
METROLOGY PROCESSOR MP-8D

Version 1.0

OPERATION INSTRUCTIONS



Brunswick Instrument

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INTRODUCTION

The Brunswick "Metrology Processor" MP-8D is a self contained, bench-top display and processing device specifically designed for direct interface with Mitutoyo brand or other compatible measuring tools having "Digimatic" type data outputs. Up to eight digital tools may be directly connected to the Model MP-8D without the need for additional data converters of any kind. The unit offers both BASIC and ADVANCED operating modes.

In BASIC mode, the unit functions solely as a multi-channel data converter and data switch. The measurement data from any connected tool is displayed and, on command, is converted to simple standardized ASCII text code and transmitted out the RS232 serial port to an external device (PC, SPC data collector, etc.). The "AutoSwap" function can automatically switch between measurement tool inputs simply by sensing activity at a particular tool. Measurement values can be sent individually from one selected tool, or in sequence from multiple tools.

In ADVANCED mode, the powerful gaging and mathematic calculation functions of Brunswick's Metrology Processor line of products can be accessed. Multiple "part feature" setups can be defined, each having unique tolerance limits, preset value, measurement resolution and display format. Simple or complex mathematic formulas can be defined to manipulate or combine individual measurement tool values.

This manual is divided into two separate parts, each describing only the BASIC or ADVANCED operating modes. As shipped, the MP-8D is set to operate in the BASIC mode. A simple setup menu selection performs the switch to ADVANCED mode.

INITIAL SETUP AND OPERATION

Connecting the tools:

Eight tool connectors are present on the rear of the unit. **With the unit power switched OFF**, the individual tools may be connected to any available tool connector. The unit power may be switched on when all the tools are connected and all the tools are turned on.



Powering on:

When the MP-8D is turned on it starts a scan of all the tool ports to determine which ports have connected tools. It performs this scan every time the unit is powered up. When the scan is complete a list of the eight ports is displayed indicating either “OK” for a port with an active connected tool, or “NOT FOUND” if no active tool was present at the port. If at least one active tool is found, the operator is given the choice to either “PROCEED” by pressing the F1 key, or to “RESCAN” by pressing the F5 key. If no active tools are found, only the option to “RESCAN” is offered. When the operator determines that all the necessary tools have been identified, he may “PROCEED”. If one or more needed tools are not found because they have not been connected or not turned on, they should be connected or turned on at this time and the “RESCAN” be performed.

IMPORTANT: Once the power-up scan has been performed and the operator has told the unit to “PROCEED”, additional tools connected to the unit or turned on WILL NOT BE RECOGNIZED. The MP-8D must be powered down and back up again to add new tools. The MP-8D uses the results of this scan to save time in operation by not wasting time looking for activity at empty or unused tool ports.

BASIC OPERATION MODE

“INDIVIDUAL” AND “MULTI” VIEW MODES:

The MP-8D can operate and display measurement results in two distinctly different ways depending on the application requirements.

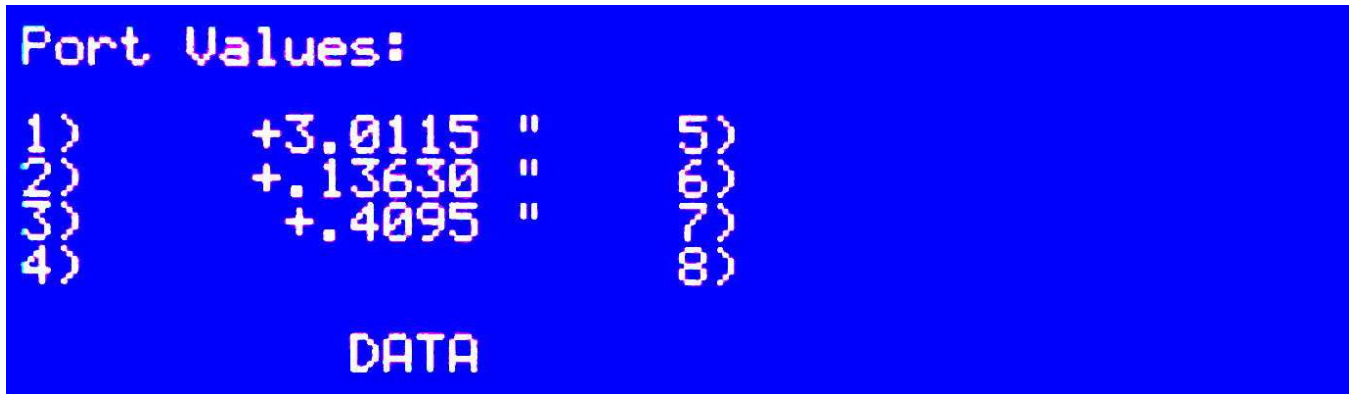
INDIVIDUAL VIEW MODE is used when gaging setups are used to inspect individual part features, one at a time. Simple examples are a height or thickness measurement using a micrometer, caliper or indicator, or a bore diameter measurement using a digital bore gage.



The individual view mode display shows the currently selected tool measurement value and the port number from which it comes. Individual ports may be switched between by the user, either manually by keypad selection or automatically with the “AutoSwap” function. The AutoSwap function monitors tool movement activity for all the connected tools and can automatically switch the display to the port that corresponds to the active tool. A practical example of an AutoSwap application would be a setup where multiple bores of different sizes are being inspected with several different hand-held bore gage tools. As each bore gage is picked up and inserted into the appropriate hole, AutoSwap senses the activity and instantly

switches the display to the corresponding tool. As another gage is used, a different corresponding tool is selected automatically.

MULTI VIEW MODE is used when gaging setups are used to inspect multiple part features simultaneously. The multi view display is a list of the various digital numeric tool values.



BASIC Mode Default Settings:

The unit has several user programmable settings that are retained in non-volatile memory. Initially, these are set to factory defaults. The default settings are:

Global Settings Defaults:

- Basic mode enabled
- Auto-Swap OFF
- Individual view mode
- Display mode normal (White characters on blue background)
- Switch input #1 triggers data output function
- Switch input #2 triggers the port "STEP" function

Front Panel Display and Controls:

The front panel contains a numeric keypad to the right and a display with five "soft keys" below it, to the left.

The keypad is used for entry to the unit "SETUP" menus, making menu selections, entry of various setup parameters and selection of the desired port number for viewing of measurement results.

The five "soft keys", F1 through F5, below the display have variable functions depending on what screen is currently being viewed. The soft key functions are always labeled by name, just above each key, on the bottom line of the display. If a particular soft key has no label displayed above it, the key is currently disabled.

Port # Selection:

When the unit power is turned on the default port display selection is the first port found to be active. Other active ports may be selected by pressing the keypad keys 1 through 8. Selection of in-active ports is not allowed.

“Individual” View Mode Controls

While operating in “Individual” view mode the five soft keys F1-F5 are assigned the following functions:

F2: Data

This key is used to trigger a transmission of the displayed measurement out the RS232 data communications port. The data may be sent to an external device like a personal computer or SPC data collector. The SW1 footswitch input on the rear of the unit performs this same function.

F5: Step

This key is used to step the display to the next ACTIVE port number. As an alternative to manually selecting the desired port by number using the keypad, the STEP function selects the next port in a sequence. After the last active port in the sequence is displayed, the STEP key will again select the first in the sequence. The SW2 footswitch input on the rear of the unit performs this same function

“Multi” View Mode Controls

While operating in “Multi” view mode the five soft keys F1-F5 are assigned the following functions:

F2: Data

This key is used to trigger a transmission of the ALL the displayed measurements out the RS232 data communications port one after another. The data may be sent to an external device like a personal computer or SPC data collector. The SW1 footswitch input on the rear of the unit performs this same function.

SETUP MENUS:

The “SETUP” key on the keypad presents the menu of unit setup selections. The initial setup menu offers four choices, which are selected by pressing the corresponding keypad number key (1-4).

1) Advanced mode

This selection sets the unit to ADVANCED mode operation, described in the other section of this manual.

2) AutoSwap ON/OFF

This menu selection immediately toggles the setting of the “AutoSwap” function between ON and OFF. The Auto-Swap function monitors tool movement activity for all the connected tools and can automatically switch the display to the port that corresponds to the actively moving probe. AutoSwap only functions when the unit is operating in the “Individual” view mode.

3) Individual / Multi View Mode Selection

This menu selection immediately toggles the unit between “Individual” and “Multi” view mode operation.

4) Utilities

The utilities menu offers three further setup functions, which are selected by pressing the corresponding keypad number key (1-3).

1) Display Reverse

This immediately toggles the setting of the display mode between white-on-blue and blue-on-white. Choice is by user preference.

2) Display Adjust

This displays a dummy digital reading to view and the means for adjusting both the display contrast and backlight levels up and down.

3) Reset All

This function resets all the unit and feature setting parameters to their factory defaults. A warning message is displayed before parameters are reset.

RS232 Port Details: BASIC OPERATION MODE

The Metrology Processor is equipped with a RS-232 serial data output port. Data may be transmitted electronically to other devices such as data collectors, personal computers or SPC systems.

Data Output Connector Wiring:

The 9 pin female "D-Sub" connector is organized and wired as follows:

Metrology Processor pin#, name	Connects to device pin name
2 - Transmitted Data (output)	Received Data (input)
3 - Received Data (input)	Transmitted Data (output)
5 - Ground	Ground
All other pins are not connected	

The data communications protocol is fixed as:

9600 baud, 8 data bits, 1 stop bit, no parity. No handshaking is implemented.

The character codes output are standard ASCII codes recognized by most data communications software and printers. The data output stream is always 12 characters long. The output is formatted as follows:

+ XXXXXXX M X CR LF

The first character is always either a "+" or "-" polarity sign.

The second through eighth characters are always either a decimal point "." or the numerals 0 through 9.

The ninth character is always "I" (capital eye) or "M" depending on whether the measurement is in inches or millimeters.

The tenth character is always a numeral "1" through "8" indicating the port number of the reading.

The eleventh and twelfth characters output are "Carriage Return" (decimal ASCII value 13) followed by "Line Feed" (decimal ASCII value 10).

The unit will output data each time the F2: DATA button is pressed or the footswitch connected to the SW1 input is pressed.

When operating in "Individual" view mode, only the measurement result for the currently selected port is output. When operating in the "Multi" view mode, the measurement result for each active feature is output, one after another.

The "DATA" send buttons that may be present on digital tools can also trigger the data transmission. The "DATA" send buttons on all tools are DISABLED when operating in Multiple View Mode. The "DATA" send buttons are also DISABLED when AutoSwap is ON during Individual View Mode.

DIGITAL GAGE PORT WIRING

The 10 pin header connectors are wired as follows:

- 1 - Ground
- 2 - Data (input)
- 3 - Clock (input)(low when data valid)
- 4 - Ready (input)
- 5 - Request (output)

DIGITAL GAGE PORT DATA FORMAT

The digital gage ports are designed to accept data from Mitutoyo brand digital instruments or others conforming to their standard.

The data stream is expected to be a 13 digit (4 bit/digit) configuration. The data stream is bit serial starting from the LSB of digit #1 and terminating with the MSB of digit #13.

Digit 1- 4:All bits always high (FFFF).

Digit 5 :Sign 0=+, 8=-

Digit 6-11:Numeric data - BCD, 0-9, 6 digits

Digit 12 :Decimal point location - BCD, 2-5

Digit 13 :Unit - 0=Metric, 1=Inch

ADVANCED OPERATION MODE

“PORTS” AND “FEATURES”

Understanding the terminology of “Ports” and “Features” is key to understanding the way in which the Metrology Processor operates.

PORTS:

A “port” is any one of multiple connected digital tools. At power-up each active port number, #1 up to #8 is determined. The reading from any individual port can be thought of as a variable piece of data that is assigned by the user, either by itself or in combination with other port readings, to a “Feature” setup.

FEATURES:

“Features” are the user-defined setups that produce and display measurement results and perform decision-making based on tolerance limits. The term “Feature” is appropriate because, most often, each feature setup corresponds to a single dimensional feature of the part or product being measured. The Metrology Processor supports and stores multiple feature setups that are easily selected by the user at will.

Each programmed feature is provided its own unique setup parameters for:

- 1) Preset (or zero) value.
- 2) Upper and lower tolerance limits.
- 3) Measurement resolution setting.
- 4) Peak Hold mode – MAX, MIN, or TIR (MAX-MIN)
- 5) Display mode – either digital or analog (numeric or bar graph meter style).
- 6) Feature formula.

The feature “formula” is used to define:

- 1) Which port or ports are used to produce the particular feature result.
- 2) If and how the readings from more than one port are mathematically combined.
- 3) If and how further mathematic manipulations of the port values are performed.

The feature formulas and other setup parameters can be entered by the user directly from the unit’s front panel keypad or be created and edited as simple text files on an external PC. These files may be downloaded and uploaded to and from the unit over a serial port connection using a typical data communication program like “HyperTerminal”. All setup parameters are retained in non-volatile memory.

Besides addition, subtraction, multiplication and division, formula entry supports trigonometry functions for conversions between linear and angular results, square root, absolute value, exponents and multiple levels of parenthesis.

Other special formula functions are supported that specify the highest or lowest port or feature value from within a specified group of port or feature values, allowing simplified flatness, straightness and alignment inspection setups.

“INDIVIDUAL” AND “MULTI” VIEW MODES:

The Metrology Processor can operate and display feature results in two distinctly different ways depending on the application requirements.

INDIVIDUAL VIEW MODE is used when gaging setups are used to inspect individual part features, one at a time. In individual view mode applications the user is looking for a single result that can be compared to a single set of tolerance limits for accept / reject decision making. Simple examples are a height or thickness measurement using a micrometer, caliper or indicator, or a bore diameter measurement using a digital bore gage, or a single flatness measurement derived from the readings of multiple indicators simultaneously in contact with some planar surface.



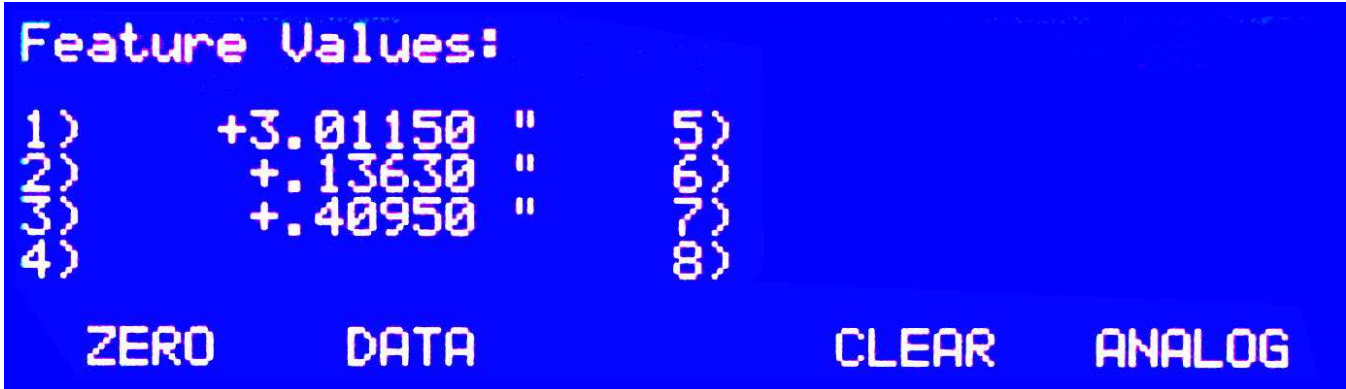
The individual view mode display can be either a digital numeric value or an analog meter style representation of the result. Accept / reject conditions are prominently displayed as either “HIGH” or “LOW” and relay contact outputs (optional) actuated accordingly.



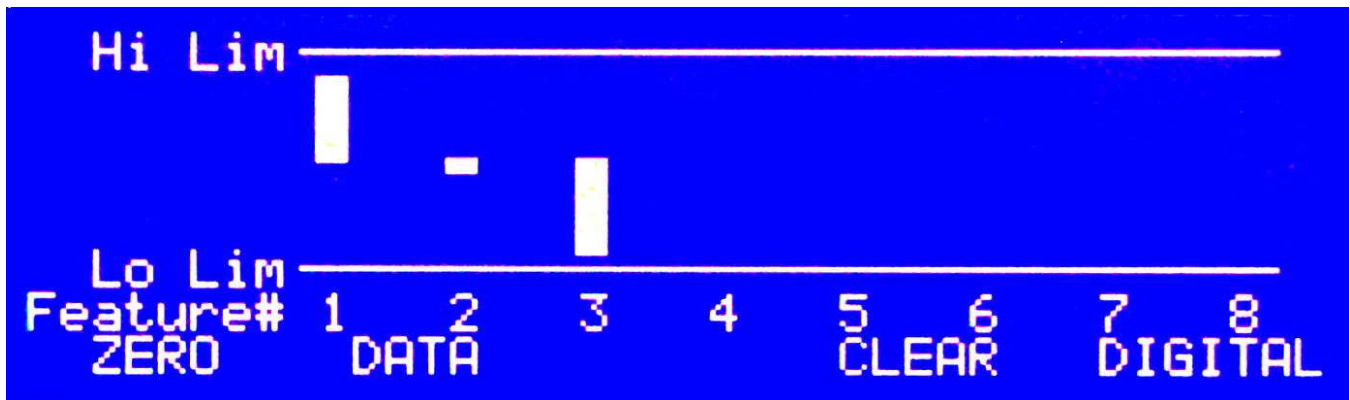
Multiple, individual features may be defined and switched between by the user, either manually by keypad selection or automatically with the “Auto-Swap” function. The Auto-Swap function monitors tool movement activity for all the connected tools and can automatically switch the display to the feature setup that corresponds to the actively moving tool. A practical example of an Auto-Swap application would be a setup where multiple bores of different sizes are being inspected with several different hand-held bore gage fixtures. As each bore gage is picked up and inserted into the appropriate hole, Auto-Swap senses the activity and instantly switches the display to the corresponding feature. As another gage is used, a different corresponding feature is selected automatically.

During individual view mode operation, user inputs like Preset (or zeroing) and data output actuation are performed only for the currently displayed feature.

MULTI VIEW MODE is used when gaging setups are used to inspect multiple part features simultaneously. In multi view mode applications the user is generating multiple measurements that are compared to multiple sets of tolerance limits for a single accept / reject decision.



The multi view display can be either a list of the various digital numeric feature values or a multiple bar graph display that emulates a multiple column-gage setup. Often the operator is not concerned with the actual values of the measurements but only with an accept / reject decision. In the bar graph mode, the upper and lower tolerance limits for all features are proportionally unified and positioned at the top and bottom of the display. The operator can quickly visually scan the display to see that all feature results are within limits or to determine which feature values exceed them. If any of the feature values exceed their tolerance limits the reject condition is prominently displayed and relay contacts (optional) actuated accordingly.



During multi view mode operation user inputs like Preset (or zeroing) and data output actuation are performed for all displayed features simultaneously.

Default Settings:

The unit has many user programmable settings that are retained in non-volatile memory. Initially, these are set to factory defaults. The default settings are:

Global Settings Defaults:

- Basic operation Mode
- Auto-Swap OFF

Individual view mode
Inch mode
No probe or feature groups are defined
Display mode normal (White characters on blue background)
Switch input #1 triggers data output function
Switch input #2 triggers port STEP function
Relay (if installed) option is 1
RS232 option is 1
No password set for setup mode

Feature Settings Defaults (Features 1-8):

Features 1 – 8 are enabled (turned on)
Formula – Feature #1 is set to process Port #1, Feature #2-Port #2, etc.
Preset, 0
Resolution, .00005" (fifty millionths of an inch)
High Limit, +1000"
Low Limit, -1000"
Hold mode, OFF
Display mode, Digital

Front Panel Display and Controls:

The front panel contains a numeric keypad to the right and a display with five "soft keys" below it, to the left.

The keypad is used for entry to the unit "SETUP" menus, making menu selections, entry of various setup parameters like tolerance limits, preset values, feature formulas, etc. and selection of the desired feature number for viewing of measurement results.

The five "soft keys", F1 through F5, below the display have variable functions depending on what screen is currently being viewed. The soft key functions are always labeled by name, just above each key, on the bottom line of the display. If a particular soft key has no label displayed above it, the key is currently disabled.

Feature # Selection:

When the unit power is turned on the default feature display selection is Feature #1. Other features may be selected by pressing the keypad keys 1 through 8.

"Individual" View Mode Controls

While operating in "Individual" view mode the five soft keys F1-F5 are assigned the following functions:

F1: Zero (or Preset)

This key is used to "zero" the measurement value or "preset" the measurement value. If the Preset value for the particular feature is set to zero, the key is labeled "zero" and the display will be "zeroed" when the key is pressed. If the Preset value for the particular feature is set to any value other than "zero" the key will be labeled "Preset" and the displayed measurement will be set to this value when the key is pressed.

A typical application of a Preset value is when you want the measurement displayed as an “actual” dimension like 3.5000 even though the digital tool may have only a short measurement stroke. The Preset value is set to 3.5 and the tool(s) positioned in contact with a setting master or part known to be 3.5000 in dimension. When the Preset key is pressed the display will be set to read 3.5000 and as the tool is displaced from that position the reading will become incrementally larger or smaller than the preset value.

NOTE: Zeroing and Presetting has no effect on the measurement displayed at the digital tool. The reading taken from the tool at the time of zeroing or presetting is used as the zero or preset reference for the display.

F2: Data (or Data ON / Data OFF)

This key is used to trigger (or start) a transmission of the displayed measurement out the RS232 data communications port. The data may be sent to an external device like a personal computer or SPC data collector. Several options for the transmitted data format are selectable by the user and are discussed in the “Utilities” section of this manual

F3: Hold

This key is used to select three different modes of measurement “peak hold” for the current feature. The current hold mode setting is indicated on the display following the displayed “Feature #”. The label “MAX”, “MIN”, or “TIR” will appear as the F3 key is repeatedly pressed. When none of the above labels appear, the HOLD mode is off. All the connected ports continuously record the maximum and minimum values that they encounter. When set to MAX, the maximum value for the current feature is displayed. When set to MIN, the minimum value for the current feature is displayed. When set to TIR (Total Indicator Reading), the difference between the maximum and minimum readings (MAX-MIN) is displayed.

It is important to understand that when a feature result is calculated from the readings of more than one port, ALL the ports assigned to the feature will operate in whichever HOLD mode is selected for the feature. Example: If the feature formula is defined as “P1+P2” and the HOLD mode for the feature is set to MAX, the actual mathematic operation performed is MAX of Port #1 PLUS MAX of Port #2. In most cases the peak HOLD modes are intended to be applied to features that are derived from the readings of a single port.

F4: Clear

This key is used to clear the previously held maximum and minimum peak readings. The CLEAR function operates on ALL the connected ports simultaneously and regardless of whether any HOLD modes are active for any feature. At the moment the key is pressed, the maximum and minimum peak memory for all ports is set to the current port position and the TIR value (MAX-MIN) for each port will become zero.

F5: Step

This key is used to step the display to the next ENABLED feature number. (Any feature may be enabled or disabled by the user as discussed in the Feature Editing section of this manual.) As an alternative to manually selecting the desired feature by number using the keypad, the STEP function selects the next feature in a sequence. After the last enabled feature in the sequence is displayed, the STEP key will again select the first in the sequence. Disabling unused or unwanted features will make the STEP function skip past them effectively removing them from the step sequence.

Either of the SW1 or SW2 external switch closure inputs on the rear of the unit can be assigned to control any of the F1-F5 soft key functions by footswitch or other remote control.

“Multi” View Mode Controls

While operating in “Multi” view mode the five soft keys F1-F5 are assigned the following functions:

F1: Zero (or Preset)

This key is used to “zero” or “preset” the measurement value for all displayed features simultaneously. The key is always labeled “zero” and the value for each feature will be set to its particular Preset value when the key is pressed.

NOTE: Zeroing and Presetting has no effect on the measurement displayed at the digital tool. The reading taken from the tool at the time of zeroing or presetting is used as the zero or preset reference for the display.

F2: Data (or Data ON / Data OFF)

This key is used to trigger (or start) a transmission of the ALL the displayed feature measurements out the RS232 data communications port. The data may be sent to an external device like a personal computer or SPC data collector. Several options for the transmitted data format are selectable by the user and are discussed in the “Utilities” section of this manual. .

F3: Inactive

F4: Clear

This key is used to clear the previously held maximum and minimum peak readings. The CLEAR function operates on ALL the connected ports simultaneously and regardless of whether any HOLD modes are active for any feature. At the moment the key is pressed, the maximum and minimum peak memory for all ports is set to the current port position and the TIR value (MAX-MIN) for each port will become zero.

F5: Digital / Analog / Mult

This key is used to toggle the display mode between a list of numeric readings (Digital) for all the displayed features or a bar-graph type display (Analog) for all the displayed features. At anytime during multi view operation the user may select a feature by number (1-8) using the keypad to temporarily view the feature in an individual mode format. In this case the F5 key will become labeled “MULT” to indicate that the key will return the display to the “multi” view mode when pressed.

Either of the SW1 or SW2 external switch closure inputs on the rear of the unit can be assigned to control any of the F1-F5 soft key functions by footswitch or other remote control.

SETUP MENUS:

The “SETUP” key on the keypad presents the menu of unit setup selections. The initial setup menu offers seven choices, which are selected by pressing the corresponding keypad number key (1-7).

1) Basic Mode

This selection sets the unit to BASIC mode operation, described in the other section of this manual.

2) Auto-Swap ON/OFF

This menu selection immediately toggles the setting of the “Auto-Swap” function between ON and OFF. The Auto-Swap function monitors tool movement activity for all the connected tools and can automatically switch the display to the feature setup that corresponds to the actively moving tool. Auto-Swap only functions when the unit is operating in the “Individual” view mode. Auto-Swap will not respond to tool movement for any tool that is assigned to more than one enabled feature.

3) Individual / Multi View Mode Selection

This menu selection immediately toggles the unit between “Individual” and “Multi” view mode operation.

4) Utilities

The utilities menu offers nine further setup functions, which are selected by pressing the corresponding keypad number key (1-9).

Utility 1) Display Reverse

This immediately toggles the setting of the display mode between white-on-blue and blue-on-white. Choice is by user preference.

Utility 2) Display Adjust

This displays a dummy digital reading to view and the means for adjusting both the display contrast and backlight levels up and down.

Utility 3) Reset All

This function resets all the unit and feature setting parameters to their factory defaults. A warning message is displayed before parameters are reset.

Utility 4) Relay Outputs

(Future expansion not yet implemented.) Offers several options for the way the relay outputs operate in relation to out-of-tolerance conditions.

Utility 5) RS232 Options

Offers several options for the way the RS232 data output operates. Selection #1 “Single” offers a single burst data transmission when the F2: “DATA” key is pressed while taking measurements. Selection #2 “Stream” offers continuous data output. While measurements

are being performed and the Stream mode selected, the F2 key will be labeled “DATA ON” or “DATA OFF”. Pressing the F2 key while it is labeled “DATA ON” will start the data streaming and the key will then be re-labeled “DATA OFF”. Pressing the key again will stop the data streaming and the key is again re-labeled “DATA ON”. Selection #3 (Option 3) is for future development and currently operates the same as Selection #1. More detail on the RS232 output follows in the “RS232 Details” section of this manual.

Utility 6) Password

Access to the entire SETUP menu section can be denied unless a numeric password is entered. A numeric password having 1 to 9 digits can be defined. The password cannot begin with “zero”. The password can be removed by changing it to the single digit “zero”.

Utility 7) Set Probes (Port Values)

This utility function presents a screen that displays the positions of all the currently connected tools. It is useful to view this screen while initially mounting, positioning and locking down dial indicators in fixtures. The measuring range and current position of each tool can be tested and observed and the over-range conditions seen without being affected by Feature Formulas or Preset settings. The F1:ZERO ALL and F2:ZERO # keys can be used to “zero” the readings of all tools or of any specified tool. These “zero” offsets are stored in memory and applied each time the unit is powered up. If any tool has been previously zeroed, the F3:UNZERO function will be available to allow all zero offsets to be removed from memory. This screen is also useful for troubleshooting probe group calculations and formula definitions that don’t seem to be working. The raw tool values being generated can be observed, providing clues as to why the probe group results or formula calculations are behaving as they are.

NOTE: Zeroing and Unzeroing has no effect on the measurement displayed at the digital tool. The reading taken from the tool at the time of zeroing is used as the zero reference for the display.

Utility 8) Switch Inputs

The rear panel switch (or footswitch) inputs may be assigned to provide remote control over the five “soft key” functions while the unit is operating in either Individual or Multi view modes. For example, if you want a footswitch to operate the F1: Preset (or zero) function and another switch closure to trigger the F2: Data send function, the assignments can be made using the Switch Inputs menu selection. Similarly, the hold CLEAR and STEP functions could be controlled by remote switch closures.

Utility 9) Transfers

This utility function provides the means to either 1) Dump Memory to, or 2) Load Memory from, text files on an external PC. All the unit and feature setup parameter programming can be transferred into or out of the unit, through the RS232 communications port, using a typical data communications program running on an external PC like HyperTerminal (supplied with Microsoft Windows software). Furthermore, the setup parameter text files may be edited on the external PC with a common text editor program like “NotePad” (also supplied with Microsoft Windows software) and then be loaded back into the unit. This allows a faster, less tedious way to create and edit complex feature formulas and a means to store or archive multiple Metrology Processor setups outside the unit.

The data transfers utilize “X-Modem” protocol, a common data transfer method. An appropriate RS-232 serial interconnect cable is required for connecting the unit to the external PC.

5) Inch / Millimeter Mode Selection

This menu selection immediately toggles the unit between “Inches” and “Millimeters” mode operation. As the switch is made, all setup parameters (presets, resolutions, limits, etc.) are converted from one unit system to the other.

WARNING: Formulas and their contents ARE NOT converted. Formulas may be created that contain constant values or other expressions that only make sense in one unit system and not the other.

6) Feature

All the individual feature setup parameters are viewed, entered or edited using this menu function. When selected, a feature setup summary is displayed for a particular feature number (usually the last currently selected feature number, or feature #1, the default). Any feature number may be specified by pressing the corresponding key on the numeric keypad (1-8). The feature setup summary presents all the current settings for the feature: Enabled or Disabled status (on or off), Feature Formula, Resolution, Preset Value, High and Low Tolerance Limits, Hold Mode (MAX, MIN, TIR or OFF) and Display Mode (Digital or Analog). If the feature is currently OFF (disabled) the summary will not be displayed until the feature is turned ON (enabled) with the F2 key . The soft keys F1-F5 are assigned the following functions:

F1: Edit

This key allows any of the feature setup parameters to be entered or edited. When selected, a further menu of six selections is presented.

1) Formula

This selection allows the entry or editing of the feature formula. The second and third lines of the Feature Formula entry screen display the formula being entered or edited. The formula may contain up to 76 individual characters. The minimum and simplest formula required for any feature is the character “P” (for port) followed by a numeral 1 through 8. This specifies which port will supply a reading for the feature result. Formulas are entered by using the F1 and F2 keys to move a cursor left or right along a displayed list of “operator” functions. When the desired operator is highlighted with the cursor it is entered into the formula using the F3: Select key. The F4: Bksp key is used to backspace (and erase) unwanted characters from the end of the formula. The F5:Exit key exits the formula entry screen WITHOUT saving any changes to the formula. To save changes, the ENTER key at the bottom of the numeric keypad is used.

Formula Operators:

The list of formula operators offers:

“A” – Absolute value. The ABS function will transform the following value, variable or expression into a positive value regardless of its negative or positive status. When selected, the ABS function is entered into the formula with a “left parenthesis” automatically following. You are required to add the “right parenthesis” following whatever value, variable or

expression is specified after the ABS operator. Example: ABS(P1) would produce readings from port #1 that are always positive regardless of the actual polarity of the port reading.

“Q” – Square Root. The SQR function will transform the following value, variable or expression into its calculated square root. When selected, the SQR function is entered into the formula with a “left parenthesis” automatically following. You are required to add the “right parenthesis” following whatever value, variable or expression is specified after the SQR operator. Example: SQR(P1) would transform the reading of port #1 to its square root.

“^” – Exponentiation. The ^ function will perform exponentiation of the value, variable or expression immediately preceding the ^ character by the value of the numeral immediately following. Parenthesis may be required around the entire value and exponentiation to clarify the mathematics. Example: (P1^2) would raise the value of port #1 to the second power (multiply port#1 reading times itself or “square” it).

“N” – Group Minimum. The “N” character is immediately followed by a numeral 1-8. Group definition is described further elsewhere. Example: N2 would instruct the unit to use the minimum value found within Group 2 as the feature value.

“X” – Group Maximum. The “X” character is immediately followed by a numeral 1-8. Group definition is described further elsewhere. Example: X3 would instruct the unit to use the maximum value found within Group 3 as the feature value. The difference between the maximum and minimum values within group #2 would be written as X2-N2.

“F” – Previous Feature Value. Only operates for “Multi” view applications. The feature result from a lower numbered feature may be specified as a variable in another, higher numbered feature formula. Example: the feature formula for Feature #2 may contain F1 which specifies the result of Feature 1 as a variable.

“P” – Port reading. The “P” character is immediately followed by a numeral 1-8. This specifies the port reading to use for the feature. Example: P3 specifies the reading from port #3.

“+” – Addition. The “+” character operates to add two values, variables or expressions together. Example: P1+P2 sums the value of ports #1 and #2.

“-“ – Subtraction or negation. The “-“ character operates to subtract one value, variable or expression from another. Example: P1-P2 subtracts the value of port #2 from the value of port #1. The “-“ character may also be used to “negate” (invert polarity of) the following value, variable or expression. Example: -P1 reverses the polarity of the readings from port #1 and is the means for reversing the direction of readings for a given direction of tool travel.

“*” – Multiplication. The “*” character operates to multiply one value, variable or expression by another. Example: P1*5 multiplies the value of the port #1 reading times the constant 5. Simple calibration corrections can be easily programmed with the multiplication operator and numeric constants like P2*.9999532 or P3*1.000347.

“/” – Division. The “/” character operates to divide one value, variable or expression by another. Example: P1/2 divides the value of port reading #1 by the constant 2.

“)” and “(“ – Right and Left Parenthesis. As feature formulas become longer and more complex, parenthesis are necessary to define the order of calculations within the formula. Example #1: $(P1+P2+P3)/3$ sums the values of port readings #1, #2 and #3 first and then divides the result by the constant 3, effectively calculating an average of the three readings. Example #2: $SQR(P1^2+P2^2)$ calculates the square root of the sum of the squares of port readings #1 and #2. The formula could also be written with additional parenthesis as $(SQR((P1^2)+(P2^2)))$ for added clarity.

“S” – Sine. The SIN function is a trigonometric function that calculates the SINE of a following angular value, variable or expression stated in degrees. When selected, the SIN function is entered into the formula with a “left parenthesis” automatically following. You are required to add the “right parenthesis” following whatever value, variable or expression is specified after the SIN operator. Example: $P1*SIN(45)$ would multiply port reading #1 times the sine of the constant 45 degrees.

“C” – Cosine. The COS function is a trigonometric function that calculates the COSINE of a following angular value, variable or expression stated in degrees. When selected, the COS function is entered into the formula with a “left parenthesis” automatically following. You are required to add the “right parenthesis” following whatever value, variable or expression is specified after the COS operator. Example: $P1*COS(60)$ would multiply port reading #1 times the cosine of the constant 60 degrees.

“T” – Tangent. The TAN function is a trigonometric function that calculates the TANGENT of a following angular value, variable or expression stated in degrees. When selected, the TAN function is entered into the formula with a “left parenthesis” automatically following. You are required to add the “right parenthesis” following whatever value, variable or expression is specified after the TAN operator. Example: $P1*TAN(30)$ would multiply port reading #1 times the tangent of the constant 30 degrees.

“s” (lower case) – ArcSine. The ASN function is a trigonometric function that calculates the angle in degrees from the following value, variable or expression stated as a SINE value. When selected, the ASN function is entered into the formula with a “left parenthesis” automatically following. You are required to add the “right parenthesis” following whatever value, variable or expression is specified after the ASN operator. Example: $ASN(P1)$
Assuming the port #1 reading is a linear measure of a sine value, the formula would convert the port reading #1 to a measure of degrees.

“c” (lower case) – ArcCosine. The ACN function is a trigonometric function that calculates the angle in degrees from the following value, variable or expression stated as a COSINE value. When selected, the ACN function is entered into the formula with a “left parenthesis” automatically following. You are required to add the “right parenthesis” following whatever value, variable or expression is specified after the ACN operator. Example: $ACN(P1)$
Assuming the port #1 reading is a linear measure of a cosine value, the formula would convert the port reading #1 to a measure of degrees.

“t” (lower case) – ArcTangent. The ATN function is a trigonometric function that calculates the angle in degrees from the following value, variable or expression stated as a TANGENT value. When selected, the ATN function is entered into the formula with a “left parenthesis”

automatically following. You are required to add the “right parenthesis” following whatever value, variable or expression is specified after the ATN operator. Example: ATN(P1)
Assuming the port #1 reading is a linear measure of a tangent value, the formula would convert the port reading #1 to a measure of degrees.

Formula Errors:

Formula errors can be produced under a variety of circumstances. Common formula errors are misplaced or missing parenthesis (there has to be as many left hand parenthesis in a formula as there are right hand), division by zero, attempts to calculate infinite values (like the Tangent of 90 degrees) or attempts to calculate ArcSine or ArcCosine of a value greater than 1. Under these circumstances the unit will simply return a zero value as the formula result if an error has been produced. The displayed reading may or may not be zero depending on the Preset or Zero setting for the particular feature. If after entering a formula, the display seems to be locked (always displaying the same result when the tool is moved), the likely cause is an erroneous formula definition.

2) Preset

This selection allows the entry or editing of the feature preset (or zero) value. A screen is displayed showing the current Preset value for the particular feature. A new value may be entered using the numeral keys (0-9), the decimal point and the polarity (+/-) keys on the numeric keypad. The CLEAR key will clear the currently displayed value to zero. The ENTER key is used when the value has been entered and is to be saved. The F5:Exit key will exit the Preset entry screen WITHOUT saving any changes.

3) Resolution

This selection allows setting of the feature measurement resolution. A screen is displayed showing the first nine available measurement resolution selections. The F1:Next key will present another nine available resolution settings. At this second screen, the F1 key is labeled “Back” and will return to the first set of selections. The selections offered are either in inch increments or millimeter increments depending on the inch / millimeter setting of the unit. The selections are numbered in the menu and selected with the corresponding numeral keys (1-9) on the keypad.

It is important to recognize that the resolution selection is applied to the “Feature” result and not the port or ports used to generate the feature result. The port readings themselves are always made with the measurement resolution for which the particular tool is set. The feature formula and preset value may transform the reading from a port or ports into a completely different sort of measurement. For example, port readings over a short measurement range of +/- .010” may be mathematically manipulated into angular readings ranging from maybe 0 to 180 degrees. Although the ports may be taking readings in inches, with 5 decimal place accuracy, the calculated angular result may only be usable with maybe 1 or even no decimal places displayed. A total of eighteen different resolution settings are offered for both the inch and metric display modes to accommodate a wide variety of situations.

4) Tolerance Limits

This selection allows entry or editing of the low and high tolerance limits for the feature. A screen is displayed first showing the current Low Limit. A new value may be entered using the numeral keys (0-9), the decimal point and the polarity (+/-) keys on the numeric keypad. The

CLEAR key will clear the currently displayed value to zero. The ENTER key is used when the value has been entered and is to be saved. Once the Low Limit is entered, the High Limit is entered or edited in the same manner.

The tolerance limits operate in relation to the feature Preset value. If the feature Preset value is set to zero the tolerance limits would be entered as “comparative” (plus and minus) limits. Example: Low Limit = $-.001$, High Limit = $+.001$. If the Preset is some actual dimension (like 3.5000) and the tolerance is $\pm .001$, then the limits would be entered as actual dimensions. Example: Low Limit = 3.499, High Limit = 3.501.

Both limits can be positive, or both negative. The high limit entered must be of greater (more positive) value than the low limit or an error message will be displayed.

The F5:Exit key will exit the Limits entry screen WITHOUT saving any changes.

5) Hold

This selection is used to set the default peak Hold mode for the feature. A screen is displayed showing the four HOLD setting options (MAX, MIN, TIR or OFF). The selections are numbered in the menu and selected with the corresponding numeral keys (1-4) on the keypad. This only sets the hold mode that will automatically be in effect for the feature when the unit is powered up. During “Individual” view operation, the hold mode for any particular feature may still be stepped through the four hold settings at will with the F3: Hold key.

6) Display Mode

This selection allows the user to choose either of two “Individual” view display modes for the feature. A screen is displayed offering the choice of a purely Digital (numeric) or Analog (meter style) display format. The choice depends on the application and user preference. Typically, digital display format is preferred for measurements that are static in nature. The analog format is typically preferred when the measurement is moving as a part feature is scanned in different positions.

The increment size and span range of the analog meter display is variable and based on the current resolution setting for the feature. The meter span range is always ± 50 resolution increments. Example: In inches mode, with a resolution setting of $.000005$ ” (five millionths of an inch) the meter span is $\pm .00025$ ”, in millimeter mode, with a resolution setting of $.001$ mm (one micron) the meter span is $\pm .05$ mm.

The meter is always displayed with “zero” at the center, positive values to the right and negative values to the left. The value of “zero” on the meter will always be equal to the feature Preset value. The upper and lower tolerance limits for the feature will be visible on the analog meter as limit marks above the meter scale. For the limit marks to be visible, a feature resolution setting must be chosen so that the limits are within the span range of the analog meter. The digital value for the measurement is still displayed under the analog meter, but in a smaller format than that displayed in Digital mode,

F2: OFF/ON (Enabling / Disabling a feature)

At the feature setup summary screen, this function will toggle between enabling or disabling (turning on or off) the particular feature. During “Individual” view operation, disabling unused or unwanted features will make the STEP function skip past them effectively removing them from

the step sequence. During “Multi” view operation, disabling unused or unwanted features will make the display update faster.

F4: Copy (Copying a feature)

This function offers a fast way to create multiple feature setups that are similar. Often, a multiple feature setup will have many features that share similar settings. For instance, if all features have the same +/- .005 tolerance limits, .0002 resolution setting and Analog display mode, the COPY feature can be used to quickly create these similar feature setups. First, edit one feature to have the basic parameter settings you want. Then, while viewing the feature setup summary screen for that feature, press the F4: COPY key. The display will request you to “Enter feature # to Overwrite”. Enter the number of the feature to receive the copied information by pressing the corresponding numeral key (1-8) on the keypad. Repeat this for other feature numbers that should receive the same similar setup. Once complete, the individual features may be further edited with only the changes unique to the individual features, like the formula definitions.

F5: Exit

The F5: Exit key will back out from the feature setup summary screen and return to the main Setup menu.

7) Probe (Port) and Feature Groups

Multiple groups of probe or feature values may be defined for the purpose of determining which readings from within a group are the highest or lowest. This simplifies inspection setups for many flatness, straightness and alignment applications. When this menu function is selected, a screen is displayed showing four different “probe groups” (#1-4) and four different “feature groups” (#5-8). “Feature Groups” only operate for “Multi” view applications. Selection of the group to be edited is made with the corresponding numeral keys (1-8) on the keypad. A screen is displayed first showing the current group code. A new value may be entered using the numeral keys (0-8) keys on the numeric keypad. The CLEAR key will clear the currently displayed code to zero. The ENTER key is used when the code has been entered and is to be saved. The F5: Exit key will exit the group entry screen WITHOUT saving changes.

A group is defined by entering a code string of numerals that correspond to the individual probe or feature numbers to be included in the group. Example: If probes #3, #4 and #7 are to comprise a group, the numeric code to be entered would be “347”. Once a group (or groups) has been defined, the formula operators “N” (Group Minimum) and “X” (Group Maximum) can be used in feature formulas to work with these minimum or maximum values. Any group is rendered inactive and ignored when the group code is set to zero only. A feature group can only contain feature numbers lower than the feature number that uses the group. For example, if the formula for Feature #4 specifies “N6” (minimum of group #6), then the group code for group #6 can only contain the feature numbers 1, 2 and 3.

In some applications like flatness measurement, it may not be enough to simply calculate the difference between maximum and minimum probe readings for the result. One typical flatness measurement situation has multiple probes mounted in a fixture. The fixture itself has some fixed contacts that rest on the planar surface to be measured and establish a reference plane. The multiple probes then also contact this surface. The probes are all zeroed when this fixture is in contact with some known-flat master surface. When put in contact with a sample surface to be measured, if the highest probe in the group reads +.002 and the lowest probe in

the group reads -.004, the flatness can be called the difference between them, or .006. However, if the highest probe reads +.005 and the lowest probe reads +.003, the difference would be only .002. Remembering that we have fixed reference points on the fixture at the “zero” plane, .002 would be an incorrect result for the flatness. In this situation, the value “zero” must always also be considered as an additional probe reading. Then, the highest reading would be +.005 and the lowest reading would be zero, for a difference of .005 and a correct flatness result.

To accomplish this, the value “zero” can be defined within a group like it is an additional reading that always reads zero. The value “zero” can be included in any group by the addition of the numeral zero at the end of the group code. Using the group code programming example above (“347”), to include zero, it would be entered “3470”. Many group MAX / MIN applications do not require the inclusion of “zero” as a probe value.

RS232 Port Details: ADVANCED OPERATION MODE

The Metrology Processor is equipped with a RS-232 serial data output port. Data may be transmitted electronically to other devices such as data collectors, personal computers or SPC systems.

Data Output Connector Wiring:

The 9 pin female "D-Sub" connector is organized and wired as follows:

Metrology Processor pin#, name	Connects to device pin name

2 - Transmitted Data (output)	Received Data (input)
3 - Received Data (input)	Transmitted Data (output)
5 – Ground	Ground
All other pins are not connected	

The data communications protocol is fixed as:
9600 baud, 8 data bits, 1 stop bit, no parity. No handshaking is implemented.

The character codes output are standard ASCII codes recognized by most data communications software and printers. The data output stream is always 16 characters long. The output is formatted as follows:

+.XXXXXX " (inch mode) +.XXXXmm (metric mode)

The first through twelfth characters form the reading value and are always a space, + or - polarity sign, decimal point ., or the numerals 0 through 9.

The thirteenth and fourteenth characters are always either a space followed by the inch mark " or the letters mm depending on Inch or Metric mode selection on the unit.

The fifteenth and sixteenth characters output are "Carriage Return" (decimal ASCII value 13) followed by "Line Feed" (decimal ASCII value 10).

With RS232 option #1 “Single” selected, the unit will output data each time the F2: DATA button is pressed. With RS232 option #2 “Stream” selected, and streaming turned on, the unit will output data continuously.

When operating in “Individual” view mode, only the measurement result for the currently selected feature is output. When operating in the “Multi” view mode, the 14 character measurement result for each active feature is output, one after another, with a single carriage return and line feed sequence following at the end of the transmission.

DIGITAL GAGE PORT WIRING

The 10 pin header connectors are wired as follows:

- 1 - Ground
- 2 - Data (input)
- 3 - Clock (input)(low when data valid)
- 4 - Ready (input)
- 5 - Request (output)

DIGITAL GAGE PORT DATA FORMAT

The digital gage ports are designed to accept data from Mitutoyo brand digital instruments or others conforming to their standard.

The data stream is expected to be a 13 digit (4 bit/digit) configuration. The data stream is bit serial starting from the LSB of digit #1 and terminating with the MSB of digit #13.

Digit 1- 4:All bits always high (FFFF).

Digit 5 :Sign 0=+, 8=-

Digit 6-11:Numeric data - BCD, 0-9, 6 digits

Digit 12 :Decimal point location - BCD, 2-5

Digit 13 :Unit - 0=Metric, 1=Inch

Relay connections (optional)

If the unit has been supplied with the MP-RLY option, a six-position terminal block connector on the rear panel is supplied for the relay contact connections. Two, single-pole, double-throw, relays are provided that work in conjunction with the tolerance limit conditions.

When operating in “Individual” view mode, Relay #1 is actuated when the measurement exceeds the High tolerance limit, Relay #2 is actuated when the measurement exceeds the Low tolerance limit.

When operating in “Multi” view mode, Relay #1 is actuated when any active feature measurement exceeds EITHER of the feature’s High or Low tolerance limits.

Both relays have a common contact, a normally open contact and a normally closed contact. The contacts are rated to switch up to 5 amps. The 6 position connector is wired as follows:

- | | |
|------------------------|------------------------|
| Pin 1 – Relay #1 (NC) | Pin 4 – Relay #2 (NC) |
| Pin 2 – Relay #1 (NO) | Pin 5 – Relay #2 (NO) |
| Pin 3 – Relay #1 (COM) | Pin 6 – Relay #3 (COM) |



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