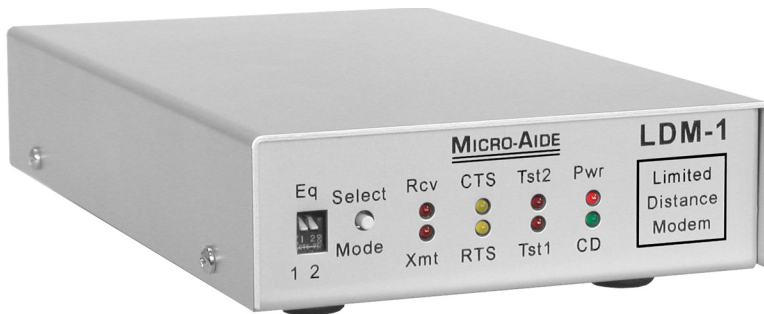

LIMITED DISTANCE MODEM USER MANUAL

by **MICRO-AIDE CORP.**



LIMITED DISTANCE MODEM USER MANUAL

A comprehensive document for the following LDM products:

- *LDM-1 standalone*
- *LDM-1 plug-in*
- *LDM-16 nest*



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TABLE OF CONTENTS

CHAPTER 1	GENERAL DESCRIPTION	
	Introduction.	1
	Key Features	2
	About This Manual	2
	Revision Level	3
	TxDOT Applications.	3
CHAPTER 2	SETUP AND INSTALLATION	
	Introduction.	5
	Unpacking.	7
	LDM-1 Basics.	8
	Network Types	9
	Point-to-Point	9
	Multi-drop Network	10
	Accessing the LDM-1 PCB.	12
	User Configured Settings	12
	Setup	13
	Rcv and Xmt Terminations (AX1 and AX2).	13
	Enable Xmt Channel Busy Detector (AX3)	14
	RS-232 Protective Ground (AX5)	14
	RTS to CTS Delay (SW2)	14
	Equalization (SW3)	14
	Permanently Asserting the RTS	15
	Installation	15
	LDM-1 Standalone	15
	LDM-1 Plug-in	16
	LDM-16 Nest.	16
	Attaching the Network Lines.	17
	Connecting to the DTE	17
CHAPTER 3	OPERATION	
	Introduction.	19
	Indicators and Controls	19
	LEDs	19

Select Mode Pushbutton Switch	20
Operating Modes	20
Normal Mode	21
Test Mode A - Analog test with digital loop back.	22
Test Mode B - Analog loop back with DTE data	22
Test Mode C - Analog loop back with test data	23
CHAPTER 4 MAINTENANCE	
Introduction	25
PCB Removal and Insertion	25
Jumper and Switch Locations	26
Trouble-Shooting Guide	27
APPENDIX A TECHNICAL DATA	
LDM-1 Specifications	29
LDM-16 Specifications	30
Transmission Range Specifications.	30
Recommended Equalizations Settings	31
DB-25 Connector Wiring	31
APPENDIX B TXDOT APPLICATIONS	
Introduction	33
Network Configurations	33
Point-to-Point	33
Multi-Drop	34
RS-232 Cables	34
LCU to LDM-1	34
PSDM to LDM-1	34
ADU to LDM-1	34
Test Software	35
Requirements.	35
Installation	35
Test Procedure	36

GENERAL DESCRIPTION

INTRODUCTION

MICRO-AIDE's family of Limited Distance Modem (LDM) products can be used in a variety of data communications applications. The family consists of the following products.

- **LDM-1 standalone** - a complete LDM (photographed on the cover page of this manual).
- **LDM-1 plug-in** - functionally identical to the standalone version, it is a printed circuit board (PCB) that is mounted within the LDM-16 nest.
- **LDM-16 nest** - a 19" rack-mounted chassis that can be equipped with 1 to 16 LDM-1 plug-in PCBs.

The LDM-1 can be thought of as a device for extending RS-232 communications over great distances (e.g., thousands of feet). It serves as an interface between the customer's Data Terminal Equipment (DTE) and data communications network. It is designed to be compatible with four-wire, private line networks. It can be used to facilitate point-to-point and multi-drop network configurations. Its unique performance characteristics permit data transmission and reception over distances of many miles. Additionally, the LDM-1 will operate over a wide temperature range.

The LDM-1 is easy to install and operate. Several self-test modes allow the user to verify its performance and network segment integrity. Light Emitting Diode (LED) indicators inform the user of all critical functions.

KEY FEATURES

Listed below are just a few of the features associated with MICRO-AIDE's family of LDM products.

- Broad transmission range, up to 25 miles, point-to-point, at 4800 Baud.
- Data transparent transmission and asynchronous operation.
- Baud rates from 75 to 19,200.
- Supports multi-drop configurations of up to eight LDM-1s. Transmission distance and data rate performance are not de-rated by adding drop points.
- Standard DB-25 female connector provides simple cabling to any RS-232 device.
- Easy-to-activate analog and digital loop back test modes.
- Includes transmit channel detector to avoid data transmission collisions. Data contention can be resolved at the LDM-1, not at the DTE.
- Allows full duplex operation on four wires.
- Compact size, LDM-1 standalone footprint is approximately 5" by 8" and less than 2lbs. in weight.
- LDM-16 nest can be equipped with 1 to 16 LDM-1 plug-in PCBs for applications requiring multiple network interfaces at a single location.

ABOUT THIS MANUAL

This document is intended to provide the user with comprehensive, easy-to-read instructions on how to install, set up, operate and maintain all three LDM products. Wherever possible, step-by-step instructions are listed. In the event the user has questions about any of the described procedures the user should contact MICRO-AIDE for assistance.

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The MICRO-AIDE Material Return and Limited Warranty policies can be found on the inside back cover of this manual.

REVISION LEVEL

This User Manual makes specific reference to Revision D of the LDM-1. Additionally, this manual is applicable to LDM-1s that have been factory reworked to the Revision D level. The revision level can be found near the lower right-hand corner of the LDM-1's printed circuit board (PCB).

TXDOT APPLICATIONS

The LDM products are frequently used with MICRO-AIDE's Local Control Unit (LCU) and other data communications devices throughout the State of Texas. They have been approved by the Texas Department of Transportation for use in various highway communications networks. Appendix B includes information specific to these applications.

SETUP AND INSTALLATION

INTRODUCTION

This chapter describes how to properly unpack, set up and install each of the MICRO-AIDE LDM products. Typical point-to-point and multi-drop network installations are described.

Figure 1 on page 6 includes an illustration of the front and rear panels of the LDM-1 standalone modem. The LDM-16 nest is illustrated in Figure 2 on page 7.

NOTE: Unless otherwise stated, the term LDM-1 will refer to either version of the modem (i.e., LDM-1 standalone and LDM-1 plug-in).

TIP: The LDM-1 must be properly configured before it can be put into operation. As the setup procedure requires that the user have access to the LDM-1 PCB, it is advisable that the user complete the setup procedure described herein and then proceed to install the modem.

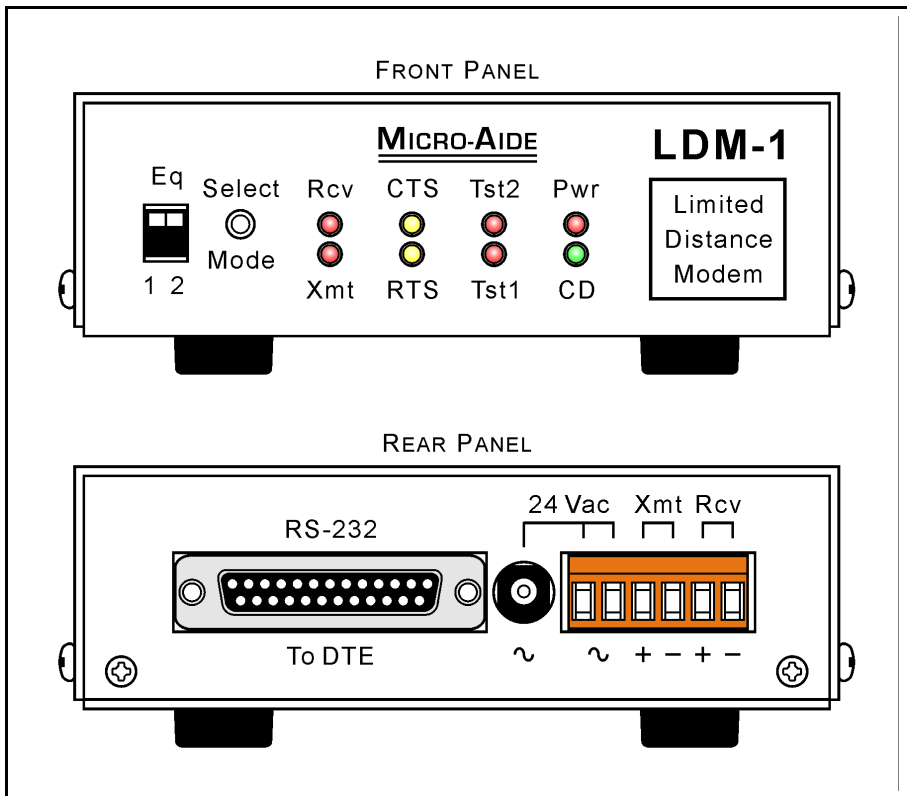


Figure 1 - LDM-1 Standalone

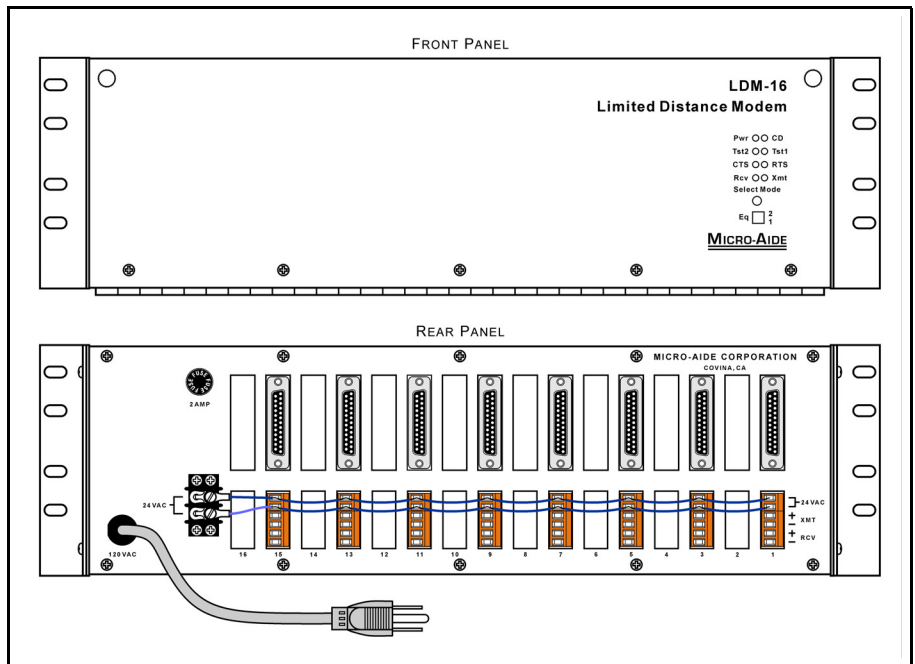


Figure 2 - LDM-16 Nest

UNPACKING

The LDM-1 standalone and LDM-16 nest are packed in individual containers that are properly sized for the unit. The LDM-1 plug-in PCBs are secured inside the LDM-16 nest. Abundant packing materials are provided to minimize mechanical shock to the contents. Before opening the shipping carton inspect the carton for damage. Damage to the container should be noted. Carefully remove the unit. It is advisable to save all packing materials in the event the unit ever needs to be returned to MICRO-AIDE.

Inspect each unit and PCB for any visual damage. The unit should not be scratched, dented or deformed in any way. If it appears that the unit was damaged in shipment the responsible carrier should be notified immediately. MICRO-AIDE will assist the user in filing a claim in the event damage was sustained during shipment.

LDM-1 BASICS

The LDM-1 can be thought of as a device that extends the distance that RS-232 serial data can be transmitted and received. It does so over four-wire (i.e., two pair) private line networks. It includes a standard DB-25 female connector that allows for direct connection to any DTE device. The LDM-1 is configured as a DCE device. Refer to Figure 7 on page 31.

Regardless of the network configuration (refer to section entitled “Network Types” on page 9) at least two modems must be used. The master modem broadcasts to one or more slave modems. Each slave modem listens to the data on its receive channel and passes that data to its DTE device. Under control of its DTE device only one of the slave modems is allowed to respond at a time to the master modem’s message. The slave modem sends data via its transmit channel.

The basic transmit and receive methodology employed is summarized by the following rules.

- Only one master modem can be employed per network.
- The master modem broadcasts simultaneously to every slave modem.
- Only one slave modem can respond to the master modem at a time. It can only transmit data to the master modem (i.e., not to another slave modem).
- The slave DTE device, via its application, controls the response of each slave modem.
- Hardware flow control must be enabled within each DTE device. Specifically, the DTE device must not attempt to send data until its modem has asserted its Clear to Send (CTS) signal.
- If only two modems are used, as is the case in a point-to-point network, the RTS signal of each modem can be permanently asserted. Refer to the section entitled “Permanently Asserting the RTS” on page 15.

NOTE: The LDM-1 (master or slave) will only transmit data when its Request to Send (RTS) signal is asserted and the LDM-1 has in response asserted its CTS signal.

NETWORK TYPES

The LDM-1 has several options and performance settings that can be configured by the user. Equalization, line termination and timer settings are among the various items. Before the LDM-1 can be properly set up the type of network that will be used must be understood and selected. The LDM-1 is designed for use in point-to-point and multi-drop networks. They are described in the following two sections.

WARNING: The LDM-1 **cannot** be used in a star network configuration involving spoke lengths that are greater than 100 ft.

POINT-TO-POINT

The point-to-point network is the simplest of the two configurations. It is characterized by a two-pair cable and a single modem at each cable end. The cable pairs are referred to as Xmt and Rcv for transmit and receive, respectively. Figure 3 on page 10 illustrates a typical point-to-point network.

The proper LDM-1 setup configuration for a point-to-point network is as follows:

- The Xmt and Rcv Terminations for both modems must be set to On.
- Since only two modems are used, the RTS signal of each modem can be permanently asserted. Refer to the section entitled “Permanently Asserting the RTS” on page 15.
- The end-to-end cable length must not exceed the recommendations as listed in Table 5 on page 30 for the given cable diameter and selected Baud rate.
- The Equalization setting for both modems must be identical and set in accordance with the recommendations as listed in Table 6 on page 31.

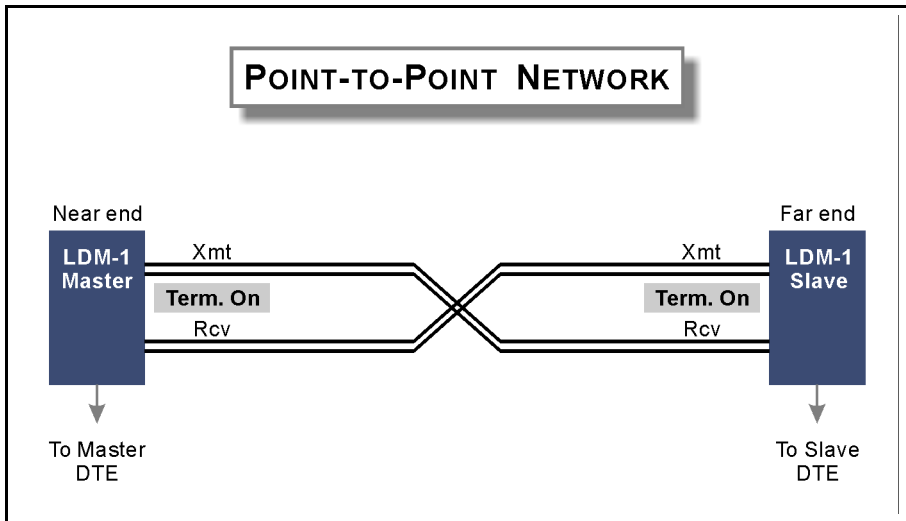


Figure 3 - Typical Point-to-Point Network

MULTI-DROP NETWORK

The multi-drop network involves two or more, two-pair cable segments. Each cable segment includes a Xmt and Rcv cable pair. The ends of the cable are connected to a single modem. These modems are also referred to as the near- and far-end modems. The master modem is located at the near end. The far end is equipped with a slave modem. The intersection of two cable segments forms a drop point. A slave modem can be connected to the network at each drop point. Figure 4 on page 11 illustrates a typical multi-drop network.

NOTE: A multi-drop network is limited to no more than eight modems.

The proper setup configuration for a multi-drop network is as follows:

- The Xmt and Rcv Terminations for the near- and far-end modems must be set to On.
- The Xmt and Rcv Terminations for each modem at a drop point must be set to Off.

Setup and Installation - Network Types

- The RTS signal of the master modem can be permanently asserted. Refer to the section entitled “Permanently Asserting the RTS” on page 15.
- RTS-CTS flow control must be used by each DTE device connected to a slave modem.
- The near- to far-end cable length must not exceed the recommendations as listed in Table 5 on page 30 for the given cable size and selected Baud rate.
- The Equalization setting for the near- and far-end modems must be identical and set in accordance with the recommendations as listed in Table 6 on page 31. Assume a cable length equal to the near-end to far-end cable length.
- The Equalization setting for a drop point modem must also be set in accordance with the recommendations as listed in Table 6 on page 31. Assume a cable length equal to the length between the near-end modem (i.e., master) and the drop point modem.

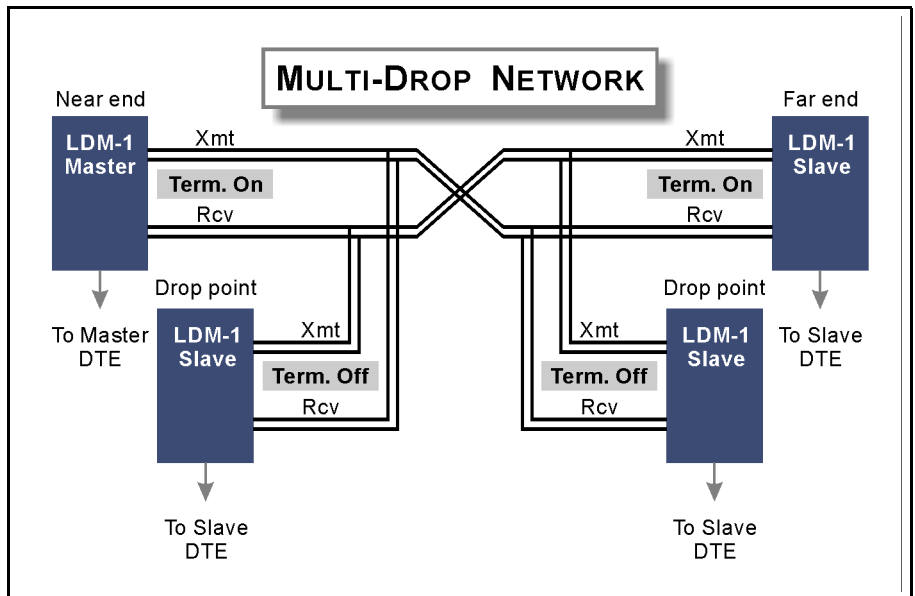


Figure 4 - Typical Multi-Drop Network

ACCESSING THE LDM-1 PCB

The various LDM-1 settings are controlled by jumpers and switches. They are located on the LDM-1's PCB. Only the Equalization (SW3) setting can be accessed externally of the standalone modem. The other settings require that the cover of the standalone unit be removed or that the plug-in PCB be removed from its LDM-16 nest.

The cover of the standalone unit can be removed by removing the four screws at the side of the unit. The plug-in PCBs can be removed by first unfastening the hinged front cover of the LDM-16. Remove the PCB retaining bar located at the top front edge of the nest. It is secured by two screws. The xmt/rcv and power connectors should then be unfastened at the rear of the nest. Remove the plug-in PCB by depressing the PCB retainer at the bottom front edge of the nest while rotating the PCB's card ejector upward.

CAUTION: Electrostatic discharges can cause serious damage to electronic components. Normal anti-static precautions are recommended when handling the LDM-1 PCB.

USER CONFIGURED SETTINGS

Two switch assemblies and four jumpers comprise the collection of user configured settings. Table 1 provides a brief definition of each setting. Also included in Table 1 are the factory default settings.

Label	Description	Position / Setting				Default Setting
AX1	Receive channel termination	On or Off				On (150 Ohms)
AX2	Transmit channel termination	On or Off				On (150 Ohms)
AX3	Transmit channel busy detector	On or Off				Off (disabled)
AX5	RS-232 protective ground	On or Off				Off (isolated)
SW2	RTS to CTS delay (msec.)	64	32	16	8	8 msec.
SW3	Receive channel Equalization	see below				Minimum

Table 1 - User Configured Settings

NOTE: The factory default switch and jumper settings for AX1 through AX5 and SW2 are satisfactory for use with a point-to-point network. The Equalization setting controlled by SW3 may need to be changed as required by the length of cable being used.

Figure 5 illustrates the location of each setting on the LDM-1 PCB.

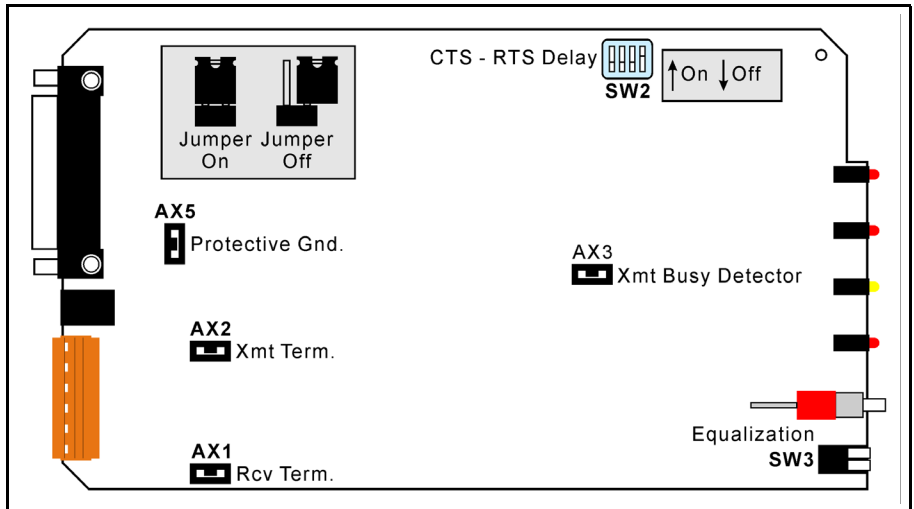


Figure 5 - LDM-1 PCB

SETUP

In the sections that follow a description is provided for each jumper and switch setting. A description of how to permanently assert the modem's RTS signal is also provided.

Rcv AND XMT TERMINATIONS (AX1 AND AX2)

AX1 and AX2 allow the user to select either a 150 Ohm (On) or high impedance (Off) termination. These jumpers are used in accordance with the following rules.

- The AX1 (Rcv) and AX2 (Xmt) settings must always match each other.
- Irrespective of the type of network, always terminate the extreme ends of the network (i.e., the near and far ends).

- If two modems are located at an end point in the network only one modem should be terminated.
- Never terminate a modem located at a drop point.
- There should never be more than two terminations per network channel.

CAUTION: Failure to provide the correct termination and Equalization settings can result in significant communication errors.

ENABLE XMT CHANNEL BUSY DETECTOR (AX3)

The LDM-1 has a built-in carrier detector for its transmit channel. When enabled, the LDM-1 will not assert its CTS signal until it verifies that a carrier is no longer present at the transmit channel. This feature prevents two modems from attempting to transmit simultaneously. To enable the busy detector, set the AX3 jumper. The factory default setting is Off.

RS-232 PROTECTIVE GROUND (AX5)

Installing the jumper at AX5 will connect the signal ground of the LDM-1 to the protective ground of the DTE device. Generally, the LDM-1 and DTE can be left isolated from one another by leaving the jumper set to Off. The LDM-1 is provided 24Vac power by a fully isolated transformer. The factory default setting is Off.

RTS TO CTS DELAY (SW2)

The LDM-1 will respond to the DTE's RTS signal by asserting its CTS signal. The delay from RTS to CTS is controlled by the SW2 setting. The delay can be used to ensure that the transmit channel is available. SW2 allows the user to select any of four settings. Only one switch must be closed. Refer to Table 1 on page 12. Silkscreening on the LDM-1 PCB lists the correspondence between switch position and delay. The factory default setting is 8msec.

EQUALIZATION (SW3)

SW3 is a dual position switch that is accessed from the front panel of the modem. Refer to Figure 1 on page 6. SW3 allows the user to set the Equalization level required to compensate for the transmission characteristics of the cable being used. To provide the broadest performance range possible, four

distinct settings are available. Table 2 details the correspondence between Equalization settings and switch positions.

Equalization Setting	Switch 3-1	Switch 3-2	Cable Length
1 (min. default)	On	On	Short
2	Off	On	Mid-range
3	On	Off	Mid-range
4 (max.)	Off	Off	Long
	On=down Off=up		

Table 2 - Equalization Settings

Selecting the proper Equalization setting relates directly to cable length and wire diameter. The higher settings are used when the master and slave modems are separated by a greater distance and/or a smaller wire diameter is employed. Table 6 on page 31 includes a list of suggested Equalization settings. The factory default Equalization setting is 1 (i.e., minimum).

PERMANENTLY ASSERTING THE RTS

The LDM-1 can be used with DTE interfaces that lack RTS and CTS signals provided the modem's use is limited to point-to-point networks or as a master in a multi-drop network. For these applications the DTE-to-modem cable must include a jumper between pins 4 (RTS) and 6 (DSR) at the LDM-1 end. This technique will force the modem's RTS to be constantly asserted. Figure 7 on page 31 illustrates the pin assignments used by the LDM-1's DB-25 connector.

INSTALLATION

Physical installation of the modems and nests can be performed after the configuration settings are in place.

LDM-1 STANDALONE

The standalone version LDM-1 can be placed in any convenient location. It generates very little heat and utilizes no hazardous voltages. A desktop or shelf within several feet of the network lines is perfectly satisfactory as a

mounting location. The standalone modem comes equipped with four vibration absorbing rubber feet. It is powered by a 24Vac wall mount transformer (included with the LDM-1 standalone). Nearby access to 120Vac power is required. The female connector of the transformer plugs directly into the round, male connector located at the rear panel of the modem. Refer to Figure 1 on page 6. The modem is always on when power is connected.

NOTE: The ambient operating temperature of the all LDM products is -4°F (-20°C) to 158°F (70°C).

LDM-1 PLUG-IN

The user may find it necessary to install the correct complement of PCBs into the LDM-16 before the nest can be used. LDM-1 plug-in PCBs are installed by unfastening the front cover of the nest, depressing the PCB retainer bar and inserting the PCB into the plastic card guides. The PCB should be pushed as far forward as possible. The retainer bar should then spring back, locking the PCB in place. If fewer than nine modems are being installed it is recommended that an empty slot be left between adjacent PCBs. It may be necessary to remove the plastic shield that covers the rear connector cut-outs before the PCB can be inserted. Spare plastic shields should be used to cover any vacant cut-outs.

The nest is equipped with a 120-to-24 Vac transformer. The 24 Vac power source must be connected to each PCB. Use the connector harness provided for this purpose. It can be used to daisy-chain as many as eight PCBs together. Additional connectors can be easily attached to the end of the standard harness.

WARNING: The two-position power connector must be inserted on the top two pins of the PCB's six-position connector. Failure to do so will result in damage to the PCB.

LDM-16 NEST

The LDM-16 nest is a chassis that can be installed in any standard 19" equipment rack. It includes a pair of rack mounting brackets. It is 5.75" high and requires four rack increments of vertical space. The chassis can be secured at

any convenient location in the rack with four screws. Figure 2 on page 7 provides front and rear views of the LDM-16. The nest requires access to 120 Vac power. It is equipped with a 2Amp fuse located along the rear panel.

ATTACHING THE NETWORK LINES

The LDM-1 is designed to operate with four-wire private line networks. Both the transmit and receive channels are polarity sensitive. The network's + conductor must always be wired to a corresponding + input at the rear panel. Network lines are secured to appropriate screw-down terminals at the quick-disconnect plug. The rear panel silk screening clearly labels each connector position. The cable that connects the LDM-1 to the network should be limited to 100ft. in length.

CONNECTING TO THE DTE

The LDM-1 can be used with any DTE that utilizes an RS-232 interface. The LDM-1's operation is asynchronous. It uses the Baud rate selected by the DTE. The DTE connects to the DB-25 female connector located at the modem's rear panel. The pin assignments for the modem's DB-25 connector are listed in Figure 7 on page 31. It is wired in accordance with DCE standards.

This completes the chapter on how to set up and install the various LDM products. The next chapter describes how to operate the modem and how to use its self-test features.

OPERATION

INTRODUCTION

This chapter describes how to operate the LDM-1. An explanation of each LED indicator and use of the Select Mode pushbutton switch are also provided. Normal operation and the three test modes are described.

INDICATORS AND CONTROLS

LEDs

The front panel of each LDM-1 includes a set of eight, multi-colored LED indicators. The location of each LED and the Select Mode pushbutton switch is depicted in Figure 1 on page 6. The operational mode and signal status of the modem is conveyed via the LEDs. A description of each LED is listed in Table 3 on page 20.

Label	Name	Color	Description
Pwr	Power	Red	Modem has internal 5 Vdc power
CD	Carrier Detect	Green	Data is present on receive channel Flashes if Test Mode C is receiving data
Tst2 & Tst1	Test 2 & Test 1	Red	Off & Off: Normal Mode On & Off: Test Mode A Off & On: Test Mode B On & On: Test Mode C
CTS	Clear to Send	Amber	DTE can send data
RTS	Request to Send	Amber	DTE has asserted RTS
Rcv	Receive Data	Red	Receive channel is receiving data
Xmt	Transmit Data	Red	Transmit channel is transmitting data

Table 3 - LED Indicators

SELECT MODE PUSHBUTTON SWITCH

The Select Mode pushbutton switch located at the front panel is used to select the operating mode of the LDM-1. The Normal Mode of operation occurs automatically when the unit is first powered up. By momentarily pressing the Select Mode pushbutton switch, the modem can be advanced from Normal Mode to Test Mode A, Test Mode B, Test Mode C and finally back to Normal Mode. Each time the pushbutton switch is pressed the modem advances one step in the cycle.

OPERATING MODES

Each of the four operating modes are described in the following sections. Figure 6 on page 21 illustrates the signal flow applicable to each operating mode.

NOTE: Regardless of the operating mode selected the transmit and receive channels will remain terminated in accordance with the user's selections.

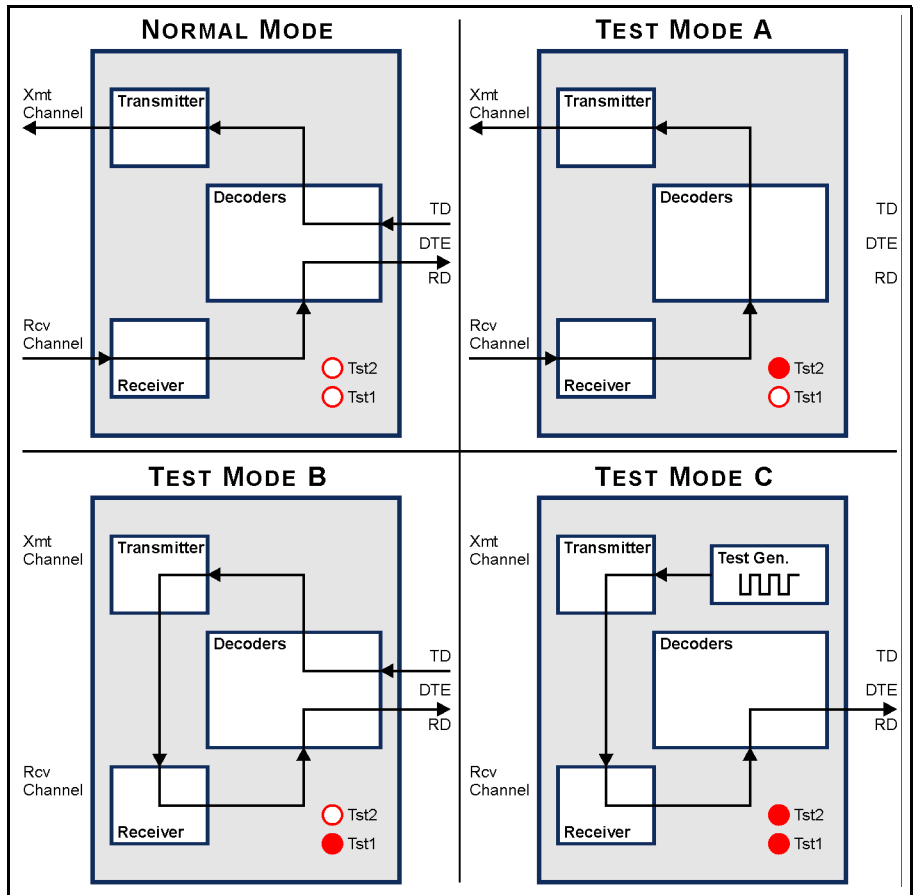


Figure 6 - Test Mode Signal Flow

NORMAL MODE

Normal Mode is automatically selected when the LDM-1 is powered up. The modem will transmit/receive data to/from the network in accordance with the jumper and switch settings selected in the setup procedure. The RS-232 interface will be fully operational. The Tst2 and Tst1 LEDs are off when the modem is in Normal Mode.

TEST MODE A - ANALOG TEST WITH DIGITAL LOOP BACK

In Test Mode A the analog signal present at the receive channel is decoded into a digital data signal. The receive data signal is then presented to the modem's transmitter section. The transmitter outputs the decoded data via the transmit channel. In Test Mode A the Tst2 and Tst1 LEDs will be on and off, respectively. The DTE interface is disabled in this test mode. The CD indicator will operate normally. The RTS and CTS indicators will illuminate in accordance with the DTE status. Neither signal, however, has an effect on Test Mode A. The Rcv and Xmt indicators will be off.

Test Mode A can be used to perform an effective end-to-end test of a network segment. The modem at the end of the segment under test should be placed in Test Mode A. All other modems should be left in Normal Mode. Transmitted data will be returned to the source modem's receiver where it can be checked against the originally transmitted data.

TIP: Test Mode A requires the same equalization setting as Normal Mode.

TEST MODE B - ANALOG LOOP BACK WITH DTE DATA

Test Mode B loops the analog output signal of the transmit channel to the input of the receive channel. The data to be transmitted is provided by the DTE. The transmit and receive channels are left terminated but are disconnected from the test data (i.e., test data is not sent to the network). In Test Mode B the Tst2 and Tst1 LEDs will be off and on, respectively. The CD indicator will be off. The RTS and CTS indicators will be either on or off depending upon the status of the DTE. The Rcv and Xmt indicators will illuminate when data is being received and transmitted, respectively. The RTS signal does not need to be asserted in this test mode.

Test Mode B is useful in checking major elements of the modem and DTE interface.

TIP: Test Mode B requires an equalization setting of 1 (i.e., minimum).

TEST MODE C - ANALOG LOOP BACK WITH TEST DATA

Test Mode C also loops the transmit channel's analog output signal to the input of the receive channel. However, the transmitted data is provided by an on-board test data generator. The test data consists of alternating mark and space bits. The test data has a Baud rate of 19,200. The receive and transmit channels are left terminated but are disconnected from the test data (i.e., test data is not sent to the network). In Test Mode C the Tst2 and Tst1 LEDs are both on. The CD LED will flash as an indication that the test data is being received properly. The RTS, CTS and Xmt indicators will illuminate depending upon the status of the DTE interface. However, these signals are ignored in Test Mode C. The Rcv indicator will be on.

Test Mode C can also be used to test the modem separately from the network and DTE. If a DTE is connected it should display a sequence of U characters (i.e., ASCII code 85).

TIP: Test Mode C requires an equalization setting of 1 (i.e., minimum).

This completes the chapter on how to operate the LDM-1. The next chapter describes maintenance of the modem.

MAINTENANCE

INTRODUCTION

The primary purpose of this chapter is to describe the recommended troubleshooting method to be used with the LDM products. It should be referred to if ever a questionable symptom arises during the operation of any LDM device.

The LDM products are designed to provide users with many years of trouble-free operation. There are no user serviceable components in any LDM device. There are no consumable items or supplies that need to be replaced or replenished. The user may, occasionally, need to wipe dust away from the external surfaces of a unit. This should be done with a clean, dry cloth. The mechanical design of the housing and chassis provide the electronic assemblies with a nearly sealed environment. Due to the low power requirement of each product, ventilation holes are not required. The inside of each unit should remain clean indefinitely.

PCB REMOVAL AND INSERTION

The PCB inside the standalone version LDM-1 should never be removed from its aluminum case. Internal jumpers and switches are accessible once the top cover is removed. However, access to the user configured settings of the LDM-1 plug-in PCB installed within the LDM-16 nest require removal of the

PCB. PCB removal should be performed in accordance with the following procedure. Refer to Figure 2 on page 7. Power to the nest can be left on while PCBs are being removed and inserted. Damage will not occur provided normal care is exercised.

CAUTION: Electrostatic discharges can cause serious damage to electronic components. Normal anti-static precautions are recommended when handling the LDM-1 PCB.

- Disconnect the cables attached to the PCB at the rear of the nest. Modems are labeled 1 through 16.
- Open the hinged front cover.
- If the PCB bracket is still in place remove it from the chassis by unscrewing both ends. The PCB bracket can be discarded. While depressing the PCB retainer bar, rotate the PCB ejector upward and remove the PCB from the chassis.
- Inspect or replace the PCB. Change the setup configuration as necessary.
- Install the PCB by aligning its edges with the plastic card guides secured to the top and bottom panels of the nest. Push the PCB forward until it clears the retainer bar.
- Attach any cables to their respective PCB connectors. Cables are keyed, so they can be inserted in only one direction. Do not force a cable into a connector.

WARNING: The two-position power connector must be inserted on the top two pins of the PCB's six-position connector. Failure to do so will result in damage to the PCB.

- Close the front cover.

JUMPER AND SWITCH LOCATIONS

Several jumpers and switches are mounted on the LDM-1 PCB. Only SW3, which controls the receive channel Equalization setting, is accessible exter-

nally. The identity and location of each jumper and switch is illustrated in Figure 5 on page 13.

TROUBLE-SHOOTING GUIDE

The following guide will assist the user in resolving problems that may occur with the operation of the LDM-1. It can be especially helpful when attempting to operate the modem for the first time. Procedures for resolving both local and remote problems are listed. Where multiple steps are indicated it is recommended that they be performed in the order listed. Removal of any PCB should be performed in accordance with the procedures described earlier in this chapter.

The three test modes can be very helpful in isolating problems. Refer to the previous Chapter 2 entitled Operation for instructions on how to use the test modes. If the user is still unable to resolve the problem, MICRO-AIDE customer service should be contacted. The user will be asked to state the problem, specify related symptoms, and indicate any operations or conditions that have a bearing on the problem.

Symptom or Problem	Resolution
No indication of power	Measure 22-26 Vac across power pins of quick-disconnect connector
DTE data is never transmitted	Verify RTS is asserted by DTE Verify DTE-LDM cable wiring
RTS is asserted, but CTS is not asserted	Verify one switch in SW2 is closed Verify Tst2 and Tst1 are off (Normal Mode) Transmit channel may be occupied by another slave modem
Transmit data is being sent, but Rcv LED never illuminates	Check polarity of transmit and receive channels' \pm connections

Table 4 - Trouble Shooting Guide

Receive data contains errors	Change Equalization settings to better match cable transmission properties Termination settings are incorrect (should measure 150 Ohm if On, 40K Ohm if Off)
Test Mode B does not echo sent character	Set Equalization to setting 1 (minimum)
U character is not issued in Test Mode C	Set Equalization to setting 1 (minimum) Change Baud rate at DTE to 19,200

Table 4 - Trouble Shooting Guide (Continued)

This completes the User Manual for the LDM-1. Two appendices have been provided. They include detailed specifications for each of the LDM products and additional information concerning Texas DOT related applications.

Any comments the reader may have on how to improve this manual are welcomed. Comments can be forwarded to the Director of Marketing, MICRO-AIDE Corporation.

TECHNICAL DATA

LDM-1 SPECIFICATIONS

Physical

Length: 8.6"
Width: 5.3"
Height: 1.9"
Weight: 22 oz.

Environmental

Storage

Temperature: -20°F to 180°F
Humidity: 0% to 95% non-condensing

Operating

Temperature: -4°F to 158°F
Humidity: 0% to 95% non-condensing

Mounting

Shelf or desktop

Construction

Housing

Fully enclosed, anodized aluminum
Removable cover allows access to inside
Externally accessible LEDs and connectors

Electrical

Single, conformal coated, PCB inside housing

Power

Voltage

24 Vac, from MICRO-AIDE supplied wall mount transformer

Consumption

2.5W, typical

Isolation

Rcv and Xmt channels are fully isolated from power and DTE

Connectors

DB-25 Female

Configured as DCE
See Figure 7 on page 31

Power

Round male connector

6-Conductor Female

Pin 1: 24 Vac

Pin 2: 24 Vac

Pin 3: Xmt+

Pin 4: Xmt-

Pin 5: Rcv+

Pin 6: Rcv-

LED Indicators

Power: Red

Carrier Detect: Green

Test 2: Red

Test 1: Red

Clear to Send: Amber

Request to Send: Amber

Receive Data: Red

Transmit Data: Red

Controls

External

Pushbutton Switch: selects operating mode

Equalization Switch (SW3): dual switch assembly, 4 settings to compensate for cable attenuation

Internal

DIP Switch (SW2): Selects CTS-to-RTS delay of 8, 16, 32 or 64 msec.

Jumper AX1: Enables Rcv channel termination of 150 Ohm

Jumper AX2: Enables Xmt channel termination of 150 Ohm

Jumper AX3: Enables Xmt channel busy detector

Jumper AX5: Connects DTE signal ground to protective ground

Operating Modes

Normal

Full duplex over 4-wire network
Test 2 LED: Off
Test 1 LED: Off

Test Mode A

Analog test with digital loop back

Test 2 LED: On

Test 1 LED: Off

Test Mode B

Analog loop back with DTE data

Test 2 LED: Off

Test 1 LED: On

Test Mode C

Analog loop back with test data

Test 2 LED: On

Test 1 LED: On

Data Characteristics

Format

Fully transparent to all data

Baud Rate

75 to 19,200

Network Configurations

Point-to-Point

Capacity: 2 modems total
Refer to Table 6 on page 31 for range specifications

Multi-Drop

Capacity: 8 modems total (1 master, 1 to 7 slave modems)

No transmission range de-rating with additional slave modems

Refer to Table 6 on page 31 for range specifications

Line Requirements

Type: 4-wire
Gauge: 19 to 24AWG

Receiver

Dynamic Range
 -40dBm to 0dBm
Termination Impedance
Enabled: 150 Ohm
Disabled: >40K Ohm
Isolation
 Fully isolated from power and DTE interface

Transmitter

Output Level
 approximately 0dBm into 150 Ohm, .4Vp-p
Source Impedance
Enabled: 150 Ohm
Disabled: >40K Ohm
Carrier Detection
 If enabled, checks for absence of signal on Xmt channel before asserting CTS
Isolation
 Fully isolated from power and DTE interface

LDM-16 SPECIFICATIONS

Physical

Length: 19.0"
Width: 10.5"
Height: 5.4"
Weight: 20lbs. with 8 LDM-1 plug-in PCBs

Mounting

Mounts into std. 19" equipment rack

Power

Voltage: 120Vac, 60Hz
Consumption: 40W with 8 LDM-1 plug-in PCBs

MICRO-AIDE reserves the right to make changes, at its sole discretion, to any specification listed herein.

TRANSMISSION RANGE SPECIFICATIONS

The specifications listed in Table 5 apply to both point-to-point and multi-drop network configurations limited to no more than eight modems. The transmission distances listed refer to the cable length measured from the near-end (master) modem to far-end (slave) modem.

Baud Rate (bps)	19AWG	22AWG (miles)	24AWG
2400	30	16	12
4800	25	13	10
9600	20	11	8
19,200	13	8	6

Table 5 - Cable Length vs. Baud Rate and Cable Diameter

RECOMMENDED EQUALIZATIONS SETTINGS

The Equalization settings listed in Table 6 are for approximation purposes only. The optimum setting will vary from network to network. The transmission distances listed refer to the cable length measured from the near-end (master) modem to far-end (slave) modem.

Baud Rate	19AWG					22AWG					24AWG				
	0	6	13	19	25+	0	3	6	10	13+	0	2	4	6	8+
2400	1	2	2	3	4	1	2	2	3	4	1	2	2	3	4
4800	1	2	2	3	4	1	2	2	3	4	1	2	2	3	4
9600	1	2	2	4	-	1	2	2	4	-	1	2	2	4	4
19,000	1	2	2	-	-	1	2	2	-	-	1	2	2	4	-

Table 6 - Equalization Settings vs. Cable Length and Baud Rates

DB-25 CONNECTOR WIRING

The LDM-1 includes a DB-25 female connector. It provides the RS-232 interface to the DTE. The connector is wired as illustrated in Figure 7.

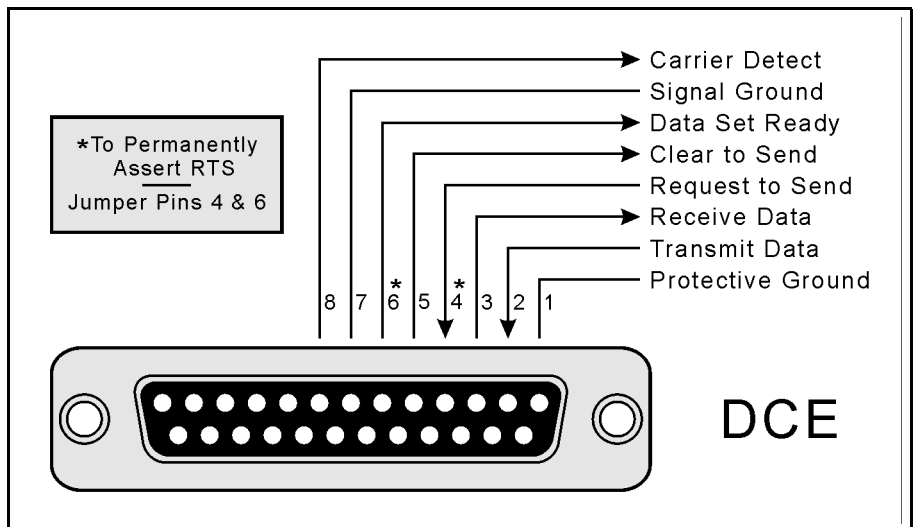


Figure 7 - DB-25 Pin Assignments

TxDOT APPLICATIONS

INTRODUCTION

The LDM-1 is used in a variety of applications by the Texas Department of Transportation. It is frequently used in conjunction with the MICRO-AIDE Local Control Unit (LCU) and PSDM and ADU modules manufactured by Coastcom. Changeable message signs, vehicle detectors and camera pan-and-tilt systems utilize the LDM-1 to facilitate RS-232 communications.

NETWORK CONFIGURATIONS

The LDM-1 can be used in point-to-point and multi-drop network configurations. Figure 3 on page 10 and Figure 4 on page 11 illustrate the basic differences in the two types of networks. Several key points concerning each network are described in the following sections.

POINT-TO-POINT

The point-to-point configuration is typically used when only a pair of devices need to communicate with each other. A single LCU communicating with a PC would be an example.

Another typical example occurs when a controller needs to communicate with a roadside camera. In many cases the controller does not support hardware handshaking. The LDM-1 will not transmit data until it receives an RTS and then issues a CTS. Consequently, the RTS signal must be forced to a continu-

ously active state. Refer to the section entitled “Permanently Asserting the RTS” on page 15 for details.

MULTI-DROP

Multi-drop networks require slave LDM-1s to be connected only to DTEs that support hardware handshaking. The MICRO-AIDE LCU supports this requirement. However, the hardware handshaking option must be enabled in the Coastcom PSDM. The user should consult Coastcom for information on how a PSDM is enabled for hardware handshaking.

Another consideration in multi-drop networks concerns the number of LDM-1s that can be placed in one branch of the network. No more than seven slave LDM-1s can communicate with a master LDM-1.

RS-232 CABLES

Each LDM-1 is equipped with a standard DB-25 female connector. The connector is wired in accordance with DCE standards. The pin assignments for the connector are illustrated in Figure 7 on page 31. The following list provides the user with additional information concerning cable types.

LCU TO LDM-1

The LCU to LDM-1 cable is a simple one-to-one cable with DB-25 male connectors at each end. A one-to-one cable can be purchased at any computer supply store. It can also be easily assembled using 25-conductor, flat-ribbon cable and connectors.

PSDM TO LDM-1

The PSDM must first be configured for hardware handshaking. The correct setting involves having the RTS signal track the state of the CD signal. A standard null modem cable can then be used to interconnect the PSDM and LDM-1.

ADU TO LDM-1

The ADU to LDM-1 cable must be assembled in such a way that the LDM-1 is given a constantly asserted RTS signal. The best way to achieve this is to wire pins 4 and 6 together at the LDM-1 end. This allows the RTS to be con-

trolled by the Data Set Ready (DSR) signal which is always active. Crossing of the Receive Data and Transmit Data signals must also be performed.

This cable is also useful when connecting an LDM-1 to any DTE that does not assert an RTS signal. However, its application is limited to point-to-point network segments.

TEST SOFTWARE

CTSCU.exe is a DOS application designed to test the operation of LCUs and LDM-1s. CTSCU.exe can be used to quantify bit error rates over point-to-point and multi-drop networks. This section describes in detail how to use the CTSCU.exe software to perform a typical communication test.

WARNING: CTSCU.exe runs best with 3.X versions of Windows. It will not run properly in a Windows XP environment. It frequently has performance problems running under Windows 98.

REQUIREMENTS

To run the CTSCU.exe test software the following items are required:

- A Windows 3.X PC with the CTSCU.exe software installed.
- One or more LCUs installed with the TxDOT provided TMS Version 2.2 EEPROM.
- One master LDM-1 that will be connected to the PC running CTSCU.exe.
- One slave LDM-1 for each LCU.
- A two-pair cable connecting the LDM-1s in either a point-to-point or multi-drop network configuration.
- One 9-pin (female) to 25-pin (male) serial communications cable to be connected between the master LDM-1 and the comm. port of the PC.
- A DB-25 (male) to DB-25 (male) cable, wired one-to-one, that will connect each slave LDM-1 to each LCU.

INSTALLATION

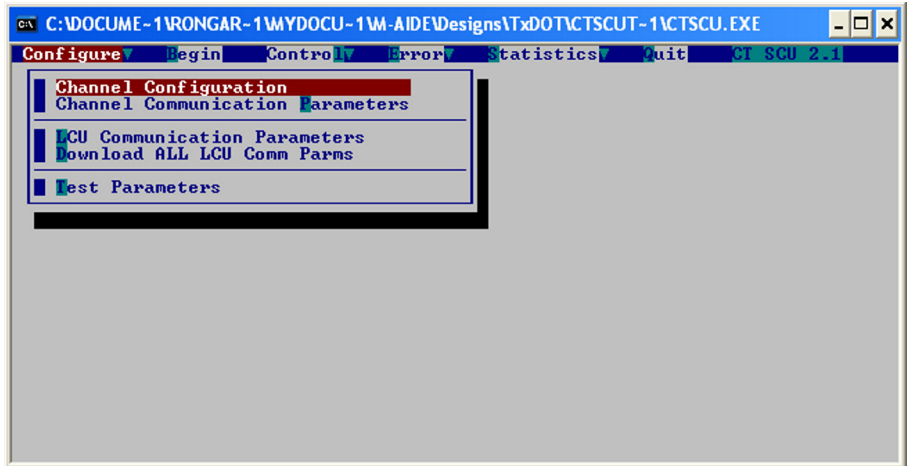
With power off to all of the equipment items, do the following:

1. The Rcv and Xmt Termination settings for the near-end (master) and far-end (slave) modems must be set to On. The termination settings for all other modems must be set to Off.
2. Connect the PC's serial comm. port to one end of the serial comm. cable. Connect the other end to the DTE port of the master LDM-1.
3. Connect the Xmt and Rcv + and - pins of each modem to the network cable.
4. Connect the DTE port of each slave modem to the RS-232 port of the LCU labeled "Communications".
5. Install the TMS 2.2 EEPROM into the CPU PCB of each LCU.
6. Set the Unit ID of the first LCU to 1. Set the Unit ID of additional LCUs to 2, 3, etc.
7. Apply power to all equipment items.
8. Launch the CTSCU.exe software in the PC.
9. Verify the test LEDs of each modem are off.
10. Verify the RTS and CTS LEDs are on at the master and off at each of the slave modems.
11. Verify the CD LED of each slave modem is on.

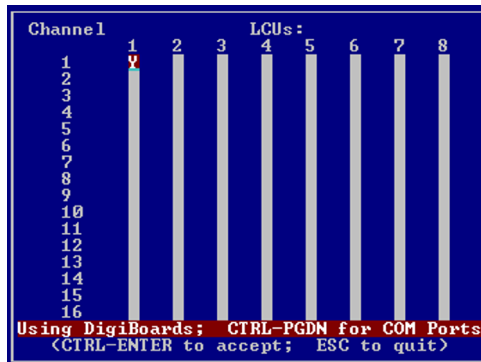
TEST PROCEDURE

To test the bit error rate of the network, do the following:

1. A screen similar to the following should be displayed at the PC after launching the CTSCU.exe application.



2. Execute the **Configure>Channel Configuration** command. A screen similar to the following will be displayed.



The Channel Number refers to the number of available comm. ports in the PC. Each of the LCU Numbers must correspond with one and only one LCU thumb wheel setting. In the example cited above, LCUs 1, 3 and 4 are included in the network to be tested.

3. Execute the **Configure>Channel Communication Parameters** command. Accept the default parameters as listed below.

Channel	Data Rate (bps)	TX Delay (msec)	RX Timeout (msec)
1	9600	0	40
2	9600	0	40
3	9600	0	40
4	9600	0	40
5	9600	0	40
6	9600	0	40
7	9600	0	40
8	9600	0	40
9	9600	0	40
10	9600	0	40
11	9600	0	40
12	9600	0	40
13	9600	0	40
14	9600	0	40
15	9600	0	40
16	9600	0	40

<CTRL-ENTER to accept; ESC to quit>

4. Execute the **Configure>LCU Communication Parameters** command. Accept the default parameters as listed below.

Ch.	CTS-ON to TX Delay <10 ms ticks>	TX to RTS-OFF Delay <10 ms ticks>	Comm. Failure Timeout <min>
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0

<PgUp/Dn CHANNEL, CTRL-ENTER - accept, ESC - quit>

5. Execute the **Statistics>Reset Statistics File**. Execute the **Error>Reset Error/Log File** command.

6. Execute the **Control>Reset All LCU**s command. After a brief delay a message will indicate that the reset was successful.

7. Execute the **Control>Download LCU Code to All LCU**s command. After a brief delay a message will indicate that the download was successful.

8. Start the test at 9600Baud by executing the **Begin** command. Highlight the command and then press the Enter key twice. The test will start. A display similar to the following will appear.

TxDOT Applications - Test Software

Ch.	Data Errs	Len. Errs	CRC Errs	Timeouts	Err Blks	Err Secs
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
Total:	0	0	0	0	0	0

[PgDown] - Other Stats Screens [ESC] - Exit

The test will run continuously until it is stopped by pressing the Esc key. The number of test blocks and errors by type will be reported. Run the test in accordance with the TxDOT acceptance criteria.

Material Return Policy

In the event the customer identifies a malfunction in any product, call or write MICRO-AIDE and obtain a Return Material Authorization (RMA) number from the customer service department. Return the product to MICRO-AIDE, freight prepaid, with a note (in-warranty repair) or a purchase order (out-of-warranty) for the repair listing the following information:

- RMA number from MICRO-AIDE
- Return shipment address
- Name and telephone number of person familiar with the problem
- Brief description of the problem (include any printouts that may have a bearing on the problem)
- Method of payment for repair costs (out-of-warranty)
- Send product to the following address:

MICRO-AIDE CORP.

685 Arrow Grand Circle

Covina, CA 91722

Tel: 626-915-5502 Fax: 626-331-9484

E-mail: support@micro-aide.com

Limited Warranty

MICRO-AIDE warrants its products to be free from defects in material and workmanship for a period of five (5) years from the date of shipment. This warranty is in lieu of any other warranty, expressed or implied. In no event shall MICRO-AIDE be held liable for incidental or consequential damage resulting from (1) the use of any of its products, or (2) any alleged breach of this warranty provision. MICRO-AIDE's liability shall be limited to repairing or replacing, at its sole discretion, any defective product which is returned in accordance with the MICRO-AIDE Material Return Policy.

Product that has been subjected to abuse, misuse, alteration, accident, lightning damage, neglect or unauthorized installation or repair shall not be covered by this warranty.

MICRO-AIDE reserves the right to make a final decision as to the existence of any failures and the cause of such failures. No warranty is made with respect to custom equipment or products produced to buyer's specifications except as mutually agreed upon in writing.

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