Proven
DryCal
TECHNOLOGY

ML-One
User Manual

MesaLabs

Mesa Labs' Commitment

As a manufacturer of critical equipment, quality is the highest priority in our manufacturing process. Mesa Labs commits to providing creative, innovative thinking and the engineering and scientific expertise needed to produce gas flow-related products and solutions that are universally recognized for their superior performance, quality and value.

Proven DryCal technology is the recognized leader in gas flow measurement, providing the industry's most reliable products, service and solutions for professionals in environmental protection, workplace safety, industrial process control and laboratory calibration.

We strive to provide the closest NIST-traceable, legal defensibility of any flow calibration equipment manufacturer, and we actively maintain our NVLAP (NIST) ISO 17025 laboratory accreditation in order to support our claims and continually improve our quality system and laboratory proficiency. Thank you for purchasing our products. From all of us at Mesa Labs, best wishes for many years of accurate, defensible primary flow measurements.

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⫮ Accuracy
⫮ Reliability
⫮ Convenience

About Your ML-One

Congratulations! You've chosen the Met Lab Series ML-One, featuring Proven Bios DryCal technology. Like all Bios Dry-Cal primary standards, the ML-One is a positive displacement primary piston prover for gas flow measurements. Using patented Proven Bios DryCal® Technology, it combines the accuracy of a primary calibrator with unequaled speed and convenience, providing gas flow measurements with the touch of the screen. By nature, your ML-One performs a primary measurement of volumetric flow. However, since pressure variations within any measurement system can cause ambiguous results, the ML-One is generally used in a standardized mode, automatically converting its volumetric flow measurements to the flow that would exist under standard temperature and pressure conditions. An excellent tool for the calibration of instruments that read in mass flow, your ML-One measures flow from 5 ccm (Cubic Centimeters Per Minute) to 50,000 ccm within an accuracy of ±0.15% of reading standardized. Flow measurements can be taken manually (one reading at a time), or automatically in the continuous mode, with up to 100 measurements in an averaging sequence. The ML-One is controlled through an LCD touch screen or through the RS-232 or USB data port. For information regarding the metrology behind your ML-One, referred to as Proven Bios DryCal® Technology, please visit our web site, at www.drycal.com .

Precautions

• The ML-One internal components are designed to handle corrosive gases compatible with boro-silicate glass, 304 – 316 stainless steel and AFLAS® fluoroelastomer. When measuring corrosive gases the user must take appropriate laboratory safety procedures to contain and prevent inadvertent gas leakage from the ML-One and connecting plumbing.

• The ML-One is not designed to measure gas pressure above 16 psia (1103 mbar) or for gas flows above 50,000 ccm. If pressurization reaches 15.9psia (1096mbar), the following warning will appear on the display on the main control panel: OVERPRESSURE! If this occurs, remove the overpressure situation, then touch "Stop" on the LCD display to clear this warning.

• The ML-One does not contain user-serviceable parts and must be returned to Mesa's New Jersey, USA location for maintenance.

Unpacking Your ML-One

Your ML-One is a high accuracy primary standard, and has been shipped in Mesa's rugged, reusable shipping container. The ML-One weighs 62 lbs / 28 kilograms; unpacking by two people is recommended. The ML-One can be lifted from the shipping container by grasping the back or bottom of the unit. Your ML-One comes with the following:
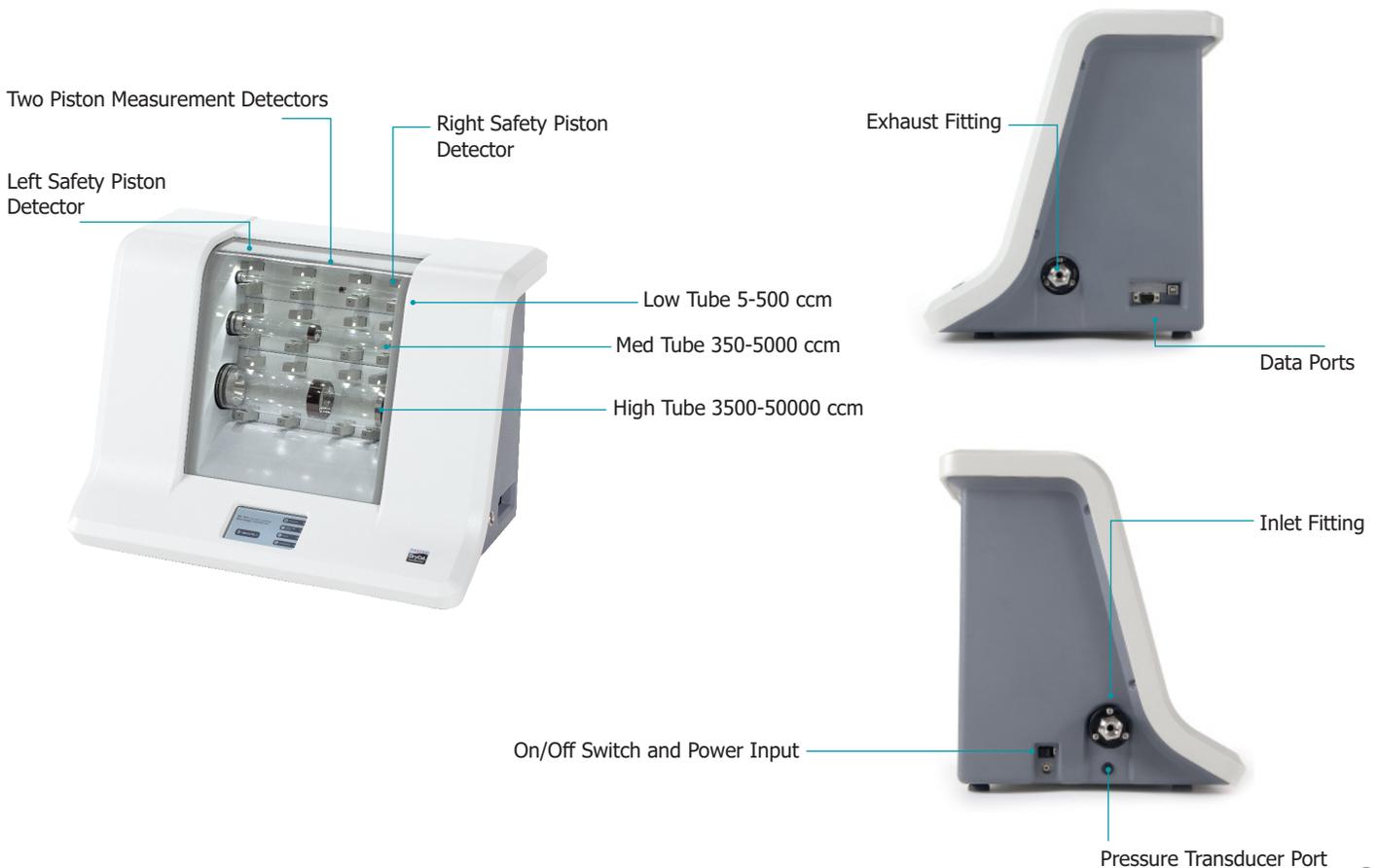
• AC Power Adapter

• PC Serial Cable (RS-232)

• Calibration Certificate

• Reusable shipping container

You can also utilize Mesa's DryCal Pro software package available for download from www.drycal.com. DryCal Pro software captures flow data from your Bios DryCal® instrument for easy export into common software packages. See page 9 for software requirements.

ML-One Introduction

The ML-One contains three measurement tubes for measuring gas flow rates from 5 to 50,000 ccm across a pressure range of 14 to 15.9 psia. The "High Flow" tube, located at the bottom, measures flow rates of 3,500 to 50,000 ccm, the middle "Medium Flow" tube measures flow rates from 350 to 5,000 ccm and the "Low Flow" tube, located at the top, measures flow rates from 5 to 500 ccm. The ML-One will select the correct measurement tube as flow readings are taken. Standardized flow rate corrections are made using the internal temperature and pressure transducers and the application of a compressibility factor correction.

Four piston detectors are used for each tube. The two inner piston detectors measure the time required to displace the piston a known volume/distance. From this time interval the volumetric flow rate is calculated. The two outer most piston detectors are used to initialize the piston position and as a safety in case of measurement piston detector failure. The piston detector assemblies also contain white LEDs that illuminate the active measurement tube. Small green LEDs located on the bottom arm of the piston detectors indicate internal valves activity. When a gas flow measurement is initiated two normally closed valves for the selected tube open and four flow control valves operate directing the gas flow. The piston oscillates between two piston measurement detectors and the time interval required for the piston to sweep the calibrated tube volume provides the volumetric flow rate. A temperature transducer located at the gas stream entrance to the tube measures gas temperature. A precision pressure sensor measures gas pressure in the measurement tube. From the gas temperature, gas pressure and a compressibility factor the volumetric gas flow rate is converted to a standardized gas flow rate. The ML-One is controlled by the front panel touch screen or through commands sent through the Data Port.

Two Piston Measurement Detectors

Right Safety Piston Detector

Left Safety Piston Detector

Low Tube 5-500 ccm

Med Tube 350-5000 ccm

High Tube 3500-50000 ccm

Exhaust Fitting

Data Ports

Inlet Fitting

On/Off Switch and Power Input

Pressure Transducer Port

Locating the ML-One

Your ML-One can be placed on a steady, secure work surface or mounted on a work cart for portable use. The ML-One has self adjusting feet on its base. The inlet gas fitting (1/2" VCR® fitting) is located on the left side, the outlet gas fitting (1/2" VCR® fitting) is located on the right side. Remove the protective caps and connect to the gas source. The outlet port can be connected to an exhaust line or left open if inert safe gases are being measured. When measuring hazardous gases the ML-One should be placed in a vent hood as a safety precaution. The ML-One can also be operated at sub atmospheric pressures as a safety precaution against accidental gas leakage.

Power

Plug your AC power adapter (supplied) into an AC wall outlet, and insert the DC output cord into the input power connection on the left side of the ML-One. Turn on the ML-One with the ON-Off switch located on the right side of the unit.

Pressure Transducer Port

Located below the Gas In fitting is a test port for connecting to the internal pressure transducer. This is used for verifying the accuracy of the pressure transducer see DIAGNOSTICS screen.

Data Ports

A USB and a RS-232 interface are located on the right side of the ML-One. The data ports allow for control of the ML-One and for recording flow readings. See appendix A for details on ML-One data port commands. The USB to serial driver has to be loaded to enable the USB in your ML-One to communicate to a PC. Use the included CD and run the driver suitable to your operating system.

Getting Started

The power switch is located on the left side of the unit. When powered up an introduction screen appears followed by the home screen.

Operation Screen:

• Select the Language to be displayed on the touch screen. Touch the arrows to scroll through the available languages.

• Select the default measurement mode: (Single) take a single reading, (Burst) take a series of consecutive readings equal to the number of readings selected in the average, or (Continuous) take continuous readings.

• Select REMOTE to set the ML-One control from the Data Port. Note: Once in remote mode the touch panel is inactive until a command is sent to the data port to return control to the touch screen interface or the ML-One is power cycled.

Home Screen

Touch to go to MEASURE, OPERATION, DATE/ TIME DELAY, ABOUT or DIAGNOSTICS screen.

Operation Screen

Touch CONFIRM to save changes or Home to return to the home page without saving the changes.

Date/Time Delay Screen:

• Set the Date, touch Date to highlight Day/Month/Year. Use the up and down arrows to set the highlighted segment.

• Set the Time, touch Time to highlight hour/minute/ AM-PM. Use the up and down arrows to set the highlighted segment.

• Delay: When taking continuous or burst readings the MLOne will wait the entered delay interval between readings.

About Screen:

• Displays the serial number of the ML-One.

• Displays the firmware revision.

• Displays the revision of the touch screen firmware.

• Displays the date when the ML-One was last calibrated and the authorized calibration laboratory that performed the calibration.

• For each tube the number of measurements taking since the last calibration is displayed followed by a calibration number associated with the tube. The calibration number represents the volume swept by the piston during a measurement.
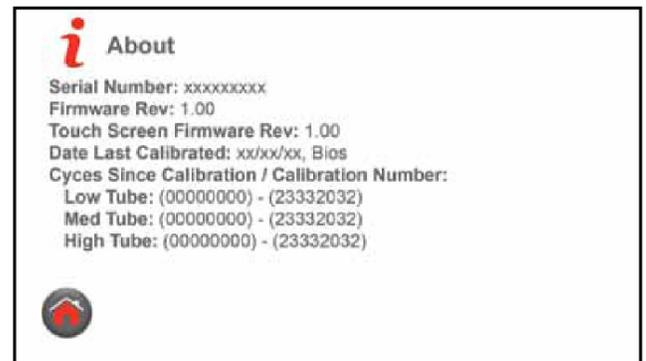
Diagnostics Screen:

• Observe the reading of the pressure transducer

• Observe the temperature sensor readings for each tube; the temperature transducers are located at the center of the incoming gas flow stream for each tube.

• Observe the readings from the twelve optical piston detectors. Each tube has four detectors two center measurement detectors are used for timing the piston displacement during a flow measurement. The right and left most detectors are used to initialize the piston location and as a safety in case a measurement detector fails. Readings for the detectors should be between 300 and 1026 unless a piston is located under a sensor in which case the reading should be less then 50.

• Touch (OPEN EXTERNAL PRESSURE TAP) connects the internal pressure transducer to the pressure port on the left side of the ML-One under the inlet fitting. This allows the user to connect a reference pressure indicator to the internal pressure transducer for verification.

• Touch (OPEN ALL FLOW VALVES) will set all of the internal valves to an open condition. This can be used to perform leak verification testing. After opening all of the internal valves the user would:

−−Cap the outlet port

−−Pressurized the ML-One to a maximum of 20 PSIA or have a vacuum applied.

−−Close the pressure source or vacuum source to the ML-One.

−−Observe that the vacuum or pressure in the ML-One is stable after allowing time for thermal stabilization of the captured gas.

• Touch (Valve Test) to be taken to a schematic diagram of the internal ML-One valves.

Date/Time Delay Screen

Touch CONFIRM to save changes or the home button to return to the home page without saving the changes

About Screen

Touch Home to return

Diagnostic Screen

Touch Home to return

Valve Test Screen:

The valve test screen provides a schematic representation of the ML-One. Each valve is shown as ▶◀

A valve symbol in red indicates the valve is open and a valve in gray indicates a valve is closed Touching a valve will change the state of the valve. Manual activation of individual valves can be used as a diagnostic tool to identify valve operation issues.

Measure Screen:

The measure screen is the screen from which measurements are taken and the user can select units of measure and change measurement settings. If the ML-One is being operated remotely the touch screen functions are inactive and the screen only displays measurement results.

Valve Test Screen

Touch Home to return

Measure Screen:

The flow reading is displayed. Touching the box allows the user to select Flow Units, Volumetric or Standardized Flow, Standardization-Temperature and Number in Average

Shows Gas Pressure and Temperature, touch the box to change units

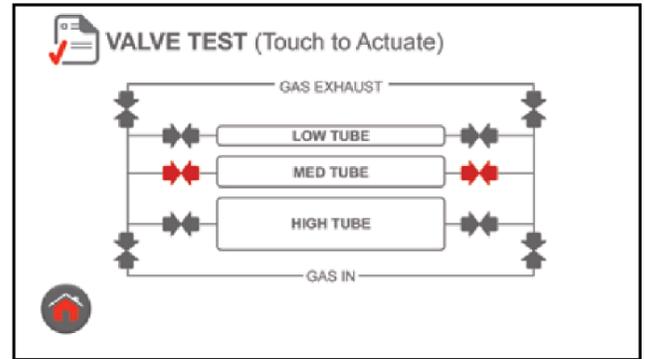Touch to select a gas compressibility factor correction

Press to start a reading

Touching selects the measurement tube. High Tube is default. The ML-One will auto change to a different tube if the flow is outside the tube's flow range.
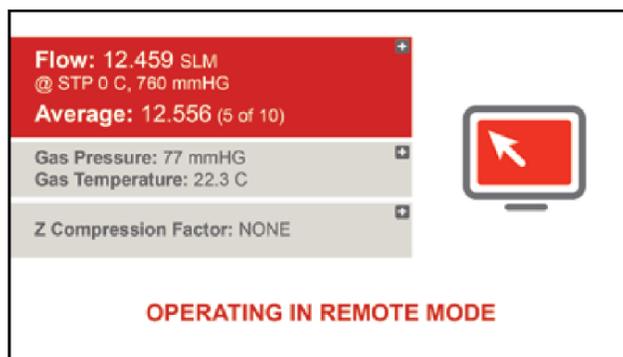
Press to toggle through measurement modes (Single, Burst, Continuous)

Measure Remote Mode Screen

Notes

Out of Range! If your Device Under Test is generating more flow than your ML-One's rated flow range of 50,0000 ccm, the "Out of Range!" warning appears when you attempt to take a flow measurement. Immediately lower or disconnect the flow source.

Over Pressure! If your ML-One has an internal pressure that is greater than 14.9 psiA the "Over Pressure !" warning appears. This can occur before or during a flow measurement. You will need to determine the source of the over pressure. This is most likely caused by a restriction in the exhaust flow path.

Program The recessed Program button, located on the rear of your ML-One, enables firmware updates. Please contact Mesa if you need a firmware update.

Reset Function If your ML-One fails to respond to commands, try resetting the unit by pressing the reset button on the back. This can be done easily with a bent paper clip. Please note that resetting your ML-One will not affect your user settings. However, if you are in the middle of a calibration, your ML-One will return to the home screen and you'll need to initiate a new flow measurement.

Storage To store your ML-One for an extended period, please follow these guidelines:

• Always store it in a clean, dry place

• Cap Inlet and Outlet fittings

Taking Measurements Once you've finished customizing your ML-1500's SETUP and have confirmed your changes, select MEASURE to begin a set of measurements. MEASURE gives you access to the main menu, where you can choose between the following flow measurement options:

- Single. Each time the "Enter" button is pressed, one measurement is taken.

- Cont. When the "Enter" button is pressed, measurements continue automatically until stopped by the user.

- Burst. A single series of measurements is taken until the number of readings in the average is met.

To take a flow measurement, select the type of flow measurement you want, and then press ENTER. Your ML-1500 will begin talking flow measurements. When taking flow measurements, the previous measurement, the running average of all measurements and the number of measurements in the average are provided simultaneously. The flow-cell viewing window lights each time the piston rises, and you will hear the internal valve clicking open and closed at the beginning and end of each flow measurement. You can stop flow measurements at any time by choosing either PAUSE or RESET. PAUSE terminates the flow measurement but leaves the flow results on the screen and returns to the measurement menu. The set of measurements may be resumed where they were stopped by selecting SINGLE, CONT., or BURST . You may switch between continuous and burst modes at will but once single readings are selected RESET must be selected once or twice to return to the measurement menu to choose continuous or burst modes. RESET clears the screen, resets the average counter to 0, and returns to the measurement menu. From the measurement menu, selecting EXIT returns the main menu. Choosing SETUP in the main menu allows you to further customize your ML-1500's operation.

Using Sensor Factors Your ML-1500 is factory-calibrated with nitrogen or purified laboratory air, although you can run other gases, provided they are noncorrosive, noncondensing and noncombustible (like most primary standards, your ML-1500 is not intrinsically-safe). When calibrating an MFC or MFM using a surrogate or proxy gas (meaning the MFC or MFM was originally calibrated by the manufacturer for a gas other than what you are currently using), refer to the manufacturer's sensor factor. To enable your ML-1500 to scale its actual flow measurements to match the adjusted flow from the MFC or MFM, input the sensor factor into the ML-1500 before calibrating the MFC or MFM (see SETUP – Readings). Because a sensor factor other than your ML-1500's default value of 1.000 modifies the actual flow to a "reported" flow, an exclamation mark (!) will appear next to any ML-1500 measurement that is being adjusted according to a sensor factor when your display is set to Zoom (see SETUP, Preferences, Magnification). If your display is set to Detail, then no exclamation point appears. Rather, the sensor factor (SF) will be displayed, along with its value on the measurements screen along with the individual flow measurements.

Annual Maintenance and Calibration

Your ML-One is engineered to provide years of reliable service, with appropriate care and maintenance. Mesa recommends annual calibration by an ISO17025-accredited laboratory, such as Mesa Labs, to help ensure the best possible flow measurements, meet regulatory requirements and provide a bulletproof audit trail in the event of litigation. Should you encounter any problems with your ML-One, immediately contact Customer Service.

Recertification

Your ML-One is a precision measuring standard with moving parts machined to extremely close tolerances. Various environmental factors, product wear, drift of the temperature sensors and pressure transducers or inadvertent damage may adversely affect your ML-One's measurement accuracy or general performance. For these reasons, we highly recommend having your ML-One annually verified and serviced by our experienced personnel in Mesa Labs accredited ISO 17025 metrology laboratory, located in New Jersey, USA. For those applications subject to regulatory or ISO requirements, verification by our accredited laboratory provides you with assurance of measurement integrity. Please note that while many accredited gas flow measurement laboratories may be capable of properly verifying the accuracy of your ML-One, Mesa is the only authorized service center in the USA for Bios DryCal products. Outside the USA, please check with Mesa to determine if a local authorized Bios DryCal service center is available. Our elective Recertification program is a complete product service package that provides pre-validation at significant flow points; sensor calibration, full product testing, and available firmware upgrades; post-validation at significant flow points; and NIST-traceable Bios DryCal calibration certificates backed by Mesa Labs accreditation to ISO 17025, ANSI Z-540, and NIST Handbook 150 quality standards. Recertification includes a 90-day service warranty should any related labor or parts replacements prove faulty. Turnaround time is generally two weeks within Mesa's facility from the date we received your ML-One. To obtain current Recertification pricing, please contact Mesa at **973.492.8400**, or visit our web site at **www.drycal.com**. Please contact us to see if expedited service is available for an additional charge.

Sending Your ML-One to Mesa

Please contact Mesa for an RMA (return merchandise authorization) number before sending your ML-One to our factory for elective Recertification or other service. You can get an RMA number by email to **biosdrycal@mesalabs.com**, or by telephone at **973.492.8400**. Our web site address is **www.drycal.com**. Sending your ML-One to Mesa without an RMA number may result in return of the instrument without inspection or a substantial delay in service turnaround time. When requesting an RMA number, provide your ML-One serial number and revision level. Also describe any product issues you may be experiencing. Please keep in mind that Mesa will not begin evaluation and service of your ML-One until you have approved our formal RMA quote. If sending your ML-One for repair or evaluation (rather than elective Recertification), please contact Mesa for technical support or troubleshooting assistance prior to shipping the unit. We will first attempt to resolve the situation over the phone or via email. If you've provided us with a detailed description of your ML-One's issue and application details and we're unable to resolve the situation by phone or email, we'll issue you an RMA number for prompt return of your ML-One for evaluation. Please note that Mesa will make every attempt to verify your issue, as we want you to get the most out of your ML-One. However, if we are unable to detect a product issue or if we determine that the issue is application-related rather than product-related, we reserve the right to charge an evaluation fee.

Shipping

When shipping your ML-One, please use the reusable shipping container that was supplied with your unit. We highly recommend insuring the product against damage in transit, and using a standard freight carrier (e.g., FedEx, UPS) that provides tracking numbers and offers door-to-door delivery directly to Mesa. Please note that Mesa does not arrange, or pay for, shipment transfers from local airports to our facility, so we are not responsible for additional expense and transit time incurred through airport deliveries. Mesa is generally not responsible for freight costs associated with shipments to and from Mesa, except in certain instances; please contact us for information before initiating a shipment. Mesa isn't responsible for damage that may occur during shipment.

Appendix A: Specifications

Flow Range: 5–50,000 sccm*

    Low Tube: 5–500 sccm*

    Medium Tube: 350–5,000 sccm*

    High Tube: 3,500–50,000 sccm*

Accuracy Standardized Flow: 0.15% of reading and +/- 0.01 sccm

Measurement Gas Pressure: Atmospheric Pressure +/- .5 PSIA

Temperature Range Operating: 15 to 30°C

Temperature Range Storage: 0 to 70°C

Gas Compatibility: Gases compatible with (316/304 SS, borosilicate glass, Teflon, AFLAS elastomeric)

Compressibility Factor Correction: User selection of gases to apply compressibility factor correction for non-ideal gas behavior

Interface: Touch screen or via Commands through data port

Data Port Connections: RS-232 and USB

Inlet and Outlet Fitting: 1/2 inch VCR fitting

Approximate Measurement Interval: Flow dependent (.5 - 60 seconds) typical 2 seconds

Dimensions: 22" wide x 15" high x 13" deep

Weight: 62 lbs

Warranty: 1 year

* At a gas pressure of 760 mmHg, and a gas temperature of 25° centigrade with standardization temperature set to 21.1° centigrade.

DryCal Pro Software: DryCal Pro software captures flow data from your Bios DryCal® instrument for easy export into common software packages.

• Capture flow data from your Bios DryCal® directly to a PC and export the data to a Microsoft environment.

• Real-time data monitoring

• Enter flow rates from pumps or other flow source and calibrate the flow source.

• Enter flow data from a flow meter and compare the flow measurements from your Bios DryCal® precision calibrator.

• Upload the latest version of the firmware to your Bios DryCal®.

Visit Mesa's website to download your copy of DryCal Pro software (www.drycal.com). DryCal Pro captures flow data from your ML-One directly to a pre-configured table. The data can be exported to selectable Microsoft office environment.

To run DryCal Pro, you must have Windows® XP or 7, Microsoft Excel® 2003 and up, and a RS232 port, or if your PC does not have an RS-232 port you will need a USB to RS-232 adapter.

Appendix B: Data Port Commands

ML-One Bi-Directional Communications Protocol

To enable Mesa customers to integrate their ML-One primary piston prover with their unique applications, our ML-One come standard with a bi-directional communication protocol. Using ASCII commands sent through your ML-One's RS-232 serial port or USB port, this protocol enables you to control and customize your ML-One system's operation (serial cable supplied by Mesa). For your convenience, the ASCII commands are referenced in the following tables.

Commands

$SET COMM DC	
Purpose	Transfers the control of ML-One back to touchscreen
Syntax	$SET COMM DC<cr>
Parameters	None
Query reply	
Remarks	Stops flow measurements; Transfers the control of ML-One back to touchscreen
Example	$SET COMM DC<cr>
Reply	None

$RESET DC	
Purpose	Resets all flow measurements and flow averages
Syntax	$RESET DC<cr>
Parameters	None
Query reply	$ACK 0
Remarks	Stops flow measurements; clears the current flow measurement; resets the flow average and measurement number
Example	$RESET DC<cr>
Reply	None

$STOP DC	
Purpose	Stops flow measurements
Syntax	$STOP DC<cr>
Parameters	None
Query reply	$ACK 1
Remarks	Stops flow measurements
Example	$STOP DC<cr>
Reply	None

$GET DS DC	
Purpose	Initiates a single flow measurement and acquires the data stream
Syntax	$GET DS DC<cr>
Parameters	None
Query reply	
Remarks	Reads flow data, including: Flow; flow average; flow units; measurement number; number in the series, temperature; temperature units; pressure; pressure units; standardized (Std.) temperature; Std. temperature units; Gas compression factor; time; date; cell id;<cr><lf>
Example	$GET DS DC<cr>
Reply(Std.)	760.11,760.11,scc/m, 01,10, 23.1, C, 760.6, mmHg, 21.1, C,1.0005,12:35 PM,06/15/00,H<cr><lf>
Reply(Vol.)	760.11,760.11,cc/m, 01,10, 23.1, C, 760.6, mmHg, ,,,12:35 PM,06/15/00,H<cr><lf>

$GET PI DC	
Purpose	Reads the product information
Syntax	$GET PI DC<cr>
Parameters	None
Query reply	
Remarks	Reads product information, including: Product; model; serial number; revision level; calibration constant; stroke counter, <cr><lf>
Example	$GET PI DC<cr>
Reply	ML-One,H,100503,1.07,4902111210,00000508222<cr><lf>

$SET CELL DC	
Purpose	Sets the flow tube the measurement takes place
Syntax	$SET CELL DC X<cr>
Parameters	0-2, 0-Medium, 1-Low, 2-High
Query reply	None
Remarks	Determines the flow tube the measurement takes place
Example	$SET CELL DC 1<cr>
Reply	None

$SET GAS DC	
Purpose	Sets the type of gas being measured
Syntax	$SET GAS DC X<cr>
Parameters	0-21, 0-Air,1-NH3,2-Ar,3-CO2,4-CO,5-C2H6,6-C2H4,7-He,8-H2,9-CH4,10-N2,11-N2O,12-O2,13-C3H8, 14-C3H6,15-R14,16-R23,17-R116,18-RC318,19-SF6,20-SO2,21-Xe
Query reply	None
Remarks	Sets the type of gas being measured
Example	$SET GAS DC 1<cr>
Reply	None

$GET GAS DC	
Purpose	Reads the type of gas being measured
Syntax	$GET GAS DC<cr>
Parameters	None
Query reply	None
Remarks	Reads the type of gas being measured
Example	$GET GAS DC<cr>
Reply	1 (0-21, 0-Air,1-NH3,2-Ar,3-CO2,4-CO,5-C2H6,6-C2H4,7-He,8-H2,9-CH4,10-N2,11-N2O,12-O2,13-C3H8, 14-C3H6,15-R14,16-R23,17-R116,18-RC318,19-SF6,20-SO2,21-Xe)

$GET PRES DC	
Purpose	Reads the gas pressure in the flow tube
Syntax	$GET PRES DC<cr>
Parameters	None
Query reply	None
Remarks	Reads the gas pressure
Example	$GET PRES DC<cr>
Reply	759.9

$GET TEMP DC	
Purpose	Reads the gas temperature in the flow tube
Syntax	$GET TEMP DC<cr>
Parameters	None
Query reply	None
Remarks	Reads the gas temperature in the flow tube
Example	$GET TEMP DC<cr>
Reply	23.25, 23.23, 23.26

Command Not Recognized

If a command is not recognized, you'll receive the following return: !NAK 12.

Cable

The RS-232 serial cable connecting your ML-One to the PC should be a 1 to 1 connection, 9-pin d-sub female. A Null Modem cable should not be used.

Serial Interface

Baud Rate 9600

Data Bits 8

Parity None

Stop Bits 1

Flow Control None

Limited Warranty

The Met Lab Series ML-One is warranted to the original end user to be free from defects in materials and workmanship under normal use and service for a period of one year from the date of purchase as shown on the purchaser's receipt. The Met Lab Series ML-One's battery is warranted for six months from the original purchase date. If the unit was purchased from an authorized reseller, a copy of an invoice or packing slip showing the date of purchase may be required to obtain warranty service.

The obligation of Mesa Labs under this warranty shall be limited to repair or replacement (at our option), during the warranty period, of any part that proves defective in material or workmanship under normal use and service, provided the product is returned to Mesa Labs, transportation charges prepaid.

Notwithstanding the foregoing, Mesa Labs shall have no liability to repair or replace any Mesa Labs product:

1. That has been damaged following sale, including but not limited to damage resulting from improper electrical voltages or currents, defacement, misuse, abuse, neglect, accident, fire, flood, terrorism, act of God or use in violation of the instructions furnished by Mesa Labs;

2. When the serial number has been altered or removed; or,

3. That has been repaired, altered or maintained by any person or party other than Mesa Labs' own service facility or a Mesa authorized service center, should one be established.

This warranty is in lieu of all other warranties, and all other obligations or liabilities arising as a result of any defect or deficiency of the product, whether in contract or in tort or otherwise. All other warranties, expressed or implied, including any implied warranties of merchantability and fitness for a particular purpose, are specifically excluded.

In no event shall Mesa be liable for any special, incidental or consequential damages for breach of this or any other warranty, express or implied, whatsoever.

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