MATHESON

Precision Mass Flow Controller
Model 829 Series

Operating Manual

READ AND COMPLY WITH THESE INSTRUCTIONS
BEFORE INSTALLING, OPERATING, OR SERVICING

Note: Although we provide assistance on our products both personally and through our literature, it is the complete responsibility of the user to determine the suitability of any product to their application.

The manufacturer does not warrant or assume responsibility for the use of its products in life support applications or systems.

Warranty

This product is warranted to the original purchaser for a period of one year from the date of purchase to be free of defects in material or workmanship. Under this warranty the product will be repaired or replaced at manufacturer's option, without charge for parts or labor when the product is carried or shipped prepaid to the factory together with proof of purchase. This warranty does not apply to cosmetic items, nor to products that are damaged, defaced or otherwise misused or subjected to abnormal use. See "Application" under the Installation section. Where consistent with state law, the manufacturer shall not be liable for consequential economic, property, or personal injury damages. The manufacturer does not warrant or assume responsibility for the use of its products in life support applications or systems.

Conformity / Supplemental Information:

The product complies with the requirements of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC and carries the CE Marking accordingly. Contact the manufacturer for more information.

Thank you for purchasing a MATHESON Gas Flow Controller.

Please take the time to read the information contained in this manual. This will help to ensure that you get the best possible service from your instrument. This manual covers the following MATHESON instruments:

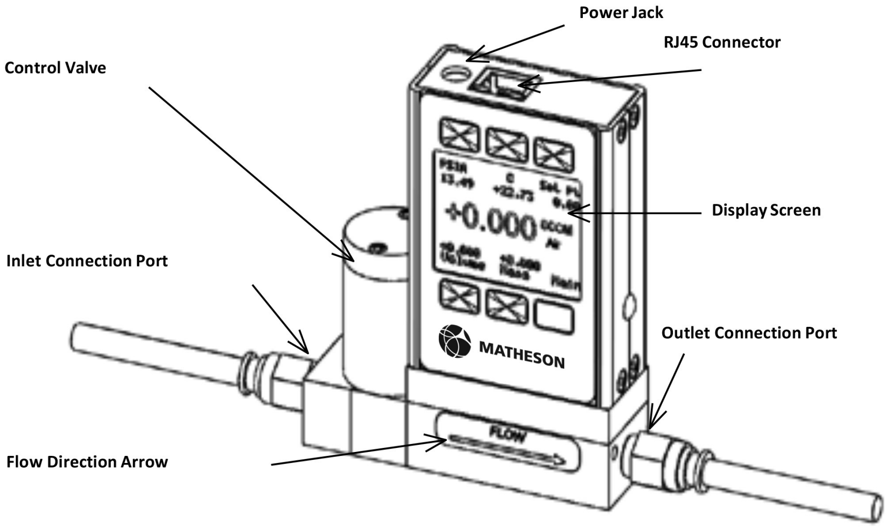
829-Series Mass Gas Flow Controllers

Unless otherwise noted, the instructions in this manual are applicable to all of the above instruments.

Full specifications for each device can be found on pages 45 and 46.

Please contact MATHESON at 1-800-828-4313 if you have any questions regarding the use or operation of this device.

GETTING STARTED



829 Mass Flow Controller shown with an upstream valve configuration and connection port fittings

MOUNTING

829-Series Gas Flow Controllers have holes on the bottom for mounting to flat panels. See pages 45-46.

Small valve controllers can usually be mounted in any position.

No straight runs of pipe are required upstream or downstream of the controller.

PLUMBING

Your controller is shipped with plastic plugs fitted in the port openings. To lessen the chance of contaminating the flow stream do not remove these plugs until you are ready to install the device.

Make sure that the gas will flow in the direction indicated by the flow arrow.

Standard 829-Series Gas Flow Controllers have female inlet and outlet port connections. Other fittings such as NPT, VCR, and other specialty fittings are available.

The inlet and outlet port sizes (process connections) for different flow ranges are shown on page 45.

Do not use thread sealing Teflon® tape on compression fittings.

On NPT threaded connections, do not wrap the first two threads. This will minimize the possibility of getting tape into the flow stream and flow body.

Do not use pipe dopes or sealants on the process connections as these compounds can cause permanent damage to the controller should they get into the flow stream.

When changing fittings, carefully clean any tape or debris from the port threads.

We recommend the use of in-line sintered filters to prevent large particulates from entering the measurement head of the instrument. Suggested maximum particulate sizes are as follows:

15 microns for units with FS flow ranges between 0-100 sccm and 0-1 slpm.
50 microns for units with FS flow ranges of 0-1 slpm or more.

PRESSURE

Maximum operating line pressure is 145psig (1 MPa).

If the line pressure is higher than 145 psig (1 MPa), use a pressure regulator upstream from the flow controller to reduce the pressure to 145 psig (1 MPa) or less.

CAUTION! ***Exceeding the maximum specified line pressure may cause permanent damage to the solid-state differential pressure transducer.***

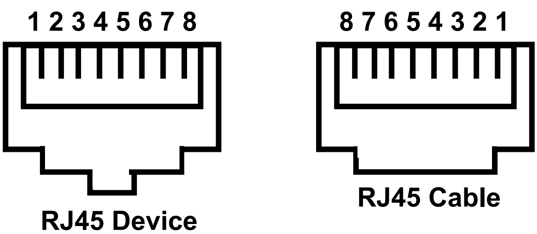
POWER AND SIGNAL CONNECTIONS

Power can be supplied to your controller through either the power jack or the RJ45 connector.

An AC to DC adapter which converts line AC power to DC voltage and current as specified below is required to use the power jack.

829 controllers require a 12-30Vdc power supply with a 2.1 mm female positive center plug capable of supplying 250 mA.

NOTE: 4-20mA analog output requires at least 15 Vdc.



1. **RS-232 Receive**
2. **Ground**
3. **Analog Output**
4. **RS-232 Transmit**
5. **Power Supply**
6. **Power Supply**
7. **Analog Input**
8. **Ground**

INPUT SIGNALS

Analog Input Signal

Apply analog input to Pin 7.

Standard 0-5 Vdc is the standard analog input signal. Apply the 0-5 Vdc input signal to pin 7, with common ground on pin 8.

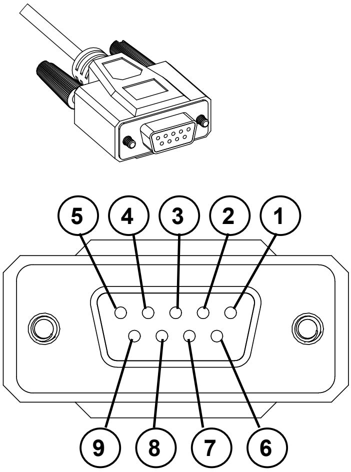
Optional 4-20 mA: If specified at time of order, a 4-20 mA input signal can be applied to pin 7, with common ground on pin 8.

NOTE: This is a current sinking device. The receiving circuit is essentially a 250 ohm resistor to ground.

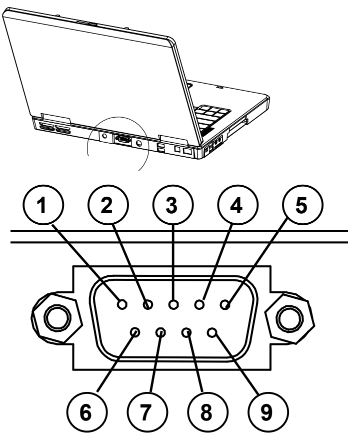
CAUTION! ***Do not connect this device to "loop powered"" systems, as this will destroy portions of the circuitry and void the warranty. If you must interface with existing loop powered systems, always use a signal isolator and a separate power supply.***

RS-232 Digital Input Signal

To use the RS-232 input signal, connect the RS-232 Output Signal (Pin 5), the RS-232 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown below. (See page 26 for details on accessing RS-232)



Serial Cable End



PC Serial Port

OUTPUT SIGNALS

RS-232 Digital Output Signal

To use the RS-232 output signal, it is necessary to connect the RS-232 Output Signal (Pin 4), the RS-232 Input Signal (Pin 1), and Ground (Pin 8) to your computer serial port as shown. (See page 26 for details on accessing RS-232 output.)

Standard Voltage (0-5 Vdc) Output Signal

829-Series flow controllers equipped with a 0-5 Vdc (optional 0-10 Vdc) will have this output signal available on Pin 3. This output is generally available in addition to other optionally ordered outputs. This voltage is usually in the range of 0.010 Vdc for zero flow and 5.0 Vdc for full-scale flow. The output voltage is linear over the entire range. Ground for this signal is common on Pin 8.

Optional Current (4-20 mA) Output Signal

If your controller was ordered with a 4-20 mA current output signal, it will be available on Pin 3. (See the Calibration Data Sheet that shipped with your controller to determine which output signals were ordered.) The current signal is 4 mA at 0 flow and 20 mA at the controller's full scale flow. The output current is linear over the entire range. Ground for this signal is common on Pin 8. (Current output units require 15-30Vdc power.)

DISPLAYS AND MENUS

The device screen defaults to **Main** display as soon as power is applied to the controller. Note: See page 24 to rotate the display 180°.

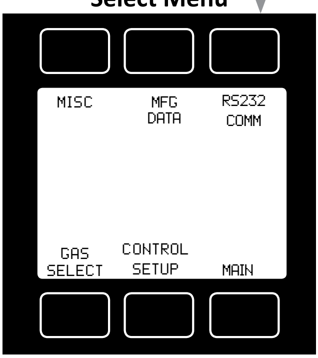
Main

The **Main** display shows pressure, temperature, set-point, volumetric flow and mass flow.

Pressing the button adjacent to a parameter will make that parameter the primary display unit.

By hitting the **MENU** button at the bottom right of the screen you will enter the **Select Menu** display.

Select Menu

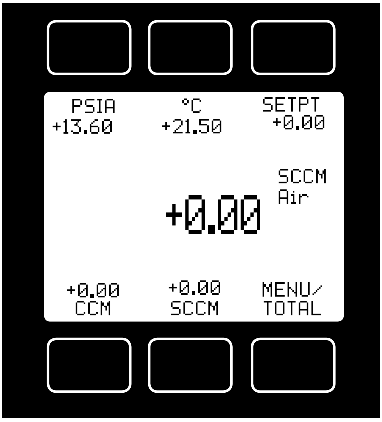


Select Menu

From **Select Menu** you can change the selected gas, interact with your RS-232 settings, read manufacturer's data or access the control set-up display.

Push **MAIN** to return to the Main display.

MAIN



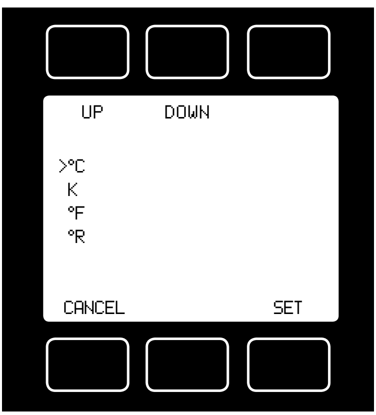
This mode defaults on power up, with mass flow as the primary displayed parameter.

The following parameters are displayed in the Main mode.

Gas Absolute Pressure: This sensor references hard vacuum and reads incoming pressure both above and below local atmospheric pressure. This parameter is moved to the primary display by pushing the button above **PSIA**.

The engineering unit associated with absolute pressure is pounds per square inch absolute (psia). This can be converted to gage pressure (psig) by subtracting local atmospheric pressure from the absolute pressure reading:

PSIG = PSIA – (Local Atmospheric Pressure)



Gas Temperature: 829-Series flow controllers measure the incoming temperature of the gas flow. The temperature is displayed in degrees Celsius (°C). This parameter is moved to the primary display by pushing the button above **°C**.

Pushing the button again allows you to select ºC (Celsius), K (Kelvin), ºF (Fahrenheit) or ºR (Rankine) for the temperature scale.

To select a temperature scale, use the UP and DOWN buttons to position the arrow in front of the desired scale.

Press SET to record your selection and return to the MAIN display. The selected temperature scale will be displayed on the screen.

Set Point: The set-point (**SETPT**)is shown in the upper right of the display.

For information on changing the set-point see SETPT SOURCE, page 14.

Volumetric Flow Rate: This parameter is located in the lower left of the display. It is moved to the primary display by pushing the button below **CCM** in this example. Your display may show a different unit of measure.

When using a mass flow controller as an absolute pressure controller, the mass flow rate may momentarily exceed the flow measurement capability (full scale + 28%) of the unit. this may occur when the unit is asked to make an abrupt pressure change.

Mass Flow Rate: The mass flow rate is the volumetric flow rate corrected to a standard temperature and pressure (typically 14.696 psia and 25 °C).

This parameter is located in the lower middle of the display. It can be moved to the primary display by pushing the button below **SCCM** in this example. Your display may show a different unit of measure preceded by the letter **S**.

To get an accurate volumetric or mass flow rate, the gas being measured must be selected. See Gas Select, page 18.

MENU: Pressing **MENU** switches the screen to the **Select Menu** display.

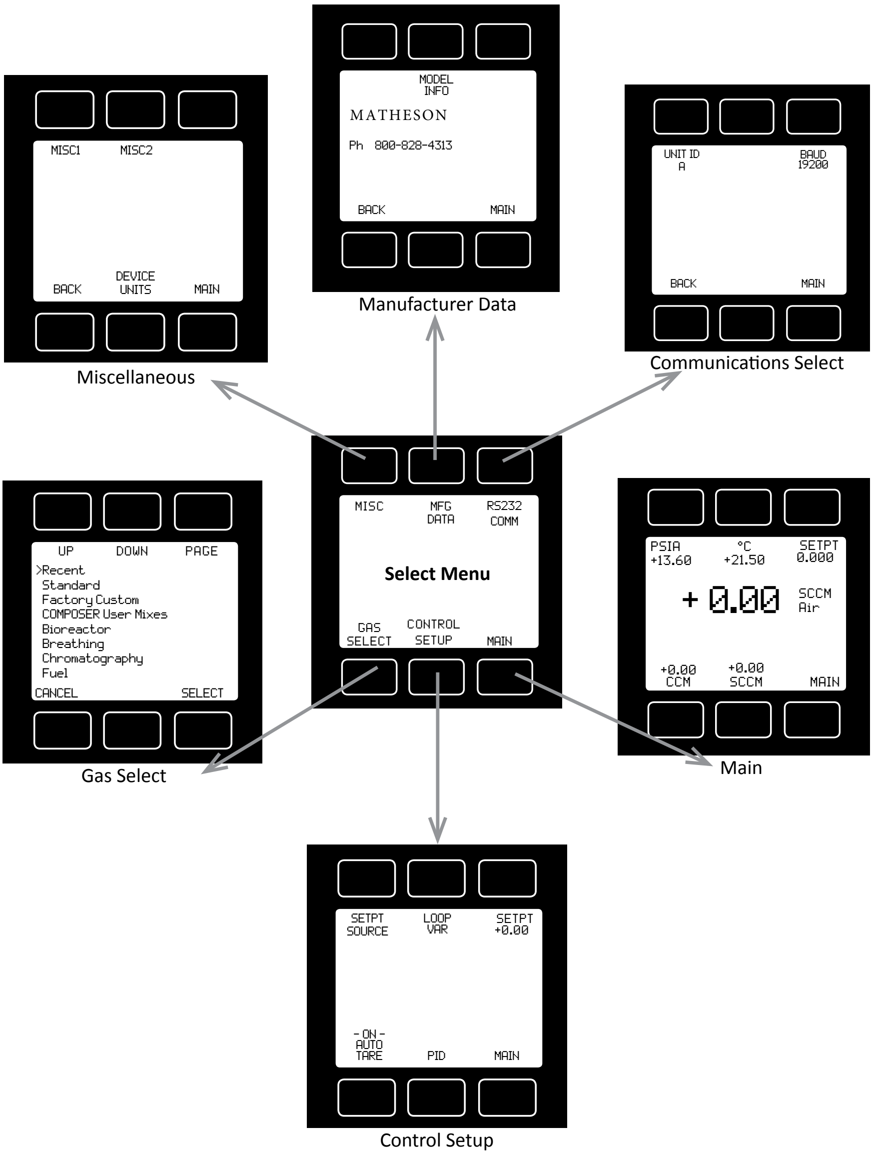
Flashing Error Message: An error message (**MOV** = mass overrange, **VOV** = volumetric overrange, **POV** = pressure overrange, **TOV** = temperature overrange) flashes when a measured parameter exceeds the range of the sensor. When any item flashes, neither the flashing parameter nor the mass flow measurement is accurate. Reducing the value of the flashing parameter to within specified limits will return the unit to normal operation and accuracy.

If the unit does not return to normal operation contact MATHESON.

SELECT MENU

From Select Menu you can change the selected gas, interact with your RS-232 settings, read manufacturer's data and access the control setup and miscellaneous screens.

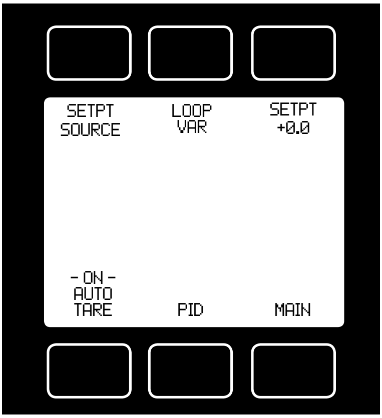
Press the button next to the desired operation to bring that function to the screen.



An explanation for each screen can be found on the following pages.

CONTROL SETUP

Control Setup is accessed by pressing the button below Control Setup on the Select Menu display. From this screen you can select your set-point source, choose a loop variable and adjust the PID terms.



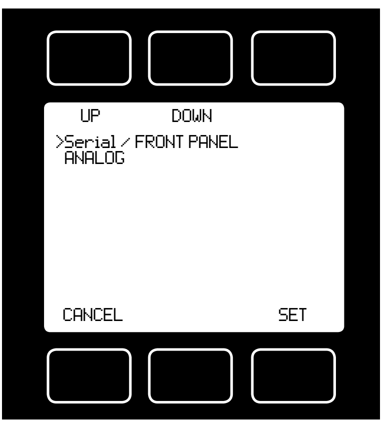
Press BACK to return to the Select Menu display.

Press MAIN to return to the MAIN display.

SETPT SOURCE – Pressing the button above SETPT SOURCE will allow you to select how the set point will be conveyed to your controller.

Use the line-up and line-down buttons to move the arrow in front of the desired option. Then press SET.

Press CANCEL to return to the previous display.



The controller will ignore any set-point except that of the selected set-point source and it will remember which input is selected even if the power is disconnected.

Serial refers to a remote digital RS-232 set-point applied via a serial connection to a computer or PLC as described in the installation and RS-232 sections of this manual. Use this setting with the **BCL-9** and control or mixing software.

Front Panel refers to a set-point applied directly at the controller.

Front Panel input must be selected prior to changing the set-point at the device.

Analog refers to a remote analog set-point applied to Pin 7 of the RJ45 connector as described in the installation section of this manual.

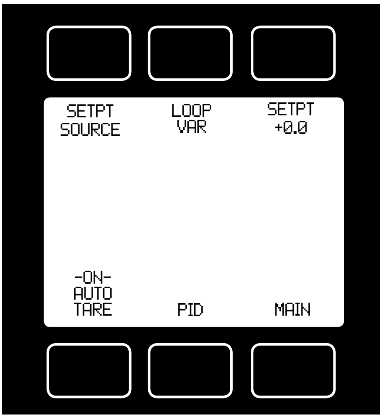
Use this setting when connecting to Matheson's **8284A Dynablender *Plus***, or **827A** single channel controller.

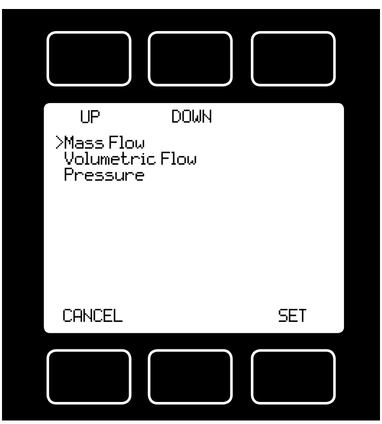
The standard analog input is 0-5 Vdc. If nothing is connected to Pin 7, and the controller is set for analog control, the device will generate random set-point values.

SETPT refers to the **set-point**. This parameter may be changed using the display only if **FRONT PANEL** is selected as the Input. Press **SETPT.** Then use SELECT to choose the decimal with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

CAUTION! ***Never leave a controller with a non-zero set-point if no pressure is available to make flow. The controller will apply full power to the valve in an attempt to reach the set-point. When there is no flow, this can make the valve very HOT!***

CONTROL SETUP (continued)





LOOP VAR—The selection of what variable to close the loop on is a feature unique to MATHESON mass flow controllers.

Pressing the **LOOP VAR** button on the Control Setup screen will allow you to change what variable is controlled.

Use the line-up and line-down buttons to move the arrow in front of the desired option.

When the mass flow controller is supplied with the **control valve upstream** of the electronics portion of the system, the unit can be set to control on outlet pressure (absolute pressures only) or volumetric flow rate, instead of mass flow rate.

The change from mass to volume can usually be accomplished without much, if any, change in the P and D settings.

When you change from controlling flow to controlling pressure, sometimes fairly radical changes must be made to the P & D variables. *See page 16 –* **PID TUNING***.*
Contact MATHESON if you are having difficulties with this procedure.

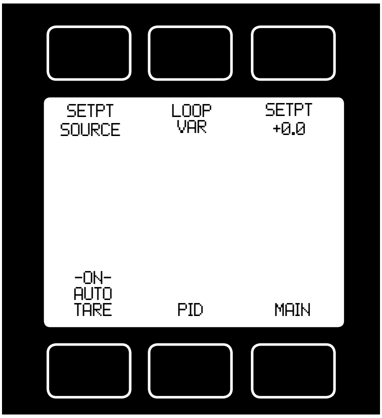
ON AUTO / OFF AUTO—refers to the standard auto-tare or "auto-zero" feature.

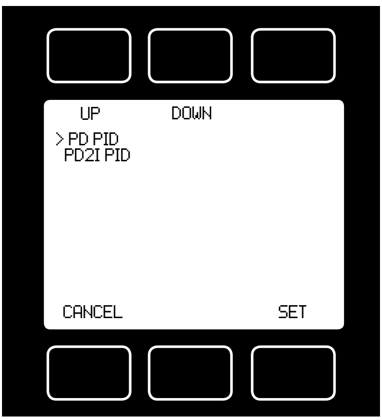
The auto-tare feature automatically tares (takes the detected signal as zero) the unit when it receives a zero set-point for more than two seconds.

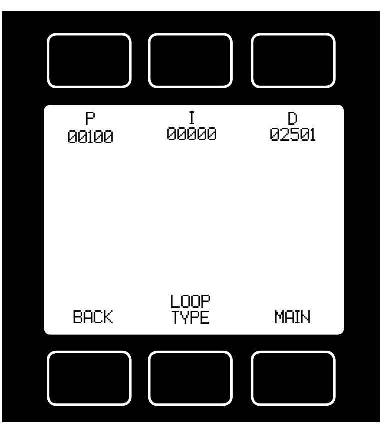
A zero set-point results in the closing of the valve and a known "no flow" condition. This feature makes the device more accurate by periodically removing any cumulative errors associated with drift.

It is recommended that the controller be left in the default auto-tare ON mode unless your specific application requires that it be turned off.

PID TUNING







PID Values determine the performance and operation of your proportional control valve. These terms dictate control speed, control stability, overshoot and oscillation. All units leave the factory with a generic tuning designed to handle most applications. If you encounter issues with valve stability, oscillation or speed, fine tuning these parameters may resolve the problem.

MATHESON controllers allow you to adjust the Proportional, Integral and Differential terms of the PID control loop.

To change the PID loop parameters, push the button below **PID**.

Press **LOOP TYPE.** Then use the UP and DOWN buttons to select the appropriate PID control algorithm. Press SET.

See the following page for descriptions of the PID Loop Types (PID Control Algorithms).

P refers to the Proportional term of the PID loop.

I refers to the Integral term of the PID loop.

D refers to the Differential term of the PID loop.

Press P, I or D. Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

Before changing the P, I or D parameter, please record the initial value so that it can be returned to the factory setting if necessary.

Valve tuning can be complex. If you would like assistance, please contact MATHESON for technical support.

The* PD *algorithm is the PID algorithm used on most MATHESON controllers.

It is divided into two segments:

The first compares the process value to the set-point to generate a proportional error. The proportional error is multiplied by the ‘P’ gain, with the result added to the output drive register.

The second operates on the present process value minus the process value during the immediately previous evaluation cycle. This ‘velocity’ term in multiplied by the ‘D’ gain, with the result subtracted from the output drive register.

The above additions to and subtractions from the output drive register are carried over from process cycle to process cycle, thus performing the integration function automatically.

Increasing the ‘P’ gain will **promote** the tendency of the system to overshoot, ring, or oscillate.

Increasing the ‘D’ gain will **reduce** the tendency of the system to overshoot.

The* PD2I *algorithm is a PID algorithm used primarily for high performance pressure and flow control applications.

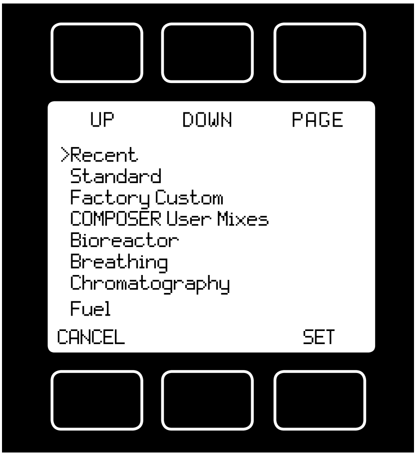
It exhibits two basic differences from the PD algorithm that most controllers utilize.

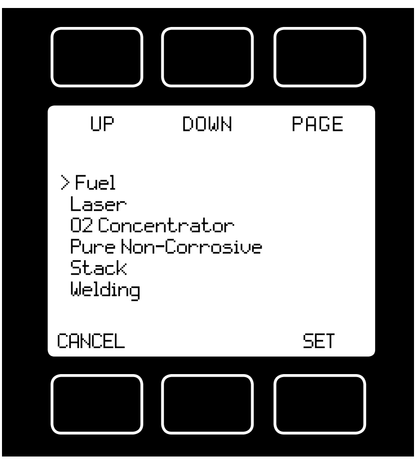
1. Instead of applying a damping function based upon the rate of change of the process value, it applies a damping function based upon the square of the rate of change of the process value.
2. The damping function is applied directly to the proportional error term before that term is used in the proportional and integral functions of the algorithm. This provides a certain amount of ‘look ahead’ capability in the control loop.

Because of these differences, you will note the following:

1. Increasing ‘P’ gain can be used to damp out overshoot and slow oscillations in pressure controllers. You will know that ‘P’ gain is too high, when the controller breaks into fast oscillations on step changes in set-point. On flow controllers, too high a ‘P’ gain results in slower response times. Too low a ‘P’ gain results in overshoot and/or slow oscillation. A good starting value for ‘P’ gain is 200.
2. If the unit was originally shipped with the PD2I algorithm selected, the ‘D’ gain value should be left at or near the factory setting because it relates primarily to the system phase lags. If you are changing from the default algorithm to the PD2I algorithm, you should start with a ‘D’ gain value of 20.
3. The ‘I’ gain is used to control the rate at which the process converges to the set-point, after the initial step change. Too low a value for ‘I’ gain shows up as a process value that jumps to near the set-point and then takes awhile to converge the rest of the way. Too high a value for ‘I’ gain results in oscillation. A good starting value for the ‘I’ gain is 200.

GAS SELECT™





Gas Select allows you to set your device to up to 150 standard gases and mixes. You can also use **COMPOSER** to program and store up to 20 additional gas mixes.

Gas Select is accessed by pressing the button below **GAS SELECT** on the Select Menu display.

To select a gas, use the UP and DOWN buttons to position the arrow in front of the desired gas category.

» Recent: Eight most recent selections
» Standard: Gases and mixes (page 39)
» Factory Custom: Present only if customer requested gases were added at the factory
» COMPOSER User Mixes: Gas mixes programmed by the user (page 19)
» Bioreactor (page 36)
» Breathing (page 37)
» Chromatography (page 39)
» Fuel (page 38)
» Laser (page 38)
» O2 Concentrator (page 39)
» Pure Non-Corrosive (page 34)
» Stack (page 39)
» Welding (page 35)

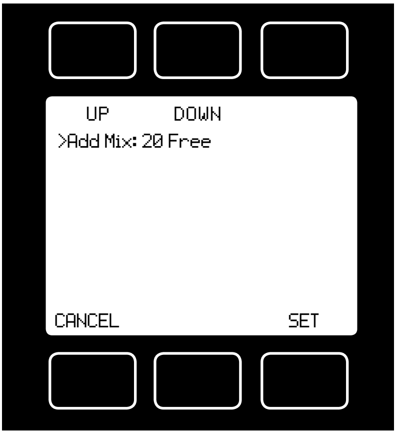
Press PAGE to view a new page in the gas category list.

Press SELECT to view the gases in the selected category. Align the arrow with the desired gas. Press SET to record your selection and return to the MAIN display. The selected gas will be displayed on the screen.

Note: Gas Select may not be available on units ordered with a custom gas or blend.

See pages 34-39 for a full list of gases in each category.

COMPOSER™

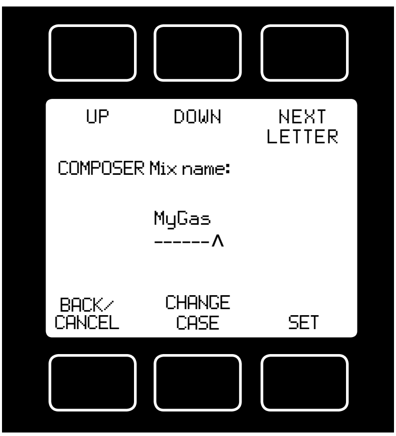


COMPOSER allows you to program and save up to 20 custom gas mixes containing 2 to 5 component gases found in the gas lists (pages 34-39). The minimum resolution is 0.01%.

COMPOSER is accessed by selecting **COMPOSER User Mixes** on the GAS SELECT display.

Press SET when the arrow is aligned with Add Mix.

Name the mix by pressing the UP and DOWN buttons for letters, numerals and symbols.

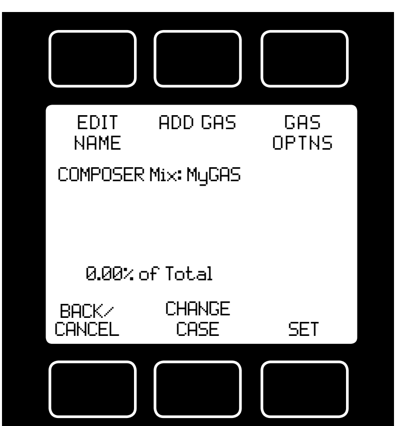


CHANGE CASE – Toggles the letter case. Letters remain in selected case until CHANGE CASE is pushed again.

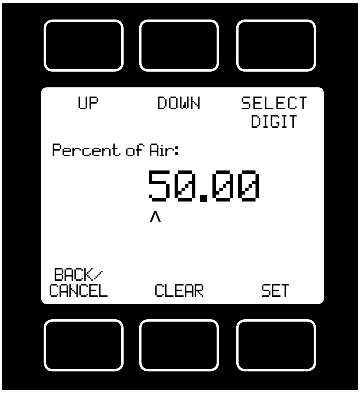
Press SET to save the name.

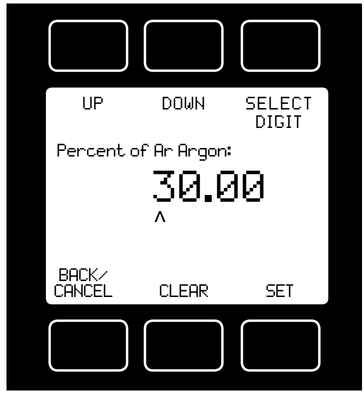
After naming the mix, press **ADD GAS** and select the gas category and the component gas.

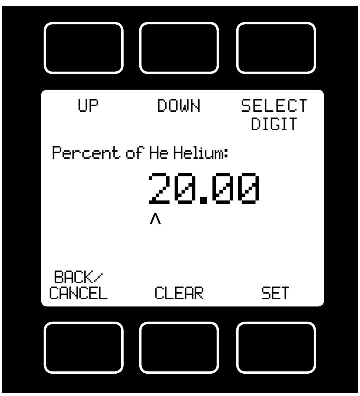
Select the digit with arrow and adjust the % with the UP and DOWN buttons. Press set to save. Add up to 4 more gases as needed. The total must equal 100% or an error message will appear.

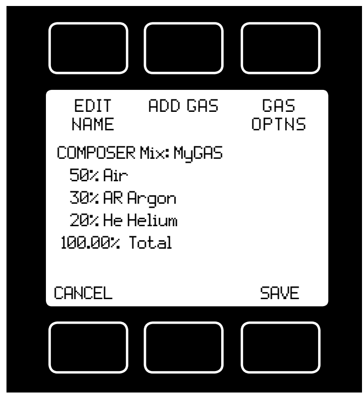


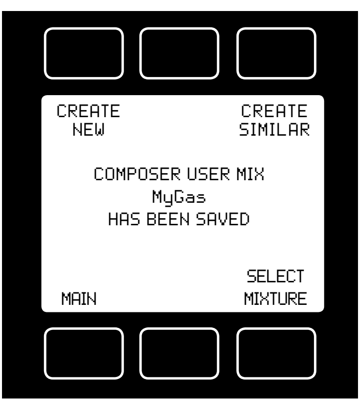
GAS OPTNS allows you to adjust the percentage of the constituents or delete a gas from the mix. Gas mixes cannot be adjusted after they have been saved.









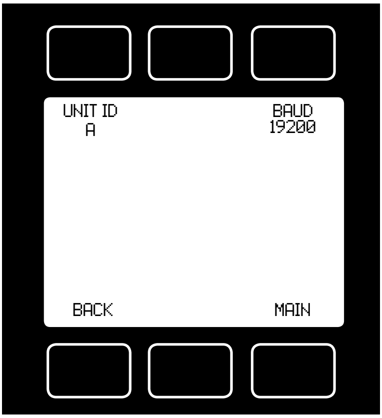


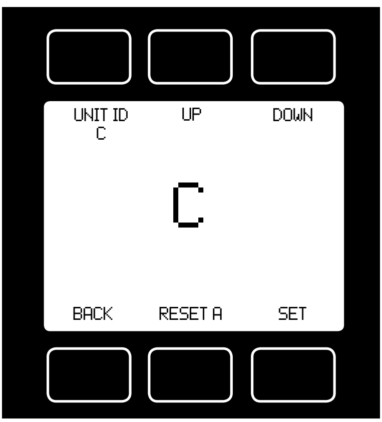
Once the mix has been saved, you may press **CREATE SIMILAR** to compose an additional mix based on the mix you have just saved. <u>This CREATE SIMILAR option is not available after leaving this screen.</u>

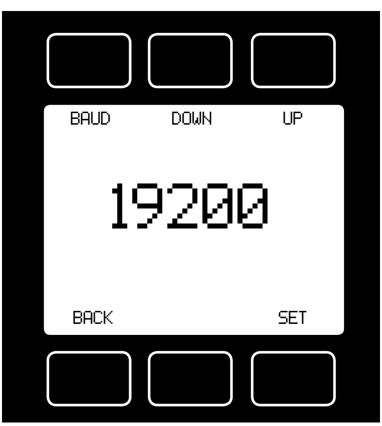
Press **CREATE NEW** to add a completely new mix.

Press **SELECT MIXTURE** to bring the custom mix onto the MAIN display.

COMMUNICATION SELECT







Access **Communication Select** by pressing the button above **RS232 COMM** on the **Select Menu** display.

Unit ID – Valid unit identifiers are the letters A-Z and @. The identifier allows you to assign a unique address to each device so that multiple units can be connected to a single RS-232 computer port.

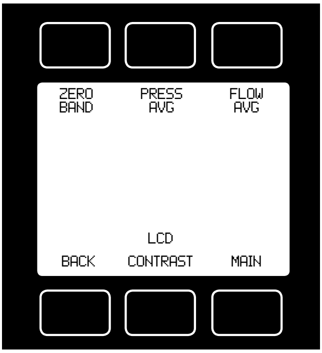
Press **UNIT ID**. Use the UP and DOWN buttons to change the Unit ID. Press SET to record the ID. Press Reset to return to the previously recorded Unit ID.
Any Unit ID change will take effect when Communication Select is exited.
If the symbol @ is selected as the Unit ID, the device will enter streaming mode when Communication Select is exited.
See RS-232 Communications (page 31) for information about the streaming mode.

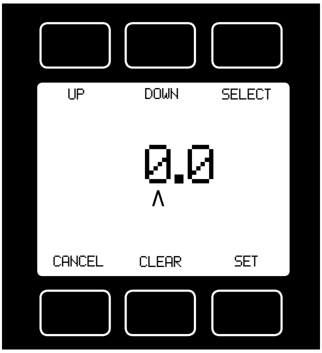
Baud – Both this instrument and your computer must send/receive data at the same baud rate. The default baud rate for this device is 19200 baud.

Press **BAUD**. Use the UP and DOWN buttons to select the baud rate that matches your computer. The choices are 38400, 19200, 9600, or 2400 baud. Press SET to record the baud rate.
Any baud rate change will not take effect until power to the unit is cycled.

MISCELLANEOUS

Miscellaneous is accessed by pressing the **MISC** button on the Select Menu display. Next select either **MISC1** or **MISC2.**





MISC1 will display as shown at left.

ZERO BAND refers to Display Zero Deadband. Zero deadband is a value below which the display jumps to zero. This deadband is often desired to prevent electrical noise from showing up on the display as minor flows or pressures that do not exist. Display Zero Deadband does not affect the analog or digital signal outputs.

ZERO BAND can be adjusted between 0 and 6.3% of the sensor's Full Scale (FS).

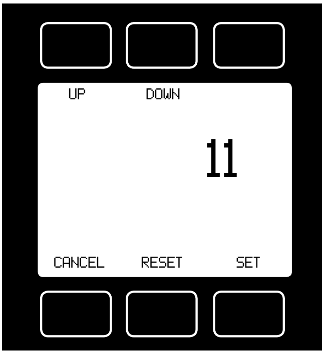
Press **ZERO BAND.** Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

Pressure Averaging and Flow Averaging may be useful to make it easier to read and interpret rapidly fluctuating pressures and flows. Pressure and flow averaging can be adjusted between 1 (no averaging) and 256 (maximum averaging).

These are geometric running averages where the number between 1 and 256 can be considered roughly equivalent to the response time constant in milliseconds.

This can be effective at "smoothing" high frequency process oscillations such as those caused by diaphragm pumps.

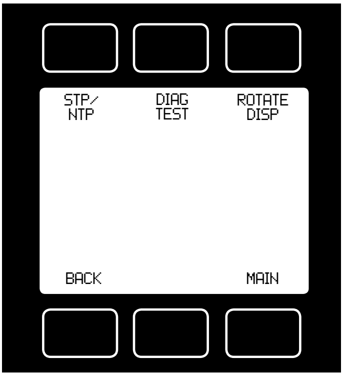
Press **PRESS AVG.** Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.



Press **FLOW AVG**. Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

Setting a higher number will equal a smoother display.

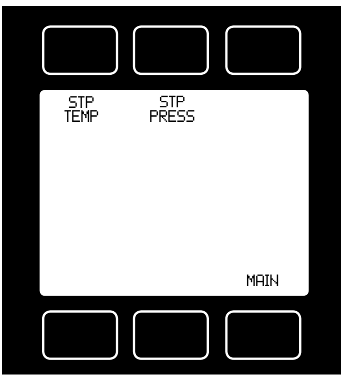
LCD CONTRAST: The display contrast can be adjusted between 0 and 31, with zero being the lightest and 31 being the darkest. Use the UP and DOWN buttons to adjust the contrast. Press SET when you are satisfied. Press CANCEL to return to the MISC display.



MISC2 will display as shown at left.

STP/NPT refers to the functions that allow your selection of *standard* temperature and pressure conditions or *normal* temperature and pressure conditions. This feature is generally useful for comparison purposes to other devices or systems using different STP parameters.

The **STP** menu is comprised of the **STP TEMP** and **STP PRESS** screens.



STP TEMP allows you to select from ºC, ºF, K or ºR. The arrow position will automatically default to the currently stored value.

The **NTP** menu is comprised of the **NTP TEMP** and **NTP PRESS** screens.

Once a selection has been made and recorded using the **SET** button, a change acknowledgement message will be displayed on screen.

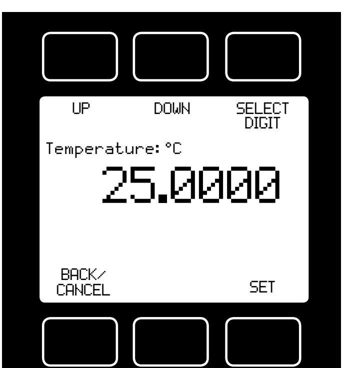
Selecting **MAIN** will revert screen to the Main display. If the **SET** selection is already the currently stored value, a message indicating that fact will appear.

STP PRESS enables you to select from a menu pressure settings. Use the UP/DOWN or PAGE buttons to view the settings.

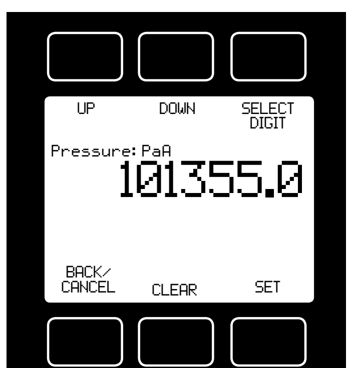
The arrow position will automatically default to the currently stored value.

Once a selection has been made and recorded using the **SET** button, a change acknowledgement message will be displayed on screen.

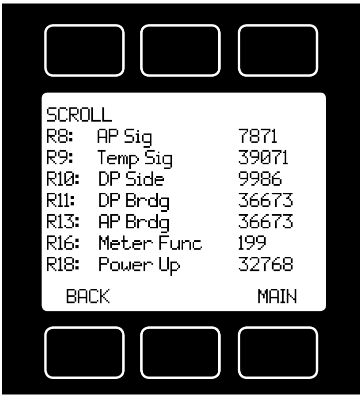
Pressing **SET** again will revert screen to the Main display. If the **SET** selection is already the currently stored value, a message indicating that fact will appear.



STP TEMP Display



STP PRESS Display



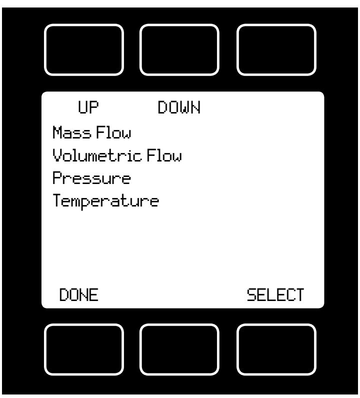
DIAG TEST: This diagnostic screen displays the current internal register values, which is useful for noting factory settings prior to making any changes. It is also helpful for troubleshooting with MATHESON customer service personnel.

Select the **DIAG TEST** button from the **MISC2** screen to view a list of select register values.

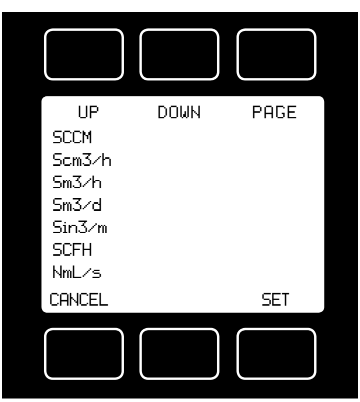
Pressing the **SCROLL** button will cycle the display through the register screens. An example screen is shown at left.

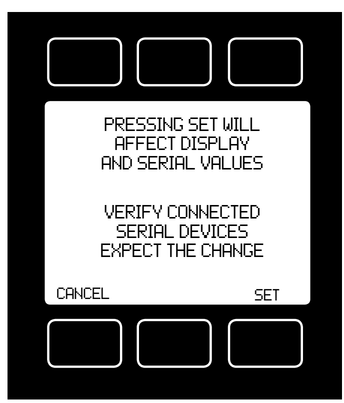
Press **ROTATE DISP** and SET to **Inverted 180°** if your device is inverted. The display and buttons will rotate together.

DEVICE UNITS



Press **DEVICE UNITS** to access menus of units of measure for each parameter. Scroll to the desired unit and press select. Once selected, you will see the message shown below. Verify that all connected devices expect the change.
See pages 40 and 41 for a full list of available units.





MANUFACTURER DATA

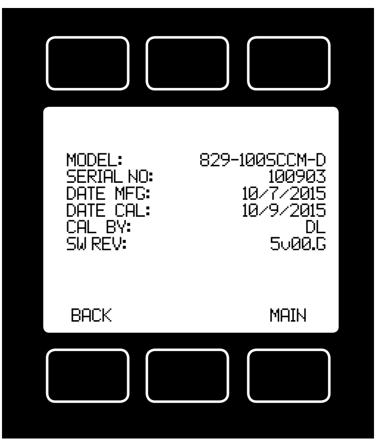
Manufacturer Data is accessed by pressing the **MFG DATA** button on the Select Menu display.

The initial display shows the name and telephone number of the manufacturer.

Press **MODEL INFO** to show important information about your flow device including the model number, serial number, and date of manufacture.

Press BACK to return to the MFG DATA display.

Push MAIN to return to the Main display.



RS-232 Output and Input

Configuring HyperTerminal®:

1. Open your HyperTerminal® RS-232 terminal program (installed under the "Accessories" menu on all Microsoft Windows® operating systems).
2. Select "Properties" from the file menu.
3. Click on the "Configure" button under the "Connect To" tab. Be sure the program is set for: 19,200 baud (or matches the baud rate selected in the RS-232 communications menu on the meter) and an 8-N-1-None (8 Data Bits, No Parity, 1 Stop Bit, and no Flow Control) protocol.
4. Under the "Settings" tab, make sure the Terminal Emulation is set to ANSI or Auto Detect.
5. Click on the "ASCII Setup" button and be sure the "Send Line Ends with Line Feeds" box is not checked and the "Echo Typed Characters Locally" box and the "Append Line Feeds to Incoming Lines" boxes are checked. Those settings not mentioned here are normally okay in the default position.
6. Save the settings, close HyperTerminal® and reopen it.

Streaming Mode

In the **default** Polling Mode, the screen should be blank except the blinking cursor. In order to get the data streaming to the screen, hit the "Enter" key several times to clear any extraneous information. Type "*@=@" followed by "Enter" (or using the RS-232 communication select menu, select @ as identifier and exit the screen). If data still does not appear, check all the connections and COM port assignments.

Streaming Mode – Advanced

The streaming data rate is controlled by register 91. The recommended default rate of data provision is once every 50 milliseconds and this is suitable for most purposes.

If a slower or faster streaming data rate is desired, register 91 can be changed to a value from 1 millisecond to 65535 milliseconds, or slightly over once every minute.

Below approximately 40 milliseconds, data provision will be dependent upon how many parameters are selected. Fewer data parameters can be streamed more quickly than more. It is left to the user to balance streaming speed with number of parameters streamed.

To **read** register 91, type "*r91" followed by "Enter".

To **modify** register 91, type "*w91=X", where X is a positive integer from 1 to 65535, followed by "Enter".

To **return** to the recommended factory default streaming speed, type "*w91= 50".

Changing From Streaming to Polling Mode:

When the meter is in the Streaming Mode, the screen is updated approximately 10-60 times per second (depending on the amount of data on each line) so that the user sees the data essentially in real time. It is sometimes desirable, and necessary when using more than one unit on a single RS-232 line, to be able to poll the unit.

In Polling Mode the unit measures the flow normally, but only sends a line of data when it is "polled". Each unit can be given its own unique identifier or address. Unless otherwise specified each unit is shipped with a default address of capital A. Other valid addresses are B thru Z.

Once you have established communication with the unit and have a stream of information filling your screen:

1. Type *@=A followed by "Enter" (or using the RS-232 communication select menu, select A as identifier and exit the screen) to stop the streaming mode of information. Note that the flow of information will not stop while you are typing and you will not be able to read what you have typed. Also, the unit does not accept a backspace or delete in the line so it must be typed correctly. If in doubt, simply hit enter and start again. If the unit does not get exactly what it is expecting, it will ignore it. If the line has been typed correctly, the data will stop.
2. You may now poll the unit by typing A followed by "Enter". This does an instantaneous poll of unit A and returns the values once. You may type A "Enter" as many times as you like. Alternately you could resume streaming mode by typing *@=@ followed by "Enter". Repeat step 1 to remove the unit from the streaming mode.
3. To assign the unit a new address, type *@=New Address, e.g. *@=B. Care should be taken not to assign an address to a unit if more than one unit is on the RS-232 line as all of the addresses will be reassigned. Instead, each should be individually attached to the RS-232 line, given an address, and taken off. After each unit has been given a unique address, they can all be put back on the same line and polled individually.

Sending a Set-point via RS-232: To send a set-point via RS-232, "Serial" must be selected under the "Input" list in the control set up mode.

Method 1: Set-point may be set in floating point in serial communication using serial command (UnitID)SX.YZ

Example: AS4.54 results in Unit ID A changing set-point to 4.54.

Method 2: Type in a number between 0 and 65535 (2% over range), where 64000 denotes full-scale flow rate, and hit "Enter".

The set-point column and flow rates should change accordingly. If they do not, try hitting "Enter" a couple of times and repeating your command. The formula for performing a linear interpolation is as follows:

Value = (Desired Set-point X 64000) / Full Scale Flow Range

For example, if your device is a 100 slpm full-scale unit and you wish to apply a set-point of 35 slpm you would enter the following value:

22400 = (35 slpm X 64000) / 100 slpm

If the controller is in polling mode as described in *Changing from Streaming Mode to Polling Mode*, the set-point must be preceded by the address of the controller. For example, if your controller has been given an address of D, the set-point above would be sent by typing: D22400 followed by "Enter"

To adjust the Proportional and Differential (P&D) terms via RS-232:

Type *@=A followed by “Enter” to stop the streaming mode of information.

To adjust the “P” or proportional term of the PID controller, type *R21 followed by “Enter”.

The computer will respond by reading the current value for register 21 between 0-65535. It is good practice to write this value down so you can return to the factory settings if necessary. Enter the value you wish to try by writing the new value to register 21. For example, if you wished to try a “P” term of 220, you would type *W21=**220** followed by “Enter” where the bold number denotes the new value.

The computer will respond to the new value by confirming that 21=220. To see the effect of the change you may now poll the unit by typing A followed by “Enter”. This does an instantaneous poll and returns the values once. You may type A “Enter” as many times as you like. Alternately you could resume streaming mode by typing *@=@ followed by “Enter”. Repeat step 3 to remove the unit from the streaming mode.

To adjust the “D” or proportional term of the PID controller, type *R22 followed by “Enter”.

The computer will respond by reading the current value for register 22 between 0-65535. It is good practice to write this value down so you can return to the factory settings if necessary. Enter the value you wish to try by writing the new value to register 22. For example, if you wished to try a “D” term of 25, you would type *W22=**25** followed by “Enter” where the bold number denotes the new value.

The computer will respond to the new value by confirming that 22=25. To see the effect of the change you may now poll the unit by typing A followed by “Enter”. This does an instantaneous poll and returns the values once. You may type A “Enter” as many times as you like. Alternately you could resume streaming mode by typing *@=@ followed by “Enter”. Repeat.

You may test your settings for a step change by changing the set-point. To do this type A32000 (A is the default single unit address, if you have multiple addressed units on your RS-232 line the letter preceding the value would change accordingly.) followed by “Enter” to give the unit a ½ full scale set-point. Monitor the unit’s response to the step change to ensure it is satisfactory for your needs. Recall that the “P” term controls how quickly the unit goes from one set-point to the next, and the “D” term controls how quickly the signal begins to “decelerate” as it approaches the new set-point (controls the overshoot).

Gas Select – The selected gas can be changed via RS-232 input. To change the selected gas, enter the following commands:

In Polling Mode: Address$$#<Enter> (e.g. B$$#<Enter>)

Where # is the number of the gas selected from the table below. Note that this also corresponds to the gas select menu on the flow controller screen. The **Standard** gas category is shown in the example below:

#	GAS	
0	Air	Air
1	Argon	Ar
2	Methane	CH4
3	Carbon Monoxide	CO
4	Carbon Dioxide	CO2
5	Ethane	C2H6
6	Hydrogen	H2
7	Helium	He
8	Nitrogen	N2
9	Nitrous Oxide	N2O
10	Neon	Ne
11	Oxygen	O2
12	Propane	C3H8
13	normal-Butane	n-C4H10
14	Acetylene	C2H2
15	Ethylene	C2H4
16	iso-Butane	i-C2H10
17	Krypton	Kr
18	Xenon	Xe
19	Sulfur Hexafluoride	SF6
20	75% Argon / 25% CO2	C-25
21	90% Argon / 10% CO2	C-10
22	92% Argon / 8% CO2	C-8
23	98% Argon / 2% CO2	C-2
24	75% CO2 / 25% Argon	C-75
25	75% Argon / 25% Helium	HE-75
26	75% Helium / 25% Argon	HE-25
27	90% Helium / 7.5% Argon / 2.5% CO2 (Praxair - Helistar® A1025)	A1025
28	90% Argon / 8% CO2 / 2% Oxygen (Praxair - Stargon® CS)	Star29
29	95% Argon / 5% Methane	P-5

For example, to select Propane, enter: $$12<Enter>

Creating and Deleting Gas Mixtures with COMPOSER™ using RS-232

Note: All commands must be prefixed with the unit ID letter. The unit should not be in streaming mode.

You may create and store up to 20 gas mixtures containing up to five constituent gases each. The constituent gases must be chosen from the existing list of gases installed on the device (which may vary model to model). Please see pages 39 – 46 for lists of gases and their corresponding gas numbers.

Create a Gas Mixture

To create a gas mixture, enter a single-line command according to the following formula:

[Unit ID] GM [Gas Name] [Gas Mix Number] [Percent 1] [Gas Number 1] [Percent 2] [Gas Number 2] …etc. etc.

Notes: Do not type the brackets. There should be only one space between all items. Any percentages less than 1, should have a leading zero before the decimal (i.e. 0.25 for .25%). Trailing zeros are not necessary but they are allowed to help visualize the percentages on screen (as in the example). The sum of all percentages must be 100.00 otherwise an error will occur.

Here is an example of a three gas mixture for a new gas called "MyMix1" (50% O2, 49.5% Helium, and .5% Neon), stored in user location #236, where the unit ID of the device is "A":

A GM MyMix1 236 50.00 11 49.50 7 0.50 10 <ENTER>

Gas Name: Name your mixture using a maximum of 6 characters.

Gas Mix Number: COMPOSER™ user mixes have MATHESON gas numbers between 236 and 255. You can assign any number in this range to your new mixture. If another mixture with the same number exists, it will be overwritten, even if that gas is currently selected on the unit. If you enter a 0 here, the new mix will be assigned the next available number between 236 and 255.

Percent 1: The percentage of the first constituent gas. The percentage of each constituent must be between 0.01 and 99.99. Values entered beyond two decimal points will be rounded to the nearest 0.01%.

Gas Number 1: The MATHESON gas number of the first constituent gas.

Percent 2: The percentage of the second constituent gas. Values entered beyond two decimal points will be rounded to the nearest 0.01%.

Gas Number 2: The MATHESON gas number of the second constituent gas.

Additional Gases: (Optional) The above pattern of [Percent] + [Gas Number] may be repeated for additional constituent gases (up to a total of five).

Upon success, the unit ID (if set) is returned followed by a space. The number of the gas mixture is then returned, followed by the percentages and names of each constituent in the mix. If the gas mix is not successfully created, a "**?**" is returned, and you must start over.

Delete a Gas Mixture

To delete a gas mixture, enter:

[Unit ID]**GD [Gas Number]:** The number of the COMPOSER™ user mixture you wish to delete from the unit

Only COMPOSER™ user mixtures can be deleted with this command.

On success, the unit ID (if set) is returned followed by a space and the number of the gas deleted. If the gas is not successfully deleted, a "**?"** is returned.

Collecting Data:

The RS-232 output updates to the screen many times per second. Very short-term events can be captured simply by disconnecting (there are two telephone symbol icons at the top of the HyperTerminal® screen for disconnecting and connecting) immediately after the event in question. The scroll bar can be driven up to the event and all of the data associated with the event can be selected, copied, and pasted into Microsoft® Excel® or other spreadsheet program as described below.

For longer term data, it is useful to capture the data in a text file. With the desired data streaming to the screen, select "Capture Text" from the Transfer Menu. Type in the path and file name you wish to use. Push the start button. When the data collection period is complete, simply select "Capture Text" from the Transfer Menu and select "Stop" from the sub-menu that appears.

Data that is selected and copied, either directly from HyperTerminal® or from a text file can be pasted directly into Excel®. When the data is pasted it will all be in the selected column. Select "Text to Columns..." under the Data menu in Excel® and a Text to Columns Wizard (dialog box) will appear.

Make sure that "Fixed Width" is selected under Original Data Type in the first dialog box and click "Next". In the second dialog box, set the column widths as desired, but the default is usually acceptable. Click on "Next" again. In the third dialog box, make sure the column data format is set to "General", and click "Finish". This separates the data into columns for manipulation and removes symbols such as the plus signs from the numbers. Once the data is in this format, it can be graphed or manipulated as desired. ***For extended term data capture see page 32.***

Data Format:

The data stream on the screen represents the flow parameters of the main mode in the units shown on the display.

For mass flow controllers, there are six columns of data representing pressure, temperature, volumetric flow, mass flow, set-point, and the selected gas

The first column is absolute pressure (normally in psia), the second column is temperature (normally in °C), the third column is volumetric flow rate (in the units specified at time of order and shown on the display), the fourth column is mass flow (also in the units specified at time of order and shown on the display), the fifth column is the currently selected set-point value, the sixth column designates the currently selected gas. For instance, if the controller was ordered in units of scfm, the display on the controller would read 2.004 scfm and the last two columns of the output below would represent volumetric flow and mass flow in cfm and scfm respectively.

+014.70	+025.00	+02.004	+02.004	2.004	Air
+014.70	+025.00	+02.004	+02.004	2.004	Air
+014.70	+025.00	+02.004	+02.004	2.004	Air
+014.70	+025.00	+02.004	+02.004	2.004	Air
Pressure	Temp	Vol. Flow	Mass Flow	Set Point	Gas

829-Series Mass Flow Controller Data Format

Sending a Simple Script File to HyperTerminal®

It is sometimes desirable to capture data for an extended period of time. Standard streaming mode information is useful for short term events, however, when capturing data for an extended period of time, the amount of data and thus the file size can become too large very quickly. Without any special programming skills, the user can use HyperTerminal® and a text editing program such as Microsoft® Word® to capture text at user defined intervals.

1. Open your text editing program, MS Word for example.

2. Set the cap lock on so that you are typing in capital letters.

3. Beginning at the top of the page, type A<Enter> repeatedly. If you're using MS Word, you can tell how many lines you have by the line count at the bottom of the screen. The number of lines will correspond to the total number of times the flow device will be polled, and thus the total number of lines of data it will produce.

For example:

A
A
A
A
A
A

will get a total of six lines of data from the flow meter, but you can enter as many as you like.

The time between each line will be set in HyperTerminal.

4. When you have as many lines as you wish, go to the File menu and select save. In the save dialog box, enter a path and file name as desired and in the "Save as Type" box, select the plain text (.txt) option. It is important that it be saved as a generic text file for HyperTerminal to work with it.

5. Click Save.

6. A file conversion box will appear. In the "End Lines With" drop down box, select CR Only. Everything else can be left as default.

7. Click O.K.

8. You have now created a "script" file to send to HyperTerminal. Close the file and exit the text editing program.

9. Open HyperTerminal and establish communication with your flow device as outlined in the manual.

10. Set the flow device to Polling Mode as described in the manual. Each time you type A<Enter>, the meter should return one line of data to the screen.

11. Go to the File menu in HyperTerminal and select "Properties".

12. Select the "Settings" tab.

13. Click on the "ASCII Setup" button.

14. The "Line Delay" box is defaulted to 0 milliseconds. This is where you will tell the program how often to read a line from the script file you've created. 1000 milliseconds is one second, so if you want a line of data every 30 seconds, you would enter 30000 into the box. If you want a line every 5 minutes, you would enter 300000 into the box.

15. When you have entered the value you want, click on OK and OK in the Properties dialog box.

16. Go the Transfer menu and select “Send **Text** File…” (NOT Send File…).

17. Browse and select the text “script” file you created.

18. Click Open.

19. The program will begin “executing” your script file, reading one line at a time with the line delay you specified and the flow device will respond by sending one line of data for each poll it receives, when it receives it.

You can also capture the data to another file as described in the manual under “Collecting Data”. You will be simultaneously sending it a script file and capturing the output to a separate file for analysis.

Operating Principle

All 829-Series Gas Flow Controllers are based on the accurate measurement of volumetric flow. The volumetric flow rate is determined by creating a pressure drop across a unique internal restriction, known as a Laminar Flow Element (LFE, and measuring differential pressure across it. The restriction is designed so that the gas molecules are forced to move in parallel paths along the entire length of the passage; hence laminar (streamline) flow is established for the entire range of operation of the device. Unlike other flow measuring devices, in laminar flow meters the relationship between pressure drop and flow is linear.

STANDARD GAS DATA TABLES: Those of you who have older MATHESON products may notice small discrepancies between the gas property tables of your old and new units. MATHESON has incorporated the latest data sets from NIST (including their REFPROP 9 data where available) in our products’ built-in gas property models. Be aware that the calibrators that you may be using may be checking against older data sets such as the widely distributed Air Liquide data. This may generate apparent calibration discrepancies of up to 0.6% of reading on well behaved gases and as much as 3% of reading on some gases such as propane and butane, unless the standard was directly calibrated on the gas in question.

As the older standards are phased out, this difference in readings will cease to be a problem. If you see a difference between the MATHESON meter and your in-house standard, in addition to calling MATHESON at 800-828-4313, call the manufacturer of your standard for clarification as to which data set they used in their calibration. This comparison will in all likelihood resolve the problem.

GAS SELECT > Standard:

MC Controllers will display: Acetylene, Air, Argon, Butane, Carbon Dioxide, Carbon Monoxide, Ethane, Ethylene (Ethene), Helium, Hydrogen, Iso-Butane, Krypton, Methane, Neon, Nitrogen, Nitrous Oxide, Oxygen, Propane, Sulfur Hexafluoride, Xenon, HE-25, HE-75, A1025, C-2, C-8, C-10, C-25, C-75, P-5, Star29.

PURE NON-CORROSIVE GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
14	C2H2	Acetylene	104.44800	1.07200	0.9928000	97.374	1.1728	0.9905
0	Air	Air	184.89890	1.18402	0.9996967	172.574	1.2930	0.9994
1	Ar	Argon	226.23990	1.63387	0.9993656	210.167	1.7840	0.9991
16	i-C4H10	i-Butane	74.97846	2.44028	0.9735331	68.759	2.6887	0.9645
13	n-C4H10	n-Butane	74.05358	2.44930	0.9699493	67.690	2.7037	0.9591
4	CO2	Carbon Dioxide	149.31840	1.80798	0.9949545	137.107	1.9768	0.9933
3	CO	Carbon Monoxide	176.49330	1.14530	0.9996406	165.151	1.2505	0.9993
60	D2	Deuterium	126.59836	0.16455	1.0005970	119.196	0.1796	1.0006
5	C2H6	Ethane	93.54117	1.23846	0.9923987	86.129	1.3550	0.9901
15	C2H4	Ethylene (Ethene)	103.18390	1.15329	0.9942550	94.697	1.2611	0.9925
7	He	Helium	198.45610	0.16353	1.0004720	186.945	0.1785	1.0005
6	H2	Hydrogen	89.15355	0.08235	1.0005940	83.969	0.0899	1.0006
17	Kr	Krypton	251.32490	3.43229	0.9979266	232.193	3.7490	0.9972
2	CH4	Methane	110.75950	0.65688	0.9982472	102.550	0.7175	0.9976
10	Ne	Neon	311.12640	0.82442	1.0004810	293.822	0.8999	1.0005
8	N2	Nitrogen	178.04740	1.14525	0.9998016	166.287	1.2504	0.9995
9	N2O	Nitrous Oxide	148.41240	1.80888	0.9945327	136.310	1.9779	0.9928
11	O2	Oxygen	205.50210	1.30879	0.9993530	191.433	1.4290	0.9990
12	C3H8	Propane	81.46309	1.83204	0.9838054	74.692	2.0105	0.9785
19	SF6	Sulfur Hexafluoride	153.53200	6.03832	0.9886681	140.890	6.6162	0.9849
18	Xe	Xenon	229.84830	5.39502	0.9947117	212.157	5.8980	0.9932

WELDING GASES			**25°C**			**0°C**		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
23	C-2	2% CO2 / 98% Ar	224.71480	1.63727	0.9993165	208.673	1.7877	0.998993
22	C-8	8% CO2 / 92% Ar	220.13520	1.64749	0.9991624	204.199	1.7989	0.9987964
21	C-10	10% CO2 / 90% Ar	218.60260	1.65091	0.9991086	202.706	1.8027	0.9987278
140	C-15	15% CO2 / 85% Ar	214.74960	1.65945	0.9989687	198.960	1.8121	0.9985493
141	C-20	20% CO2 / 80% Ar	210.86960	1.66800	0.9988210	195.198	1.8215	0.9983605
20	C-25	25% CO2 / 75% Ar	206.97630	1.67658	0.9986652	191.436	1.8309	0.9981609
142	C-50	50% CO2 / 50% Ar	187.53160	1.71972	0.9977484	172.843	1.8786	0.9969777
24	C-75	75% CO2 / 25% Ar	168.22500	1.76344	0.9965484	154.670	1.9271	0.995401
25	He-25	25% He / 75% Ar	231.60563	1.26598	0.9996422	216.008	1.3814	0.9999341
143	He-50	50% He / 50% Ar	236.15149	0.89829	0.9999188	220.464	0.9800	1.00039
26	He-75	75% He / 25% Ar	234.68601	0.53081	1.0001954	216.937	0.5792	1.000571
144	He-90	90% He / 10% Ar	222.14566	0.31041	1.0003614	205.813	0.3388	1.00057
27	A1025	90% He / 7.5% Ar / 2.5% CO2	214.97608	0.31460	1.0002511	201.175	0.3433	1.000556
28	Star29	Stargon CS 90% Ar / 8% CO2 / 2% O2	219.79340	1.64099	0.9991638	203.890	1.7918	0.998798

BIOREACTOR GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
145	Bio-5M	5% CH4 / 95% CO2	148.46635	1.75026	0.9951191	136.268	1.9134	0.9935816
146	Bio-10M	10% CH4 / 90% CO2	147.54809	1.69254	0.9952838	135.383	1.8500	0.993893
147	Bio-15M	15% CH4 / 85% CO2	146.55859	1.63484	0.9954484	134.447	1.7867	0.9941932
148	Bio-20M	20% CH4 / 80% CO2	145.49238	1.57716	0.9956130	133.457	1.7235	0.994482
149	Bio-25M	25% CH4 / 75% CO2	144.34349	1.51950	0.9957777	132.407	1.6603	0.9947594
150	Bio-30M	30% CH4 / 70% CO2	143.10541	1.46186	0.9959423	131.290	1.5971	0.9950255
151	Bio-35M	35% CH4 / 65% CO2	141.77101	1.40424	0.9961069	130.102	1.5340	0.9952803
152	Bio-40M	40% CH4 / 60% CO2	140.33250	1.34664	0.9962716	128.834	1.4710	0.9955239
153	Bio-45M	45% CH4 / 55% CO2	138.78134	1.28905	0.9964362	127.478	1.4080	0.9957564
154	Bio-50M	50% CH4 / 50% CO2	137.10815	1.23149	0.9966009	126.025	1.3450	0.9959779
155	Bio-55M	55% CH4 / 45% CO2	135.30261	1.17394	0.9967655	124.462	1.2821	0.9961886
156	Bio-60M	60% CH4 /40% CO2	133.35338	1.11642	0.9969301	122.779	1.2193	0.9963885
157	Bio-65M	65% CH4 /35% CO2	131.24791	1.05891	0.9970948	120.959	1.1564	0.9965779
158	Bio-70M	70% CH4 / 30% CO2	128.97238	1.00142	0.9972594	118.987	1.0936	0.9967567
159	Bio-75M	75% CH4 / 25% CO2	126.51146	0.94395	0.9974240	116.842	1.0309	0.9969251
160	Bio-80M	80% CH4 / 20% CO2	123.84817	0.88650	0.9975887	114.501	0.9681	0.9970832
161	Bio-85M	85% CH4 / 15% CO2	120.96360	0.82907	0.9977533	111.938	0.9054	0.9972309
162	Bio-90M	90% CH4 / 10% CO2	117.83674	0.77166	0.9979179	109.119	0.8427	0.9973684
163	Bio-95M	95% CH4 / 5% CO2	114.44413	0.71426	0.9980826	106.005	0.7801	0.9974957

BREATHING GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
164	EAN-32	32% O2 / 68% N2	186.86315	1.19757	0.9996580	174.925	1.3075	0.9993715
165	EAN	36% O2 / 64% N2	187.96313	1.20411	0.9996401	175.963	1.3147	0.9993508
166	EAN-40	40% O2 / 60% N2	189.06268	1.21065	0.9996222	176.993	1.3218	0.9993302
167	HeOx-20	20% O2 / 80% He	217.88794	0.39237	1.0002482	204.175	0.4281	1.000593
168	HeOx-21	21% O2 / 79% He	218.15984	0.40382	1.0002370	204.395	0.4406	1.000591
169	HeOx-30	30% O2 / 70% He	219.24536	0.50683	1.0001363	205.140	0.5530	1.000565
170	HeOx-40	40% O2 / 60% He	218.59913	0.62132	1.0000244	204.307	0.6779	1.000502
171	HeOx-50	50% O2 / 50% He	216.95310	0.73583	0.9999125	202.592	0.8028	1.000401
172	HeOx-60	60% O2 / 40% He	214.82626	0.85037	0.9998006	200.467	0.9278	1.000257
173	HeOx-80	80% O2 / 20% He	210.11726	1.07952	0.9995768	195.872	1.1781	0.9998019
174	HeOx-99	99% O2 / 1% He	205.72469	1.29731	0.9993642	191.646	1.4165	0.9990796
175	EA-40	Enriched Air-40% O2	189.42518	1.21429	0.9996177	177.396	1.3258	0.9993261
176	EA-60	Enriched Air-60% O2	194.79159	1.24578	0.9995295	182.261	1.3602	0.9992266
177	EA-80	Enriched Air-80% O2	200.15060	1.27727	0.9994412	186.937	1.3946	0.9991288
178	Metabol	Metabolic Exhalant (16% O2 / 78.04% N2 / 5% CO2 / 0.96% Ar)	180.95936	1.20909	0.9994833	170.051	1.3200	0.9992587

FUEL GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
185	Syn Gas-1	40% H2 + 29% CO + 20% CO2 + 11% CH4	155.64744	0.79774	0.9989315	144.565	0.8704	0.9992763
186	Syn Gas-2	64% H2 + 28% CO + 1% CO2 + 7% CH4	151.98915	0.43715	1.0001064	142.249	0.4771	1.000263
187	Syn Gas-3	70% H2 + 4% CO + 25% CO2 + 1% CH4	147.33686	0.56024	0.9991225	136.493	0.6111	0.9997559
188	Syn Gas-4	83% H2 + 14% CO + 3% CH4	133.63682	0.24825	1.0003901	125.388	0.2709	1.000509
189	Nat Gas-1	93% CH4 / 3% C2H6 / 1% C3H8 / 2% N2 / 1% CO2	111.77027	0.70709	0.9979255	103.189	0.7722	0.9973965
190	Nat Gas-2	95% CH4 / 3% C2H6 / 1% N2 / 1% CO2	111.55570	0.69061	0.9980544	103.027	0.7543	0.9974642
191	Nat Gas-3	95.2% CH4 / 2.5% C2H6 / 0.2% C3H8 / 0.1% C4H10 / 1.3% N2 / 0.7% CO2	111.49608	0.68980	0.9980410	102.980	0.7534	0.9974725
192	Coal Gas	50% H2 / 35% CH4 / 10% CO / 5% C2H4	123.68517	0.44281	0.9993603	115.045	0.6589	0.996387
193	Endo	75% H2 + 25% N2	141.72100	0.34787	1.0005210	133.088	0.3797	1.000511
194	HHO	66.67% H2 / 33.33% O2	180.46190	0.49078	1.0001804	168.664	0.5356	1.000396
195	HD-5	LPG 96.1% C3H8 / 1.5% C2H6 / 0.4% C3H6 / 1.9% n-C4H10	81.45829	1.83428	0.9836781	74.933	2.0128	0.9784565
196	HD-10	LPG 85% C3H8 / 10% C3H6 / 5% n-C4H10	81.41997	1.85378	0.9832927	74.934	2.0343	0.9780499

LASER GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
179	LG-4.5	4.5% CO2 / 13.5% N2 / 82% He	199.24300	0.36963	1.0001332	187.438	0.4033	1.000551
180	LG-6	6% CO2 / 14% N2 / 80% He	197.87765	0.39910	1.0000471	186.670	0.4354	1.00053
181	LG-7	7% CO2 / 14% N2 / 79% He	197.00519	0.41548	0.9999919	186.204	0.4533	1.000514
182	LG-9	9% CO2 / 15% N2 / 76% He	195.06655	0.45805	0.9998749	184.835	0.4997	1.000478
183	HeNe-9	9% Ne / 91% He	224.68017	0.22301	1.0004728	211.756	0.2276	1.000516
184	LG-9.4	9.4% CO2 / 19.25% N2 / 71.35% He	193.78311	0.50633	0.9998243	183.261	0.5523	1.000458

O2 CONCENTRATOR GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
197	OCG-89	89% O2 / 7% N2 / 4% Ar	204.53313	1.31033	0.9993849	190.897	1.4307	0.9990695
198	OCG-93	93% O2 / 3% N2 / 4% Ar	205.62114	1.31687	0.9993670	191.795	1.4379	0.9990499
199	OCG-95	95% O2 / 1% N2 / 4% Ar	206.16497	1.32014	0.9993580	192.241	1.4414	0.99904

STACK GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
200	FG-1	2.5% O2 / 10.8% CO2 / 85.7% N2 / 1% Ar	175.22575	1.22550	0.9992625	165.222	1.3379	0.9990842
201	FG-2	2.9% O2 / 14% CO2 / 82.1% N2 / 1% Ar	174.18002	1.24729	0.9991056	164.501	1.3617	0.9989417
202	FG-3	3.7% O2 / 15% CO2 / 80.3% N2 / 1% Ar	174.02840	1.25520	0.9990536	164.426	1.3703	0.9988933
203	FG-4	7% O2 / 12% CO2 / 80% N2 / 1% Ar	175.95200	1.24078	0.9991842	166.012	1.3546	0.9990116
204	FG-5	10% O2 / 9.5% CO2 / 79.5% N2 / 1% Ar	177.65729	1.22918	0.9992919	167.401	1.3419	0.9991044
205	FG-6	13% O2 / 7% CO2 / 79% N2 / 1% Ar	179.39914	1.21759	0.9993996	168.799	1.3293	0.9991932

CHROMATOGRAPHY GASES			25°C			0°C		
Gas Number	**Short Name**	**Long Name**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**	**Absolute Viscosity**	**Density 14.696 PSIA**	**Compressibilty 14.696 PSIA**
29	P-5	5% CH4 / 95% Ar	223.91060	1.58505	0.9993265	207.988	1.7307	0.9990036
206	P-10	10% CH4 90% Ar	221.41810	1.53622	0.9992857	205.657	1.6774	0.99895

Supported Units: This device supports many different units. You may select the desired units (see page 28). Note that only units appropriate to this device are available for selection.

Pressure Units

Absolute	Gauge	Differential	Notes
PaA	PaG	PaD	pascal
hPaA	hPaG	hPaD	hectopascal
kPaA	kPaG	kPaD	kilopascal
MPaA	MPaG	MPaD	megapascal
mbarA	mbarG	mbarD	millibar
barA	barG	barD	bar
g/cm2A	g/cm2G	g/cm2D	gram force per square centimeter
kg/cmA	kg/cmG	kg/cmD	kilogram force per square centimeter
PSIA	PSIG	PSID	pound force per square inch
PSFA	PSFG	PSFD	pound force per square foot
mTorrA	mTorrG	mTorrD	millitorr
torrA	torrG	torrD	torr
mmHgA	mmHgG	mmHgD	millimeter of mercury at 0 C
inHgA	inHgG	inHgD	inch of mercury at 0 C
mmH2OA	mmH2OG	mmH2OD	millimeter of water at 4 C (NIST conventional)
mmH2OA	mmH2OG	mmH2OD	millimeter of water at 60 C
cmH2OA	cmH2OG	cmH2OD	centimeter of water at 4 C (NIST conventional)
cmH2OA	cmH2OG	cmH2OD	centimeter of water at 60 C
inH2OA	inH2OG	inH2OD	inch of water at 4 C (NIST conventional)
inH2OA	inH2OG	inH2OD	inch of water at 60 C
atm			atmosphere
m asl			meter above sea level (only in /ALT builds)
ft asl			foot above sea level (only in /ALT builds)
V	volt; no conversions are performed to or from other units		
count	count	count	setpoint count, 0 – 64000
%	%	%	percent of full scale

Flow Units

Volumetric	Standard	Normal	Notes
uL/m	SuL/m	NuL/m	microliter per minute
mL/s	SmL/s	NmL/s	milliliter per second
mL/m	SmL/m	NmL/m	milliliter per minute
mL/h	Sml/h	NmL/h	milliliter per hour
L/s	SL/s	NL/s	liter per second
LPM	SLPM	NLPM	liter per minute
L/h	SL/h	NL/h	liter per hour
US GPM			US gallon per minute
US GPH			US gallon per hour
CCS	SCCS	NCCS	cubic centimeter per second
CCM	SCCM	NCCM	cubic centimeter per minute
cm3/h	Scm3/h	Ncm3/h	cubic centimeter per hour
m3/m	Sm3/m	Nm3/m	cubic meter per minute
m3/h	Sm3/h	Nm3/h	cubic meter per hour
m3/d	Sm3/d	Nm3/d	cubic meter per day
in3/m	Sin3/m		cubic inch per minute
CFM	SCFM		cubic foot per minute
CFH	SCFH		cubic foot per hour
	kSCFM		1000 cubic feet per minute
count	count	count	setpoint count, 0 – 64000
%	%	%	percent of full scale

True Mass Flow Units

Label	Notes
mg/s	milligram per second
mg/m	milligram per minute
g/s	gram per second
g/m	gram per minute
g/h	gram per hour
kg/m	kilogram per minute
kg/h	kilogram per hour
oz/s	ounce per second
oz/m	ounce per minute
lb/m	pound per minute
lb/h	pound per hour
These can be used for mass flow on gas devices. These can also be used for volumetric flow on liquid devices calibrated in one of these units (liquid density is not yet supported).	

Total Mass Units

Label	Notes
mg	milligram
g	gram
kg	kilogram
oz	ounce
lb	pound
These can be used for totalized mass on gas devices. These can also be used for totalized volume on liquid devices calibrated in one of these units (liquid density is not yet supported).	

Temperature Units

Label	Notes
°C	degree Celsius
°F	degree Farenheit
K	Kelvin
°R	degree Rankine

Time Units

Label	Notes
h:m:s	Displayed value is hours:minutes:seconds
ms	millisecond
s	second
m	minute
hour	hour
day	day

Valve Drive Units

Label	Notes
count	+/- 65536 at full drive
%	Percent of full scale drive

TROUBLESHOOTING

Display does not come on or is weak.

Check power and ground connections. Please reference the technical specifications (page 45) to assure you have the proper power for your model.

Flow reading is approximately fixed either near zero or near full scale regardless of actual line flow.

Differential pressure sensor may be damaged. A common cause of this problem is instantaneous application of high-pressure gas as from a snap acting solenoid valve upstream of the meter. If you suspect that your pressure sensor is damaged please discontinue use of the controller and contact MATHESON.

Displayed mass flow, volumetric flow, pressure or temperature is flashing and message MOV, VOV, POV or TOV is displayed:

Our flow meters and controllers display an error message (MOV = mass overrange, VOV = volumetric overrange, POV = pressure overrange, TOV = temperature overrange) when a measured parameter exceeds the range of the sensors in the device. When any item flashes on the display, neither the flashing parameter nor the mass flow measurement is accurate. Reducing the value of the flashing parameter to within specified limits will return the unit to normal operation and accuracy. If the unit does not return to normal contact MATHESON.

After installation, there is no flow.

MATHESON MC controllers incorporate normally closed valves and require a set-point to operate. Check that your set-point signal is present and supplied to the correct pin and that the correct set-point source is selected under the SETPT SOURCE list in the control set up display. Also check that the unit is properly grounded.

The flow lags below the set-point.

Be sure there is enough pressure available to make the desired flow rate. If either the set-point signal line and/or the output signal line is relatively long, it may be necessary to provide heavier wires (especially ground wiring) to negate voltage drops due to line wire length. An inappropriate PID tuning can also cause this symptom if the D term is too large relative to the P term. See pages 16 and 17 for more information on PID tuning.

Controller is slow to react to a set-point change or imparts an oscillation to the flow.

An inappropriate PID tuning can cause these symptoms. Use at conditions considerably different than those at which the device was originally set up can necessitate a re-tuning of the PID loop. See pages 16 and 17 for more information on PID tuning.

The output signal is lower than the reading at the display.

This can occur if the output signal is measured some distance from the meter, as voltage drops in the wires increase with distance. Using heavier gauge wires, especially in the ground wire, can reduce this effect.

Meter does not agree with another meter I have in line.
Volumetric meters are affected by pressure drops. Volumetric flow meters should not be compared to mass flow meters. Mass flow meters can be compared against one another provided there are no leaks between the two meters and they are set to the same standard temperature and pressure. Both meters must also be calibrated (or set) for the gas being measured. M-Series mass flow meters are normally set to Standard Temperature and Pressure conditions of 25 ° C and 14.696 psia. Note: it is possible to special order meters with a customer specified set of standard conditions. The calibration sheet provided with each meter lists its standard conditions.
When performing this comparison it is best to use the smallest transition possible between the two devices. Using small transitions will minimize lag and dead volume.

RS-232 Serial Communications is not responding.
Check that your meter is powered and connected properly. Be sure that the port on the computer to which the meter is connected is active. Confirm that the port settings are correct per the RS-232 instructions in this manual (Check the RS-232 communications select screen for current meter readings). Close Hyperterminal® and reopen it. Reboot your PC. See pages 9 and 26 for more information on RS-232 signals and communications.

Slower response than specified.
829-Series Controllers feature a programmable Geometric Running Average (GRA). Depending on the full scale range of the meter, it may have the GRA set to enhance the stability/readability of the display, which would result in slower perceived response time. Please see “Pressure Averaging” and “Flow Averaging” on page 22.

Jumps to zero at low flow.
829-Series Controllers feature a programmable zero deadband. The factory setting is usually 0.5% of full scale. This can be adjusted between NONE and 6.3% of full scale. See page 22.

Discrepancies between old and new units.
Please see “Standard Gas Data Tables” explanation on page 33.

Maintenance and Recalibration

General: 829-Series Flow Controllers require minimal maintenance. They have no moving parts. The single most important thing that affects the life and accuracy of these devices is the quality of the gas being measured. The controller is designed to measure CLEAN, DRY, NON-CORROSIVE gases.

Moisture, oil and other contaminants can affect the laminar flow elements. We recommend the use of in-line sintered filters to prevent large particulates from entering the measurement head of the instrument. Suggested maximum particulate sizes are as follows:

15 microns for units with FS flow ranges between 0-100 sccm and 0-1 slpm.
50 microns for units with FS flow ranges of 0-1 slpm or more.

Recalibration: The recommended period for recalibration is once every year. A label located on the back of the controller lists the most recent calibration date. The controller should be returned to the factory for recalibration within one year from the listed date. Before calling to schedule a recalibration, please note the serial number on the back of the instrument. The Serial Number, Model Number, and Date of Manufacture are also available on the Model Info display (page 29.

Cleaning: 829-Series Flow Controllers require no periodic cleaning. If necessary, the outside of the controller can be cleaned with a soft dry cloth. Avoid excess moisture or solvents.

For repair, recalibration or recycling of this product contact:

MATHESON
166 Keystone Drive
Montgomeryville, PA 18936
Ph: 800-828-4313
Web: www.mathesongas.com

Technical Data for MATHESON 829 Mass Flow Controllers
0 to 100 sccm Full Scale through 0 to 10 slpm Full Scale

Standard Operating Specifications (Contact MATHESON for available options)

Performance	829 Mass Flow Controller
Accuracy at calibration conditions after tare	± (0.8% of Reading + 0.2% of Full Scale)
High Accuracy at calibration conditions after tare	± (0.4% of Reading + 0.2% of Full Scale)
Repeatability	± 0.2% Full Scale
Zero Shift and Span Shift	0.02% Full Scale / ºCelsius / Atm
Operating Range / Turndown Ratio	0.5% to 100% Full Scale / 200:1 Turndown
Maximum Controllable Flow Rate	102.4% Full Scale
Typical Response Time	100 ms (Adjustable)
Warm-up Time	< 1 Second

Operating Conditions	829 Mass Flow Controller
Mass Reference Conditions (STP)	25ºC & 14.696 psia (standard — others available on request)
Operating Temperature	−10 to +50 ºCelsius
Humidity Range (Non–Condensing)	0 to 100%
Max. Internal Pressure (Static)	145 psig
Proof Pressure	175 psig
Mounting Attitude Sensitivity	None
Valve Type	Normally Closed
Ingress Protection	IP40
Wetted Materials	303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Brass, 430FR Stainless Steel, Silicon, Glass. If your application demands a different material, please contact MATHESON.

Communications / Power	829 Mass Flow Controller
Monochrome LCD Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature
Digital Input/Output Signal[1]	RS-232 Serial
Analog Input/Output Signal[2]	0-5 Vdc / 4-20 mA
Electrical Connection Options	RJ45
Supply Voltage	12 to 30 Vdc (15-30 Vdc for 4-20 mA outputs)
Supply Current	0.250 Amp

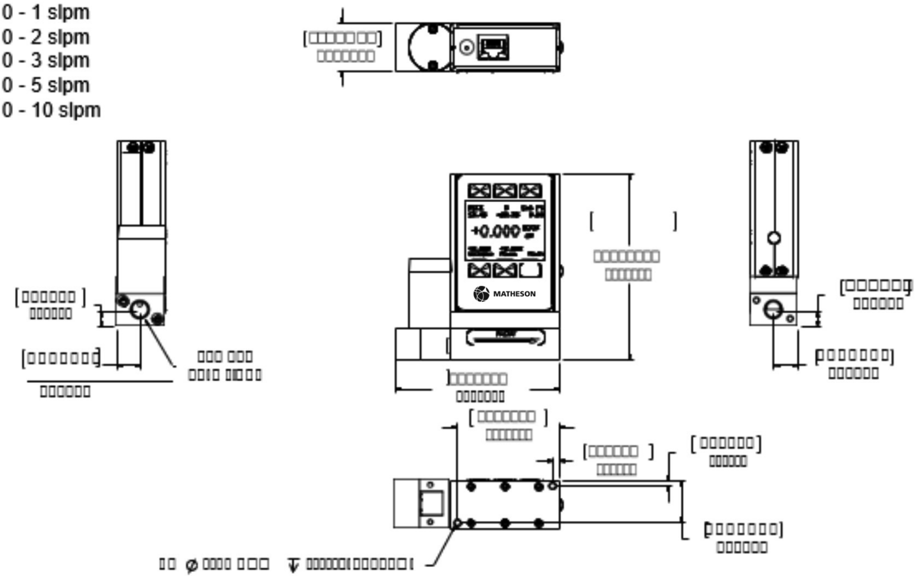
1. The **Digital Output Signal** communicates Mass Flow, Volumetric Flow, Pressure and Temperature
2. The **Analog Output Signal** communicate your choice of Mass Flow, Volumetric Flow, Pressure or Temperature

Range Specific Specifications

Full Scale Flow Mass Controller	Pressure Drop at FS Flow (psid) venting to atmosphere	Mechanical Dimensions	Process Connections[1]
100 sccm to 500 sccm	1.0	4.1"H x 3.6"W x 1.1"D	1/8" NPT Female
1 slpm	1.5		
2 slpm	3.0		
5 slpm	2.0		
10 slpm	5.5		

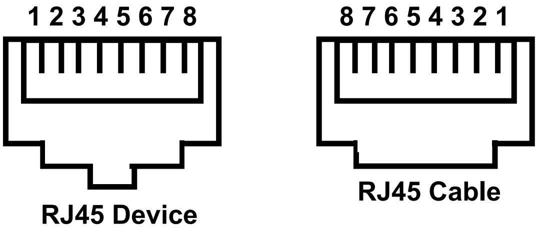
1. Compatible with, Swagelok® tube, Parker®, face seal, push connect and compression adapter fittings. VCR and SAE connections upon request.

829 -Series: 0
- 100 sccm
0 - 200 sccm
0 - 500 sccm
0 - 1 slpm
0 - 2 slpm
0 - 3 slpm
0 - 5 slpm
0 - 10 slpm



100 sccm to 10 slpm approximate weight: 1.2lb

RJ45 Connector Pin-Outs



1. RS-232 Receive
2. Ground
3. Analog Output
4. RS-232 Transmit
5. Power Supply
6. Power Supply
7. Analog Input
8. Ground

Serial Number: ______________________

Model Number: _________________________

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TERMS AND CONDITIONS OF SALE

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