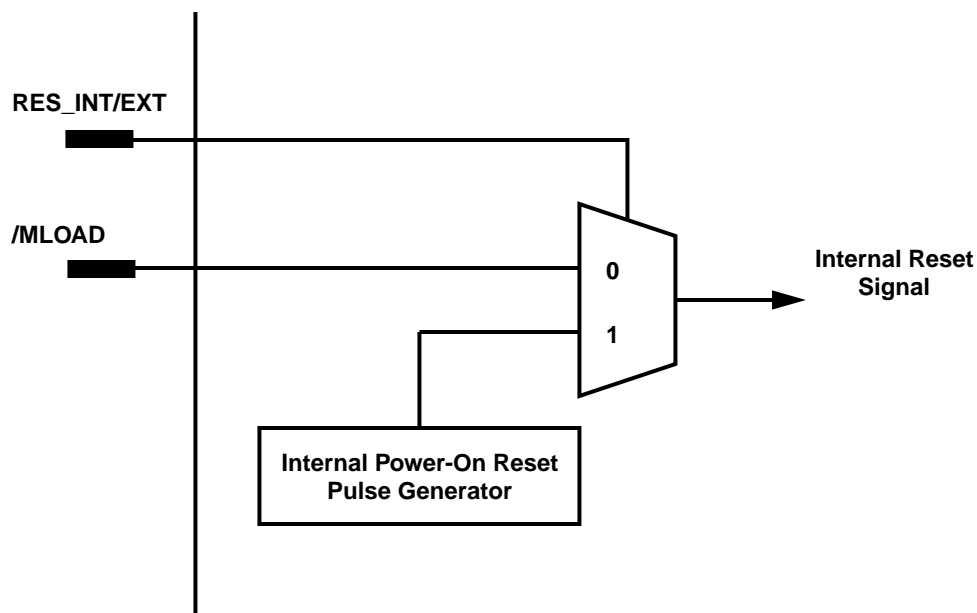


Figure 4. DP83959 Reset Logic

5.0 Functional Description (Continued)

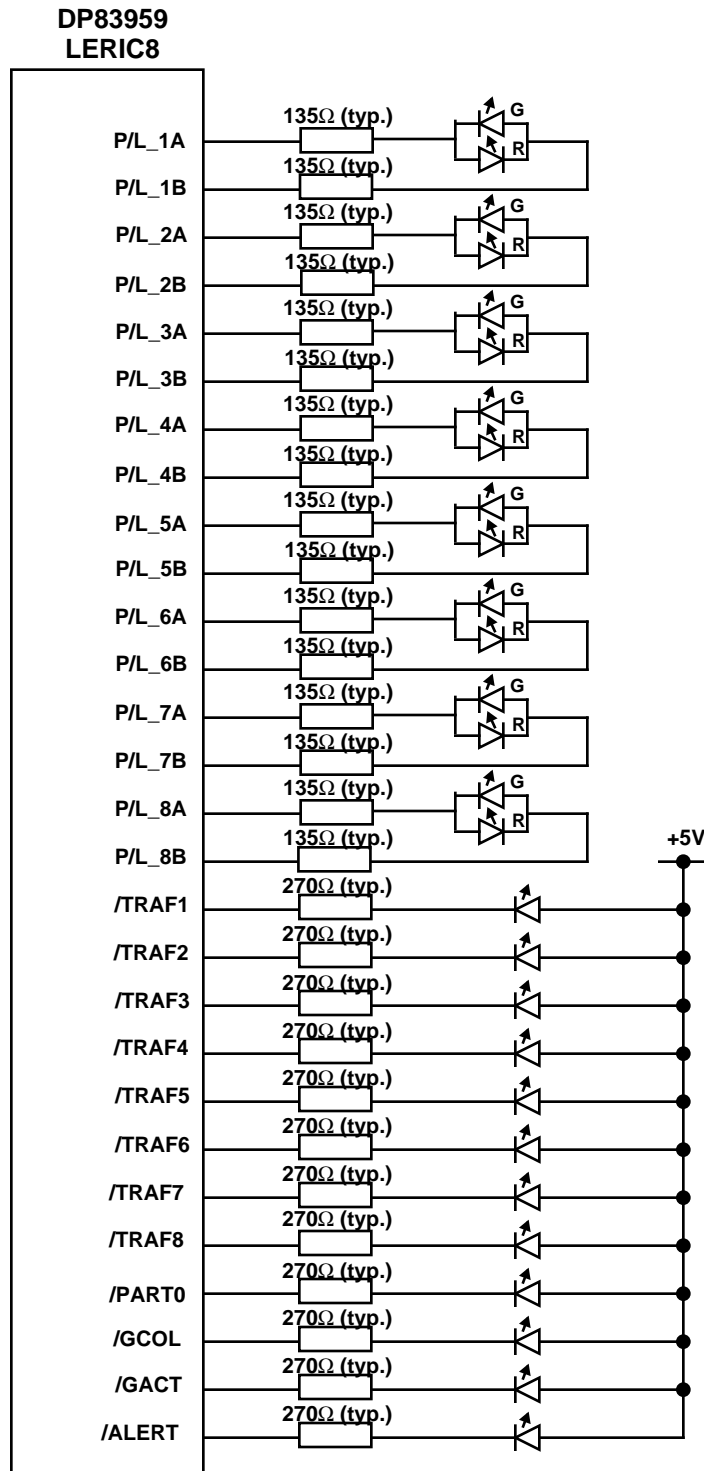


Figure 5. DP83959 Direct Drive LED Connections

5.0 Functional Description (Continued)

5.11 PORT STATUS LEADS

The eight 10BASE-T Port Partition Status/Link OK Status bi-color LED outputs have the functionality given in Table 2.

The representational logic of this function is given in Figure 6. This logic is repeated for each of the 10BASE-T ports ('n' in Figure 6 refers to any of ports 1 through 8). The DP83959 bi-color LED outputs use two pins each, so that either end of a two-lead bi-color LED may be driven high or low in order to achieve the required functionality. Two-lead bi-color LEDs require only the addition of a single series current limiting resistors. Three lead bi-color LEDs must be driven with two series resistors (one in each cathode lead) and the common anode lead taken to V_{CC} .

If required, single LEDs may be driven by the bi-color outputs (each taken to V_{CC} via an appropriate resistor). Figure 5 shows one configuration, using bi-color LEDs.

5.12 CONFIGURATION/REGISTER INTERFACE

Several operational parameters can be configured into the LERIC8 at power-on/reset time (optional mode) or the standard LERIC8 configuration can be used (default mode). Selection of the mode is made using the DEF/OPT pin.

For default mode, the DEF/OPT pin must be pulled high (to V_{CC}) with a 4.7 k Ω resistor. In this mode, the LERIC8 uses the default values given in Table 3.

For optional mode, the DEF/OPT pin must be pulled low. In this mode, the rising edge of either the internal reset signal or /MLOAD (see Section 5.9) is used to latch the logic levels

held on the D[3:0] and RA[4:0] inputs into the internal configuration registers. Configuration data is set on the D[3:0] and RA[4:0] pins using 10 k Ω pull-up or pull-down resistors as required. Table 3 shows the parameter sections possible.

A 10 k Ω pull-up resistor to V_{CC} is required to set a configuration bit to 1. A 10 k Ω pull-down resistor to GND to set a configuration bit to 0.

The LERIC8 has internal registers that are accessible from the RA[4:0] and D[3:0] interface. A certain amount of control of operation and status information is available through this interface. The LERIC8's registers are compatible with those in the DP83955/6. A full description of the registers is given in Section 6.0.

Although simple 8-port standalone hubs will not require the register interface, it was nevertheless included as a necessary factory test feature. In a simple repeater design the /RD and /WR pins should be disabled by connecting them to V_{CC} directly or via a suitable pull-up resistor (4.7 k Ω).

Since the RA[4:0] and D[3:0] interface is used for multiple functions (configuration, register access and Min/Max LED mode outputs) register read/write data must be transferred using an external buffer.

The READY pin provides a means of handshaking register accesses into the LERIC8. A simple programmable logic device (GAL) may be used to decode the address range, assert the appropriate /RD or /WR strobe and check the READY signal. This provides an appropriate interface for whatever CPU or other device is connected.

Table 2 10BASE-T Port Status LED Output Functionality Using Bi-color LEDs

Link Status	Port Partition Status	LED
Not OK	Not Partitioned	OFF
Not OK	Partitioned	OFF
OK	Not Partitioned	Color #1 (usually GREEN)
OK	Partitioned	Color #2 (usually YELLOW or RED)

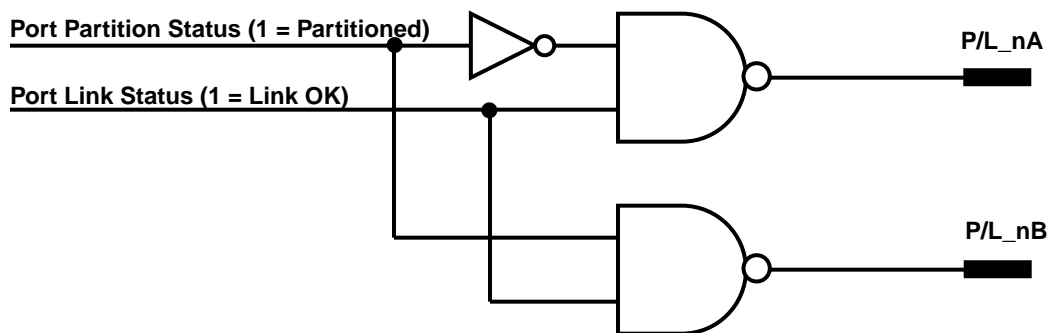


Figure 6. 10BASE-T Port Status LED Logic Function

5.0 Functional Description (Continued)

Table 3 Default/Optional Mode Configuration Parameter Selection

Pin	Function	Effect When Bit = 0	Effect When Bit = 1	Default Value	Description
D0	-	-	-	x	Not Used: Don't Care, can leave unconnected.
D1	-	-	-	x	Not Used: Don't Care, can leave unconnected.
D2	Reserved	Not Permitted	Required	1	Reserved: Must be set to 1
D3	EPOLSW	Not Selected	Selected	1	Enables polarity switching of the receive squelch on detecting polarity reversal of the incoming data.
RA0	Reserved	Not Permitted	Required	1	Reserved: Must be set to 1
RA1	/TXONLY	Selected	Not Selected	1	Allows the port partition state machines to restrict segment reconnection only to when a good packet is transmitted on the partitioned port.
RA2	/CCLIM	63	31	0	The IEEE802.3 10Mb/s Section 9 repeater partition specification requires a port to be partitioned after a certain number of consecutive collisions. The LERIC8 has two values available to allow users to customize the partitioning algorithm to their environment.
RA3	MIN/MAX	Minimum Mode	Maximum Mode	1	The operation of the DP83955/6 LERIC compatible LED display update mode is controlled by this bit.
RA4	-	-	-	x	Not Used: Don't Care, can leave unconnected.

5.13 MIN/MAX MODE LED INTERFACE

The LERIC8 supports the Min and Max LED modes of the DP83955/6 LERIC devices. If these modes are not required (for instance, if only the direct drive LED outputs are being used), then no actions/connections are required. If Min or Max mode is required, the relevant circuitry is simply added to the data and address bus pins. The /STR pin is used to latch data into external latches for display on the status LEDs.

For Min mode, the LERIC8 operates identically to the DP83955/6 devices. Table 4 shows the interface pin functions for Min mode.

For Max mode, since the LERIC8 has more ports than the DP83955/6, a slightly different latching scheme is required. Figure 7 shows how Max mode functions for the LERIC8. Data for latching (into external 74x259 addressable latches) is presented on the D[0:3] and RA0 pins. Address information is presented on the RA[1:4] pins. The address cycles from 0h through 9h and then returns to 0h and repeats continuously.

5.14 AUI PORT 0

The DP83959 LERIC8 has a single AUI port that uses the standard 3 differential pairs of signal connections. The AUI receiver input pairs (RX0+/- and CD0+/-) require external line termination (78Ω balanced termination). The AUI transmit output pairs utilize class A/B output drivers and do not require any source termination resistors (as did the DP83955/6).

The three AUI signal pairs (RX, TX, CD) require the use of an isolation transformer (standard AUI 1:1 type) in order to meet the fault condition requirements of IEEE 802.3. A typical AUI port connection is shown in Figure 8.

5.15 10BASE-T PORTS 1-8

The DP83959 will directly support up to 8 10BASE-T ports. Figure 9 shows a typical 10BASE-T port connection.

Each of the 10BASE-T ports uses 4 signal pins on the DP83959 package (two for transmit outputs and two for receive inputs) plus a shared power and ground. This minimal configuration is possible due to the 10BASE-T filtering and waveshaping being implemented internal to the device's transmit circuitry. The DP83959 still requires the use of receive filtering and termination and transmit source impedance matching resistors external to the device. Decoupling capacitors may also be required from the center taps of the transmit and receive isolation transformers.

On transmit, the 10BASE-T ports of the DP83959 requires the use of 1:2 step-up transformers in order to generate the correct transmit output drive voltage. Common mode chokes may not be required to meet emissions standards if the layout guidelines are followed.

On receive, the 10BASE-T ports of the DP83959 requires the use of 1:1 transformers. Filtering may be required to reduce high frequency interference.

5.0 Functional Description (Continued)

Table 4 LERIC8 Min Mode LED Function

Pin	Mnemonic	Min Mode Function
D0	ACOL	Any Collision: Asserted when a collision occurs on any of this LERIC8's ports.
D1	AREC	Any Receive: Asserted when any of this LERIC8's ports experiences a data or collision packet on its receive inputs.
D2	JAB	Jabber: Asserted when this LERIC8 experiences a Jabber protect condition.
D3	APART	Any Partition: Asserted when any of this LERIC8's ports is partitioned.
RA[4:0]	-	No function: Don't care
/STR	-	Strobe: Used to latch the Min mode information into an external latch (e.g. '374)

DP83959 LERIC8

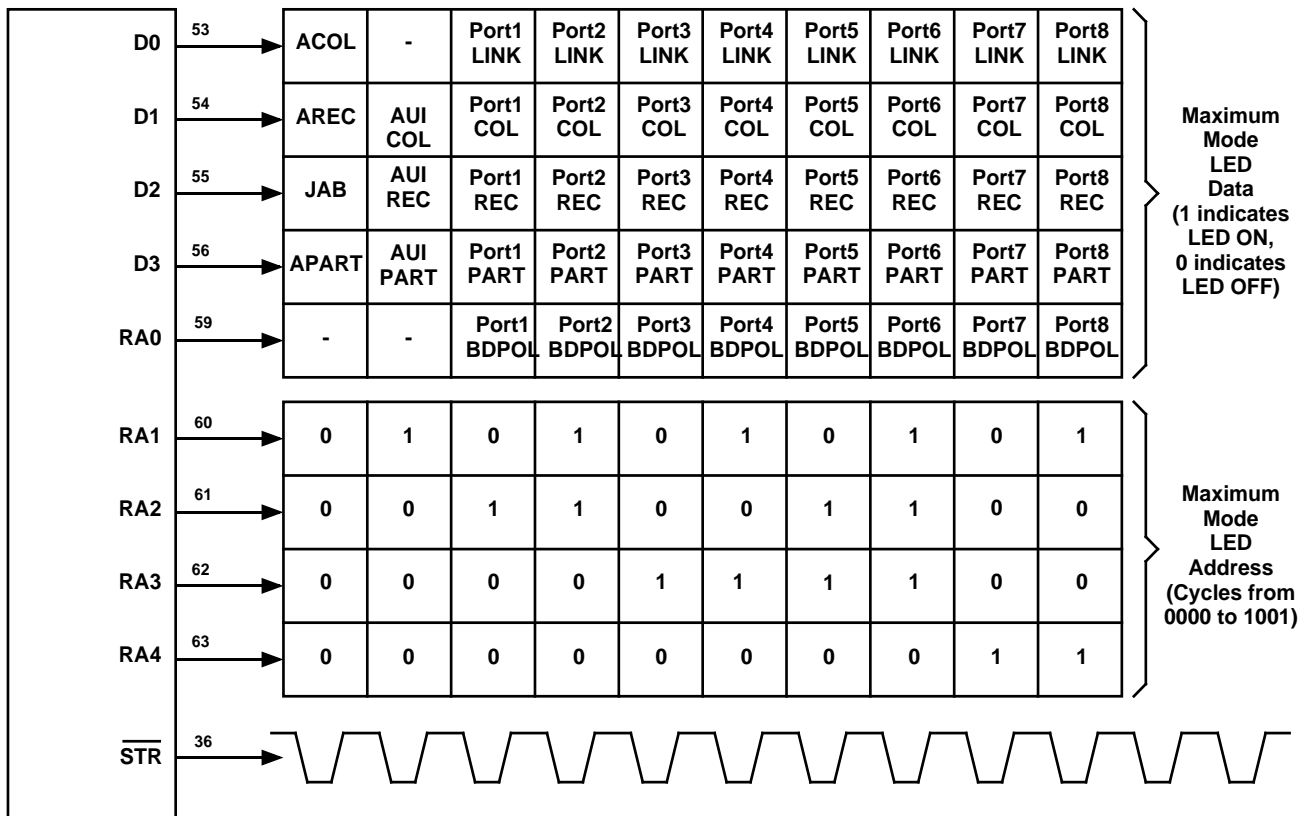


Figure 7. LERIC8 Max Mode LED Function/Mapping

5.0 Functional Description (Continued)

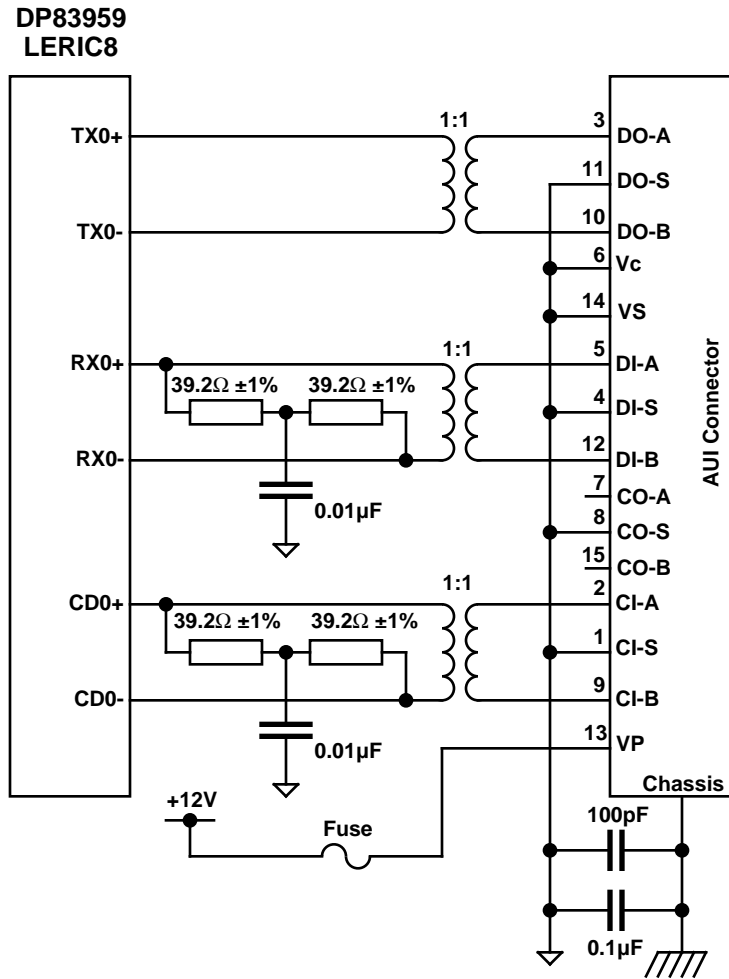
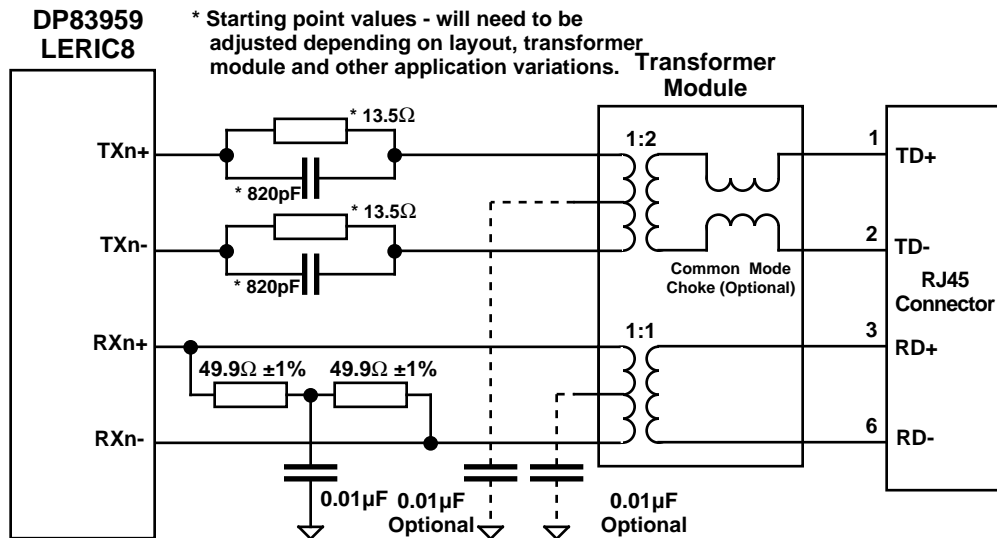


Figure 8. Typical AUI Port Connection



(Only 1 Port shown. All eight 10BASE-T ports are identical to this)

Figure 9. Typical 10BASE-T Port Connection

6.0 LERIC8 Registers

6.1 REGISTER ADDRESS MAP

The LERIC8's register address map is shown below. Since the data path is only a nibble wide interface, each register has two addresses, with the most significant address bit (RA4) used to select either the lower or upper nibble of the register byte information. Each byte wide register can be thought of as having data bits D[7:0], so that for the lower nibble bits D[3:0] are presented on D[3:0] respectively and for the upper nibble, bits D[7:4] are presented on D[3:0] respectively. Register descriptions in the following sections are given in the byte wide notation, D[7:0].

Address RA[4:0] (4 3210)	Register
0 0000 1 0000	LERIC8 Status - Lower Nibble LERIC8 Status - Upper Nibble
0 0001 1 0001	Port0 (AUI) Status/Config - Lower Nibble Port0 (AUI) Status/Config - Upper Nibble
0 0010 1 0010	Port1 Status/Config - Lower Nibble Port1 Status/Config - Upper Nibble
0 0011 1 0011	Port2 Status/Config - Lower Nibble Port2 Status/Config - Upper Nibble
0 0100 1 0100	Port3 Status/Config - Lower Nibble Port3 Status/Config - Upper Nibble
0 0101 1 0101	Port4 Status/Config - Lower Nibble Port4 Status/Config - Upper Nibble
0 0110 1 0110	Port5 Status/Config - Lower Nibble Port5 Status/Config - Upper Nibble
0 0111 1 0111	Port6 Status/Config - Lower Nibble Port6 Status/Config - Upper Nibble
0 1000 1 1000	Port7 Status/Config - Lower Nibble Port7 Status/Config - Upper Nibble
0 1001 1 1001	Port8 Status/Config - Lower Nibble Port8 Status/Config - Upper Nibble

6.0 LERIC8 Registers (Continued)

6.2 LERIC8 STATUS REGISTER

Address: RA4 - RA0
0 0000 - lower nibble
1 0000 - upper nibble

Bit	Bit Name	Access	Bit Description
D0	/ACOL	RO	Any Collision: 0 = A collision is occurring at one or more of this LERIC8's ports 1 = No collisions
D1	/AREC	RO	Any Receive: 0 = One of this LERIC8's ports is the current data or collision receiver 1 = No data packet or collision reception within this LERIC8
D2	/JAB	RO	Jabber Protect: 0 = This LERIC8 has been forced into the Jabber Protect state by one of its ports or by another port on another LERIC8 connected to this LERIC8's Inter-LERIC bus 1 = No Jabber Protect conditions exist currently
D3	/APART	RO	Any Partition: 0 = One or more ports of this LERIC8 are partitioned 1 = No ports are partitioned
D4	Reserved	RO	Reserved - Don't care
D5	Reserved	RO	Reserved - Don't care
D6	Reserved	RO	Reserved - Don't care
D7	Reserved	RO	Reserved - Don't care

Key: RO = Read Only, R/W = Read Write.

6.0 LERIC8 Registers (Continued)

6.3 PORT 0 (AUI) STATUS/CONFIGURATION REGISTER

Address: RA4 - RA0
0 0001 - lower nibble
1 0001 - upper nibble

Bit	Bit Name	Access	Bit Description
D0	Reserved	RO	Reserved - Don't care
D1	/COL	RO	Collision: 0 = A collision is happening or occurred during the current packet 1 = No collisions have occurred (as yet) in the current packet
D2	/REC	RO	Receive: 0 = This port is now, or has been, the receive source of data packet or collision information for the current network event 1 = This port is not, and has not been, the receive source for the current network event
D3	/PART	R/W	Partition: 0 = This port is currently partitioned 1 = This port is not currently partitioned Writing a 1 to this bit forces segment reconnection and partition state machine reset. Writing a 0 to this bit has no effect.
D4	Reserved	RO	Reserved - Don't care
D5	Reserved	RO	Reserved - Don't care
D6	Reserved	RO	Reserved - Don't care
D7	DISPT	R/W	Disable Port: 0 = Port operates as defined by normal repeater operations 1 = All port activity is prevented

Key: RO = Read Only, R/W = Read Write.

6.0 LERIC8 Registers (Continued)

6.4 PORTS 1-8 (10BASE-T) STATUS/CONFIGURATION REGISTERS

Address: RA4 - RA0
0 0010 to 0 1001 - lower nibble
1 0010 to 1 1001 - upper nibble

Bit	Bit Name	Access	Bit Description
D0	/GDLNK	R/W	Good Link: 0 = Link pulses are being received by this port 1 = Link pulses are not being received by this port Writing a 1 to this bit will cause the 10BASE-T transceiver not to transmit or monitor the reception of link pulses. Writing a 0 to this bit will return the 10BASE-T transceiver to normal operation.
D1	/COL	RO	Collision: 0 = A collision is happening or occurred during the current packet 1 = No collisions have occurred (as yet) in the current packet
D2	/REC	RO	Receive: 0 = This port is now, or has been, the receive source of data packet or collision information for the current network event 1 = This port is not, and has not been, the receive source for the current network event
D3	/PART	R/W	Partition: 0 = This port is currently partitioned 1 = This port is not currently partitioned Writing a 1 to this bit forces segment reconnection and partition state machine reset. Writing a 0 to this bit has no effect.
D4	SQL	R/W	Squelch Level: 0 = This port's 10BASE-T transceiver operates with normal IEEE defined receive squelch level 1 = This port's 10BASE-T transceiver operates with reduced receive squelch level
D5	POL	RO	Polarity: 0 = This port's receive polarity is normal (not inverted) 1 = This port's receive polarity is inverted
D6	Reserved	R/W	Reserved: 1 = LERIC8 factory test mode - Do not use.
D7	DISPT	R/W	Disable Port: 0 = Port operates as defined by normal repeater operations 1 = All port activity is prevented

Key: RO = Read Only, R/W = Read Write.

7.0 System Considerations

The DP83959 can be designed into several types of repeaters. The most common design is the unmanaged, stand-alone, 8-port repeater, where a single LERIC8 will be used to provide the repeater capabilities. For designs that require more than 8 ports, up to 3 LERIC8s may be cascaded on a single board.

7.1 CASCADING

Figure 10 shows the connection diagram for using 3 DP83959s in a single repeater. Most of the inter-LERIC bus is tied together. /ACKO of one device is connected to /ACKI of the next one. /ACKI on one end of the chain is tied high, while /ACKO on the other end is a no-connect.

7.2 IEEE CONFORMANCE

The LERIC8 was tested for IEEE 802.3 conformance in a repeater system. Without any resistive loading on the RTX and REQ pins, the repeater passed all conformance tests with the exception of Peak Differential Output Voltage (V_{OD} into a resistive load). With only one twisted pair port loaded and transmitting a packet, with the system running at 5.25 V in a 0 °C chamber, the output violated the Peak Differential Output Voltage (V_{OD} into a resistive load) marginally at the upper limit. With all eight twisted pair ports loaded and transmitting, and with the system running at 4.75 V in a 80 °C chamber, the output violated the Peak Differential Output Voltage (V_{OD} into a resistive load) marginally at the lower limit. Performance is also dependent on PCB layout.

The violation of this specification under these conditions will not affect a normal network. The LERIC8 passes the IEEE Output Waveform with Scaling Voltage template and the inverted template, both of which specify V_{OD} at the end of a cable. The LERIC8 has also undergone endurance testing in various platforms and has not shown any loss of data.

The RTX and REQ pins can be used to tune the internal transmit filter and wave shaping circuitry. The RTX input can be used to adjust the differential voltage (V_{OD}) of all of the output drivers. By placing a resistor between RTX and V_{CC} , the peak-to-peak voltage will be increased. Conversely, connecting the resistor to GND will decrease V_{OD} .

The REQ input can be used to adjust the shape of the waveform for all outputs. By placing a resistor between REQ and V_{CC} , the amplitude of the pre-emphasis waveform will be increased. Conversely, connecting the resistor to GND will decrease the amplitude.

Caution should be taken when using RTX and REQ to make adjustments. The following IEEE parameters may be adversely affected by adjusting the amplitude or shape of the transmitted waveform, as well as PCB layout and design: Peak Differential Output Voltage, Harmonic Content, Output waveform with Scaling of Voltage template, Output Waveform with Scaling of Voltage inverted template, TD circuit Differential Output Impedance, Transmit Output Timing Jitter with Cable Model, and Transmit Output Timing Jitter without Cable Model.

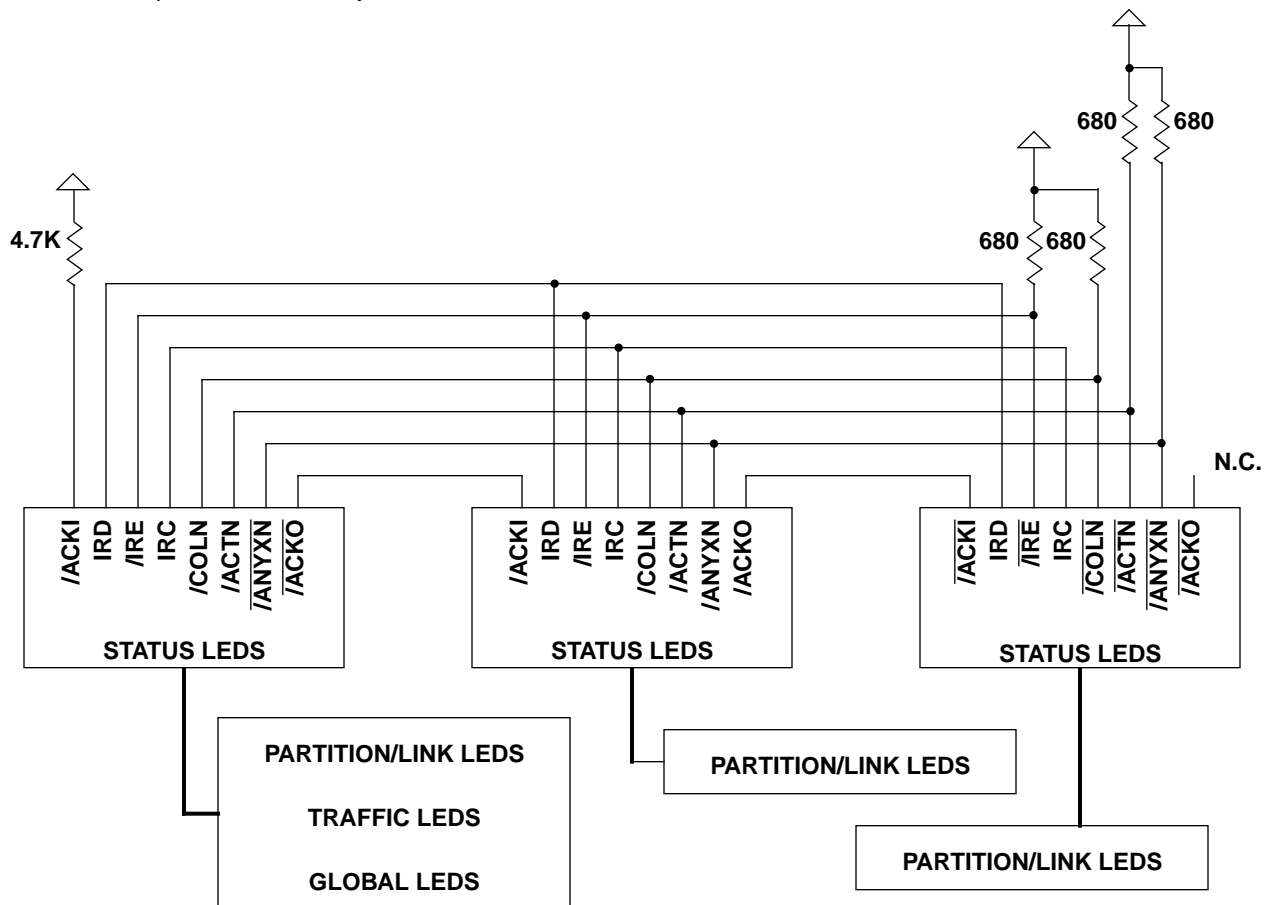


Figure 10. Connection Diagram for Cascading

8.0 DC Specifications

Absolute Maximum Ratings

Supply Voltage (V_{CC})	-0.5V to 7.0V
DC Input Voltage (V_{IN})	-0.5V to $V_{CC} + 0.5V$
DC Output Voltage (V_{OUT})	-0.5V to $V_{CC} + 0.5V$
Power Dissipation (P_D)	(Note 1) 4.5 W
Storage Temperature Range (T_{STG})	-65°C to 150°C
Lead Temp. (T_L) (Soldering, 10 sec)	260°C
ESD Rating ($R_{ZAP} = 1.5k$, $C_{ZAP} = 120$ pF)	2.0 kV

Recommended Operating Conditions

Supply Voltage (V_{CC})	5 Volts \pm 5%
Ambient Temperature (T_A)	0 to 70°C

Note: Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits.

DC Specifications

$T_A = 0^\circ\text{C}$ to 70°C , $V_{CC} = 5V \pm 5\%$ unless otherwise specified

Symbol	Description	Conditions	Min	Typ	Max	Units
PROCESSOR, LED, AND INTER-LERIC INTERFACES						
V_{OH}	Minimum High Level Output Voltage	$I_{OH} = -8$ mA	3.5			V
V_{OL}	Minimum Low Level Output Voltage	$I_{OL} = 8$ mA			0.4	V
V_{IH}	Minimum High Level Input Voltage		2.0			V
V_{IL}	Maximum Low Level Input Voltage				0.8	V
I_{IN}	Input Current	$V_{IN} = V_{CC}$ or GND	-1.0		1.0	μA
I_{OZ}	Maximum TRI-STATE Output Leakage Current	$V_{OUT} = V_{CC}$ or GND	-10		10	μA
I_{CC}	Average supply current	$V_{IN} = V_{CC}$ or GND $V_{CC} = 5.25V$		570	800	mA

AUI (PORT 0)

V_{OD}	Differential Output Voltage (TX \pm)	78 Ω Termination	± 550		± 1200	mV
V_{OB}	Differential Output Voltage Imbalance (TX \pm) (Note 2)	78 Ω Termination		40		mV
V_U	Undershoot Voltage (TX \pm) (Note 2)	78 Ω Termination		80		mV
V_{DS}	Differential Squelch Threshold (RX \pm , CD \pm)		-175		-300	mV
V_{CM}	Differential Input Common Mode Voltage (RX \pm , CD \pm) (Note 2)		0		5.5	V

10BASE-T (PORTS 1-8)

V_{RON}	Minimum Receive Squelch Threshold: Normal Mode Reduced Mode		± 300 (Note 3)		± 585 ± 340	mV mV
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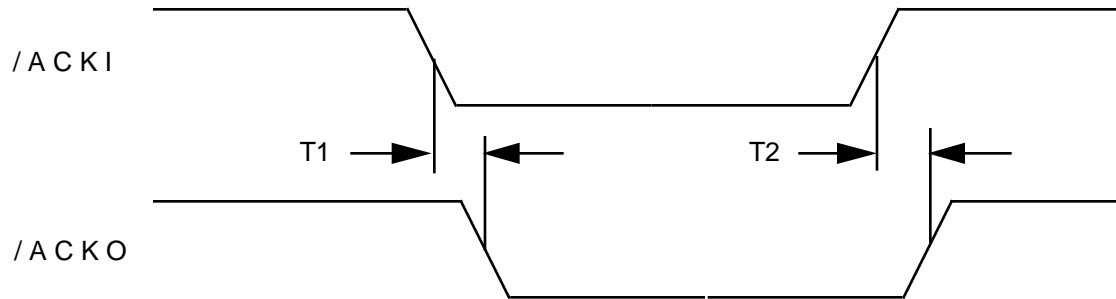
Note 1: This value is the absolute maximum, and not intended to be used to calculate case temperature. A value of 1.8W can be used for the purpose of device heat calculations.

Note 2: This parameter is guaranteed by design and is not tested.

Note 3: The operation in Reduced mode is not guaranteed below 300 mV.

9.0 Switching Characteristics

9.1 PORT ARBITRATION

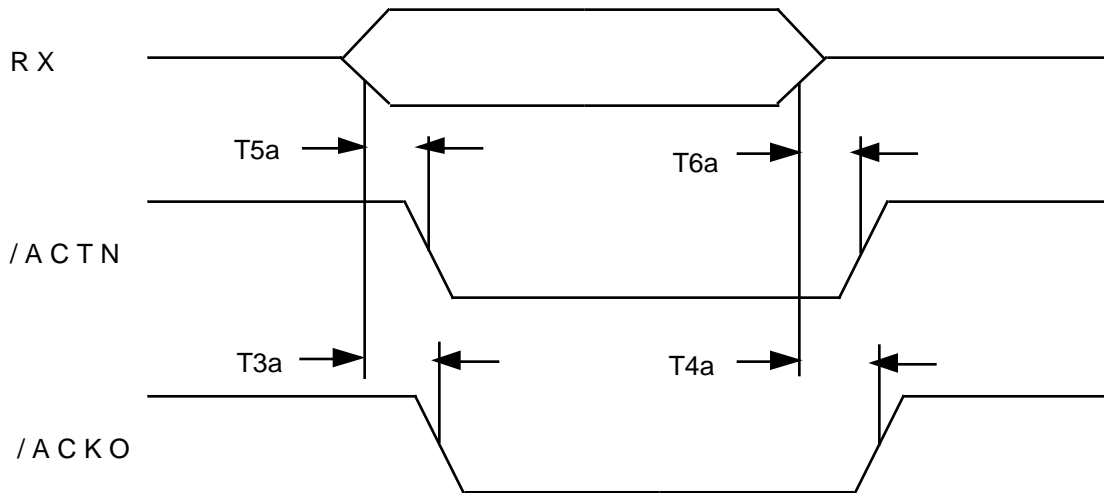


Number	Symbol	Parameter	Min	Max	Units
T1	ackilackol	/ACKI Low to /ACKO Low		26	ns
T2	ackihackoh	/ACKI High to /ACKO High		23	ns

Note: Timing valid with no receive or collision activities.

9.2 RECEIVE - AUI PORT

Receive activity propagation start up and end delays for the AUI port.



Number	Symbol	Parameter	Min	Max	Units
T3a	rxackol	RX Active to /ACKO Low (Note 2)		66	ns
T4a	rxackoh	RX Inactive to /ACKO High (Note 1)		235	ns
T5a	rxactnl	RX Active to /ACTN Low (Note 2)		75	ns
T6a	rxactnh	RX Inactive to /ACTN High (Note 1)		235	ns

Note: /ACKI assumed high.

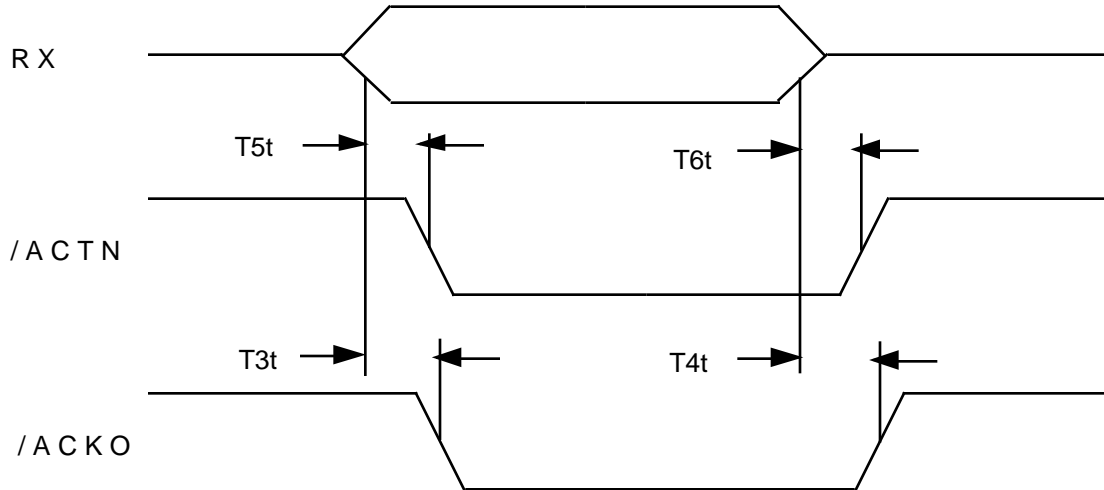
Note 1: This time includes EOP.

Note 2: This parameter assumes squelch triggers on negative edge of RX data.

9.0 Switching Characteristics (Continued)

9.3 RECEIVE - 10BASE-T PORTS

Receive activity propagation start up and end delays for 10BASE-T ports.



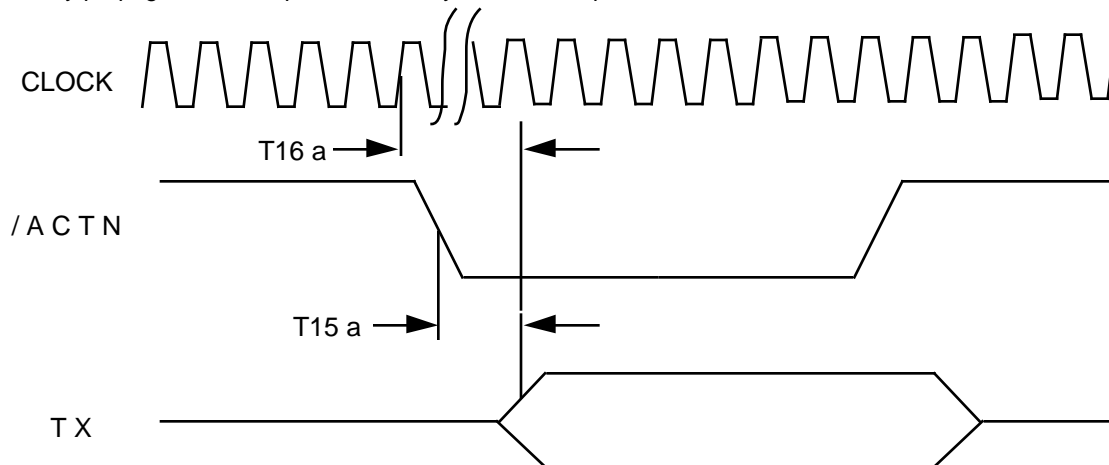
Number	Symbol	Parameter	Min	Max	Units
T3t	rxackol	RX Active to /ACKO Low		300	ns
T4t	rxiackoh	RX Inactive to /ACKO High (Note 1)		280	ns
T5t	rxactnl	RX Active to /ACTN Low		300	ns
T6t	rxiactnh	RX Inactive to /ACTN High (Note 1)		280	ns

Note: /ACKI assumed high.

Note 1: This time includes EOP.

9.4 TRANSMIT - AUI PORT

Transmit activity propagation start up and end delays for the AUI port.



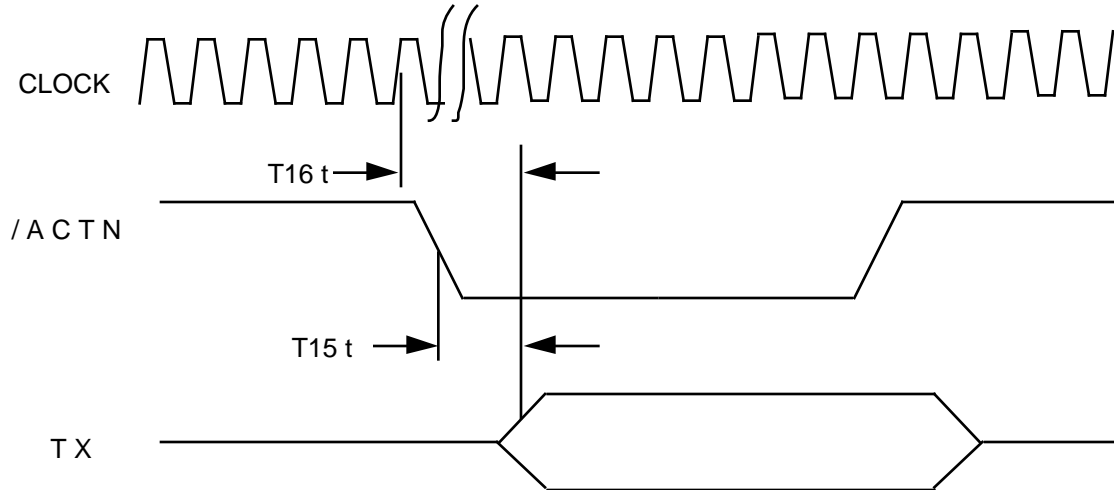
Number	Symbol	Parameter	Min	Max	Units
T15a	actnltxa	/ACTN Low to TX Active		675	ns
T16a	clkitxa	CLOCK in to TX Active		45	ns

Note: /ACKI assumed high.

9.0 Switching Characteristics (Continued)

9.5 TRANSMIT - 10BASE-T PORTS

Receive activity propagation start up and end delays 10BASE-T ports.



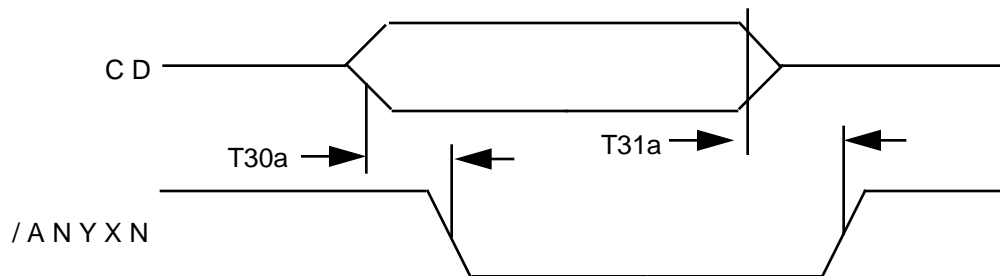
Number	Symbol	Parameter	Min	Max	Units
T15t	actnltxa	/ACTN Low to TX Active		790	ns
T16t	clkitxa	CLOCK in to TX Active		45	ns

Note: /ACKI assumed high.

9.6 COLLISION - AUI PORT

Collision activity propagation start up and end delays for the AUI port.

9.6.1 Transmit Collisions



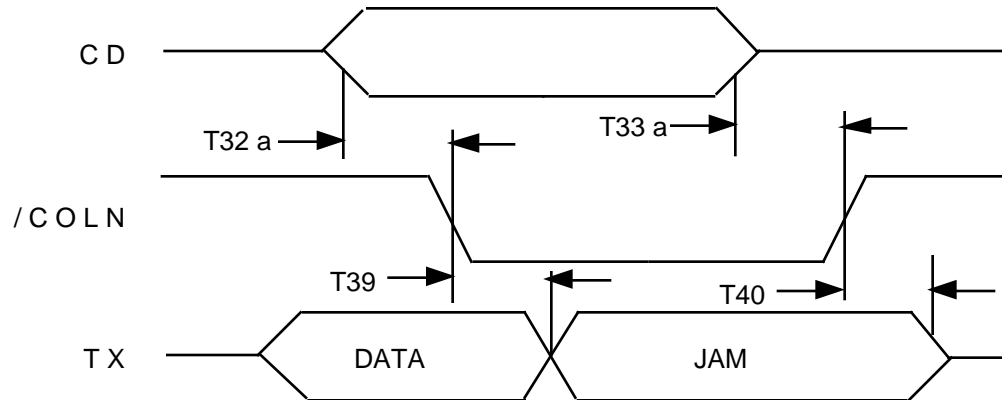
Number	Symbol	Parameter	Min	Max	Units
T30a	cdaanyxnl	CD Active to /ANYXN Low		85	ns
T31a	cdianyxn	CD Inactive to /ANYXN High (Note 1,2)		285	ns

Note 1: TX collision extension has already been performed and no other port is driving /ANYXN.

Note 2: Includes TW2.

9.0 Switching Characteristics (Continued)

9.6.2 Receive Collisions

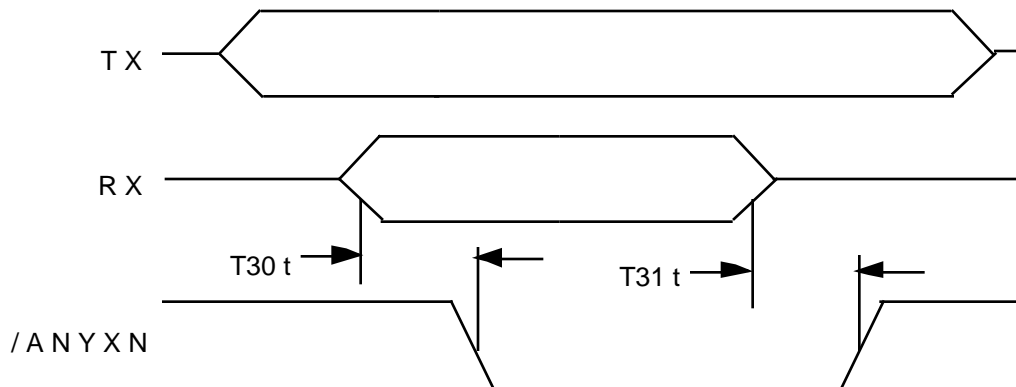


Number	Symbol	Parameter	Min	Max	Units
T32a	cdacolna	CD Active to /COLN Low		75	ns
T33a	cdicolni	CD Inactive to /COLN High		215	ns
T39	colnljs	/COLN Low to Start of JAM		400	ns
T40	colnhje	/COLN High to End of JAM (Note 1)		585	ns

Note 1: Reception ended before /COLN goes high.

9.7 COLLISION - 10BASE-T PORTS

Collision activity propagation start up and end delays for 10BASE-T ports

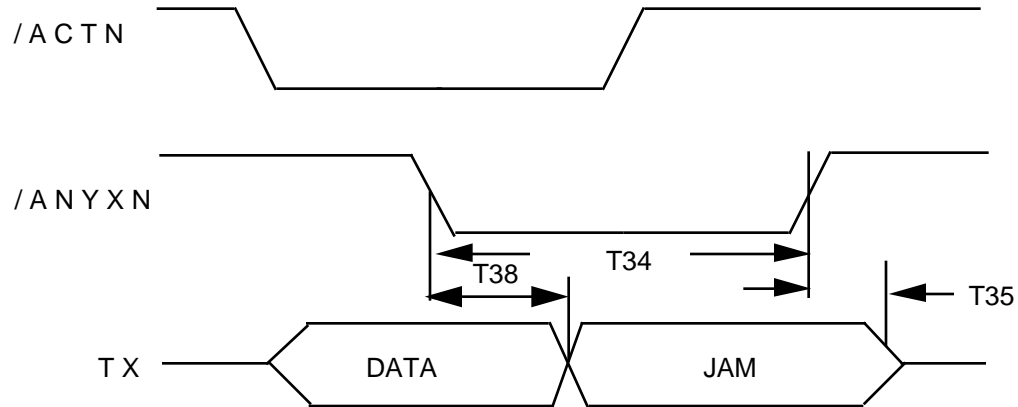


Number	Symbol	Parameter	Min	Max	Units
T30t	colaanyl	Collision Active to /ANYXN Low		800	ns
T31t	colianyh	Collision Inactive to /ANYXN High (Note 1)		450	ns

Note 1: TX collision extension has already been performed and no other port is asserting /ANYXN.

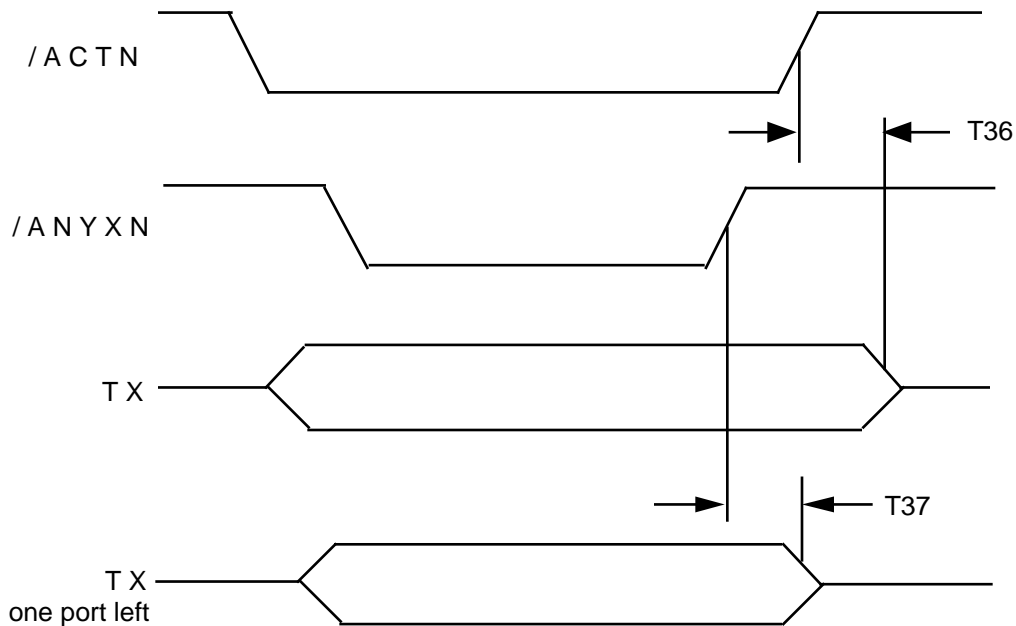
9.0 Switching Characteristics (Continued)

9.8 COLLISION - ALL PORTS - INTER-LERIC BUS



Number	Symbol	Parameter	Min	Max	Units
T34	anylmin	/ANYXN Low time	960		ns
T35	anyhtxai	/ANYXN High to TX to all Inactive	20	370	ns
T38	anyslj	/ANYXN Low to Start of JAM		565	ns

9.9 COLLISION - ALL PORTS - ONE PORT LEFT

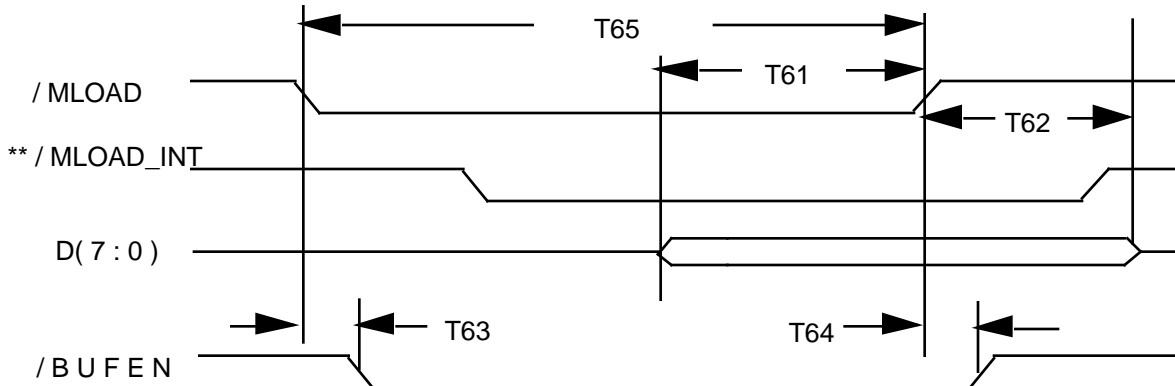


Number	Symbol	Parameter	Min	Max	Units
T36	actnhtxi	/ACTN High to TX Inactive		410	ns
T37	anyhtxoi	/ANYXN High to TX 'One Port Left' Inactive	20	200	ns

Note: 96 bits of JAM have already been propagated.

9.0 Switching Characteristics (Continued)

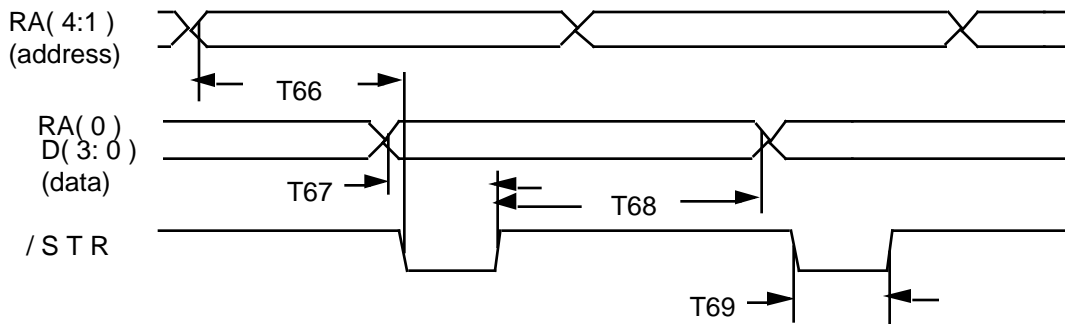
9.10 RESET



** /MLOAD_INT is the internal signal which is delayed 5 cycles from the external /MLOAD signal

Number	Symbol	Parameter	Min	Max	Units
T61	resdats	Data Setup	20		ns
T62	resdath	Data Hold	20		ns
T63	reslbufl	/MLOAD Low to /BUFEN Low		35	ns
T64	reshbufh	/MLOAD High to /BUFEN High		35	ns
T65	resw	/MLOAD Width	800		ns

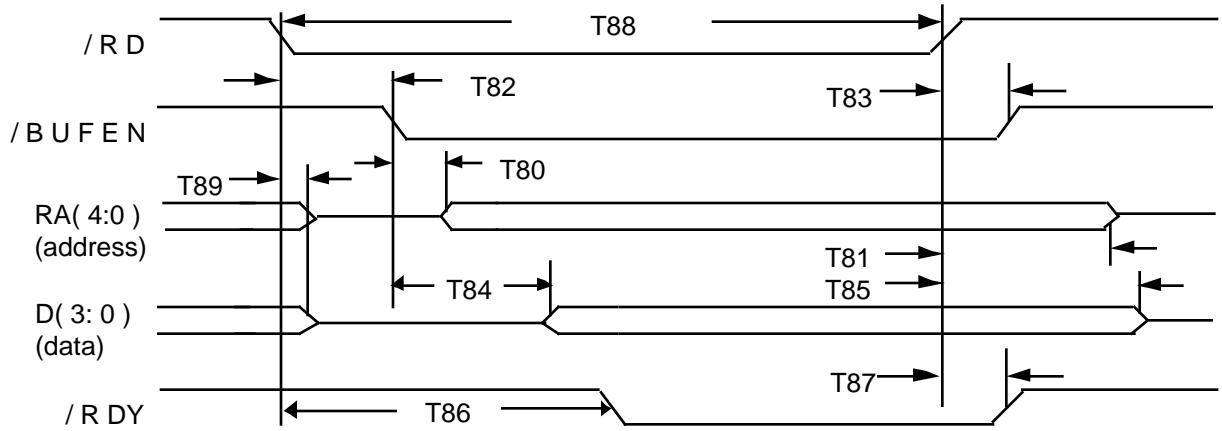
9.11 LED STROBE



Number	Symbol	Parameter	Min	Max	Units
T66	strads	Strobe Address Setup	70	100	ns
T67	strdats	Strobe DATA SETUP	35	55	ns
T68	strdath	Strobe Data Hold	145	165	ns
T69	strw	Strobe Width	30	65	ns

9.0 Switching Characteristics (Continued)

9.12 REGISTER READ

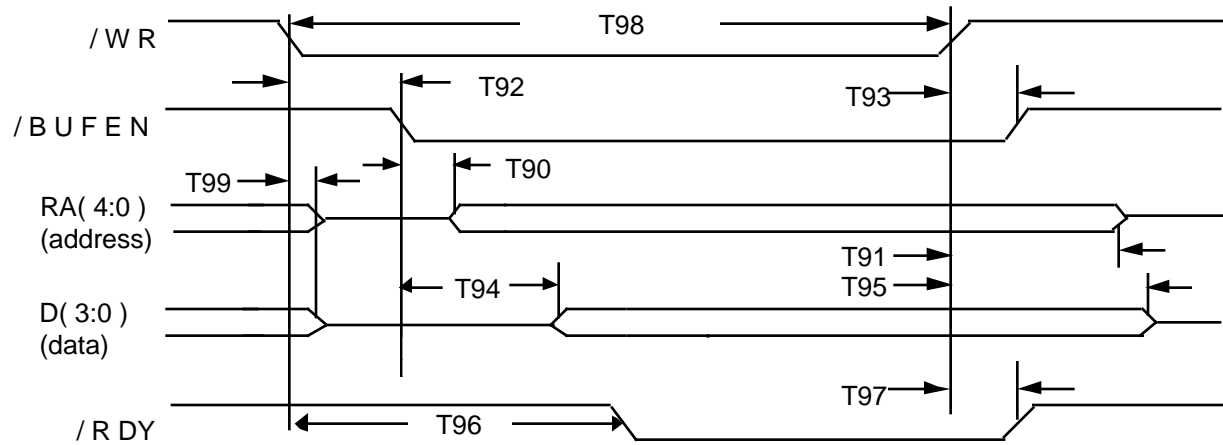


Number	Symbol	Parameter	Min	Max	Units
T80	rdads	Address Setup from /BUFEN Low Address Hold after /RD High	0	85	ns
T81	rdadh		0		ns
T82	rdlbufl	/RD Low to /BUFEN Low /RD High to /BUFEN High	80	355	ns
T83	rdhbufh			35	ns
T84	bufldatv	/BUFEN Low to Data Valid Data Hold After /RD High		190	ns
T85	rddath		60		ns
T86	rdlrdyl	/RD Low to /RDY Low /RD High to /RDY High	340	585	ns
T87	rdhrdyh			30	ns
T88	rdw	/RD Width	650		ns
T89	rdtr	/RD Low to D(3:0) TRI-STATE	80	355	ns

Note: Minimum high time between read/write cycles is 100 ns.

9.0 Switching Characteristics (Continued)

9.13 REGISTER WRITE

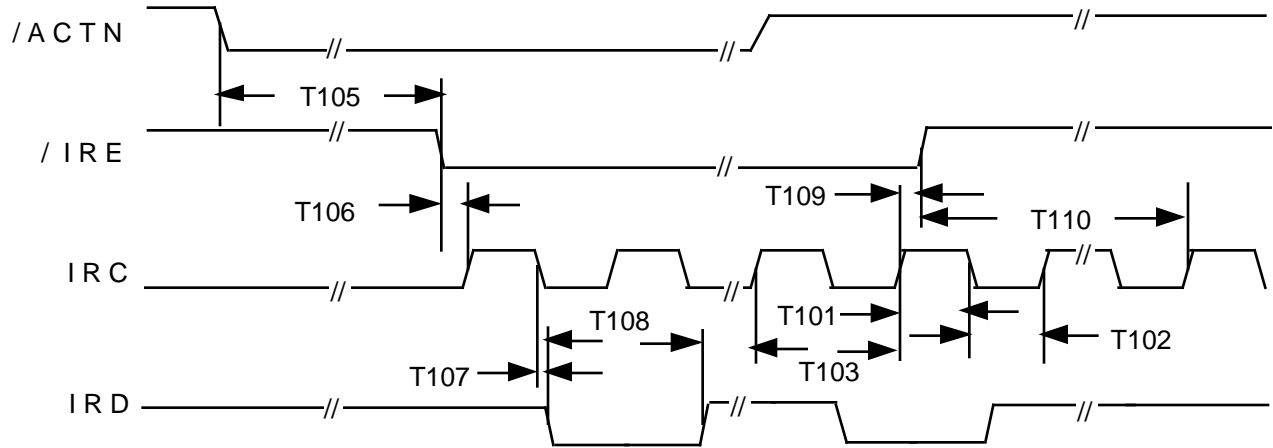


Number	Symbol	Parameter	Min	Max	Units
T90	wrads	Address Setup from /BUFEN Low Address Hold after /WR High	0	14	ns
T91	wradrh		0		ns
T92	wrlbufl	/WR Low to /BUFEN Low /WR High to /BUFEN High	80	355	ns
T93	wrhbufh			35	ns
T94	wradatv	/BUFEN Low to Data Valid Data Hold After /WR High		160	ns
T95	wrdath		0		ns
T96	wrlrdyl	/WR Low to /RDY Low /WR High to /RDY High	340	585	ns
T97	wrhrdyh			30	ns
T98	wrw	/WR Width	650		ns
T99	wrtr	/WR Low to D(3:0) TRI-STATE	80	355	ns

Note: Minimum high time between read/write cycles is 100 ns.

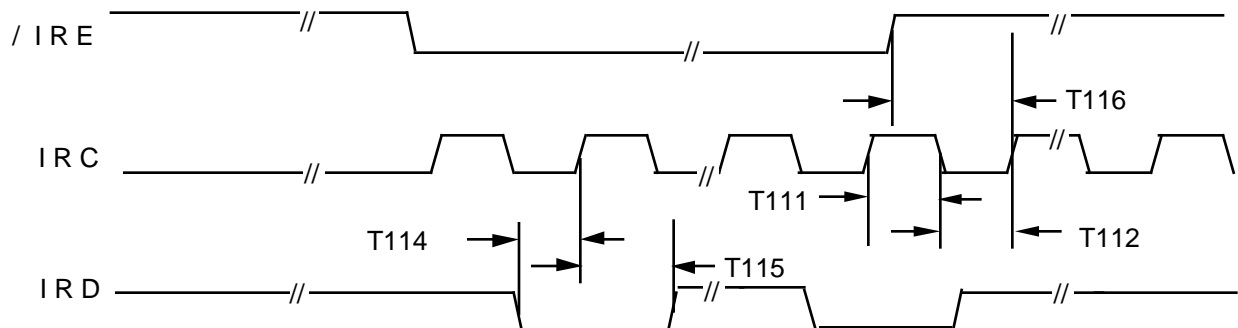
9.0 Switching Characteristics (Continued)

9.14 INTER-LERIC BUS (PACKET OUTPUT)



Number	Symbol	Parameter	Min	Max	Units
T101	ircoh	IRC Output Duty Cycle High Time	40	60	%
T102	ircol	IRC Output Duty Cycle Low Time	40	60	%
T103	ircoc	IRC Output Cycle Time	90	110	ns
T105	actnolireol	/ACTN Output Low to /IRE Output Low	500		ns
T106	ireolirca	/IRE Output Low to IRC Active		1.8	μs
T107	irdov	IRD Output Valid from IRC		10	ns
T108	irdos	IRD Output Stable Valid Time	90		ns
T109	ircohireh	IRC Output High to /IRE High	30	70	ns
T110	ircclks	Number of IRCs after /IRE high	5		clks

9.15 INTER-LERIC BUS (PACKET INPUT)



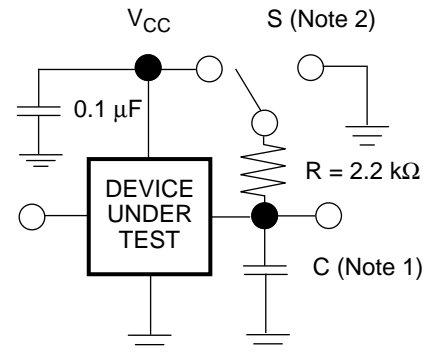
Number	Symbol	Parameter	Min	Max	Units
T111	ircih	IRC Input High Time	20		ns
T112	ircil	IRC Input Low Time	20		ns
T114	irdisirc	IRD Input Setup to IRC	5		ns
T115	irdihirc	IRD Input Hold from IRC	10		ns
T116	ircihireh	Set Up Time of the Rising Edge of IRE to the Rising Edge of IRC for End of Packet Generation	25	75	ns

10.0 AC Timing Test Conditions

10.1 GENERAL TEST CONDITIONS

All AUI specifications are valid only if the mandatory isolation transformer is employed and all differential signals are measured at the AUI connector (not at the DP83959 LERIC8 directly).

Input Pulse Levels (TTL/CMOS)	GND to 3.0V
Input Rise and Fall Times (TTL/CMOS)	5 ns
Input and Output Reference Levels (TTL/CMOS)	1.5V
Input Pulse Levels (Differential)	-350 to -1315 mV
Input and Output Reference Levels (Diff.)	50% Point of the Differential
TRI-STATE Reference Levels	Float (ΔV) \pm 0.5V
Output Load (See <i>Figure</i> below)	



Note 1: 100 pF, includes scope and test jig capacitance.

Note 2: S1 = Open during timing tests for push pull outputs.

S1 = V_{CC} for V_{OL} test.

S1 = GND for V_{OH} test.

S1 = V_{CC} for High Impedance to active low, and active low to High Impedance measurements.

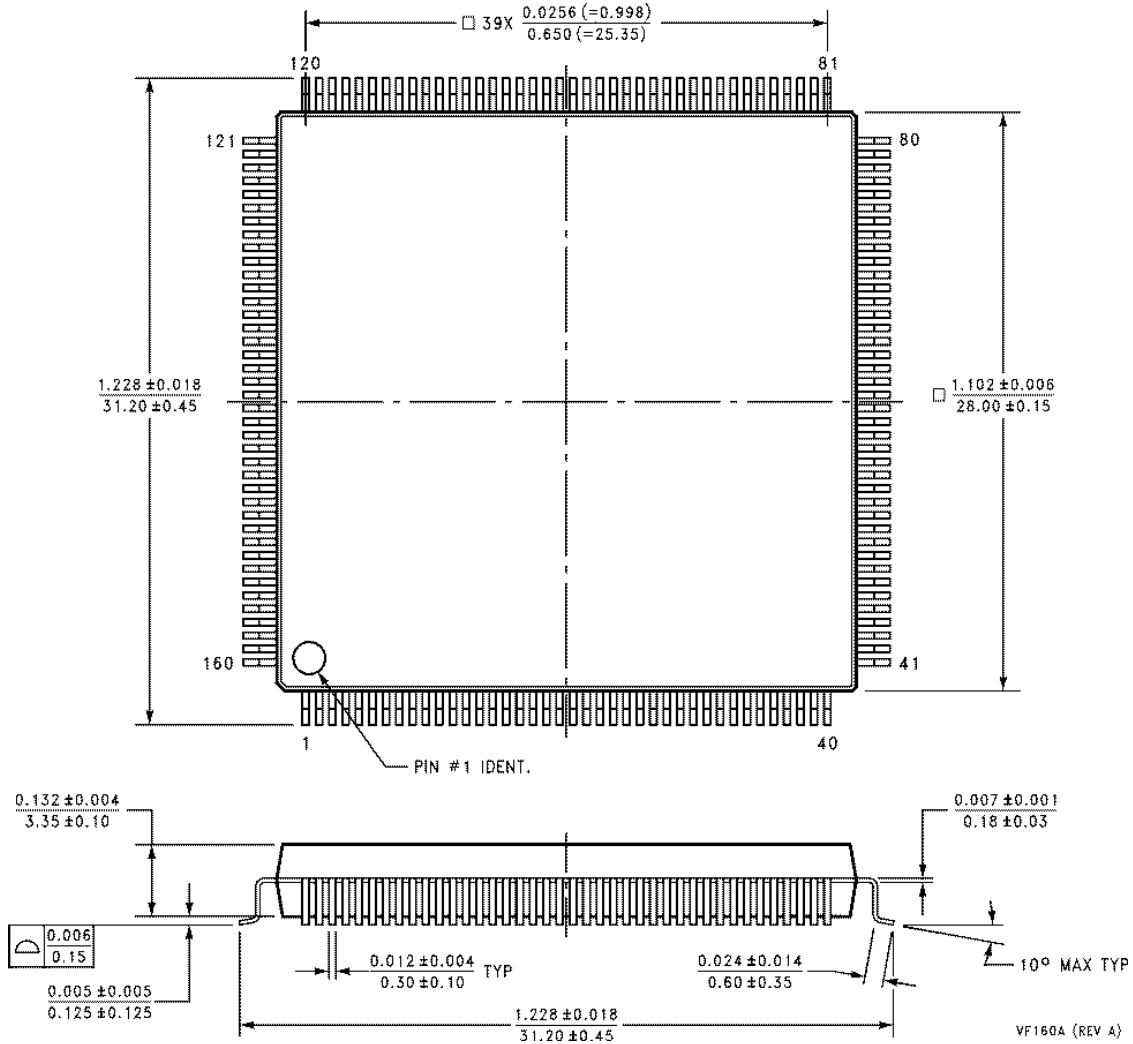
S1 = GND for High Impedance to active high, and active high to High Impedance measurements.

10.2 CAPACITANCE

T_A = 25°C, f = 1 MHz

Symbol	Parameter	Typ	Units
C _{IN}	Input Capacitance	7	pF
C _{OUT}	Output Capacitance	7	pF

11.0 Physical Dimensions inches (millimeters) unless otherwise noted



**Molded Plastic Quad Flat Package, JEDEC
Order Number DP83959VUL
NS Package Number VUL160A**

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



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