

# **L3000 Gaging System**

## **Table of Contents**

### **L3000 Quick Start Guide**

#### **Basic System Operation**

- 1.0 Overview of System Operation
- 1.1 Panel Controls and Connectors
- 1.2 Powering Up the L3000
- 1.3 Default Setup Loading
- 1.4 Input Connections
- 1.5 Powering Down the System
- 1.6 Keypad Entry and Control
- 1.7 Main Display Configurations
- 1.8 Main Programming Menu

#### **System Parameters Screen**

- 2.0 System Parameter Screen
- 2.1 I/O Configuration
- 2.2 User Configuration
- 2.3 R & R Setup

#### **Creating A New Setup**

- 3.0 Defining a Setup
- 3.1 Primary Setup Creation Screen
- 3.2 Secondary Setup Creation Screen
- 3.3 Optional Setup Menu for Setup Creation

#### **Editing An Existing Setup**

- 4.1 The Edit Menu
- 4.2 Basic Parameters
- 4.3 Input Parameters
- 4.4 Scale Information
- 4.5 Masters Setup
- 4.6 Spec./Approach Limits
- 4.7 Zero/Gain Adjust
- 4.8 Operational Setup
- 4.9 Operator Messages
- 4.10 Master Instructions
- 4.11 Part Display XY
- 4.12 Exit

#### **Additional Setup Tools**

- 5.1 Changing to a Different Setup
- 5.2 Deleting A Setup
- 5.3 Options ( Data Transfer and Remote Programming )
- 5.4 Utility (External Inputs)
- 5.5 Reset Zero & Gain

#### **Run Mode**

- 6.1 Selecting a "Run" Mode for the System

#### **Viewport Scroll**

- 7.1 Viewport Information Displays

**Statistical Screens**

- 8.1x and R Screen
- 8.2 Histogram

**Mastering**

- 9.1 Using LVDT Probes
- 9.2 Using Air/Electronic Converters
- 9.3 Initial Calibration
- 9.4 Automastering

**R & R Test Runs and Reports**

- 10.1 Setting up For A Test
- 10.2 Running an R & R Test
- 10.3 Generating an R & R Report

**Storing Reading Data**

- 11.1 Data File Formats
- 11.2 Initiating Data Readings
- 11.3 Viewing and Printing Data

**APPENDIX**

- A1**- Specifications
- B1** - Connector Wiring

## **L3000 QuickStart Guide**

### 1/ Power On

Ensure that unit is plugged in and that the "Power" rocker switch on the cabinet rear is "On". Press the power on button on the front panel right side momentarily. The system will start and after a few moments of loading files, the main menu will appear. A generic setup called <Default> is loaded initially. There must always be at least one setup present on the system. The L3000 system allows for up to 100 user-defined setups to be created.

### 2/ Screen Items

Bargraph displays for setup will appear in the main window, in the upper left portion of the screen. Up to 8 bars are displayed at any time, and an additional 20 displays can be seen (where they exist) by scrolling the screen to the right using the <Back> button. The bar screen may be changed to Digital button or custom Part display screens by pressing the appropriate keys on the front panel. A single screen displaying all 28 available displays can be accessed by pressing the "Column" button. Pressing this button will toggle between the 28 bar display screen and the normal bar display screen.

The main window also displays setup menus, statistical charts, etc., when these menus are called up.

The right side of the screen has a viewport which can be scrolled to display different setup information by pressing the <Viewport> button. The initial default is to display the values of the last readings taken.

A counter window appears just below this viewport, and it will increment numerically each time the <Read> button is pressed. This can be reset by engaging a User button as described below.

A lower window displays text information pertinent to the function being performed, such as help information, instructions, and special counters. The left corner of this window displays the text "Reading" whenever the <Read> pushbutton is pressed.

The bottom portion of the screen displays the name of the current setup which is loaded, and the names of 4 user-defined pushbuttons.

The upper right of the screen displays 4 annunciators which can be programmed to light up under certain user-defined system events.

### 3/ Initial Default Setup

An initial setup file always exists on a new L3000 system, called Default. This enables the system to function when it is first powered up, until the user creates a new custom setup (or the user may simply prefer to modify the parameters of this setup). Up to 100 setups can exist on the system at any time. The default setup is programmed to show 3 bar displays, each display responding to inputs # A through #D respectively. If an LVDT is plugged into input # A, the display will move as the LVDT probe is depressed. If an operational error occurs with a particular setup, the operator is allowed to load the Default setup instead in order to access the system.

### 4/ Creating a New Setup

When the <Setup> button is pressed on the front panel, a setup menu appears in the Viewport Window. The user can scroll through the selections by pressing the up/down arrow keys. Scroll to "Create New Setup", and press the <Enter> button.

#### a) Create New Setup Primary Parameters

Several prompts will appear in the main window on the left. The user can type in a Setup name, which can have alpha-numeric characters( avoid leaving spaces in the name), followed by a part number, and a description. Text data can be entered either from a keyboard ( special ) or from the front panel. If entering text from the front panel buttons, the vertical character listings beside the keys indicate which letters that key can create. For example, to type in the letter "T", press the Hist Key ( 6,S,T,U in text mode) once. The number 6 will appear in the prompt. Pressing the same key again will change this to an "S", and pressing once more will change this to a "T". Pressing the <Enter> key will advance the text one character to the right. Pressing the <Tab> key will advance to the next prompt, and pressing the <Back> key will move to the previous prompt. Other more advanced setup parameters can also be set at this time, such as Read Cancel , Sense Part, Probe Check, and SPC Storage. When this prompt is hi-lit, pressing the <Enter> key will cause a dropdown menu to appear, which can be scrolled using the up/down arrow keys, and selected by pressing the <Enter> key once again. These do not have to be set at this time, and can be edited later. "Reading Sequence" allows the user to type in a sequence for step gaging, if this is to be used, and the numbers entered represent Reading Group numbers. Leave this prompt blank for now. Press <Tab> to advance to the Save & Add Displays Button, and press <Enter> to bring up the next essential menu.

#### b) Configure the Primary Column Displays and Associated Inputs

This menu has prompts for up to 28 displays, although the user may configure for as few displays as are required. The "Characteristic" prompt is a text prompt, which allows the user to type a brief description of the characteristic being monitored by each display. Enter text ( if desired ) as described above. Press <Tab> to move to the next prompt , Input Type. This is initially set to "Off". Press the <Enter> button to show a drop-down selection of input possibilities. The "Aux" input is used for Air/Electronic converter inputs, or other transducer types. QuickCalc provides a list of often used calculation functions, and operates in active time. LastCalc is similar, except that the display will respond only to the last recorded value for the inputs ( as stored when the | <Read> button is pressed.) The user can also select from 20 user-developed formulas as created in another menu area. For more details on the setup for calculated displays, see the detailed programming areas of this manual.

When "LVDT" is selected as the input type, another scrollable prompt will appear. Press the up or down arrow keys to select the input connector which is associated with this display , and the desired polarity of the movement ( scrolls from -D to +D on a 4 input unit, or -H to +H on an 8 input unit, or -P to +P if using the L3100 Remote Input module, which provides an additional 8 inputs to the gage.) Changing polarity from + to - or vice versa will cause the bar display to move in the opposite direction. Pressing <Enter> will accept this input designation and polarity. With LVDT inputs, the gain range is automatically set depending on what "Scale Range" is selected ( In a later menu.)

If the input is "Aux" ( for air inputs ), the procedure is similar except that a "Set Aux Gain" user prompt also appears after the Input Type prompt. The user can scroll this prompt from .5 x gain through to 50 x gain. This is typically a trial and error type setting, and may have to be modified when the air input is later calibrated. The air input gains are independent of any display scale settings.

Program as many inputs as necessary for the setup, pressing the <Tab> key to move from one prompt to another. If more than 14 displays must be programmed, Tab to the <Page> button and press Enter. The screen will then present inputs 15 to 28 for similar programming. Pressing <Page> again will return to displays 1 - 14. When done, <Tab> to the "Save" screen button in order to save the information for the setup, or the "Cancel" button to abort the setup creation., and press <Enter>.

#### c) Additional Setup Parameters

If the above setup information was saved, a further scrollable menu will appear, allowing the user to program further parameters at this time if desired, such as scale ranges, limit settings, etc. If the setup procedure is exited at this point, the setup will be created with default settings, which the

user will later have to edit later. Exiting from this menu will return the system to the main programming menu. At any point after this, the initial setup parameters and other default parameters for the setup can be changed by entering the "Edit Setup" menu.

#### 5/ Changing System Parameters

When this item is selected from the main programming menu, the user can establish a "customer name", a station ID, and primary and secondary security codes. The security codes can be applied independently to 4 different menu access points. This menu also allows for the setting of the gaging system clock and system date, as well as other general parameters.

#### 6/ Main Bar Displayed

Exiting from the main setup menu will bring up the column bar screen, and the individual columns should now respond to changes in the input signals.

#### 7/ Other Basic Screen Functions

Once programmed, other functions may also be called up from the keyboard.

**COLUMN Button:** Pressing will toggle between the normal column display screen (8 displays visible at a time ) and another bar display screen which shows all 28 displays.

**DIGITS Button:** Display only the digital representation of input values, in larger characters.

**PART Button:** Available as an option, a drawing or picture of a part can be imported in a .PCX format, and the user can position digital displays at any position on the screen .

**VIEWPORT Button:** Press the Up or Down Cursor key to scroll through various information windows on the system.

**Xbar/ HIST :** Create statistical charts of Xbar and R or Histograms from archived data files.  
( Must 1st have data in the file by taking several readings )

**PRINT Button:** View or print the archived data readings.

**R & R Button:** Perform Repeatability and Reproducibility Tests and View Results.

**OPTIONS Button:** Brings up a small menu for use when communicating with an external computer via the serial port for purposes of programming or data retrieval.

**UTILITY Button:** A menu allows the user to program 3 external input contacts ( up to 8 available optionally ) to respond to momentary contact closures with a variety of system events.

#### 8/ Power Down

To turn off the L3000, press and hold the *Power* button for at least 4 seconds. The amber activity LED will go off. To prevent the unit from being powered up from the front panel button, press the rear panel rocker switch to the "off" position ( dot end out ).

**BASIC SYSTEM OPERATION**

## 1.0 Overview of System Operation

The L3000 Gaging System Provides a complete means of doing multiple point gaging and inspection of machined parts at a low cost and with small space constraints. The large LCD monitor provides a clear and graphic picture of the manufacturing process at any point in time.

The L3000 system performs a similar function to a bank of Air or LVDT column gages, but has many additional features which provide the user with data storage, SPC analysis, and sophisticated I/O control, to mention a few. Some of the basic features are described below:

- Can be ordered with either 4 or 8 signal inputs.
- Inputs can be expanded to 16 with the L3100 Remote Input Module
- Each input can be either LVDT probe type, or analog voltage type, for use with Lance Air/Electronic converters or other transducer type devices.
- Create up to 99 different setups, each with different configurations as needed.
- Each setup can show anywhere from 1 to 28 column displays. 8 displays are visible on the screen at any one time on the main bar display screen, and the remaining six can be scrolled into view by pressing the <Tab> key. Alternatively, one can use the alternate bar display which will show all 28 on one screen.
- Any column display can be configured to show either
  - the input signal,
  - or a "quickcalc" calculated display, where the user can select a calculation format from a pick list, and the display will respond as a 'live' display..
  - or a "lastcalc" calculated display, similar to above, but where the calculation will be based on a previous reading, rather than a 'live' display.
  - or a "formula" calculation, which occurs only when a Reading is taken.
- Column displays can be configured for 3 colours, green [OK], amber [ Approach ], and red [ exceeding tolerance limits ].
- Column displays can be configured to respond in TIR (Total Indicating Readout ) mode, where the display will show Min, Max, or Max-Min values, as well as others.
- In TIR mode, a thin blue column next to the main column bar will respond in normal mode, giving the operator a clear picture of where the zero position of the probe currently is.
- A small digital display above each column bar can be configured to display in either tolerance mode or actual part size.
- Markers on column edges indicate positions of specification and approach limits
- Switch from column part to large character digital display boxes at the press of a button.
- Establish *Reading Groups* for columns, for purposes of step gaging, where the system will sequence through groups of columns for data read purposes - or, take measurements from just one group of columns based on a user selection.
- A *Viewport* window on the right side of the screen can be scrolled at any time with the press of the button. The user can view last data readings, setup information for all columns, current statistics, or the last 30 readings.
- Engage an *Automastering* menu with a button press, where all columns, or groups of columns can be automatically mastered at any time (Min/Max or Mean Masters)
- 4 User defined annunciators are available on the screen. The user can select the circumstances which will turn these annunciators on or off from a pick list, including such items as Out of Spec., Out of Control, etc.
- 4 User defined buttons are available, for quick 1-button access to a number of functions

- Create screen Xbar and R charts based on archived data.
- Create histogram plots based on archived data
- Print out data readings to an attached printer
- Control external devices based on 2 standard internal relays ( 8 relays optional ), and select the desired trigger criteria from a user pick-list.
- Do R&R (Repeatability and Reproducibility) studies from a menu driven format, and then produce R&R reports based on the readings taken.
- 8 Available external inputs for triggering events in the L3000 gage. (3 standard).
- Data storage system automatically creates archive files. There are 300 sets of time-tagged data readings for all columns engaged, for each data archive file, and up to 400 archive files can be stored for a setup, in a revolving file basis, limited only by the memory size limitation of the gage.
- Data readings can be sent to an external computer via the serial port with each data reading taken, or, archived data can be sent via the serial port on demand.
- Export R & R data files to an external computer via the serial port.
- Program the L3000 gage from an external computer if desired, using the Lance L3150 Communication software package. Alternatively, upload setup files and programming from an L3000 gage for programming backup.
- Locate the 17" LCD Monitor on top of or beside the L3000, or alternatively, have it mounted to a moveable arm for greater flexibility.



Fig. 1a

### 1.1 PANEL CONTROLS AND CONNECTORS

The front panel of the L3000 Unit has 25 pushbutton controls, for use primarily in controlling the gage operation, and also for use in creating or editing setups. See Fig. 1a. The button on the top right, when pressed momentarily, will turn the unit on or off. A small "Ready" light near this, will blink a few times when the unit is powered up, and will stay on when it is ready for operation. 3

buttons on the lower right are dedicated to the functions of <Data Reading>, <Automastering>, and <TIR Reset>. Four horizontal buttons along the top are user-defined with functions selected from a pick-list.

12 buttons make up the main control keypad. These have dual functions, depending on whether the user is in operating mode, or in programming mode.

A further 5 buttons on the left are used for scrolling lists, moving the cursor in text editing, tabbing between menu prompts, backing up in editing fields, and *Entering* program information.

The rear panel includes AC Power items, and external connectors. On the lower right is a removable AC power cord ( normally 120 VAC). Above this is a fuse holder containing a 1 amp rated fuse, and above this is a "rocker" type AC power switch. When "Off", power is disconnected from the unit. When "On", the L3000 can be turned on or off from the front panel "On/Off" pushbutton. See Section 1.5 regarding turning the L3000 off.

When the unit is purchased with 4 signal inputs , they are labeled A, B, C, and D. When purchased with 8 inputs the additional 4 inputs are labeled E, F, G, and H. The input connectors are 6 Pin , 240 ° DIN type. Other connectors on the rear panel are:

- Contact Inputs : 8 Pin DIN used for external control of gage operations
- Factory Setup : 5 Pin DIN, used for gage supplier setup and programming
- Monitor: 15 Pin D type Female, for connection to standard SVGA LCD monitor.
- Serial : 9 Pin D type Male, for communication with an external device or computer
- Printer : 25 Pin D type Female, for connecting an external printer
- Relay Output : 25 Pin D type Male, for connecting internal relays to external devices
- Auxiliary : 15 Pin D type Female, for custom configurations - otherwise, not used.

If the L3100 Remote Input Module is used to provide an additional 8 inputs, they are labeled as I, J, K, L, M, N, O, and P



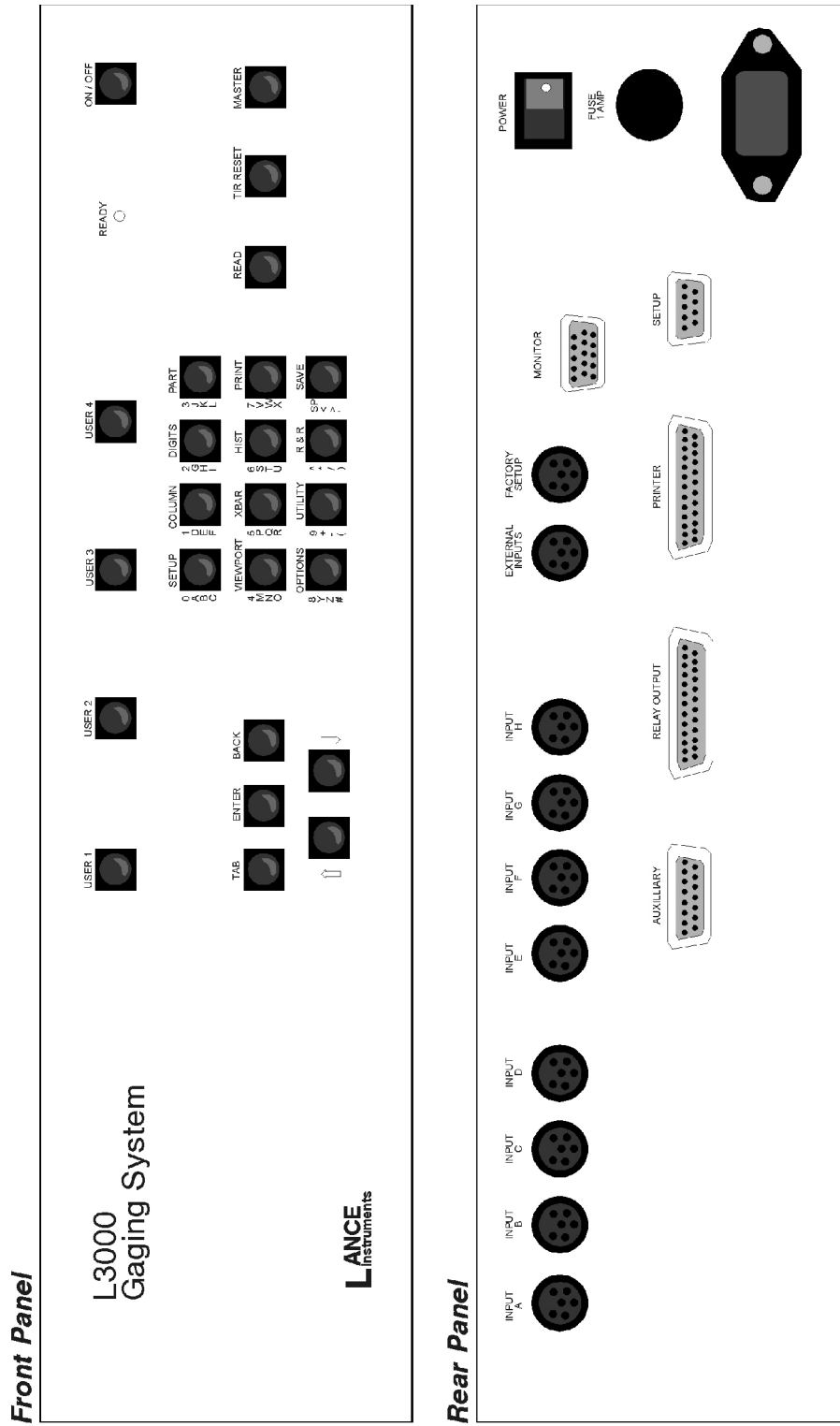


Fig. 1b L3000 Panel Controls and Connectors

## 1.2 POWERING UP THE L3000

Ensure that the AC line cord is firmly plugged in to the back panel AC receptacle. Plug the other end of the line cord into a 120 VAC outlet. Make sure that a monitor is securely connected to the rear panel "Monitor" connector, and turn the monitor on. Ensure that the "Power" rocker switch on the rear panel is ON ( white dot side of button pressed "in" ) and then press the "On/Off" pushbutton on the upper right of the front panel momentarily. The Power LED will blink a few times, and the monitor screen will show program loading activity. When the power LED stops blinking, and stays on, it means that the internal signal processing boards are ready for operation. The monitor will display an opening logo screen, and a line bar will indicate the rate of progress in loading files and programming the system. When finished, after a few seconds the main bar screen will appear indicating that the system is ready for use. The setup loaded will be the same as the setup which was loaded the last time the unit was powered down. As with all precision electronic measuring devices, a "warm up" period of at least 5 minutes, and preferably 10 minutes, should be allowed before taking measurements or doing any mastering or calibration. For "Power Down" procedure, see section 1.5 .

## 1.3 DEFAULT SETUP LOADING

When an L3000 Gage is purchased and first powered up, it will automatically load a setup called "Default", which is configured for 3 displays, using inputs A,B, and C respectively. This is necessary since the system always needs a setup to be loaded when powering up. Once a new customer defined setup is created, then "Default" no longer needs to be used, and resides on the system files as a safety. If for any reason a customer setup file becomes corrupted, then the Default setup files can be loaded in order to gain access to the system menus.

## 1.4 INPUT CONNECTIONS

In the DEFAULT setup, an LVDT probe ( must be wired as per Appendix) can be plugged into any of the 1st three inputs, and when depressed, a corresponding change in the associated bar column display will be seen. Similarly, a Lance L8356 Air/Electronic converter can be plugged into an input, and a change in outlet back pressure will deflect the bar. Any other type of sensor can be used as an input device, so long as the pin connections are correct, and the output voltage is compatible with the system requirements ( See Appendix).

Any column display can be programmed to respond to any particular signal input, and more than one display can respond to the same input, or a calculation based on that input.

LVDT inputs on the L3000 use a phase-demodulation technique. It should be noted that when an LVDT is positioned in a fixture, it should be "Body-set" such that a part of nominal size causes a display ( electronic zero at mid-point ) to deflect to the mid position on the bar display.

L8356 Air/Electronic converters do not need separate power supplies when plugged into an L3000 unit, as power is supplied to the converters through the input connector. When 2 or more converters are supplied with air from a common manifold, supply pressure should be monitored from the end of the manifold opposite the air supply line, to ensure that all converters receive at least the minimum required supply pressure.

## 1.5 POWERING DOWN THE SYSTEM

The L3000 can be powered down at any time by pressing and holding the <On / Off > button on the upper right of the front panel for at least 4 seconds. However, if any reading data has been collected since it was powered up, the <Save> button ( lower right on the keypad ) should be pressed first. This will save any data currently in RAM memory which has not yet been saved to the hard drive. The POWER button should never be pressed while the system is in the process of

saving data or configuration files, as this may result in corrupted files and prevent proper system operation. An annunciator light can be programmed to be lit whenever there is reading data in the system which has not yet been stored.

## 1.6 KEYPAD ENTRY AND CONTROL

The keys on the 4 x 3 matrix on the front panel have dual functionality, depending on if the gage is in "run" mode (Blue front-panel labeling) , or "program" mode (Black front-panel labeling). Most of the buttons, when pressed in program mode, will either cause the main screen to change, or will cause a pop-up menu to appear, relating to the button function.

In program mode, the keys are generally for editing user-entry text. Each button can be used to enter 4 different keyboard characters, as listed vertically on the label next to the button. For example, the upper left key label is :

0 (zero)  
A  
B  
C

When the cursor is on a text-entry field, pressing this key once will cause a zero to appear in the prompt. Pressing a 2nd time will cause the letter A to appear. A 3rd press will print B in the prompt, and a 4th press will print the letter C. Pressing the <Enter> button after a character press will cause the cursor in the text prompt to move 1 space to the right for the next letter entry. Only capital letters can be entered from the gage keypad. If small case letters, or other keyboard symbols are required, then a computer keyboard must be used. For initial programming, a keyboard is recommended due to the faster entry speed. A special adapter cable is required (available from Lance) in order to use a standard computer keyboard.

The 5 keys on the lower left of the L3000 front panel are used for navigating setup menus.

The <Tab> key will move from one prompt to another, moving to the right or down.

The <Back> key will move from one one prompt to another in reverse direction. In a text field, however, the <Back> key will move the cursor to the left, until the 1st character position is reached. Pressing the <Back> key again will move to the previous menu item.

The <↑> and <↓>keys will increment or decrement a number, or will scroll a light bar drop-down menu item, or will scroll a menu selection pick list.

The <Enter> key will accept an entry, or cause a drop-down menu to appear, or cause an on-screen pushbutton to be pressed.

The remaining front panel keys have special functions which are described later in this manual.

## 1.7 MAIN DISPLAY CONFIGURATIONS

The L3000 System has 3 available ways to display input activity. The primary one is the COLUMN BAR screen (Fig. 1c ) which simulates a bank of column gages. As a signal input to a display changes, the indicator bar will rise or fall from a centre zero position accordingly. The amount of movement is determined by the gain and range settings in the system. The bars can be programmed to change colour from green ( in-tolerance ) to amber (approach) to red (out of tolerance. Numbers to the left of the bar indicate scale positions, and coloured triangles indicate the "approach" and "limit" positions as set up in the gage. Above each column bar, a 7 digit numeric display shows the digital representation of the bar height. Up to 8 columns can be displayed at one time, and an additional 6 columns can be seen by pressing the <Tab> or <Back> keys to scroll the columns to the left or right.

Pressing the "Column" Button again will bring up the "Allparts" bar screen (Fig. 1d), which will show all 28 displays on the screen simultaneously, although with less information. The bar scale is set according to the maximum column scale of the 28. Pressing "Column" again will return to the normal bar display.

The DIGITS screen (Fig.1e ) appears when the Digits button is pressed. It shows the same

parameters in strictly a digital format, with large screen digits. A light bar under each digit will change from green to amber to red, depending on if the display is in-tolerance, in approach, or out-of tolerance.

Under this, the programmed "characteristic" of the display is shown.

The PARTS screen (Fig. 1f) is an optional item. This displays a user-supplied digital drawing of the part being measured, with small digital displays positioned at the area of the part being measured.

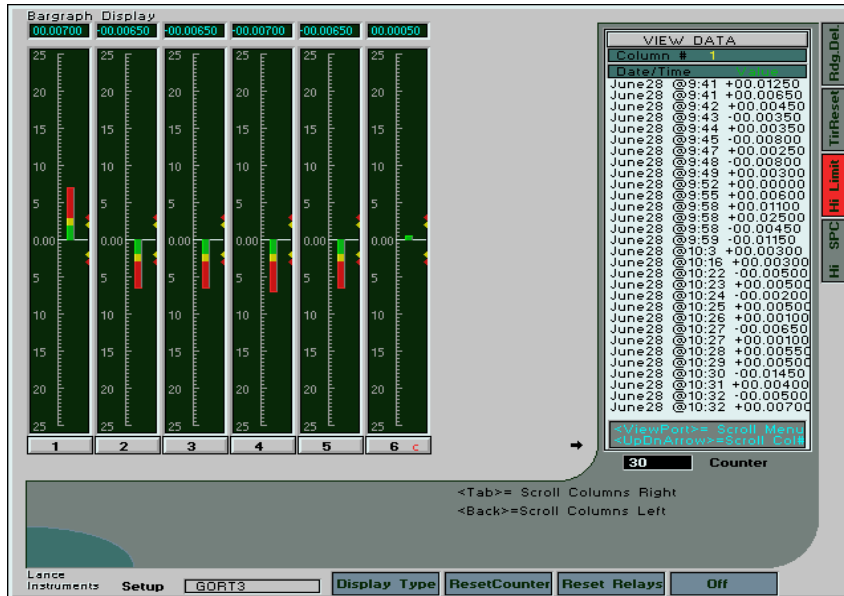


Fig. 1c Column Bar Screen

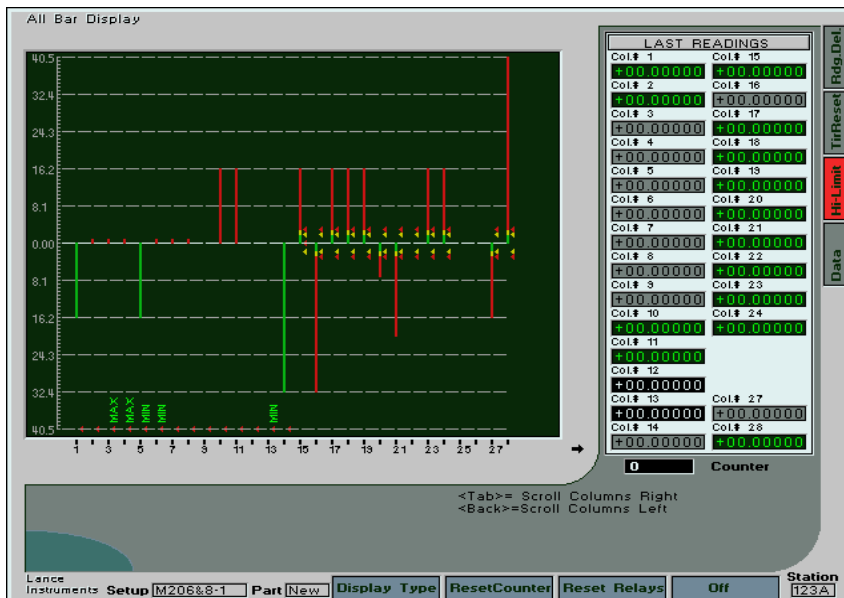


Fig. 1d All Bar Screen

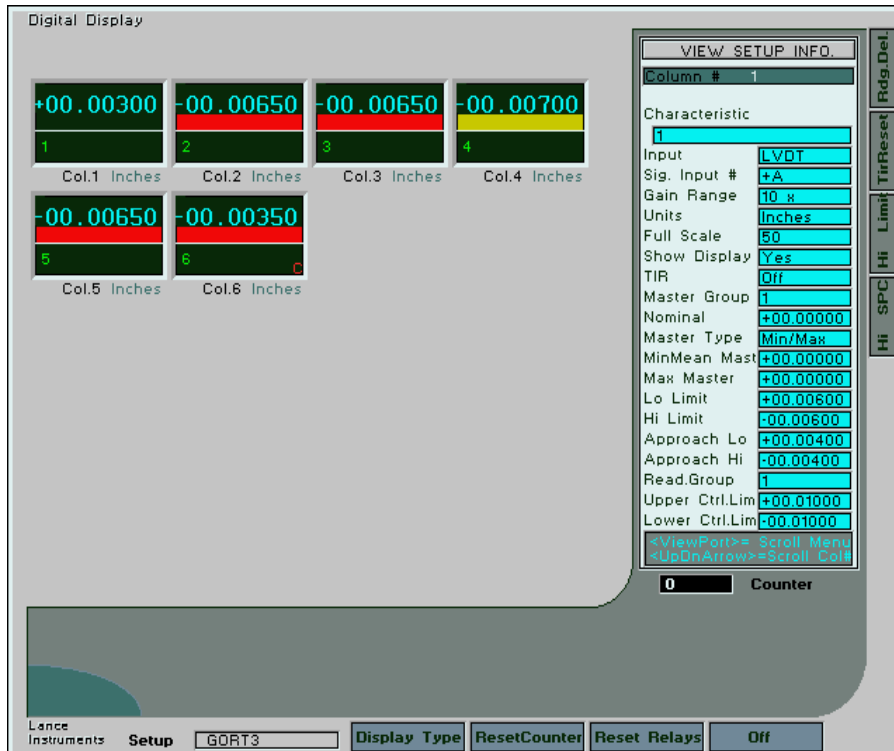


Fig. 1e Digits Screen

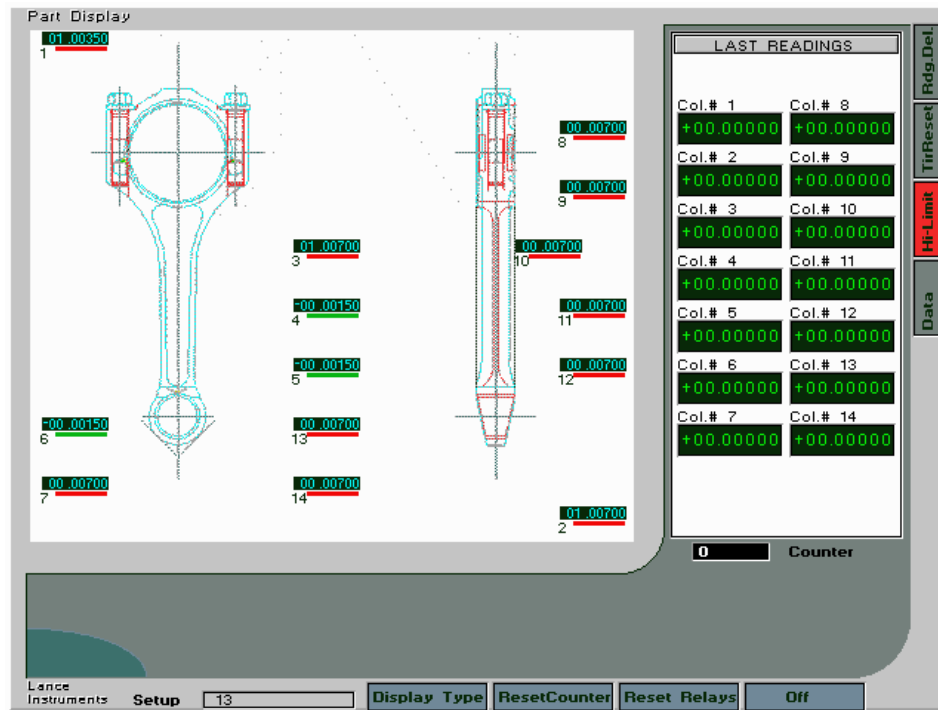


Fig. 1f (Optional) Part Screen

## 1.8 MAIN PROGRAMMING MENU

When the <Setup> button is pressed (upper left in the front panel keypad), the main programming selection menu (Fig. 1g) will appear in the viewport area. This menu is used to select the general programming functions in the gage. Use the up or down arrow keys to scroll to the desired item, and press <Enter> to select. To return to normal run mode, scroll to the "Exit" item, and press <Enter>.

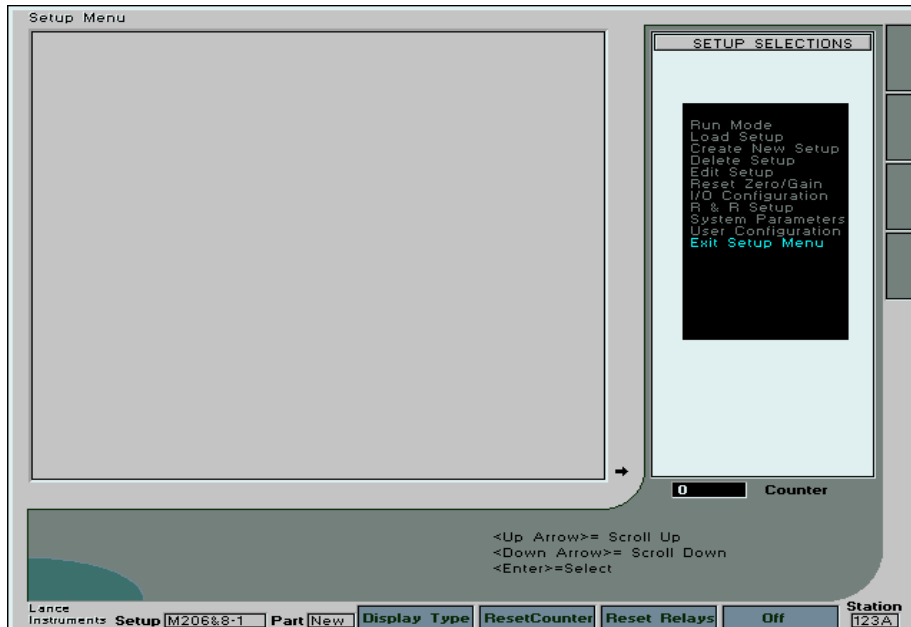


Fig. 1g Main Programming Menu

## SECTION 2

### SETTING UP SYSTEM-WIDE PARAMETERS

#### 2.0 SYSTEM PARAMETERS SCREEN

When the <Setup> button is pressed, a programming selection menu appears in the right window. One of the items is "System Parameters". This menu contains parameter items which apply to the L3000 generally and do not change depending on the setup selected. The screen menu is shown in Fig. 2a. Fields are identified below:

"Customer Name". The user may type in an alpha-numeric name of up to 16 characters. This name will be displayed on the logo screen which is seen upon power-up when the L3000 is being programmed.

"Station #" - Optionally, enter an alpha-numeric station number of up to 4 characters. This is used for station identification during data serial transmission.

"Primary Security Code" - Enter an alpha-numeric code number of up to 5 characters. The primary security code is the highest level of security, and is usually reserved for secure access to main setup information (such as system parameters). See "Select Menu Security Modes" section below for application.

"Secondary Security Code" - Enter an alpha-numeric code number of up to 5 characters. The secondary code is a lower level code, which can prevent unauthorized access to certain menus which will affect programming and system operation. See "Select Menu Security Modes" section below for more information.

“Select Menu Security Modes” - For the 4 prompts listed below, assign a security level to each menu type. The 3 options for each menu type are *Off*, *Primary Code*, and *Secondary Code*. The 4 menu types are Setup Menus, System Menu, Delete Setup, and Edit Setup. Press <Enter> on any of the 4 prompts to display the drop-down selection menu, use the up/down arrow keys to scroll to the desired selection, and press <Enter> to select.

“Set System Time” - Use this section to set the time of the L3000 internal clock. Press the up/down arrow keys to scroll the hours and the minutes. This is used for time-tagging system data.

“Set System Date” - Press the up/down arrow keys to scroll the year, month, and date. This sets the date for the L3000 system and is used for date-tagging recorded data.

“Communication Protocol” - Press the up/down arrow keys to scroll the communication protocol prompt from 1 to 3. This determines what the data output to the serial port will look like if the system is configured for serial transmission each time a data reading is taken. The formats are shown below:

- 1 - aBCDExFG.HIJKL for inches and aBCDExFGH.IJKL for metric
- 2 - xFG.HIJKL for inches and xFG.HIJKL for metric
- 3- as in 1 but a CR ( asc(13) ) is sent at the end of each string of readings

where a = the character “A” indicating the beginning of a new reading.

BC= the 1<sup>st</sup> 2 characters of the setup name

DE= the column number ( from 1 to 14 )

x = polarity ( + or -)

FG.HIJKL the reading ( decimal moves depending if inch or metric)

The readings are comma delimited.

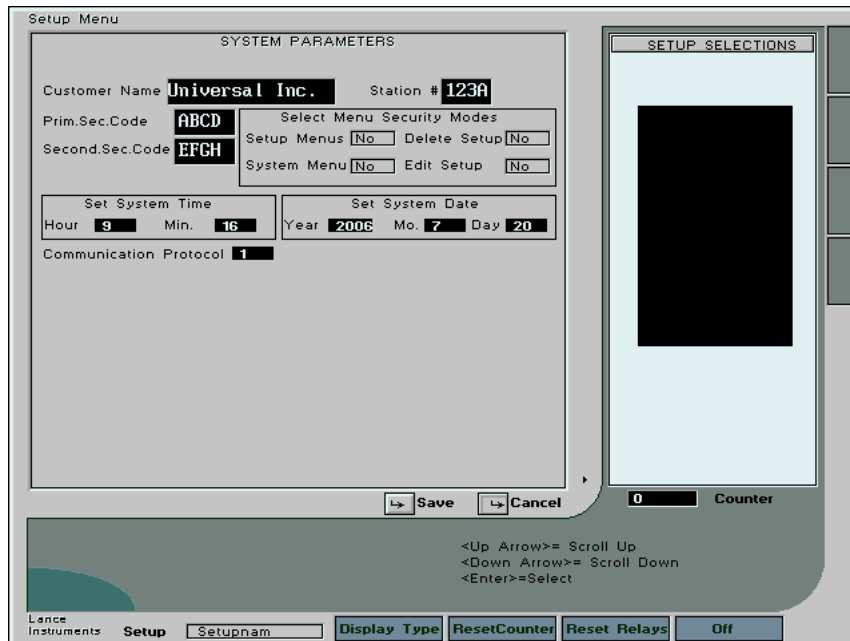


Fig. 2a System Parameters Menu

## 2.1 I/O CONFIGURATION

This menu (Fig. 2b) establishes the desired operation for each of the internal relays in the L3000 system. The standard unit comes with 2 internal relays, but up to 8 relays are available optionally.

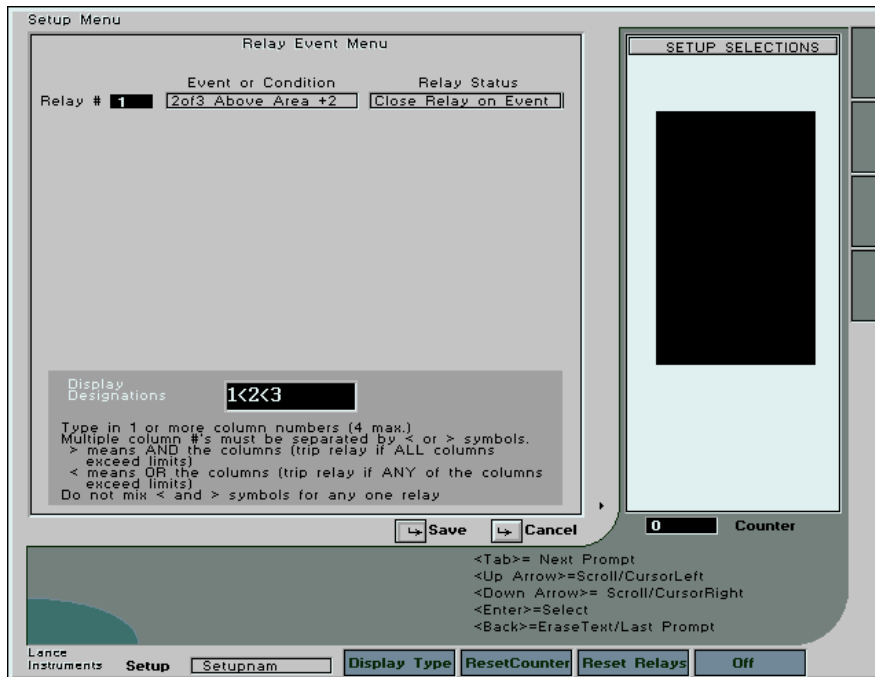


Fig. 2b I/O Configuration Menu

With the cursor at the 1st prompt on the left, use the up/down arrow keys to scroll the relay number from 1 to 8 ( Note: Relays 3 to 6 are available only as an option when purchasing). The program information for each relay in the other prompts will change as the relay number is scrolled. Press the <Tab> key to edit the information for any relay number.

**Event or Condition:** Press the <Enter> key to show a drop down menu list, and scroll the list with the up/down arrow keys. These events, occurring when the gage is running, will cause the associated relay to change status. The list is as follows:

- 1/ Off - Do not change relay status
- 2/ OK - Change the relay status as the signal moves to an OK ( in-tolerance ) condition.
- 3/ Hi/Lo Exceeded - Change the relay status if the signal moves to an out-of-tolerance condition.
- 4/ Appr. Hi/Lo Exceeded - Change the relay status if the signal moves to an approach ( amber ) area of the display.
- 5/ Hi Exceeded - Change the relay status is the signal exceeds the High Specification Limit.
- 6/ Appr. Hi Exceeded - Change the relay status if the signal exceeds the High Approach Limit.
- 7/ XbCtrl Hi/Lo Exceeded - Change the relay status if the signal exceeds either the Hi Control limit or the Lo Control limit.
- 8/ XbarCtrl Hi Exceeded - Change the relay status if the signal exceeds the Hi Control Limit.
- 9/ 2 of 3 Above Area +2 ( See fig.2c ) - Change the relay status if 2 of the last 3 readings taken have been above the Area +2 line. [Zone A]
- 10/ 2 of 3 Below Area -2 ( See fig. 2c ) - Change the relay status if 2 of the last 3 readings taken have been below the Area -2 line. [Zone A]
- 11/ 4 of 5 Above Area +3 - ( See fig. 2c ) Change the relay status if 4 of the last 5 readings taken have been above the Area +3 line.
- 12/ 4 or 5 Below Area -3 - ( See fig. 2c ) Change the relay status if 4 or the last 5 readings taken have been below the Area - 3 line.



NOTE: See appendix for a chart explanation of items 9 thru 12 (for fig. 2c)  
 13/ Setup Loaded: The user can select from a menu list of setups. When this setup is loaded, the relay status will change. This serves as a confirmation signal to external equipment that the desired setup is programmed in the system.

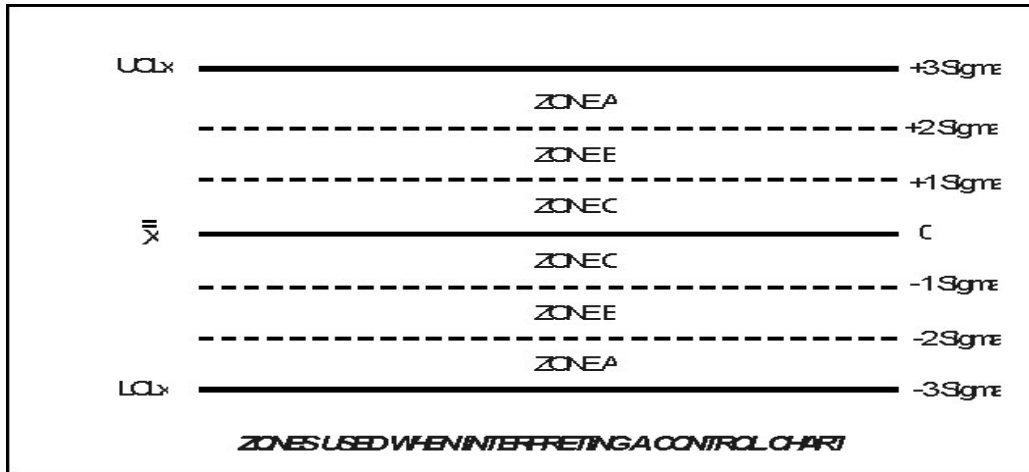


Fig. 2c Zone Chart

14/ Reading Group # : This option allows the user to select a reading group number ( from 1 to 8 ). When the chosen reading group number is selected during operation from the "Run" menu option, then the relay will close and stay closed until this reading group is de-selected. Use the up or down keys to scroll the reading group number and <Enter> to select.

*Relay Status:* A dropdown menu item allows the user to either have the relay contacts close or open on event. The first selection energizes the relay coil, and the 2nd selection de-energizes. The actual relay output ( closed or open ) will depend on whether the user is connecting to the "Normally Open" or "Normally Closed" relay contacts. For example, "Normally closed" contacts will cause a relay closure on an "in-tolerance" condition if the "Event Energize Static" menu option is selected.

Menu items 3, and 4 perform a special relay function. "Event Energize Dynamic" and "Event De-Energize Dynamic" operate similar to their "Static" counterparts except that once the relay is tripped, it stays latched in this position until an external reset occurs. To see how to reset relays programmed in this mode, see "Reset Dynamic Relay" under the External Input Section 5.4 .

*Display Designations:* This menu item allows the user to assign one or more displays to the event condition. For example, typing the single digit "1" into this space will result in the relay looking at the condition of Display # 1 in determining if any relay action should occur. If "1>2>3" were typed into the prompt, then the system would look at the AND of the 3 columns. In other words, only when the programmed condition was met by all 3 columns would the relay status change. If, for example, the condition was "Hi Limit Exceeded", then all 3 columns would have to be above the Hi specification limit point before the relay status would change.

If "1<2<3" were type into the prompt, then the columns are OR 'd, meaning that any one of the 3 displays meeting the condition will cause a change in the relay status.

Up to 4 columns max. can be used for this purpose. Do not mix the < and > symbols in the prompt ( although each relay can have it's own configuration ).

Alternatively, if the letter "A" or "a" is typed in the prompt, and nothing else, then the system will OR all of the columns. This is useful, for example, in signaling if any of the columns on the screen are out-of-tolerance.

## 2.2 USER CONFIGURATION

The L3000 System allows for the custom programming of 4 front panel buttons. These buttons ( User 1 to User 4 ) are located along the top of the cabinet front panel. Each button can be set to perform any of the following functions:

- 1/ Off
- 2/ Display Type ( Bar, Digits )
- 3/ Reset Counter
- 4/ Erase Last Reading
- 5/ Reset Relays

The above function settings will also appear as labels along the bottom of the monitor. This will provide a match to the button if the monitor is positioned on top of the cabinet.

There are also 4 annunciators or light boxes along the right side of the monitor screen, which can be programmed to light up under the following circumstances:

- 1/ Off
- 2/ TIR Reset
- 3/ Limit Exceeded – At least one display exceeds the specification limits
- 4/ SPC Exceeded – At least one display exceeds the control limits
- 5/ No Part - At least 1 display is off the scale.
- 6/ Unsaved Data - 1 or more data readings have been taken and are not yet stored.
- 7/ Delete Last Reading – A reading is being deleted

## 2.3 R & R SETUP

The L3000 System is capable of doing automated R & R ( Repeatability and Reproducibility ) tests, where the operators are presented with sequential menus indicating who should be taking readings at each step, what part number to use, and what trial is currently being performed. Although the data records kept are unique for each setup, the above 3 parameters are defined in the R & R Setup screen , and are common to all setups unless they are changed in this menu. The first prompt seen when this menu is selected is the

*Number of Trials:* At this dropdown prompt, the user defines the number of times that each part will be measured by each operator. This can range from 2 to 3. The next menu displayed is

*Number of Samples:* This dropdown prompt allows the user to select a number between 1 and 10, representing the number of parts which will be used for readings during the test.

After this is selected, another menu prompt occurs called

*Number of Operators:* This can range from 1 to 3, and specifies how many people will be measuring parts during the process of the test. Following this, prompts will appear allowing the user to define the actual names of the operators for identification purposes.

When finished, this data is stored in a file, and can be edited and changed at any time.

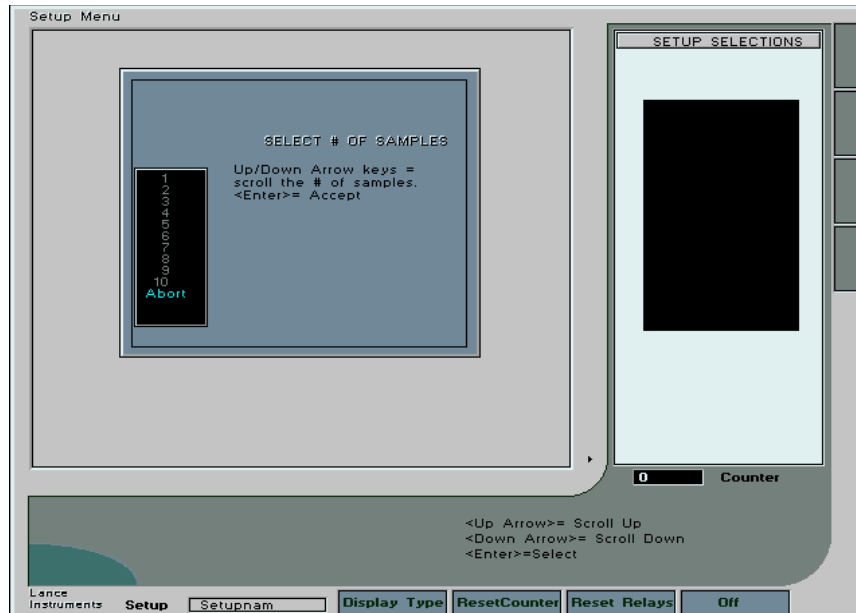


Fig. 2d R&R Setup

### SECTION 3

## CREATING A NEW SETUP

### 3.0 DEFINING A SETUP

The L3000 system allows for the creation of up to 99 different setup configurations. New setups may be created to accommodate new gage tooling or masters. It should be recognized that the more setups which exist on the system, and have data readings recorded, the less memory space there will be available for data readings for each individual setup. The setup creation menu system will guide the user in the selection of all essential parameters, and those parameters which are not absolutely essential can, if desired, be programmed later by editing the setup. Each setup must have a name, which is typed in by the user, and a name can be up to 8 characters max. in length. It can be any combination of alpha-numeric characters, and is case sensitive. Upon creation of a new setup, it is automatically loaded as the current operating setup. Also, in each prompt, a default value will appear for new setups. These may be typed over or changed while creating the new setup. If the system is to be set up to transmit data through an exterior serial port each time a "Read" button is pressed, then the 1<sup>st</sup> 2 characters of the setup name may be sent as an ID for the data. In this case, it would be wise to ensure that the 1<sup>st</sup> 2 characters of multiple setups are not identical.

### 3.1 PRIMARY SETUP CREATION SCREEN

A number of menu prompts must be filled in or selected in order to begin creating a new setup.

*Setup Name:* An 8 character alpha-numeric name for the setup defined by the user.

*Part #:* Enter any identifying part number if desired ( up to 14 characters ).

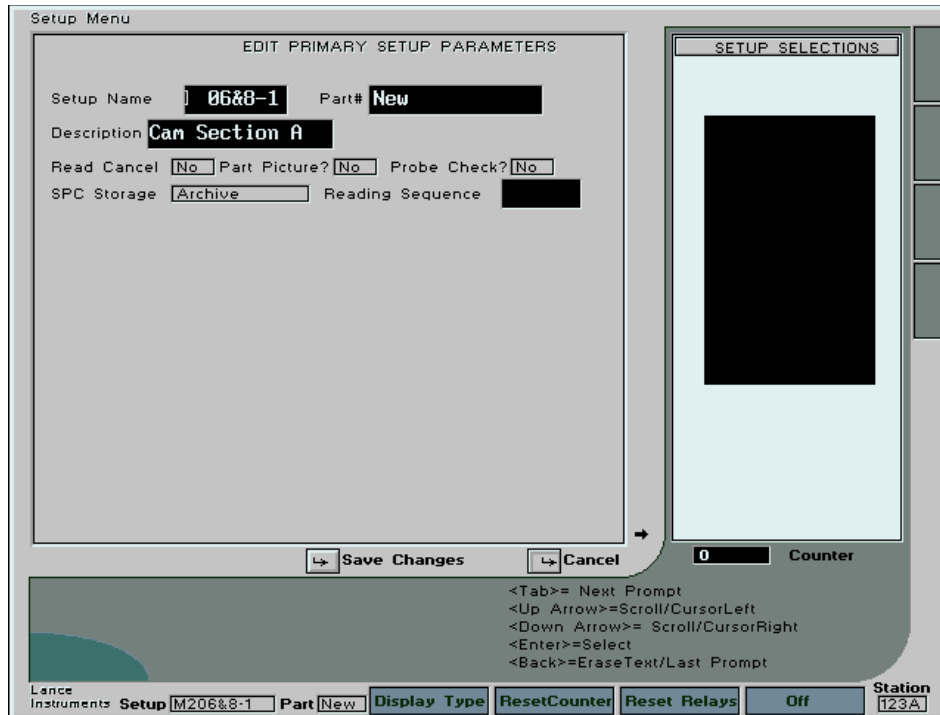


Fig. 3a New Setup Creation Step 1

**Description:** Type any user description for this setup ( up to 15 characters ).

**Read Cancel:** Press <Enter> on this prompt to bring up a dropdown menu. Select "Yes" if you would like the operator to have the ability to delete previous part readings ( must also set up a user-programmable key for this function to be engaged ).

**Part Picture:** Press <Enter> to bring up a dropdown menu. Select "Yes" if there is a custom Part drawing set up for this gage.

**Probe Check:** Press <Enter> to bring up a dropdown menu. Select "Yes" if you wish to engage an operator lockout for readings when a part is not in the fixture. When engaged, if any one of the active displays exceed the maximum display range ( indicating a part not in the fixture ) then the system will not allow a "data read" to occur. Note: If , for a particular setup, a display may exceed its maximum with the part in the fixture, then this function should not be engaged.

### 3.2SECONDARY SETUP CREATION SCREEN

This menu allows the user to define the input type and input rear panel connection for each display, or to define a calculated display. Fourteen lines will appear on page 1 of the screen, and another 14 on page 2 ( accessed by tabbing to the <Page> button and pressing <Enter> ) representing a maximum of 28 displays. Begin with display 1. Any displays left "Off" will not appear on the run-mode screens. It is best not to leave gaps of "Off" columns between groups of "On" ones.

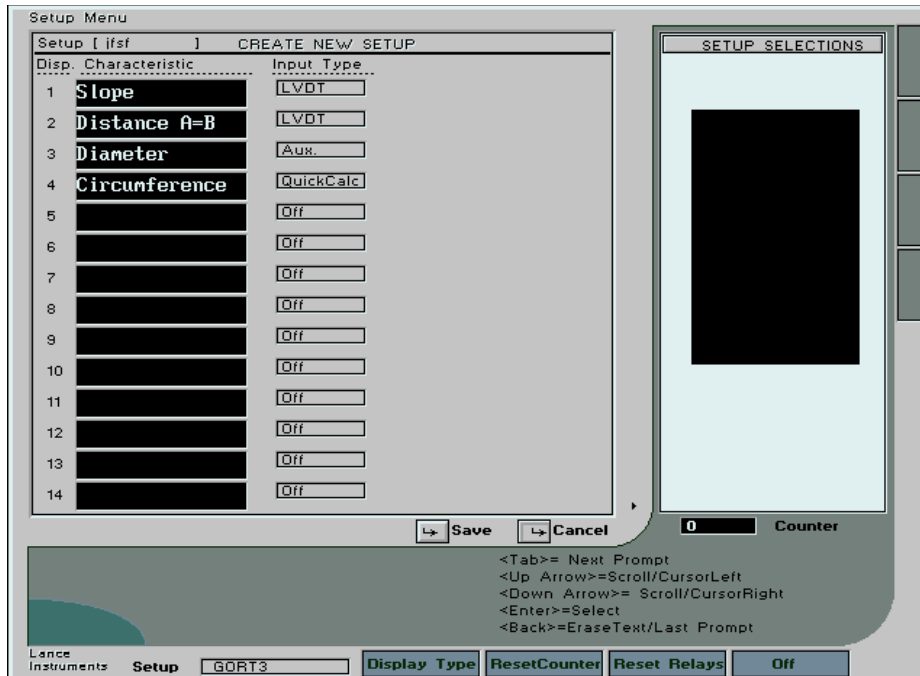


Fig. 3b New Setup Creation - Step 2

**Characteristic:** Type in any desired description of the characteristic being measured by this display. Press the <Tab> key to advance to the next prompt.

**Input Type:** Press the <Enter> key to bring up a drop down menu. Use the up/down arrow keys to scroll between the menu items.

**Off :** Don't allow any input signal to affect the display.

**LVDT:** Input will be an LVDT probe. Press <Enter> to select. A scrollable window will appear allowing for the input connector to be selected ( A to D for 4 input units, A to H for 8 inputs). Scrolling up will select positive inputs, and down will select negative inputs. Press <Enter> to select. Gain ranges are automatically programmed.

**Aux.:** Use this type if the input is any transducer which produces a varying DC voltage, or for an Air-to-Electronic Converter. Pressing <Enter> will allow the user to select the input connector associated with this display ( similar to LVDT above ). After selecting the input, another menu prompt will appear, where the user may scroll and select the gain range to be used for the input device. The gain ranges are 1 x, 2 x, 5 x, 10 x, 20 x, and 50 x. Since gain ranges are relative, experimentation will be required to find the right setting for an application.

**QuickCalc:** Pressing <Enter> on this item will bring up a dropdown menu with several menu items which can be scrolled. Quick Calc will perform arithmetic computations in "real time", such that the displays will respond instantly to any movement of the selected displays in the formula. The user can configure, for example, display number 2 as a calculated display, and then use this column again in a calculation for another display. Currently available "QuickCalc" displays are:

- 1/ Add any 2 displays.
- 2/ Subtract any 2 displays.
- 3/ Average any 2 displays.
- 4/ Average any 3 displays.
- 5/ Show the Maximum value of up to 9 displays.
- 6/ Subtract 2 Columns and Divide the value by 2
- 7/ Triangular Hypotenuse - Find the Hypotenuse of a triangle. This function will bring up a further menu with 4 items:
  - a) Enter the display numbers for the X and Y parameters of the triangle.
  - b) Add a constant to the X parameter if needed.
  - c) Add a constant to the Y parameter if needed.
  - d) Subtract an hypotenuse constant from the final result if needed.
- 8/ Min. of 9 Columns - Show the least value of up to 9 Columns

LastCalc: This is similar to the "QuickCalc" items above, except that "LastCalc" calculations are performed only when a data "Read" is taken. Calculations are performed on the reading values for the particular displays, and the values displayed will stay in memory ( and on the screen ) until the next reading is taken.

Formulas: Pressing <Enter> on this menu item will call up a sub-menu allowing the user to use the up/down keys to scroll from 1 to 20. These represent 20 user-defined formulas which can be engage for more complex custom calculations. Similar to the "LastRead" function, the calculations are performed only when a data "Read" occurs, and calculations are based on the display values at the time of the Read. When a user assigns a formula number to a display, then that formula is presented on screen (either for new creation or for editing). The formula may be up to 30 characters long, and bracketing "(", ")", must be used to ensure correct operation priority. Whenever formulas are used, and before the system is placed into final operation, the individual configuring the system MUST verify that the calculations are being performed correctly by comparing the answer with manual calculations.

Operators Allowed: + (Addition), - (Subtraction), \* (multiplication), / (division), \*\* (Exponent)

Display Designations : "G" followed by a 2 digit number representing the display number. For example (G01+G02) would represent the addition of displays 1 and 2.

Angular Functions : SIN (Sine), COS (Cos), TAN (Tan), ASIN (ArcSine), ACOS (ArcCos), ATAN (ArcTan). The function must be followed by a bracketed display number or numeric, which represents an angle in degrees. (i.e. SIN(G05) and ACOS(1.34) would be valid entries.

Other Functions : PI ( 3.14159), INT(Integer), LOG (Log), SQR ( Square Root )  
PI can be treated as a constant, while the other functions must be followed by a bracketed display number or numeric.

Numerics : These may be positive or negative, and up to 7 decimal places.

After typing a formula, if the user presses <Enter>, the formula prompt will not be saved, and will return to it's former state. If the user presses <Tab> to save it, then the system will first check for incorrect entries ( such as unbalanced brackets, incorrect symbols following "G", etc. ). If no errors are detected, then the formula will be saved as is. The user may choose to leave spaces in the formula.. this will not affect the calculation.

After all column displays are configured, press the <Tab> key to move to the [Save] on-screen button and press <Enter> in order to save the programmed information.

### 3.3OPTIONAL SELECTION MENU FOR SETUP CREATION

After the Primary and Secondary setup menus have been established in a new Setup creation, a third menu appears which allows the user to define more of the setup parameters. At this point, the user can proceed to define more of the setup configuration, or leave the setup menu for now, and continue the setup at another time.

The three setup screens are: Scale Information, Masters Setup, and Spec./Appr. Limits. These are optional, and if not configured right away, default values will be temporarily used by the system. These 3 menus can be seen in the “Editing An Existing Setup” section which follows, and the programming information is identical.

## SECTION 4

### EDITING AN EXISTING SETUP

#### 4.1THE EDIT MENU

The 4<sup>th</sup> item down on the Main Setup Menu is entitled “Edit Setup”. When this is selected, a menu appears to the left of the screen with several screen options for editing information about the current setup. Use the up/down arrow keys to scroll the list to the desired menu item and press the <Enter> key to select. On a newly created setup, some parameters have not yet been user set, and default values will appear at the menu prompts.

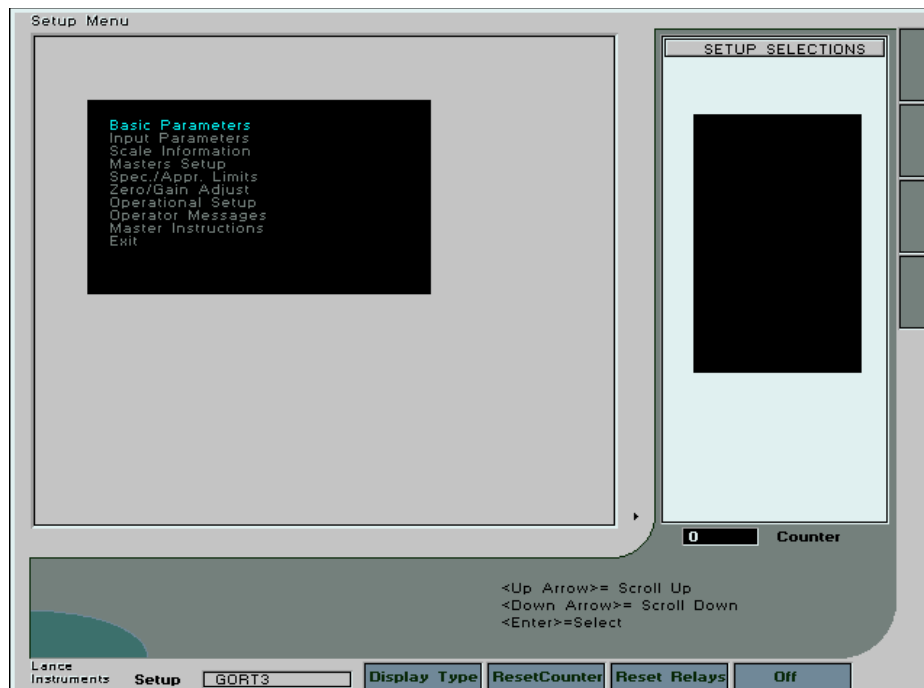


Fig. 4a Edit Setup Menu

#### 4.2BASIC PARAMETERS

This menu is describe in Section 3.1(Same as Primary Setup Creation Screen)

### 4.3 INPUT PARAMETERS

This menu is described in Section 3.2 (Same as Secondary Setup Creation Screen)  
It is not generally a good idea to add more input channels or delete any after a setup is created, as the archive data files will not be usable by the system, and the data readings in the current data file will be deleted.

### 4.4 SCALE INFORMATION

The scale information menu as shown below will vary according to the number of columns which are engaged, up to a maximum of 28. The left column of the screen will indicate the display number. Press the <Tab> key to move between prompt to the right and <Back> to move left.

*Charact.:* The column characteristic ( which was defined in the Input Parameters screen ) will be displayed.

*Disp. Units :* To the right of this, is a drop down menu to select the display units; either Thou (Imperial), microns (Metric), or Degrees. Press <Enter> to drop the menu, and use the up or down keys to scroll. Press <Enter> again to select. When switching between these 3 types, the Full Scale Range column to the right will remember the previous value for that type.

*Full Scale Range .* The Thou range scrolls from 1 to 100 in increments of 1, the Metric from 20 to 1000 microns in increments of 10, and the Degrees from 0.1 to 10 in increments of 0.1 degrees. Press <Enter> again to select.

*Resolution :* Once the user <Tab>'s to the right after selecting the Full Scale Range, the Resolution column will update accordingly. This indicates the smallest steps which will occur in the displays as an input value changes, and is 1/100 th of the full scale range.

*Show Display?* The user has the option of turning off the display of individual columns, so that only the most significant displays are seen by the operator. This is particularly valuable where there may be intermediate steps in calculations, and those steps are not needed for display. The column will still be active in terms of providing system input and recording data, but will simply not be visible on the screen.

*TIR* This stands for Total Indicating Readout, and is sometimes referred to as "Dynamic" mode.

The user can place a column display into TIR mode, by selecting either:

- Max-Min : Takes the maximum value encountered (until a Reset) minus the minimum value encountered and displays this result.
- Max: Displays the maximum value encountered .
- Min: Displays the minimum value encountered, but it is displayed as positive bar movement.
- Average: Displays the average value encountered.

When (Max-Min)TIR is engaged, since all values will be positive, the column bar screen zero position will be at the 20% point ( as opposed to 50% on other modes), in order to gain greater usage of the column bar area. Also, a fine, light blue line will move in real time "static" mode, next to the TIR bar. This gives the operator an idea of where the bar is currently positioned in reference to the zero position.

*Page :* Move to this button and press <Enter> to toggle between Displays 1-14 and Displays 15-28

*Save :* Move to this button and press <Enter> to save the changes made to the screen and to exit.

*Cancel :* Move to this button and press <Enter> to cancel any changes made to the screen and exit.



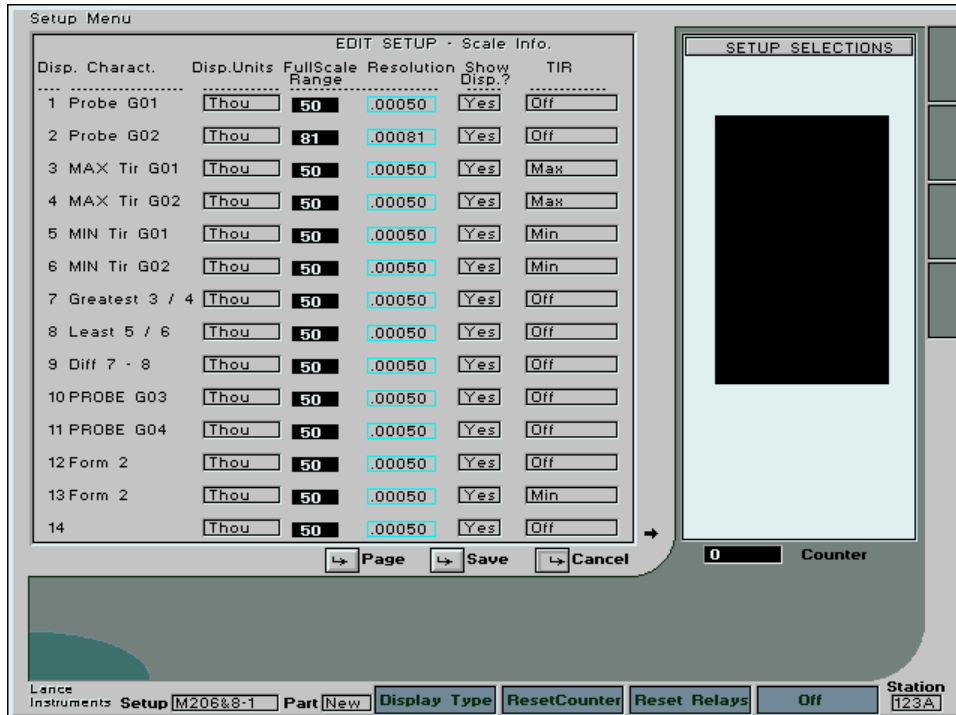


Fig. 4b Edit – Scale Info

#### 4.5 MASTERS SETUP

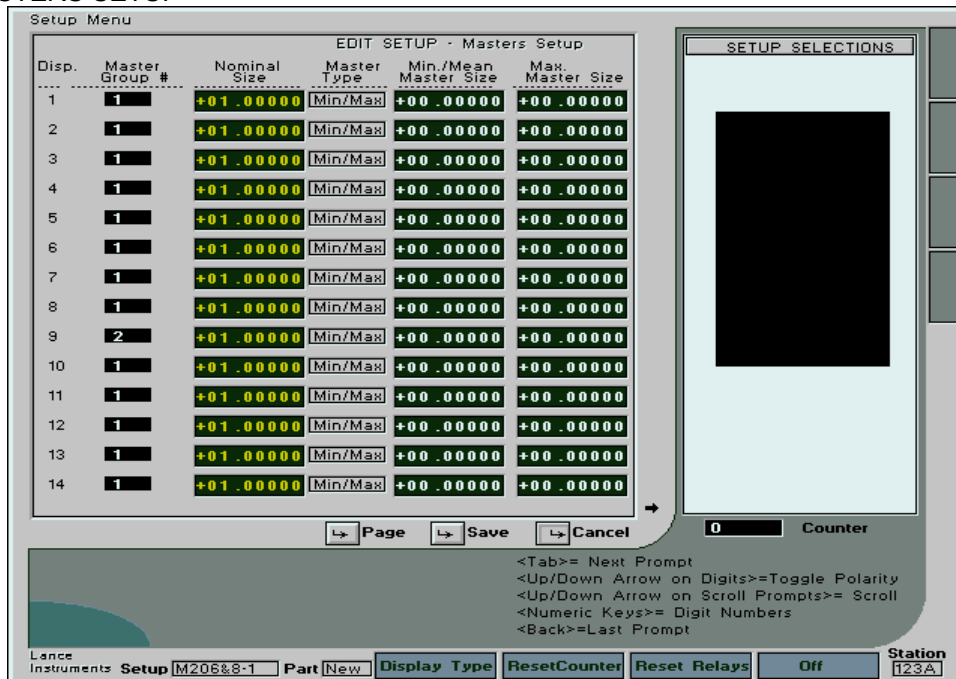


Fig. 4c Edit – Masters Setup

This screen allows the user to establish the values which are essential for any calibration of the setup. Nominal part sizes can be entered for each display, as well as master types and values. Use the <Tab> or <Back> keys to move between prompts. It is essential that these values be entered correctly or the system will not master correctly.

*Master Group:* Each display should have associated with it a Master Group number ( from 1 to 8 ). This number will be defined for that display all of the user-entered values required for mastering the display. More than 1 display can utilize the same group number. This means that in an auto-mastering mode, all of the displays with the same group number will be mastered simultaneously, although each display can still have its own master sizes.

*Nominal Size:* This is the actual nominal or ideal size of the part being measured, entered in inches or mm. Even if automastering is not being used on the L3000, the nominal part sizes should still be entered as the values are required for other gage functions, such as actual part size display and statistical analysis.

*Master Type:* Use the up/down keys to scroll between “Min/Max” or “Mean” mastering. Mean mastering is only used for calibrated LVDT probes, and requires only one mean master. Only “zero” calibration is done during mean mastering. The actual calibration ( gain ) is performed manually by a setup person prior to system installation, under the premise that the probe gain will never change.

*Min/Mean Master Size:* If Mean mastering is selected, then enter the mean master size in this prompt. Usually this will be the same as the nominal part size, and there is no need to enter any values in the Max Master prompt. If Min/Max mastering has been selected, then enter the “Min” master size.

*Max Master Size:* Enter the “Max” master size in this prompt.

*Page:* Press <Enter> on this button to toggle between displays 1-14 and displays 15-28

*Save :* Save the information entered on this menu.

*Cancel :* Do not save any changes made. Keep the master information as it was before entering the menu.

#### 4.6SPEC./APPROACH LIMITS

This screen allows the user to establish upper and lower Specification limit set points for each display, as well as upper and lower Approach limit set points. The values entered will determine at what point bargraph displays change from green (OK) to amber (in approach) and then to red (out of spec.). Similarly with digital displays, the bar colours under the displays will change accordingly. The values will also determine when annunciator lights will come on if set for Spec. or Approach limit configurations, as well as relay outputs if also programmed for this function. Approach limits are usually areas of measured values which the user establishes to indicate to an operator that the part being measured is close to being out-of-tolerance.

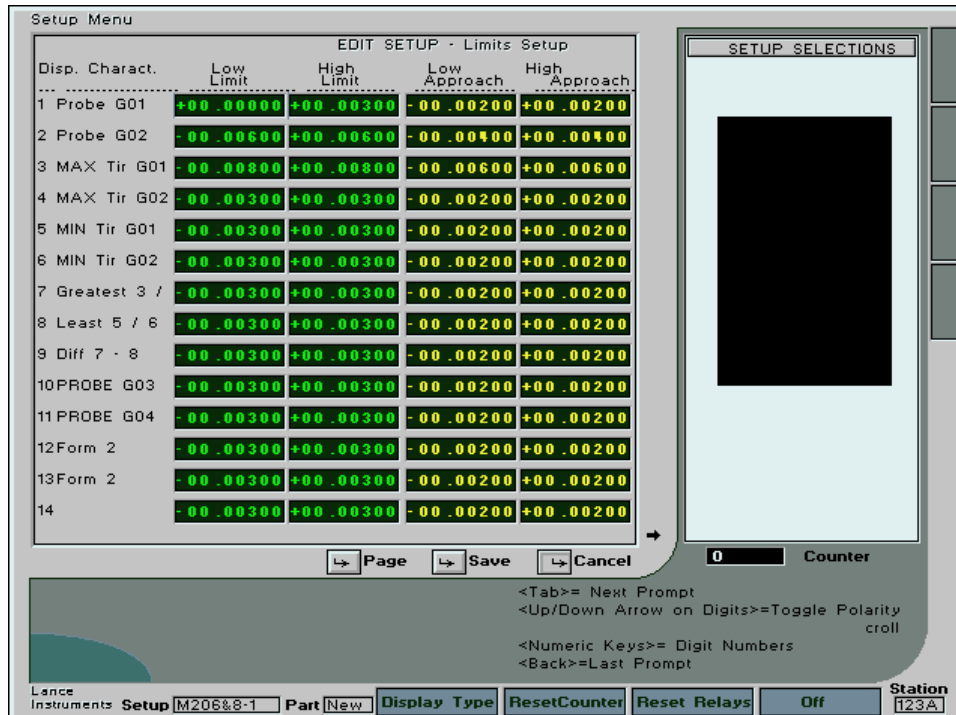


Fig. 4d Edit – Spec./Approach Limits

**Low Limit:** Enter the lower specification limit as desired for the display. If the part is being displayed as an actual part size, then enter the nominal part size less the minimum tolerance value. If the display is set up to display tolerance, then the polarity sign can be toggled between + and – by pressing the up/down arrow keys.

**High Limit:** Enter the upper specification limit as desired for the display. If the part is being displayed as an actual part size, then enter the nominal part size plus the minimum tolerance value. If the display is set up to display tolerance, then the polarity sign can be toggled between + and – by pressing the up/down arrow keys.

**Low Approach:** Enter the lower approach limit as desired for the display. If the part is being displayed as an actual part size, then enter the nominal part size less the minimum approach value. If the display is set up to display tolerance, then the polarity sign can be toggled between + and – by pressing the up/down arrow keys. If no approach zone is desired, then set the approach value the same as the lower specification value.

**High Approach:** Enter the upper approach limit as desired for the display. If the part is being displayed as an actual part size, then enter the nominal part size plus the maximum approach value. If the display is set up to display tolerance, then the polarity sign can be toggled between + and – by pressing the up/down arrow keys. If no approach zone is desired, then set the approach value the same as the upper specification value.

#### 4.7 ZERO/GAIN ADJUST

The Zero/Gain Adjust screen is available to allow the user to manually adjust the system vernier gain and zero position for each display. Ordinarily, the automastering capability will handle system calibration and manual adjustment will not be necessary. The vernier gain and zero position are the system electronic adjustments which are used for automastering purposes. Therefore, the settings for gain and zero position may vary each time mastering is performed. These 2 values should be close to the mid positions on the bar adjustments when a setup is first



Fig. 4e Edit – Zero/Gain Adjust

established, to give the automastering function a wide range of movement. If calibration is performed when these settings are already near their limits, then the automastering may not have sufficient room to move to be able to master the display. On this screen, only one column display is shown at a time, and it will move as the zero or gain adjustments are changed.

**Select Column #:** Use the up or down arrow keys to change the display number. The zero and gain control positions will change, as well as the bar display, to indicate the current settings for each column display number.

**Zero:** Use the up or down arrow keys to increase or decrease the zero position of the display. This can be done from either the front panel keypad or from a connected keyboard. A numeric value on the moving button will indicate the percent position of the control ( 1 to 100 %). The best operation position is 50 % ( midpoint ). If the control is close to the upper or lower limits of its range after mastering, then the automastering function may have insufficient room to move to complete its mastering ( particularly if there is any “slop” in the fixture).

**Gain:** Use the up or down arrow keys to increase or decrease the vernier gain of the system for this display. A numeric value on the moving button will indicate the current percent position of the total gain range ( 1 to 100 % ). If the gain control is close to the upper or lower limits of its range after mastering, then the automastering function may run out of room to be able to master ( particularly if there is any “slop” in the fixture. )

**Save:** Save the changes made to the calibration positions.

## 4.8 OPERATIONAL SETUP

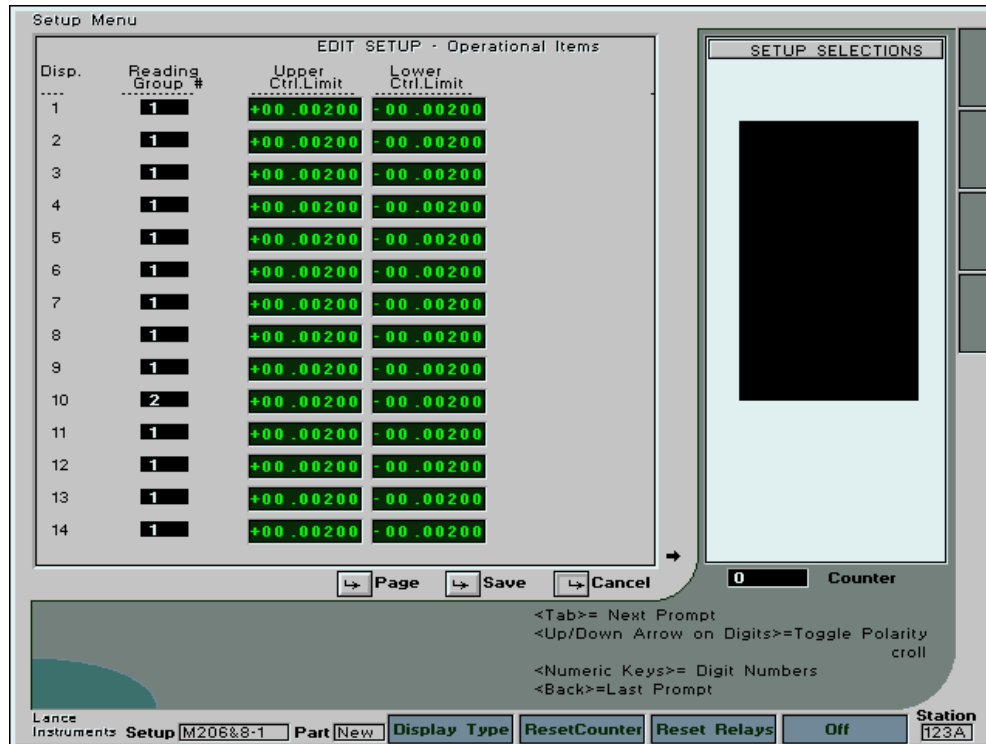


Fig. 4f Edit – Operational Setup

This screen allows the user to define 3 pieces of information which may be required.

**Reading Group Number:** Use the up/down arrow keys to scroll the reading group number for each display from 1 to 8. This is important if the system is to be configured for “Step Gaging” ( also referred to in this manual as “Sequential” gaging ), or if displays must be grouped for taking data readings at different times of the gaging process. For example, if display numbers 1, 2, and 3 are set to reading group number of “1” as illustrated above, then when a data reading is taken, these 3 displays, and none of the others will have their values recorded in the system if the operation is configured for group 1 readings at that point. Also, the operator custom instruction messages as set up in the “Operator Messages” Screen will appear on the screen. If no Step Gaging is to be used, then set all displays to Reading Group 1. For further information on this, see section 4.9 ( Operator Messages ) and section 6.1 ( Selecting an Operator Run Mode).

**Upper Control Limit:** Enter a valued which should be used as an estimated upper control limit for the display for the process. This value will be used for analyzing data in the statistical control screens, and for annunciator or relay out trigger set points if configured accordingly.

**Lower Control Limit:** Enter a valued which should be used as an estimated lower control limit for the display for the process. This value will be used for analyzing data in the statistical control screens, and for annunciator or relay out trigger set points if configured accordingly.

**Page:** Press this button to toggle between displays 1 to 14 and displays 15 to 28

**Save:** Save any changes made to this menu.

**Cancel:** Do not save any changes made.

#### 4.9 OPERATOR MESSAGES

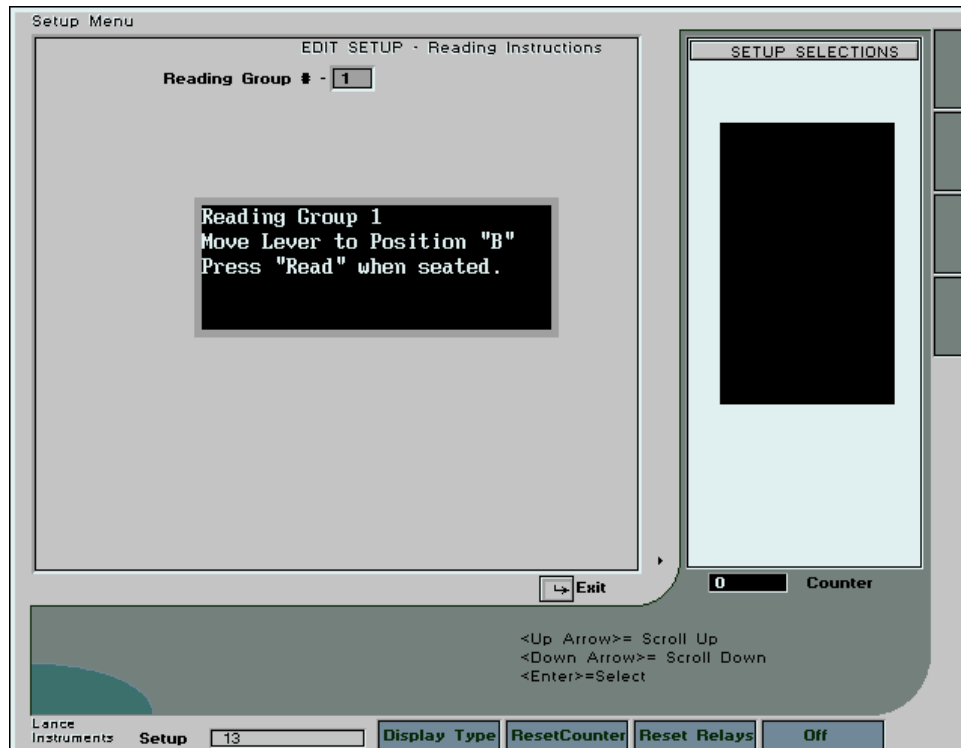


Fig. 4g Edit – Operator Messages

This screen allows the user to define operator screen messages which will appear with column groupings. If step gaging is not to be implemented, or column grouping is not required, then no messages are needed to be filled in, as they will not be displayed in any case.

*Reading Group #:* Use the up/down arrow keys to scroll the group number from 1 to 8. If any messages have been created prior to entry to this screen, they will be displayed as the number is scrolled.

*Message Area:* Type in any desired operator instruction for this reading group. This can be done from the L3000 front panel keypad, although a keyboard connected at the time of initial setup configuration is much quicker. Press the <Enter> key to move from 1 line to another ( 5 Lines of text are available ).

#### 4.10 MASTER INSTRUCTIONS

Use this screen to create operator messages which will be displayed during automastering. Up to 8 master groups are available, each with their own messages.

*Master Group # :* Use the up/down arrow keys to scroll this number from 1 to 8. If any messages have been created prior to entry to this menu, then they will appear as the master group number is scrolled.

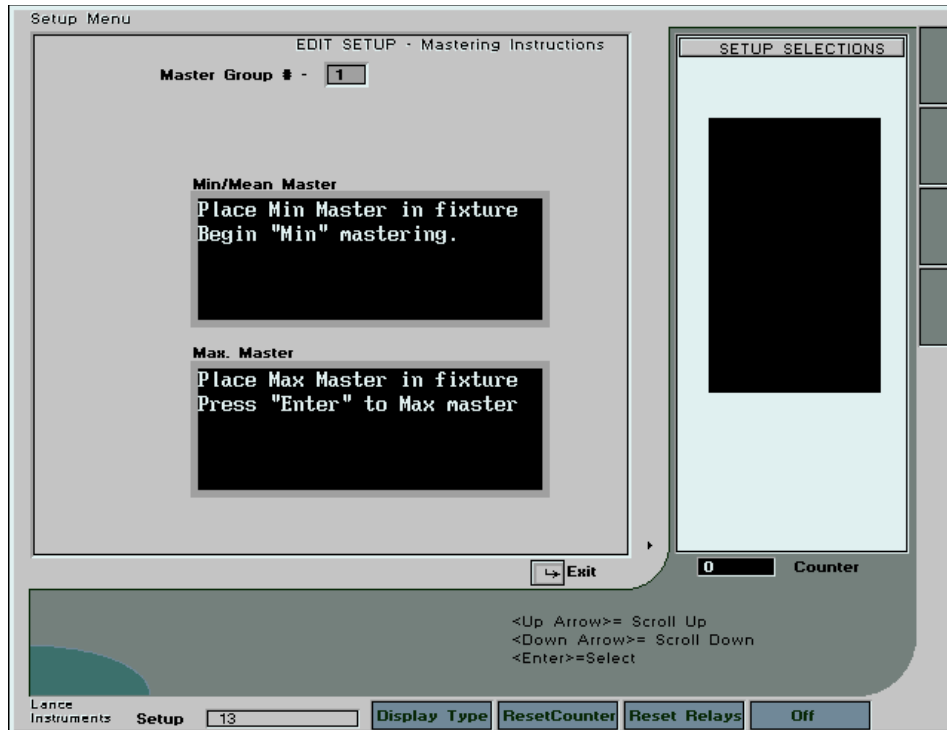


Fig. 4h Edit – Master Instructions

*Min/Mean Master:* Enter a text message which will appear to the operator when a “Min Master” or “Mean Master” operation is performed.

*Max Master:* Enter a text message which will appear to the operator when a “Max Master” operation is performed.

*Exit:* Save any changes and exit the menu.

#### 4:11 PART DISPLAY XY

This menu needs only to be configured if an optional part picture is included with your system ( displayed when the “Part” button is pressed on the L3000 front panel ). It allows the real time digital values representing probes or air jets to be positioned on the part picture at a position so as to identify where the probe is measuring the part. Press the <Tab> and <Back> keys to move from one prompt to another.

*X Position :* Use the up/down arrow keys to scroll the number from 10 to 390, representing the approximate x co-ordinate position on the screen ( in pixels ). Experimentation is required to position the digital reading to the desired screen position.

*Y Position :* Use the up/down arrow keys to scroll the number from 10 to 320, representing the approximate y co-ordinate position on the screen ( in pixels ). Experimentation is required to position the digital reading to the desired screen position.

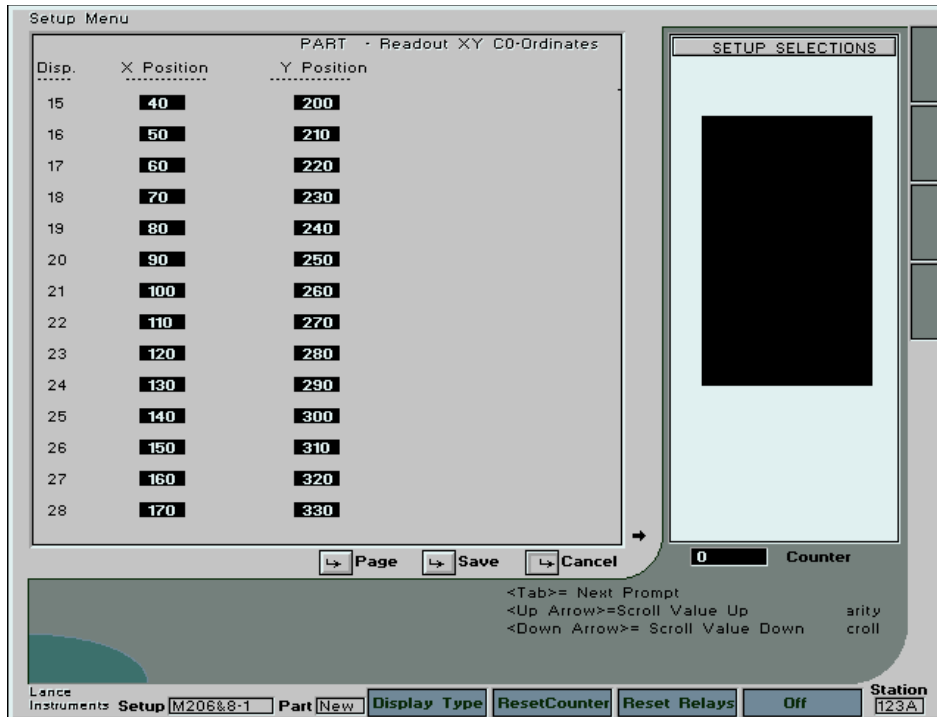


Fig. 4i Edit – Part Display XY

**Page:** Press this button to toggle between displays 1 to 14 and displays 15 to 28

**Save:** Save the values as entered.

**Cancel:** Do not save any changes made to the menu.

#### 4.12 EXIT

When the Edit menu is exited, there may be a delay of several seconds before the system displays the Main Menu again. This is because the information changes made during editing is being saved to memory and the changes are being programmed for system operation.

## SECTION 5

### ADDITIONAL SETUP TOOLS

#### 5.1 CHANGING TO A DIFFERENT SETUP (LOAD SETUP)

Since up to 99 setups can be created, the user must be able to select the desired one which will be used for an operation. Each setup, when created, keeps data files in a separate directory, and may have totally different setup parameters and programming. When the main menu is scrolled to the top item on the list ( Load Setup ) and the <Enter> button is pressed, the screen menu shown below appears. It lists all of the setups which have been created by the user, as well as the DEFAULT setup. Use the up/down arrow keys to scroll the list and then select the desired setup for the system to load by pressing the <Enter> key. Pressing the <Tab> key will allow the user to exit from the menu without changing the currently loaded setup.

After the <Enter> key is pressed, the system will take a few moments to load the selected setup and a progress bar will indicate the status. When complete, the system will return to the main



menu.

The external inputs ( Utility Menu Button ) can also be configured to automatically load setup numbers as desired when a contact closure is received from external equipment. Also, the output relays can be configured to close when a setup is selected, serving as a confirmation signal to external equipment.

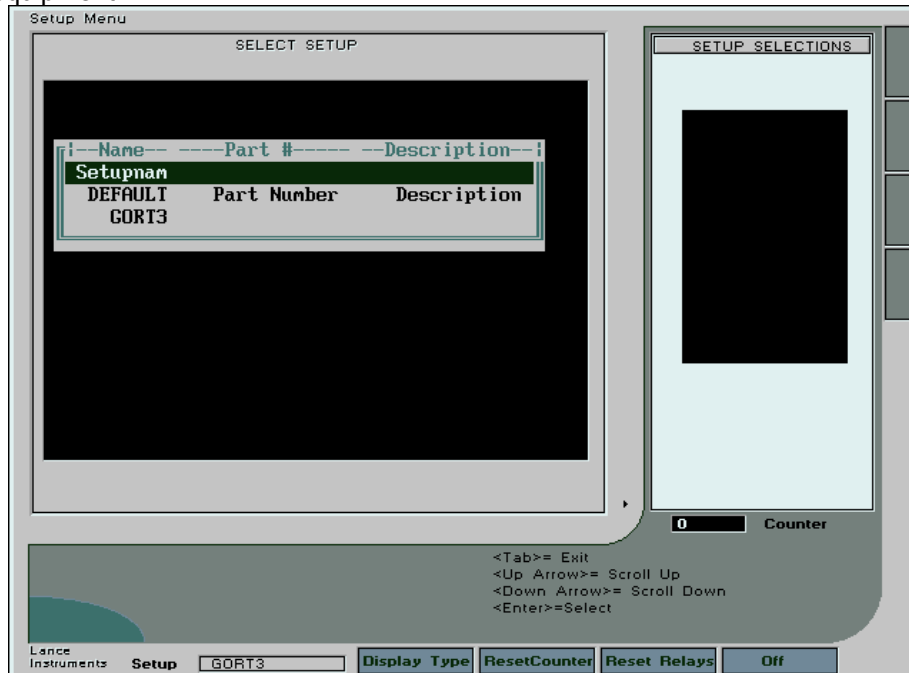


Fig. 5a Select Setup

## 5.2 DELETING A SETUP

Sometimes it may be necessary to delete a previously created setup. To accomplish this, move to the 4<sup>th</sup> item of the Main Menu (Delete Setup) and press <Enter>. The same menu will appear as for the "Load Setup" screen (See above). Scroll to the setup name which you wish to remove, and press <Enter>. A warning message will appear which gives the user a second chance to abort the deletion. It should be remembered that all programming and data files for this setup will be permanently removed, so care needs to be exercised.

## 5.3 OPTIONS ( Data Transfer and Remote Programming )

The L3000 System provides a variety of ways that configuration and data files may be transferred to an external computer via the serial port, and also for programming the system from an external computer.

When the <Options> button is pressed on the front panel keypad ( with system in the normal Bar display mode ), a scrollable menu will appear, with 6 options plus the Exit option.

"Data Read Transmit", will send a string of the display data readings to the serial port whenever a "Reading" is taken. See section 2.0 (Communication Protocol) for the data format.

"AutoDataTransfer" is a system managed means of transferring archived data from the L3000 Gaging System to an external computer using a serial port. This works in conjunction with the Lance L3150 Software package for data transfer and programming. This is the only external communication currently supported with L3150 at the time of this writing.

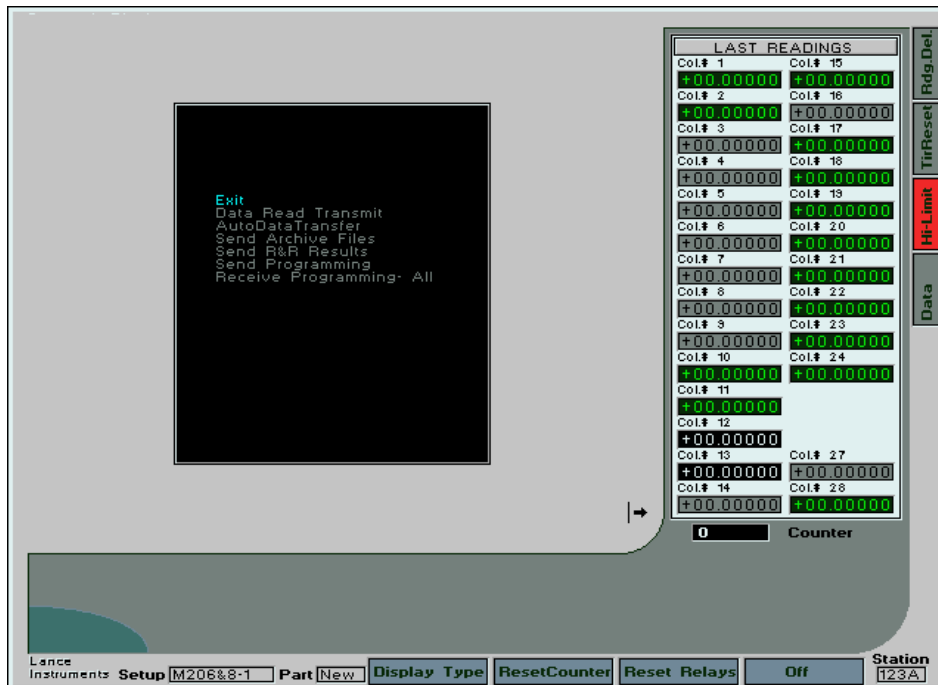


Fig. 5b Options Menu for Data Transfer and Programming

#### 5.4 UTILITY (External Inputs)

When the <Utility> button is pressed, a scrollable menu will be presented which allows the user to configure up to 7 external inputs ( 3 standard ). An 8<sup>th</sup> input can be ordered optionally also, but a special connector is installed for the 8<sup>th</sup> input. These inputs are brought out to a DB-15 connector on the rear panel. When any one of them are momentarily shorted to a ground connection, it will trigger an event for that input. The user can determine in this menu what action will take place when an event is triggered. The selectable list is as follows:

- 1/ Off - Nothing happens
- 2/ Read Data - Similar to a momentary press of the front panel "Read" button. A data reading will be initiated.
- 3/ TIR Reset - Similar to a momentary press of the front panel "TIR Reset" button. The system will reset all displays current programmed for TIR or Dynamic operation to the zero position.
- 4/ Reset Dynamic Relays – This is used in conjunction with the "Relay Status" option of section 2.1. Relays configured to "latch" closed will be reset when an external input programmed with this function is momentarily closed.
- 5/ Reset Counter - If data readings are being taken, the reading counter on the screen will be reset to zero.
- 6/ Screen Alarm – A popup message will appear on the screen informing the operator that an external event has occurred. The operator must press the <Enter> button to clear the message and "unfreeze" system operation.
- 7/ Load Setup – Another setup can be automatically loaded when the event is triggered. When this option is selected, the user can select which setup is to be loaded by scrolling an on-screen list of system setups.
- 8/ TIRReset/Unfreeze - The system will perform a TIR reset, as well as "Unfreeze" any displays which were latched. If any one of the 8 external inputs ( 3 are standard) are set to this function, then all bar displays will "Freeze" on the screen when a reading is taken. The "Freeze" is released when the external input programmed with this function is triggered, or when other system

menus are entered by the user.

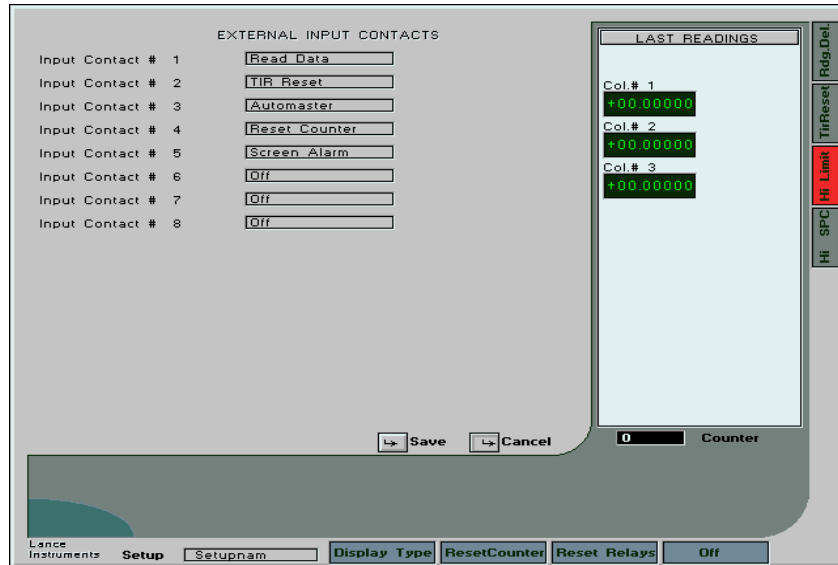


Fig. 7b External Input Contacts

## 5.5 RESET ZERO & GAIN

This menu option is available from the main Setup menu. During automastering, over time, the electronic zero and/or gain settings for the gage may drift for a variety of reasons to extreme positions. The farther these settings move from the "mid" position of their adjustment, the less room there is for the system to compensate for changes in fixture operation during automastering. With air gaging, operators may move the "Zero" or "Spread" controls from their original positions, additionally causing difficulties during automastering.

This menu option allows the user to quickly return the controls to mid-positions, which are optimum for operation.

**LVDT Operation:** This function will reset the input for the LVDT(s) to optimum operating conditions. After running, Body-Set the probes in the fixture with a master of nominal part size in place, ( or a part which has been measured to be close to nominal size ). Check calibration with Min and Max masters in place to see if calibration is within a reasonable range, and then do an automaster operation.

**AIR Operation:** Run the reset program, and then, with the air on, do a manual mastering of each input by re-adjusting the pneumatic controls, one input at a time, using normal air mastering techniques. Once the calibration is close to requirements, then an automastering operation may be performed.

The zero/gain reset function can be performed either on an individual input or on all inputs.

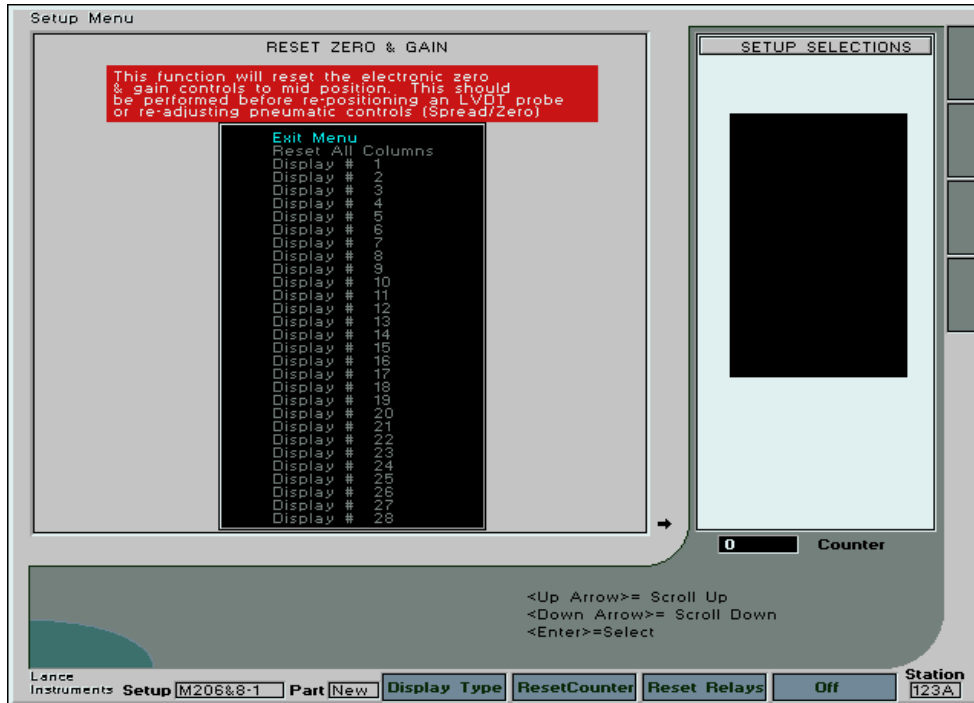


Fig. 5c Reset Zero and Gain

## SECTION 6

### RUN MODE

#### 6.1 SELECTING A "Run" MODE FOR THE SYSTEM

The system can be set up to operated in different modes relating to taking data readings. Very often, all input probes are oriented around a single fixture, and when the part is in place, all probe measurements are read and stored in the system database. In this case, the menu selection should be "Read All Columns". Sometimes, the user may have 2 or more fixtures operating on the same L3000 gage, and readings may be taken in a "batch mode", where a number of parts are measured on the one fixture, and then at another point, the parts are measured in the second fixture. This necessitates that the gage displays be grouped, such that only a particular group of displays are recorded each time a "Data Read" button is pressed. The drawback to this method is that it makes later data analysis and statistical processing messy and difficult. The system, under this kind of configuration, may be set to "Read Group #" from 1 to 8.

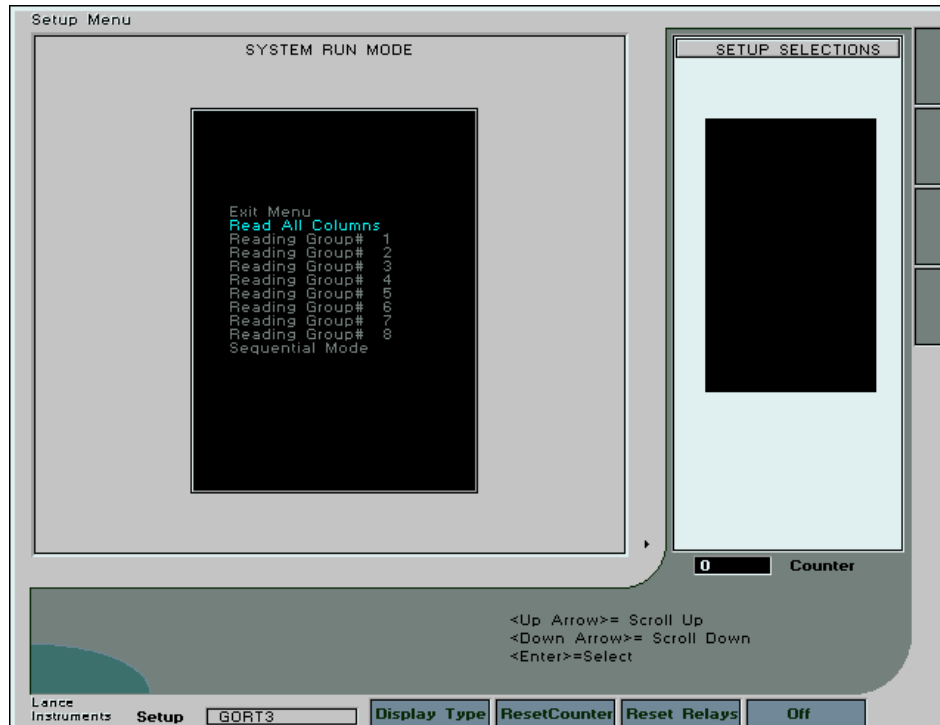


Fig. 6a Edit – System Run Mode

Another method which is also employed is called “Step” Gaging, or “Sequential” gaging. In this case, a single part is placed in a fixture, and certain of the displays from the 1<sup>st</sup> Reading Group are measured and recorded when the “Data Read” button is pressed. The fixture may be adjusted, or another fixture used for the second step, and when the “Data Read” button is again pressed, only those displays from the 2<sup>nd</sup> Reading Group are measured and recorded. This process may be continued for up to 8 reading steps. The L3000, when configured for this kind of operation, will automatically advance to the next reading group with each button press. When a sequence is complete, it returns to Reading Group 1 for the next part. To engage this kind of operation, set the Run Mode display to “Sequential Mode”. Be sure also to define the desired sequence in the Basic Parameters menu, and to set up reading group numbers for each of the displays.

Use the up/down arrow keys to scroll through the selections, and press <Enter> to select. Select “Exit” when done to exit the menu.

## SECTION 7

### VIEWPORT SCROLL

#### 7.1 VIEWPORT

The viewport is the area on the right side of the screen which displays digital measurement values

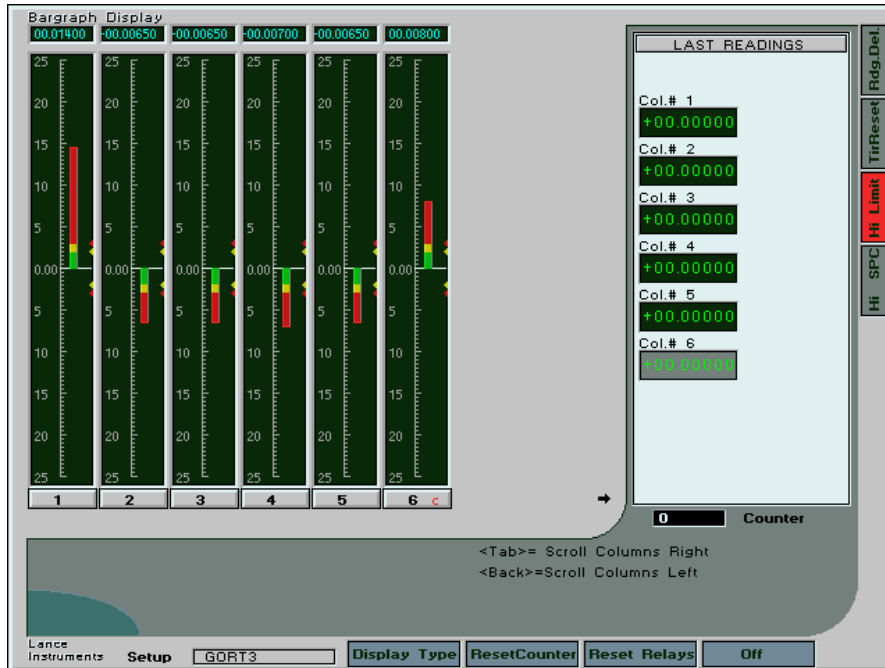
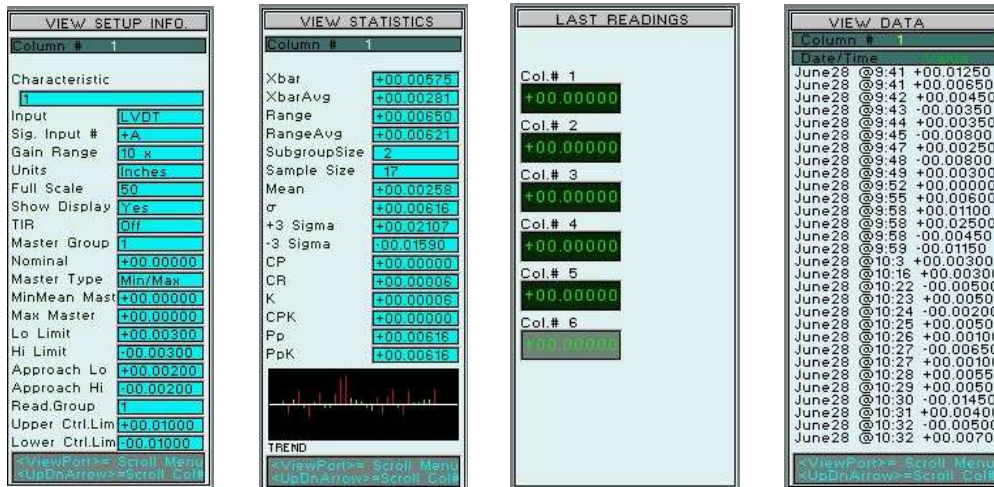


Fig. 7a Edit – Viewport Screens

when the system is first powered up. The values shown are zeros until a reading is taken, and then the values from the read are displayed for each column. Calculated columns are a different shade of gray background from the analog displays. The “LastRead” window will always display the values of the columns at the time when the last “Read” was initiated. When the <ViewPort> button on the front panel is pressed, the window will scroll to display different information as described below.



**LastRead:** Display the previous measured values at the time the <Read> button was pressed.

**View Setup Info:** View all of the relevant setup information for each display. Scroll the display

numbers by pressing the Up/Down arrow keys.

*View Statistics:* View the statistical calculations for each column based on the last 30 readings. A small chart at the bottom shows the reading trends ( Green [OK], Amber [Approach], Red [Out of tolerance]). Scroll the column number by pressing the up/down arrow keys.

*View Data:* View the measured values of the last 30 readings. Press the up/down arrow keys to scroll the column number.

## **SECTION 8**

### **STATISTICAL SCREENS**

#### 8.1 $\bar{X}$ and R CHART

An  $\bar{X}$  and R chart may be created for any segment of archived data files for a setup. It is a type of a control chart which allows for graphic comparison of measured characteristics of a part against specified limits. It allows the user to determine causes of variations and to therefore make corrections to a process. The charts do not usually plot individual readings, but rather subgroup averages of readings. The  $\bar{X}$  chart shows the average readings of each subgroup of readings, while the R chart shows the difference between the maximum and minimum readings of the subgroup.

When the Xbar button is pressed on the front panel, the user will be presented with a list of the current data files on record. Use the up/down arrow keys to scroll to the desired file ( by date and time ) and press the <Enter> button to select that file. The next menu presented is a list scrollable list of time and date tagged data records within that selected archive file. Scroll to the record desired to set the "start" data, and press <Enter>. The menu will now allow the user to scroll to the desired ending record. Press <Enter> to select, and the system will then display the total number of records selected for the report generation. Press <Enter> once again to generate the Xbar and R chart for the data.

The upper portion of the screen contains the x plot, while the Range graph is plotted directly below it. The most recent data subgroups are plotted to the right of the charts, with the oldest data to the left. The subgroup mean, as well as the + and - Sigma limits ( UCL/LCL) are always displayed also. When the screens are displayed, the charts for display # 1 are always shown first. To display data for the other columns, press the up or down arrow keys to scroll the display number.

To change the size of the subgroup for calculations, press the <Setup> button, and a secondary pop-up window will appear allowing the user to scroll to the desired subgroup size. This size will be maintained for future charts until changed again.

To the right of the charts, some of the important parameters are shown in digital readouts. Under the R chart, the time spread of the data readings is shown, as well as the subgroup size and the display number.

The screen can be exited at any time by pressing the <Tab> button.

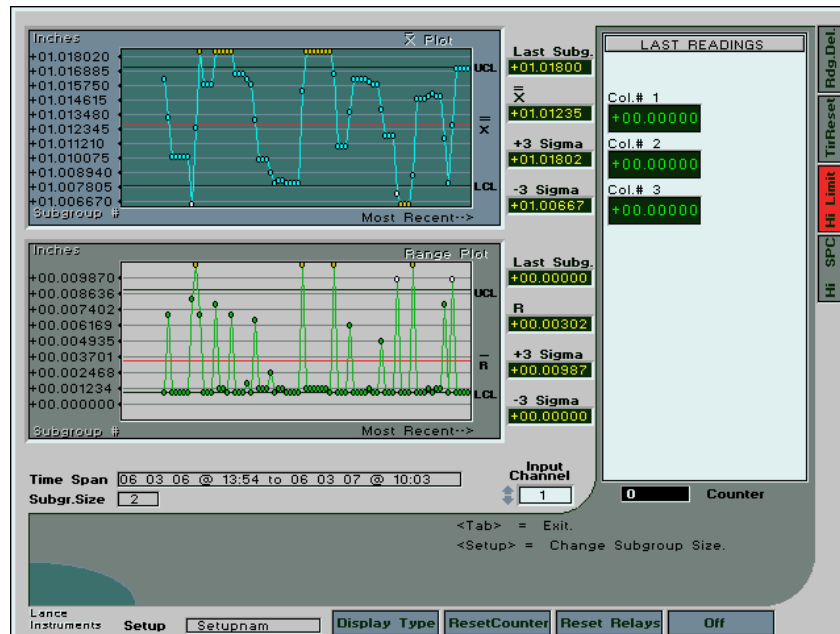


Fig. 8a Xbar and R Chart

## 8.2 HISTOGRAM

A histogram is a means of analyzing the dispersion of a process. It graphically illustrates the distribution of measurements for a part dimension. Vertical bars along the horizontal axis illustrate the dispersion. The horizontal scale depicts the range of measured values, and is usually divided up into cells. The vertical scale represents the frequency of measurements of each cell. Data collected from a process which is statistically under control will form a *normal* distribution, and therefore a normal curve is superimposed on the graph to fit the data. The accuracy of the bar fit to the curve will show to what degree the process is normal.

As with the  $X_{\text{bar}}$  & R chart, the when the Histogram panel button is pressed, the user will be presented with 2 menus. The first allows for the selection of the archive file for the setup for analysis, and the second for the selection of the data range within that file.



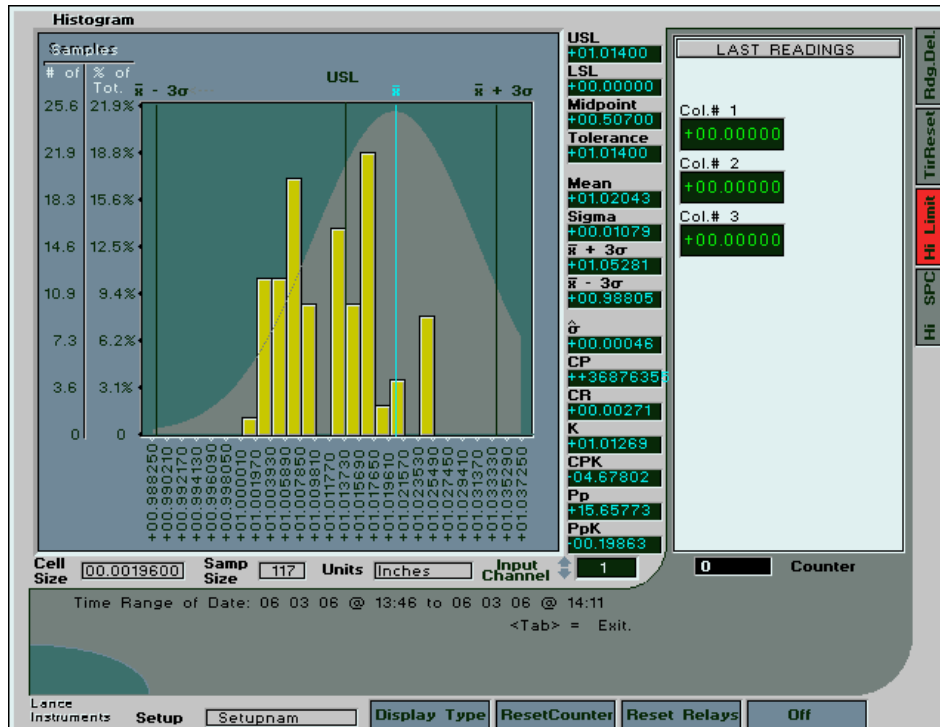


Fig. 8b Edit – Histogram

Upon selection of this information, the histogram chart is automatically created for display # 1. The chart for the other displays ( part characteristics ) can be generated by pressing the up/down arrow keys to scroll the channel number. There are 24 cells, and the data is presented both graphically and digitally. Press the <Tab> key to exit.

## SECTION 9

### MASTERING

#### 9.1 USING LVDT PROBES

The L3000 System is designed to use the standard Solartron AG-1 probe, although other probes which match the specifications can also be used. The wiring chart is shown in the appendix.

Probes should always be “bodyset” in a gage fixture first, to ensure that they are approximately zero centred with a part of nominal size in the fixture, and that the probe will have a balanced amount of travel available in both directions once in use.

Fixtures utilizing LVDT probes can be mastered in one of two ways, with Min and Max masters, or with a single Mean master. When Mean mastering is employed, it is the responsibility of the user to first calibrate the electronic gain manually against known standards, and thereafter to periodically check the calibration in the manufacturing process.

#### 9.2 USING AIR/ELECTRONIC CONVERTORS

The L3000 system is designed to be compatible with the Lance Instrument L8356 Air/Electronic converters. These units allow gaging fixtures to be designed using pneumatic back-pressure as a sensory device, and the pressure is proportional to the distance between the part surface placed in the fixture, and the jet orifice of the fixture itself. The sensed pressure is converted in the L8356 unit to a varying output voltage. The converters plug directly into the same inputs as the LVDT probes are plugged in, and their supply power is also derived from this connector. Calibration is accomplished in the same manner as an air column, with front panel “zero” and

“spread” controls available. The input specifications are listed in the appendix.

### 9.3 INITIAL CALIBRATION

#### LVDT Probes:

When Min and Max masters are used for LVDT probes, so long as the programmed parameters are correct, and the probes are correctly body set, one should be able to proceed to the Automastering menu without any other prior manual calibration. For extenuating circumstances, it might be necessary to program the inputs for an AUX configuration instead of LVDT.

When Mean mastering is employed, utilizing a single master of nominal part size, it is necessary first to enter the “Edit Setup” menu, and then select “Zero/Gain Adjust”. This will bring up a menu which allows the user to manually master each probe, by adjusting the individual electronic gain and zero position for that probe. The probe will need to be placed in a calibrated dial fixture, and the electronic gain adjusted so that the bar deflects to the desired position. Once set, the system gain should not be changed after, except for re-calibration purposes. During routine Mean mastering, only the electronic zero will be adjusted in the system.

#### Air Inputs:

Only Min and Max masters should be used for air inputs. Before attempting to automaster an air input, the electronic gain and zero controls ( in the Zero/Gain Adjust menu ) should be set to their mid positions. This will allow the system to have the greatest amount of available electronic adjustment during automastering.

Place the Min master in the fixture first, and use the converter Spread and Zero controls to bring the column bar to the Min position. Then place the Max master in the fixture and adjust the controls again to bring the bar close to the Max position. Repeat this procedure as many times as necessary till calibration is achieved. This must be repeated with each input.

It should be noted that turning the Spread control ( pneumatic gain ) *in* ( clockwise ) will increase the signal gain ( or spread ), while a counterclockwise rotation will decrease it.

### 9.4 AUTOMASTERING

Once the inputs have been approximately calibrated manually, then the Automastering menu may be used on a regular basis to master the system. If air/electronic converters are used, then the spread and zero controls should not be changed. The system electronics will adjust for any other minor day-to-day variations. Alternatively, the user may perform daily air mastering by only adjusting the Spread and Zero controls, and not using the L3000 Automastering function.

To bring up the Automastering menu, press the <Master> button on the L3000 front panel. It is assumed that all nominal part sizes and master sizes have been entered in the setup menus, and that Master group numbers have been assigned for each display.

The up/down arrow keys will allow the user to scroll the Master group number, and the columns in each group will be shown as red boxes around each display number. All columns with red boxes will be mastered at the same time.

Select the desired group number, place the Min master ( or Mean Master ) in the fixture, and press <Enter> to begin the Min mastering process. A user-defined operator message will appear at the bottom of the window if a message was typed in from the setup menu. When complete, the screen will request the Max Master (if set up for Max/Min mastering), and the bar displays will be at the min master set points ( indicated by small rectangles near the bar scale ). With the max master in place, press the <Enter> key once again to max master the column displays. When complete, the system will return to the state it was before beginning the Min master routine.

If mean mastering, press <Enter> with the mean master in the fixture, and the displays will adjust to the bar zero positions.

Change to another master group for continued mastering, or press the <Automaster> button to exit.

If, at any point during the mastering process, the system is unable to complete the process successfully, a help menu system will be activated. The user will be able to decide to abort and retry, or to enter an instruction driven help process. This works by setting the electronic zeros and gains to the mid positions ( under the assumption that the mastering process failed because the zero and gain settings had drifted over time ). The operator is instructed to manually master for air inputs using the spread and gain controls of the air/electronic converters, before proceeding with the automastering again.

## SECTION 10

### R & R TEST RUNS AND REPORTS

#### 10.1 SETTING UP FOR A TEST

In the main setup menu is a selection entitled R and R Setup ( Repeatability and Reproducibility). Sequencing through this menu, the user can define several parameters which will define how the R and R test will be run:

Number of Trials: Select 2 or 3 trials for each operator

Number of Samples: Scroll this number from 1 to 10 and select the number of sample parts which will be used for the test.

Number of Persons: Select for 1, 2 , or 3 operators.

Operator Names: Type in the names of the operators, or leave the defaults as Operator 1,2,or 3

This information will be stored in the system, and all R and R tests will be run accordingly.

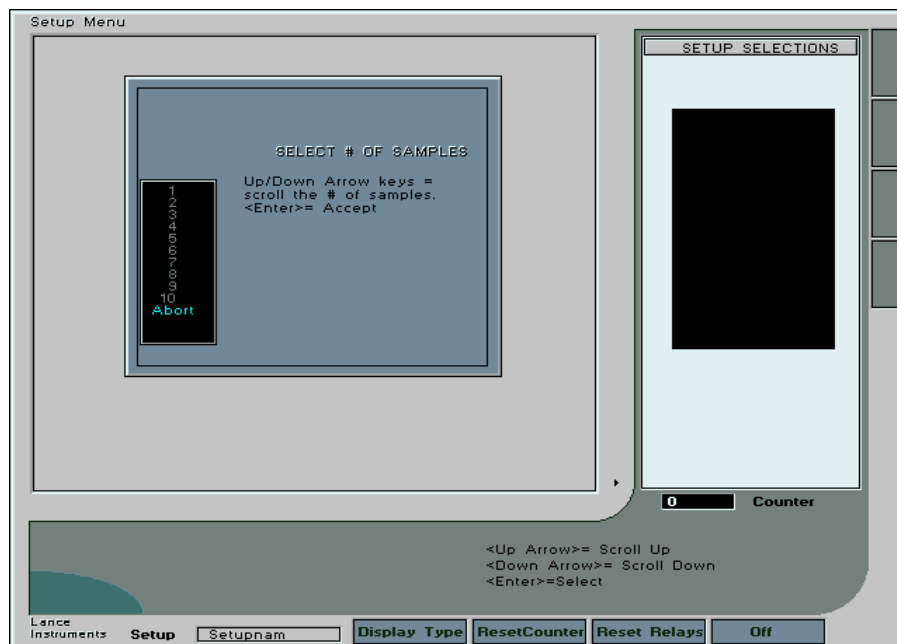


Fig. 10a R&R Test Setup Screen for # of Samples

#### 10.2 RUNNING AN R&R TEST

This test is a means of evaluating the performance of the gaging system, and more particularly, the gage fixture itself. It affords the opportunity to compare successive test readings with different

operators and different samples.

To begin a test, first press the <R & R> button on the front panel. This will bring up a menu with several selections, one of which is "Begin an R & R test". Press the <Enter> button.

The screen will be redrawn with several changes. There is a display block which indicates the "Readings Left" number, which is calculated based on the setup parameters. The instructions call for operator 1 to take the first reading using Sample 1. Place the part(s) in the fixture and press the <Read> button when ready. The values are recorded and the display changes to show Sample 2, with 1 less reading left to take. Continue following the menu prompts until the last reading is taken. When complete, a pop-up message will appear informing the operator that the test is finished.

### 10.3 GENERATING AN R & R REPORT

The results of the R& R test may be viewed at any time by selecting "View Test Results" on the R & R function selection menu. The user may select a full report of a single column, or a summary report of all columns. The report will show Repeatability ( equipment variation ), Reproducibility ( Appraiser Variation ), and Repeatability and Reproducibility, and well as percent values for the three. All formulas used are shown on screen when individual display reports are generated.

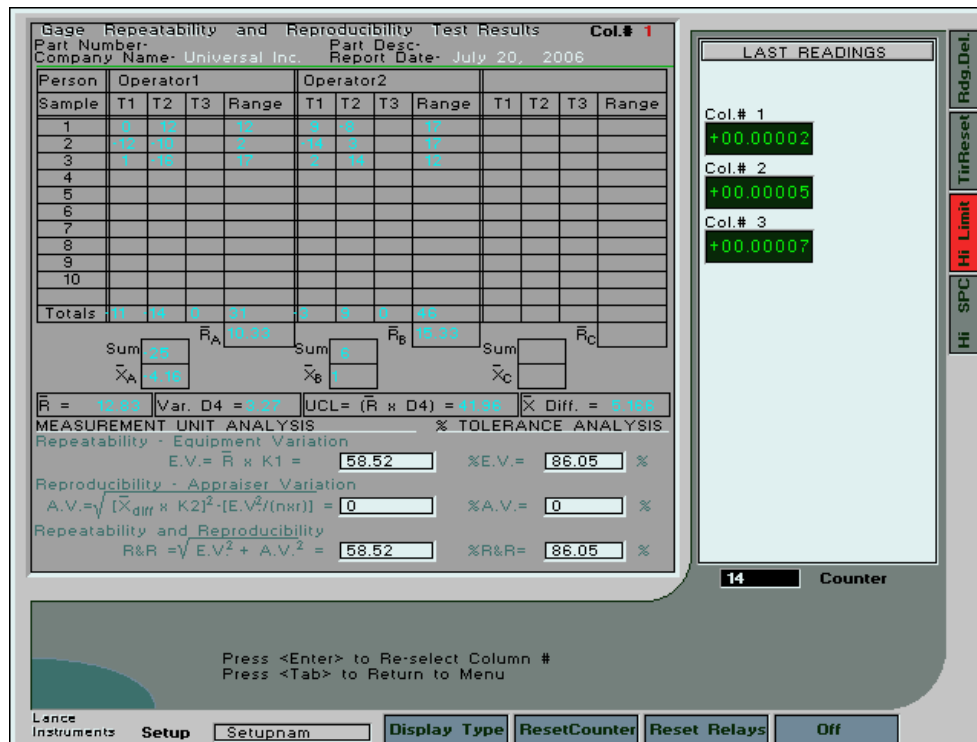


Fig. 10a - R & R Single Display Test Results

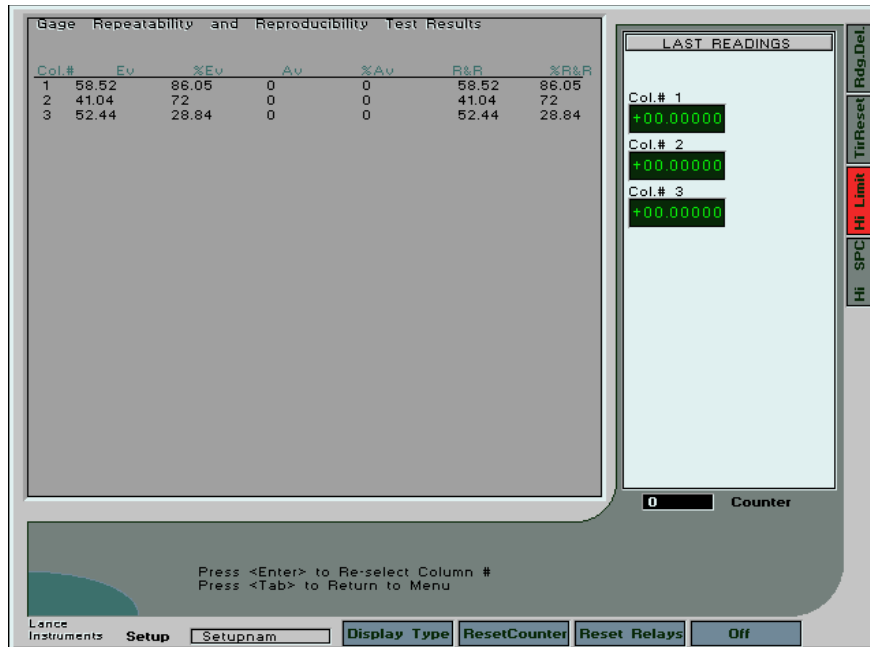


Fig. 10b - R & R Summary Results Screen

## SECTION 11

### DATA STORAGE

#### 11.1 DATA FILE FORMATS

When a new setup is create, a directory is also created on the system "flash" drive by the same setup name. All archived data readings are stored in this directory. Also, the primary data file for storage will have the same name with a ".DAT" extension. For example, if the setup name were "PART1", then the directory created would be C:\PART1, and the primary data storage file within that directory would be PART1.DAT. The data file is a standard ASCII type file, easily opened with any editor program. Each time the "Read" button is pressed to record gaged data, the file format is:

YrMoDa, HrMn, a,b,c, .... z

where Yr is a 2 digit # representing the current year

Mo is a 2 digit number representing the current month

Da is a 2 digit number representing the day of the month

Hr is a 2 digit number representing the hour of the day ( 24 hour time)

Mn is a 2 digit number representing the minute of the hour ( 00 to 59 )

a is the digitized reading of Display #1

b is the digitized reading of Display # 2

z is the digitized reading of the last "On" display.

Digitized readings will vary in size, and do not contain decimals. The decimal position when interpreted by the system is determined by the user settings regarding scale, units ( inch/metric ). Data entries are comma delimited, and each line in the data file represents one "Read" on the system. Up to 300 data readings are allowed in this file. When this size is exceeded, the file is renamed as an "archive" data file, and a new empty base file ( i.e. PART1.DAT ) is created. Archive files are automatically named with numeric designations, beginning with 00001.DAT. Each time a new archive file is created, the number increases to a maximum of 400 archive files, the last being 00400.DAT. At this point, archived files start at 00001 again, overwriting any existing files by that name. Therefore, if a historical database needs to be maintained on an external computer, backups should be done prior to this point.

A maximum of 400 archive files, with 300 readings per file, means that the system can archive 120,000 gage records for each setup, as well as the time and date stamps. If there are 28 displays, then 3,360,000 column readings are maintained for each setup.

#### *Data Storage When Reading Groups are Initiated*

When the system is programmed to record data readings in "Groups" ( See Run Mode Sect.6.1) then the file format is somewhat different. For each "group" of display readings taken, those displays specified as part of the group will have the digital gaged readings stored in a line in the current datafile. Those other displays which are "On" but are not part of that reading group will appear in the data line as the number "11111111", which is a number which cannot be generated by a system read, and therefore is isolated out as a non-reading for purposes of viewing data, printing data, or statistic analysis.

### 11.2 INITIATING DATA READINGS

Data readings may be taken by 1 of 2 means:

a) Operator Entry: Press the front panel "Read" button. The word *Reading* will appear momentarily in the lower left of the screen, and the display data values will be stored in memory. Alternatively, a separated Read box with a pushbutton may be connected to the external contacts at the rear of the L3000.

b) PLC or external relay initiated readings. These need to be connected to the L3000 external "Read" contacts on the rear panel DIN connector. During normal operation, the reading values are stored to RAM memory only, and then are stored automatically to hard memory ( internal "flash" memory card ) once in every 200 readings. If data storage is considered critical, then a UPS power supply should be used to power the L3000 to avoid data loss during a power outage or accidental shutdown.

One of the annunciators may be programmed to light up when there is "unsaved" data, as an indicator to operators not to shut down the system without first saving RAM data. Unsaved data may be saved at any time by pressing the "SAVE" button on the lower right of the front panel controls keypad.

Data from different setups are saved independently.

### 11.3 VIEWING AND PRINTING DATA

To view data in any of the archive data files, press the front panel <Print> button. <Tab> to the 2<sup>nd</sup> prompt to toggle between Viewing Data and Printing Data. To view data, the user will be asked to select which data file is desired. To print data, the user can type in which display numbers are desired to be printed.

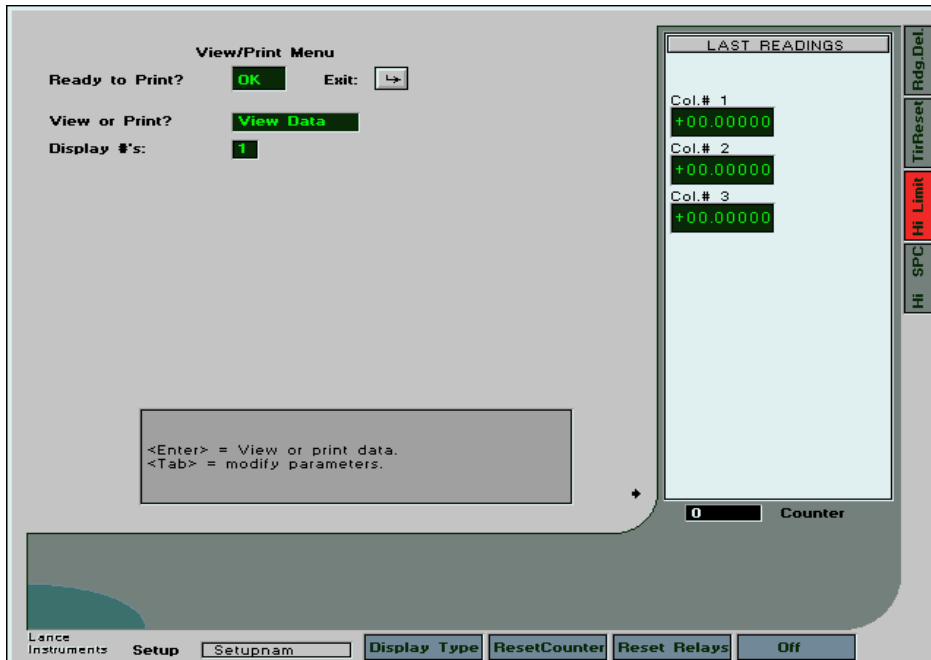


Fig. 11a - View Data Screen

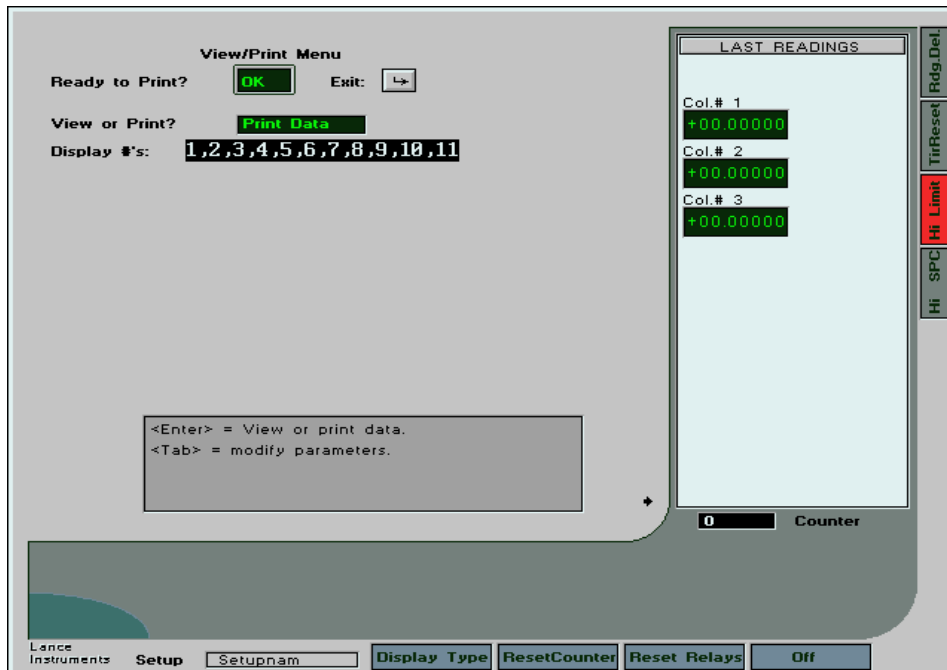


Fig. 11b - Print Data Screen

It should be noted that data can only be direct printed to an HP character compatible printer.

## APPENDIX

### A1 - Specifications

#### General

AC Input Voltage	120 VAC, 60 Hz.
Fuse	Type AGC, 1A, 1-1/4" x 1/4"
Power Consumption	Nominal 50 W
Operating Temperature	50-100 Degrees F, 10-38 Degrees C
Dimensions	4.5"H x 15.1"W x 13" D
Weight	16 lbs.
Power Cord Length	6 feet
Video Out	SVGA

#### Inputs

Inputs	4 or 8 (Specify when ordering). Can be expanded to 16 by special order when used with the Lance L3100 Remote Input Module
Input Connectors	6 Pins, 270 deg. DIN, 1 centre pin
LVDT Excitation	3 VAC, 5 Khz.
LVDT Sensitivity	1.5 - 6.5 mv./v/.001"
Aux. In voltage range	+/- 5 Vdc nominal

#### Relay Out

Number of relays	2 Standard, 7 or 8 Optionally
Type	Double Pole, Double Throw Omron G6A-2-H or equivalent
Maximum Load	Resistive 1 A @ 30 Vdc Inductive 0.5 A @ 30 Vdc Note: More conservative loads should be used for increased contact life.
Service Life Rating	100 million operations at 36,000 operations/hr.
Close Time	5 msec. Max. (Relay only) *
Release Time	3 msec. Max. (Relay only) *
Bounce Time	0.5 msec. nominal
Contact Arrangements	Both normally open and normally closed contacts are available for customer wiring. Commons are not joined between relays.

#### Relay Output Cables

\* Ratings are for relays only, and do not include the inherent response time of the computer gage, which cycles through all displays.  
Lance LC-0713 (2 Relay units)  
Lance LC-0714 (8 Relay units)

#### External Control Inputs

Number of Inputs	3 Standard, Up to 8 optionally
Type	Use mechanical switch contacts only ( i.e. switch or relay hard contact only ). Do not apply an external voltage to the control inputs.



Timing  
Cables

Momentary contact only .1 sec. to .5 seconds  
Lance LA-0716 ( Standard 3 Inputs)

Calibration Ranges

Imperial Ranges  
Metric Ranges  
Degree Ranges  
TIR Functions

1 Thou to 100 Thou ( 100 ranges )  
20 microns to 2000 microns( 200 ranges )  
.1 deg. to 10.0 deg. ( 100 ranges )  
Off, Max, Min, Max - Min, Avg.

Calculation Capabilities

QuickCalc, LastCalc

8 Standard Calculation, including addition and subtraction of 2 columns, Average of 2 or 3 Columns, Max. or Min. of up to 9 Columns, Subtract 2 Columns and divide by 2, Triangular Hypotenuse  
Formulas  
20 Available, assignable to any displays  
30 Characters Max.

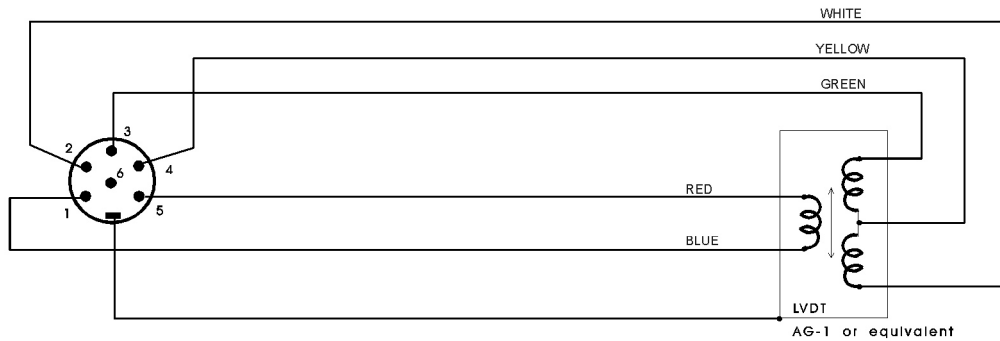
Serial Communication

Specifications  
Connector

9600 Baud, Length 8, Parity (n), 1 StopBit  
9 Pin ( DB-9)

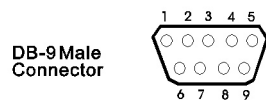
**B1 - Connector Wiring**

SIGNAL INPUT WIRING



When a DC Aux. Input is used, Pin 6 is the signal input, and Pin 1 is the ground.

SERIAL PORT PINOUTS



3- Transmit Data to External Device  
5- Signal GND