CHAPTER 3

GPIB/IEEE-488 BUS CONTROL

3.1 Introduction

When the model 1227 GPIB/IEEE-488 interface is installed and the instrument is connected to a host computer, the LDT-5910 can be used as an automated temperature controller and temperature recorder for test measurement applications.

3.2 Capabilities

The model 1227 GPIB/IEEE-488 interface allows GPIB/IEEE-488 bus control of the LDT-5910. All of the features accessible from the front panel and some advanced features can be accessed via the interface bus. Information can also be read by the host computer and printed or stored. Other features include:

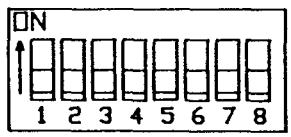
* A concise and simple command set
* Full talk/listen capability
* Full serial poll capability, with bit-maskable SRQ
* Selectable output terminators
* Full local/remote capability including LOCAL LOCKOUT
* Resistance Control Mode controls to a set resistance
* Support for the following interface messages: REN, DCL,LLO, GTL and SDC

3.2 Preparation for Bus Control

To use the LDT-5910 remotely, you will need to install an IEEE-488 interface adapter in your host computer. These adapters and support software are available from several manufacturers and can be installed in most computers. This manual assumes that you have a basic knowledge of the GPIB/IEEE-488 interface bus and how to use it for instrument control. This section also assumes that you are familiar with the controls on the LDT-5910. Read Chapter 2 again if you need more details on how to operate the LDT-5910.

Install the 1227 interface using the procedure outlined in Chapter 6. Prepare the LDT-5910 for bus control using the following procedure:

1. Turn off the power to the LDT-5910/1227 and set the GPIB/IEEE-488 interface address with the DIP switches on the back panel. The switch settings are shown in figure 3-1. You can choose any address for the LDT-5910/1227 but this address should be unique, i.e., different than any other instrument connected to the bus.



Address	Switch Positions 1	2	3	4	5
00	0	0	0	0	0
01	1	0	0	0	0
02	0	1	0	0	0
03	1	1	0	0	0
04	0	0	1	0	0
05	1	0	1	0	0
06	0	1	1	0	0
07	1	1	1	0	0
08	0	0	0	1	0
09	1	0	0	1	0
10	0	1	0	1	0
11	1	1	0	1	0
12	0	0	1	1	0
13	1	0	1	1	0
14	0	1	1	1	0
15	1	1	1	1	0

Address	Switch Positions 1	2	3	4	5
16	0	0	0	0	1
17	1	0	0	0	1
18	0	1	0	0	1
19	1	1	0	0	1
20	0	0	1	0	1
21	1	0	1	0	1
22	0	1	1	0	1
23	1	1	1	0	1
24	0	0	0	1	1
25	1	0	0	1	1
26	0	1	0	1	1
27	1	1	0	1	1
28	0	0	1	1	1
29	1	0	1	1	1
30	0	1	1	1	1
31	-Not Allowed-				

FIGURE 3-1 ADDRESS SELECTION SWITCH SETTINGS

2. Plug the GPIB/IEEE-488 bus cable into the LDT-5910/1227 rear panel connector and secure it with the plug-mounted screws.

3. Turn on the LDT-5910/1227 and press the local button to display the selected IEEE-488 instrument address on the front panel display.

3.3 An Overview of Remote Programming

The block diagram, figure 3-2 shows the flow of data from the LDT-5910/1227 to the host computer (the controller). Each block represents a register, buffer etc, contained in the LDT-5910. The input buffer receives data from the IEEE-488 bus. The output buffer receives data from the blocks to its left and sends data to the IEEE-488 bus. The serial poll register is a separate buffer that gets the attention of the controller in special conditions.

Information is transferred between blocks by device dependant commands. For example, a Put command takes a number from the input buffer and stores it in the internal memory of the LDT-5910. Likewise the Get command gets the contents of the LDT-5910 internal memory and copies it into the output buffer.

Programming commands, like print and read in BASIC or FORTRAN, transfer the information from the input or output buffers to the controller. The following simple program provides an example of how the LDT-5910 is controlled by the host computer. The exact programming statements you will need to use will depend on the programming language and IEEE-488 interface card that you are using. This program instructs the LDT-5910 to display actual thermistor temperatures and then reads out the current display. The LDT-5910 is assumed to be at GPIB address 1.

```
100 Print @1:"D2"
110 Input @1:A$
120 Print A$
130 End
```

3.4 Command Set

There are two types of commands that you can use with the LDT-5910/1227 and the GPIB bus. Messages that only the LDT-5910/1227 understands are called device dependant commands. Messages that are common to any instrument on the GPIB bus are called interface messages. The device dependant commands are summarized in Table 3.1 and described in sections 3.7 to 3.17. The LDT-5910/1227 also responds to a number of interface messages to participate in IEEE-488 bus communication. The interface messages are summarized in Table 3.5.

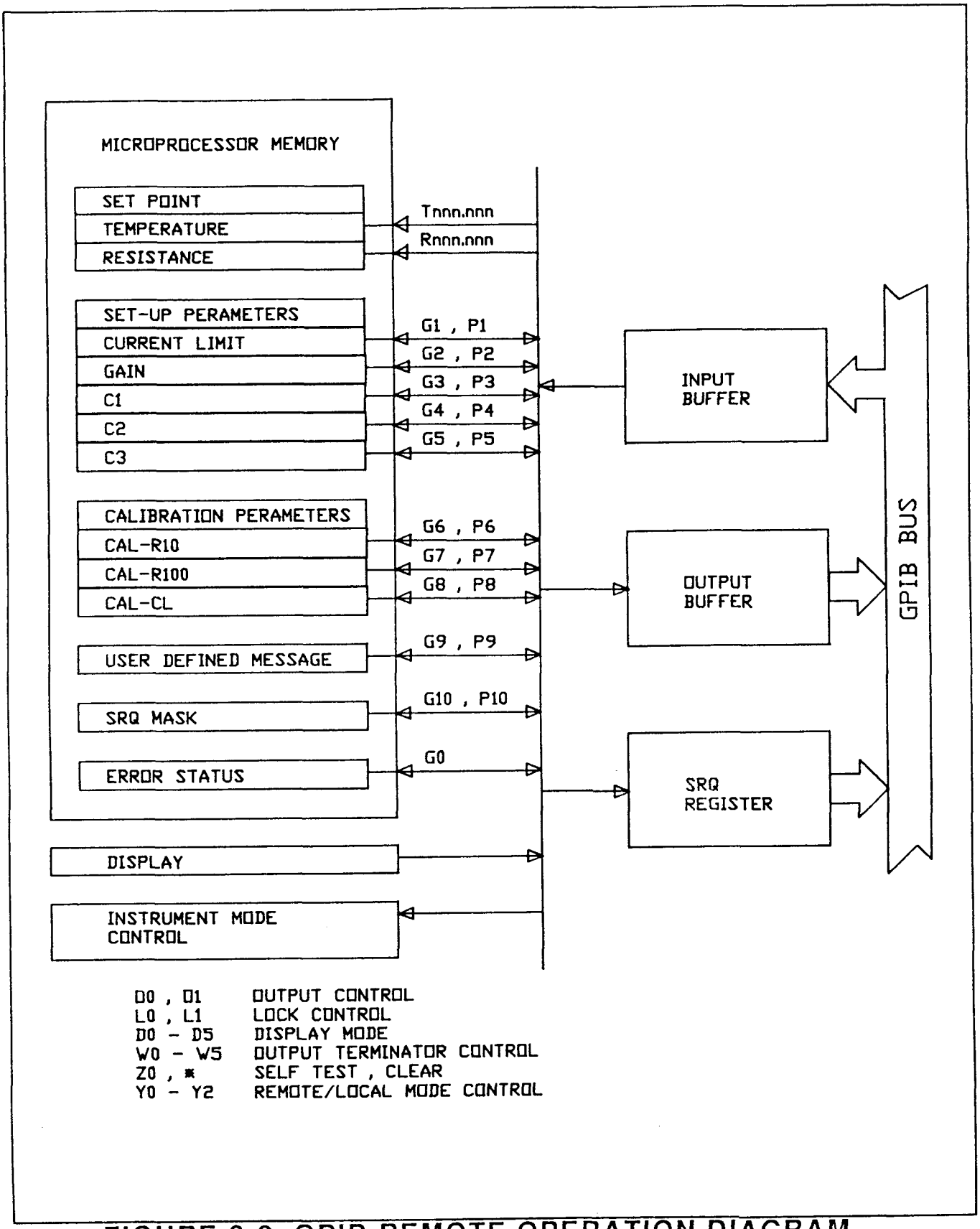


FIGURE 3-2 GPIB REMOTE OPERATION DIAGRAM

TABLE 3.1
LDT-5910/1227 DEVICE DEPENDENT COMMAND SET

Set Point Commands

Tnnn	Adjusts the set temperature to nnnnnn C.
Rnnn	Adjust the set Resistance to nnnnnn K ohm.

Data Entry Commands

Nnnn	Numeric data
'aaa'	Alphanumeric data

Output Control Commands

O0	Turn the output off.
O1	Turn the output on.

Lock Commands

L0	Disables set temp. lock
L1	Enables set temp. lock

Display Commands

D0	Blank the display
D2	Actual Temperature
D3	Set Temperature
D4	Auto display mode enable
D5	Resistance display mode

Get Commands

G0	Get error status
G1	Get current limit
G2	Get gain
G3	Get C1
G4	Get C2
G5	Get C3
G6	Get CAL-R10 value
G7	Get CAL-R100 value
G8	Get CAL-CL value
G9	Get user defined message
G10	Get SRQ Mask

Put Values

P0	Not Used
P1	Put current limit (mA)
P2	Put gain
P3	Put C1
P4	Put C2
P5	Put C3
P6	Put CAL-R10 value
P7	Put CAL-R100 value
P8	Put CAL-C1 value
P9	Put user defined message
P10	Put SRQ mask

Terminator Commands

W0	Enable CR LF EOI (default)
W1	Enable CR LF only
W2	Enable CR EOI only
W3	Enable CR only
W4	Enable LF EOI only
W5	Enable LF only
W6	Enable EOI only
W7	Disable all output terminators

Clear Commands

*	Device Clear

Self Test Command

Z0	Begin Self Test

Control Mode Commands

Y0	Enable LOCAL mode
Y1	Enable REMOTE mode
Y2	Enable LOCAL LOCKOUT mode

3.5 Remote Programming Procedure

To program the LDT-5910/1227 send it an ASCII string of characters made of one or more device dependant commands. The commands set the operating parameters such as the temperature set point, output current limit, etc.. A simple example of a command string would be:

"O1 D2 T-2.0"	In this example the LDT-5910/1227 output is turned on, the display is configured to read actual temperature and the set point temperature would be set to -2.0 C.

In the examples in this manual, device dependent commands are shown enclosed in quotation marks, as they would be entered in BASIC or other programming languages. The commands are also separated by spaces. The spaces are for clarity and may be omitted.

Example	*Explanation*
"* G9 T10.0"	This is the same as "*G9T10.0"

When the LDT-5910/1227 receives a command string it is placed in remote mode and then each command in the string is executed sequentially.

To read the display simply send an instruction to read ASCII data from the 1227 interface. When the LDT-5910/1227 receives the instruction, the contents of the interface output buffer are transmitted, as a string of ASCII characters, over the bus to the controller. Specific programming examples are given at the end of this chapter.

3.6 Input Syntax

This section describes the syntax rules for constructing device dependent command strings used to control the LDT-5910/1227. A command string is formed by a series of individual commands followed by a terminator.

The LDT-5910/1227 accepts alphabetic characters in either upper or lower case. Commands may be strung together into an ASCII string up to 30 characters long. Any character beyond thirty is truncated. Certain characters are ignored and may be included anywhere in a command string to make it easier to read. These ignored characters are shown below:

Space	" "
Back slash	"/"

A command string must be concluded with one or more input terminators. Processing of the command string begins when the first input terminator is received. Acceptable input terminators are shown below:

Carriage return	[CR]	ASCII (013)
Line feed	[LF]	ASCII (010)
EOI	[EOI]	

Illegal commands and unrecognized characters (eg, O3) will set the software error flag but are otherwise ignored. The following characters are known to produce error codes:

!@#$^()<>;[] ~

Examples of correct and incorrect Command strings are given in Table 3.2.

Table 3.2 Command String Examples

Correct Command Strings

O1T30[CR] o1t30[CR][LF]	Upper or lower case alphabetic characters may be used. These command strings are identical and will turn the output on and set the control temperature to 30 C.
O1/R4.5 L1[EOI]	Spaces (and back slashes) may be used within the command string for clarity. This command turns the output on, the set point is controlled to 4.5 K ohms and the set point lock is activated.

Incorrect Command Strings

T45.34 @ o1 [EOI]	The "@" is an unrecognized character. When the "@" is encountered the software error status bit (error 32) is set and processing continues normally. The LDT-5910/1227 controls to 45.34 C and the output is turned on.
T0 T0.34 T L1 [CR]	The operator couldn't decide which temperature to set. A numeric entry was expected following the third "T". The software error status bit (error 32) will be set but processing will continue normally beginning with L1 command.
O1 B3 R10.011 [CR]	"B3" is an unknown command and this sets software error status bit. Processing will continue normally with the next command. In this case, the output will be turned on and the LDT-5910/1227 will control to 10.011K ohm.
T1.00E-1 D2 [CR]	Although "1.00E-1" is often used as scientific notation to mean 0.100 the LDT-5910/1227 does not recognize this form of notation. In this case the "E-1" is interpreted as an unrecognized command and the software error status bit (error 32) will be set. The D2 command will change the display mode so the LDT-5910/1227 displays actual temperature.

3.7 Device Dependant Commands

3.8 Data Entry Commands

Nnnnnnn - Numeric Entry

N numeric entry where "n" is one of the following:

{signed or unsigned integer}
{signed or unsigned real number}

The N command enters the numeric values for subsequent Put commands. The interpretation of the numeric value depends on which put command it is used with. The decimal is "free floating" for real numbers, i.e., it can be placed anywhere but the LDT-5910/1227 will only control to its internal range and accuracy.

Example	*Explanation*
"N1.234 P4"	Put a value of 1.234 into the calibration constants memory in the LDT-5910/1227 as the new value of the constant C2.
"N1000 P1"	Sets the current limit to 1000.

'aaaaaaa' - Alphanumeric Data Entry

This command is used with the P9 command to put any message into non-volatile memory in the LDT-5910. Up to sixteen characters of alphanumeric data may be entered with this command. The alphanumeric information must be surrounded with the single quote sign (ASCII 39). This message can be read with the Get command, G9.

Example	*Explanation*
"'This is a test' P9"	Places the message "This is a test" into the non-volatile memory.

3.9 Set Point Commands

Tnnnnnn

This command changes the Set Temperature in the LDT-5910. Notice that there are six digits (nnnnnn) for this command. The set-point accuracy and range depend on the thermistor used and the source current setting. Appendix B discusses the limits of range and accuracy for typical thermistors.

Example	*Explanation*
"T-2.0"	Set the Set Temperature to -2.0 C.
"T200."	The LDT-5910/1227 will try to control the output to 200 C but will be limited by the available output current and the accuracy of the set-point D/A convertor.

Rnnnnnn

This control makes the LDT-5910/1227 control to a resistance value instead of a temperature value. This function is not accessible from the front panel. The resistance is entered in K ohms. The range and accuracy is limited as shown in Table 3.3.

Example	*Explanation*
"R10.2"	The LDT-5910/1227 will control to a Resistance of 10.2 K ohm.

Table 3.3 Thermistor Range and Accuracy

	10 uA	100uA
Range	0 to 450K ohms	0.2K ohms
Resolution	0 to 45 K ohms	0.02K ohms

3.10 Output Control Commands

The Output control commands toggle the LDT-5910/1227 output off or on. The output must be turned on for the LDT-5910/1227 to control to a set temperature or resistance.

Example	*Explanation*
"O1 T30.33"	Turns the output on and controls the temperature to 30.33 C.
"O0"	Turns the output off.

3.11 Lock Commands

The lock commands lock the set temperature or set resistance into memory so that it will not be lost when the power is turned off. The last number received with the set temperature or set resistance command will be the number that is stored in memory. When the lock is active, other set temperature or set resistance commands will be ignored.

Example	*Explanation*
"R8 L1 T20"	Controls to a resistance of 8K, locks this value into memory and ignores the set temperature command.
"T20 L0 R9"	The first set temperature is ignored (if the temperature is already locked), the lock is disabled and the new set resistance (9K) is entered.

3.12 Display Commands

The Display commands allow you to select what the LDT-5910/1227 will display on its front panel display. The display will indicate whatever it last displayed, before going to remote mode, until you send it a command to display something different.

DO - Blank the Display.

This command is used for best performance when high IEEE-488 Interface Data rates are required.

D2 - Actual Temperature

The display will indicate the actual temperature in degrees Centigrade.

D3 - Set Temperature

The Set Temperature will be displayed.

D4 - Auto Display Mode

This command enables the Auto display mode. In remote operation the display will indicate the actual temperature until a new temperature is sent to the LDT-5910. Then the new set temperature will be displayed for three seconds before reverting to the actual temperature again.

D5 - Resistance Display Mode

This command enables the display of the measured resistance, in K ohms, of the thermistor connected to the LDT-5910. This is only available in The remote mode and is useful when controlling to a set resistance.

Example	*Explanation*
"R8 d5 o1"	The LDT-5910/1227 controls to a resistance of 8K, the displays indicates resistance and the output is turned on.
"t30.2 d3 o1"	The set temperature is 30.2 C and the display reads this temperature. The output is turned on.

3.13 Get Commands

The get commands place information into the LDT-5910/1227 output buffer for the host computer. Each Get command loads the output buffer with an ASCII output string. The get commands must precede any computer language commands, e.g., BASIC commands like read or input, because the information must be loaded into the output buffer of the LDT-5910/1227 before it can be read. After the buffer is read, any subsequent read commands will return the number displayed on the LDT-5910 front panel display.

G0 Command - Get Error Status

This command reads the status of the internal software error byte in the LDT -5910. The ASCII string generated by the G0 command may be read back over the bus by executing a read immediately after sending the G0 command. If the G0 command is sent with a string of commands, any errors set by previous commands in the string will set the appropriate error bit. After loading the ASCII string into the interface output buffer, the software command error flag is reset.

Two digits are sent back that represent the appropriate error code if an error has occurred. A summary of the error codes are listed below.

00	No Error
01	A/D Overrange
02	Temperature Calculation Unsuccessful
04	Current Limit
08	Voltage Limit
16	Thermal Limit
32	Software Error

If there is no error a zero is returned. If there was more than one error condition the number sent back equals the sum of the errors codes. Some example output strings are given here:

Example	*Explanation*
"g0"	If a 10 is returned then the temperature calculation was unsuccessful and a voltage limit condition occurred. The error byte is reset to zero.
"t-999g0"	This set temperature command will cause the current to be limited which will set error number 04. If no other errors have been recorded, the 04 will be returned by the G0 command. If another error was present before the t-999 command, say an A/D Overrange condition, a five (05) will be returned.

G1 - Get current limit

The current limit is placed in the output buffer.

G2 Get gain

The gain will be placed in the output buffer. The gain will be one of the accepted gains (1,3,10,30,100,300).

G3 Get C1
G4 Get C2
G5 Get C3

The Get C1,C2 or C3 commands will move values, for an internally stored thermistor calibration constant, to the output buffer.

G6 Get CAL-R 10 value
G7 Get CAL-R100 value

This moves the internal resistance scaling factors, for the 10 uA and 100 uA internal resistance calibration, into the output buffer. Read chapter 5 for an explanation of what these scaling factors represent.

G8 Get CAL-CL value

This moves the internally stored current limit calibration scaling factor into the output buffer. Read chapter 5 for an explanation of what this calibration scaling factor represents.

G9 Get User Defined Message

The G9 command loads the output buffer with the user defined message that has been stored in the non-volatile memory. The message is stored in the LDT-5910's memory with the P9 command.

G10 Get SRQ Mask

This command copies the present SRQ mask into the output buffer. The SRQ mask is placed into memory with the P10 command. Service Requests, the serial poll register and the SRQ mask are discussed in sections 3.18 and 3.19.

3.14 Put Values

The put commands can configure the LDT-5910/1227 and select the operating mode by entering "putting" information in the appropriate registers. The PUT commands are described in this section.

P1-Put Current Limit (mA)

Enters the current limit for the LDT-5910.

Example	*Explanation*
"N1000 P1"	Sets the current limit to 1000 mA.

P2 - Put Gain

Enters the gain. The gain must be one of the acceptable gains for the instrument. i.e. 1, 3, 10, 30, 100 or 300. Any other number will generate an error code.

Example	*Explanation*
"N300 P2"	Sets the gain to 300.

P3 - Put C1
P4 - Put C2
P5 - Put C3

These put commands store values, of the constants C1,C2 or C3 for the Steinhart-Hart equation, in the LDT-5910's non-volatile memory.

Example	*Explanation*
"N1.434 P5"	Puts the value of 1.434 into memory for C3.

P6 Put CAL-R10 Value
P7-Put CAL R100 Value

The P6 and P7 commands enter an input calibration scaling factor used to calibrate the resistance values. The input must be a five digit integer. For more information about this calibration constant refer to Chapter 5.

Example	*Explanation*
"n10437 p6"	Puts the scaling factor 10437 into memory for the 10 uA calibration constant.

P8 - Put Calibration CL Value

The P8 command inputs the current limit calibration scaling factor to calibrate the Current Limit. The input must be a five digit integer. For more information about this calibration constant refer to Chapter 5.

Example	*Explanation*
"N11237 p8"	Puts the value of 11237 into memory for the current limit calibration constant.

P9 - Put User Defined Message

The P9 command stores user defined messages in the internal calibration memory. The message may be read with a G9 command. The message may consist of up to 16 ASCII characters and typically represents the instruments identification, calibration date, etc. Lower case letters are converted to upper case. The data must be entered in alphanumeric format and must be surrounded by single quotes (ASCII 39).

Example	*Explanation*
"'CALDATE 7.13.87'p9"	Loads the message "CALDATE 7.13.87" into the non-volatile memory.

P10 - Put SRQ Mask

The P10 command programs the LDT-5910/1227 to make service requests on user-specified conditions. The two digit number code for the SRQ mask is interpreted below.

00	To disable the SRQ
01	For SRQ on an A/D Overrange
02	For SRQ on an Unsuccessful Temperature Calculation
04	For SRQ on a Current Limit Condition
08	For SRQ on a Voltage Limit Condition
16	For SRQ on a Thermal Limit Condition
32	For SRQ on a Software Error

To enable more than one condition, add the numbers to get the mask value. Numeric entries for the P10 command must be between 0 and +63 inclusive or an error will occur and the SRQ mask will not change. The entry may be expressed as an integer, real number as described in the n command. any factional part is ignored. For more information on the SRQ mask refer to sections 3.18 and 3.19.

Example	*Explanation*
"N17 P10"	Sets the SRQ mask to 17 and enables a SRQ on A/D Overrange or Thermal Limit.
"N1 P10"	Sets the SRQ mask to 01 and enables the SRQ on A/D overrange.
"N40 P10"	The controller is alerted to generate a SRQ when there is a Software Error or a voltage limit condition. All other errors still effect the error status register, and can be read with the G0 command, but do not generate a Service Request.

3.15 Terminator Commands

The terminator commands select what terminators the LDT-5910/1227 appends to every output string. The available terminators are Carriage Return, Line feed and End or Identify. CR and LF are ASCII control codes, sent over the data lines just like output data. EOI is a uni-line message which is sent simultaneously with the last character in the output string. Normally ,each output string is terminated with CR followed by LF and EOI. The LDT-5910/1227 defaults to W0 on power up and any device clear command.

Example	*Explanation*
"W1"	The host computer will append a carriage return and a line feed to each command that is sent.

3.16 Clear Command

The asterisk command resets the LDT-5910/1227 to the power-up default settings and clears all registers and buffers except for the input buffer. The remote/local status remains unchanged. The asterisk is executed in its proper turn in a string, just like any other command, without affecting the contents of the input buffer. All commands which precede the * command are performed. The asterisk is useful to insure that the LDT-5910/1227 is initialize to the same state each time a program is run. By contrast the similar interface messages DCL (Device Clear) and SDC (Selected Device Clear) cause the entire input buffer to be cleared immediately.

Example	*Explanation*
"* t20.0 O1"	These commands first reset the LDT-5910/1227 to the power-up configuration of auto display mode, output off and local mode. The t20 command places the unit in remote and sets the control temperature to 20.0 C and the output is turned on.

3.17 Self Test Command

The Z0 command starts the diagnostic self-tests. If an error is detected an error message is loaded into the output buffer and displayed on the front panel After the last test, the LDT-5910/1227 is reset to the power-on condition and the display indicates actual temperature.

Since the LDT-5910/1227 is reset at the end of the self-test the Z0 command should only be sent by itself. The LDT-5910/1227 will ignore any subsequent commands in a command string.

Example	*Explanation*
"z0"	The LDT-5910 does a diagnostic self test and resets to the Power On conditions.
"z0 l1"	The LDT-5910/1227 diagnostic self test is performed. The instrument then defaults to the power-up settings and the L1 command is ignored.

3.18 Control Mode Command

Y0 Enable Local Mode

This command will return the LDT-5910/1227 to local mode after the Local Lockout command is issued.

Y1 Enable Remote Mode

This command is automatically sent from the 1227 interface board to the LDT-5910 with any device dependant command. It is primarily reserved for remote operation via an RS-232 interface connection.

Y2 Enable Local Lockout Mode

Local Lockout Mode will disable the remote/local button on the front panel of the LDT-5910. The instrument cannot be returned to local mode until the Enable Local Mode command (Y0) is sent.

Example	*Explanation*
"y2 d4"	The instrument is placed in local lockout and the front panel controls are disabled (including the LOCAL /REMOTE switch). The Auto display mode is activated.
"y0"	The LDT-5910/1227 is returned to local mode.

3.19 Service Requests

Service requests let bus instruments get the attention of the host computer. If more than one instrument on the bus is capable of sending service requests, the host can learn which one made the request by taking a serial poll. Each device, including the LDT-5910, responds to the poll by sending the contents of its serial poll register. The serial poll register indicates whether the device requested service, and if so, the reason for the request. Service requests are sent over a separate line (one of the IEEE-488 bus lines called the SRQ line) and do not affect the output buffer.

The LDT-5910/1227 can be programmed to make a service request on user-specified conditions. The conditions are specified by entering a value for the service request (SRQ mask) with the P10 command (which can be read with the G10 command). The SRQ mask is a two digit integer that specifies which conditions will generate a service request. The SRQ mask works by selectively ignoring any unspecified conditions of all the conditions that are monitored by the serial poll register in the LDT-5910.

3.20 The Serial Poll Register and the SRQ Mask

The serial poll register is a binary register which contains eight bits, as shown in table 3.4. The SRQ mask can enable any combination of serial poll register bits 1 through 6. Its six-bit binary representation is AND-ed bit-for-bit with error register bits 1 through 6 and the results sent to the serial poll register. If any mask-enabled bit in the serial poll register comes true the RQS bit (bit 7) is set true, generating a service request.

At power-up of on any device-clear command, the SRQ mask is set to 00. This prevents service requests by holding each bit false under all conditions. The serial poll register is cleared whenever the LDT-5910/1227 receives a new input command string.

Table 3.4 Serial Poll Register

Bit	Condition
0	No Error
1	A/D Overrange
2	Temperature Calculation Unsuccessful
3	Current Limit
4	Voltage Limit
5	Thermal Limit
6	Software Error
7	RQS

3.21 Interface Messages

Programmers working with high level languages (like BASIC) generally need not be concerned with these messages since they are often handled by the internal software drivers. The interface messages understood by the LDT-5910/1227 are listed in Table 3.5. All of these messages originate at the controller.

Table 3.5 Interface Messages

MLA	My Listen Address - Addresses the 1227 to listen.
MTA	My Talk Address - Addresses the 1227 to talk.
UNL	Unlisten - Addresses all devices to unlisten.
UNT	Untalk - Addresses all talkers to untalk.
ATN	Attention - A uni-line message that instructs the 1227 to interpret a multi-line message as an interface message (as opposed to a device dependent command).
DCL	Device Clear - A multi-line message that causes the 1227 to reset to its power-up configuration: output off, auto display and local mode.
LLO	Local Lockout - A multi-line message that disables all LDT-5910/1227 front-panel controls including the LOCAL/REMOTE button.
GTL	Go To Local - Causes the LDT-5910/1227 to switch to LOCAL mode.
SDC	Selected Device Clear - Causes the 1227 to reset to its power up configuration: output off, mode set to local. This command differs from DCL above in that it affects only the addressed interface whereas DCL affects all listeners on the bus.
REN	Remote Enable - A uni-line message which, when received with MLA, switches the LDT-5910/1227 to remote. When REN is set false the LDT-5910/1227 switches to local and removes the local lockout.

3.22 Example Programs

An example program is shown below that exercises commonly used, remotely accessible features of the LDT-5910/1227.

```
10 '***************************** TCTRL1 ******************************
12 '
14 'Program to control the LDT-5910 to a user specified temperature
16 'and determine when temperature stabilization has been achieved.
20 '
24 'This program is written for use with an IBM PC/XT or compatible
26 'using IOTech's GP488 controller card and PERSONAL488 software
28 '(IOTech, PO Box 21204, Cleveland, OH  44121).
30 '
32 'The program is written in Microsoft's GWBASIC and will also run
34 'under IBM's BASICA.
90 '*********************************************************************
100 '
102 ' Set up program parameters
104 '
110 ADDR$="01"              'LDT-5910 GPIB bus address
120 '
122 DELTMAX = .5             'Acceptable temp tolerance in deg C
124 DTDSMAX = .1             'Acceptable temp change rate in deg/sec
180 '
182 KEY OFF
200 '
202 ' Initialize the GPIB device software drivers
204 '
210 OPEN "\DEV\IEEEOUT" FOR OUTPUT AS #1
212 OPEN "\DEV\IEEEIN" FOR INPUT AS #2
300 '
302 ' Initialize the LDT-5910
304 '
312 PRINT #1, "OUTPUT ";ADDR$;";G0"      'Check error status
314 PRINT #1,"ENTER ";ADDR$
316 INPUT #2, R$
318 IF VAL(R$)<>0 THEN BEEP : LOCATE 12,1 : PRINT "ERROR DETECTED: ";R$
: END
340 '
342 PRINT #1,"OUTPUT ";ADDR$;";W1"       'Set output terminator to <CR> <LF>
400 '
402 ' Get user set temperature
404 '
406 SLAST=0
410 CLS : PRINT "                TEMPERATURE CONTROLLER DRIVER"
412       PRINT "               ============================"
420 '
422 LOCATE 10,1 : INPUT "SET TEMPERATURE (C)... ",TS$
500 '
502 ' Print output headings
```

```
504 '
512 LOCATE 10,41 : PRINT "ACTUAL TEMPERATURE (C)... ";
514 LOCATE 11,41 : PRINT "RATE OF CHANGE (DEG/SEC)... ";
600 '
602 ' Send set temperature to the 5910, turn the output on and
604 ' the display mode to actual temperature
606 '
618 PRINT #1, "OUTPUT ";ADDR$;"; T";TS$;" O1 D2"
620 '
621 ' Check to see if done
622 '
624 PRINT #1, "ENTER ";ADDR$              'Get a temperature reading
626 INPUT #2, R$ : SNOW=TIMER
630 '
634 TACT=VAL(R$) : TSET=VAL(TS$)         'Some calculations
636 DTDS=(TACT-TLAST)/(SNOW-SLAST)
640 '
642 LOCATE 10,68 : PRINT R$;"     ";     'Print current values
644 IF SLAST>0 THEN LOCATE 11,67 : PRINT USING "##.##";DTDS;
650 '
652 SLAST=SNOW : TLAST=TACT
654 IF ABS(TACT-TSET)<DELTMAX AND ABS(DTDS)<DTDSMAX THEN 700
660 '
661 ' Wait for 2 sec delay before getting new reading
662 '
664 IF TIMER-SNOW<2 THEN 664 ELSE 622
700 '
701 ' Program termination
702 '
712 BEEP
714 LOCATE 15,20 : PRINT "DONE...STRIKE <CR> TO REPEAT"
720 '
722 A$=INKEY$ : IF A$="" THEN 722
724 IF A$=CHR$(13) THEN 400
730 '
732 CLS
734 END
```