Agilent Technologies

Agilent
Precision Gas Mass Flow Meter
Operating Manual

Notices

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Warranty

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Protect Your Warranty And Extend The Life Of Your Product

CAUTION: Failure to follow general safety and operating procedures as presented in this manual violates the safety standards and intended use of this meter and may impair the functionality of the meter. The manufacturer assumes no liability for the user's failure to comply with these requirements.

IMPORTANT: This manual contains information critical to the proper operation and maintenance of your meter. The information contained in this manual should be read and understood by those responsible for the operation and maintenance of this meter. Save this manual for future reference.

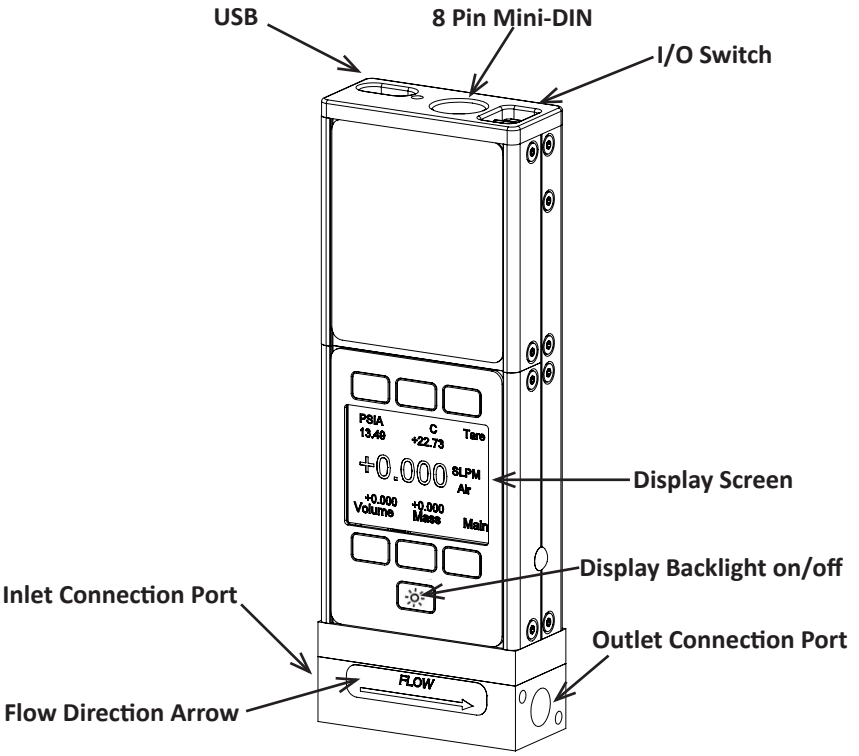
Thank you for purchasing an Agilent Precision Gas Flow Meter.

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.

Full specifications for the device can be found on pages 40 and 41.

Please contact Agilent if you have any questions regarding the use or operation of this device.

GETTING STARTED



MOUNTING

Agilent Precision Flow Meters have holes on the bottom for mounting to flat panels. See page 45.

Agilent Precision Flow Meters can usually be mounted in any position. No straight runs of pipe are required upstream or downstream of the meter.

PLUMBING

Your meter 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.

Agilent Precision Flow Meters have female inlet and outlet port connections. Use thread sealing Teflon® tape to prevent leakage around the port threads. ***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 meter should they get into the flow stream.

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 is 20 microns.

PRESSURE

Maximum operating line pressure for Agilent Precision Flow Meter units is 145 psig (1 MPa).

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

Exceeding the maximum specified line pressure may cause permanent damage to the solid-state differential pressure sensor.

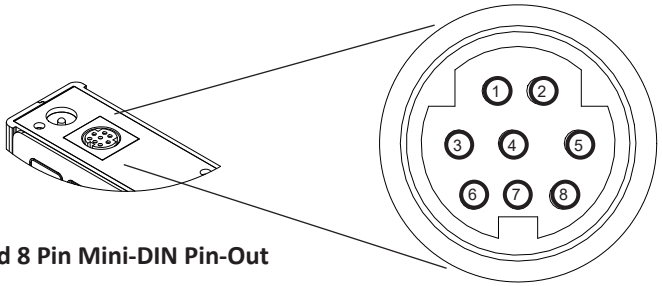
DO NOT SUBJECT AN AGILENT PRECISION FLOW METER DIFFERENTIAL PRESSURE SENSOR TO UPSTREAM-DOWNSTREAM PRESSURE DIFFERENTIALS EXCEEDING 75 PSID.

While high static pressure will typically not damage the dp sensor, sudden pressure "spikes" can result in complete failure of the sensor.

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

POWER AND SIGNAL CONNECTIONS

Power can be supplied to your meter through either the USB connection or the 8 pin Mini-DIN connector.



Standard 8 Pin Mini-DIN Pin-Out

Pin	Function	Mini-DIN cable color
1	Not Connected (or optional 4-20mA Primary Output Signal)	Black
2	Static 5.12 Vdc [or optional Secondary Analog Output (4-20mA, 5Vdc, 10Vdc) or Basic Alarm]	Brown
3	Serial RS-232RX Input Signal (receive)	Red
4	Meters/Gauges = Remote Tare (Ground to Tare) Controllers = Analog Set-Point Input	Orange
5	Serial RS-232TX Output Signal (send)	Yellow
6	0-5 Vdc (or optional 0-10 Vdc) Output Signal	Green
7	Power In (as described above)	Blue
8	Ground (common for power, digital communications, analog signals and alarms)	Purple

CAUTION! ***DO NOT CONNECT POWER TO PINS 1 THROUGH 6 AS PERMANENT DAMAGE CAN OCCUR!***

It is common to mistake Pin 2 (labeled 5.12 Vdc Output) as the standard 0-5 Vdc analog output signal. In fact Pin 2 is normally a constant 5.12 Vdc that reflects the system bus voltage and can be used as a source for the set-point signal.

INPUT SIGNALS

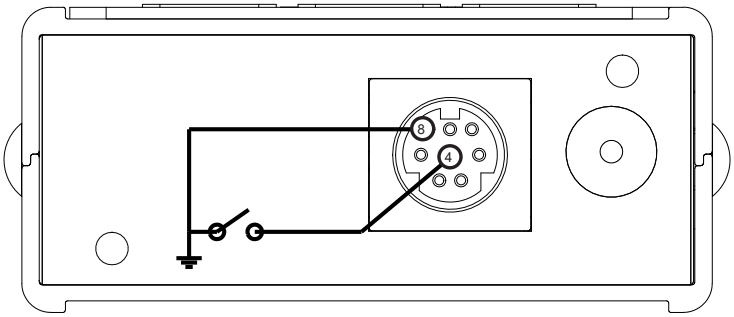
Analog Input Signal

Apply analog input to Pin 4 as shown on page 7.

0-5 Vdc is the standard analog input signal. Apply the 0-5 Vdc input signal to pin 4, with common ground on pin 8.

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

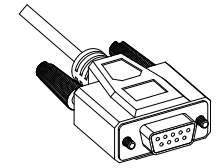
CAUTION! ***DO NOT CONNECT THIS DEVICE TO "LOOP POWERED" SYSTEMS, AS THIS WILL DESTROY PORTIONS OF THE CIRCUITRY AND VOID THE WARRANTY. IF YOU MUST INTERFACE WITH EXISTING LOOP POWERED SYSTEMS, ALWAYS USE A SIGNAL ISOLATOR AND A SEPARATE POWER SUPPLY.***

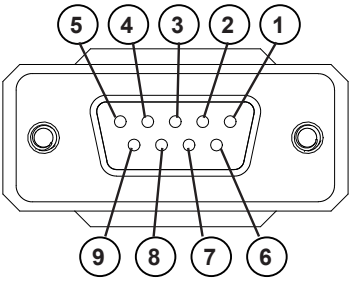


A remote tare can be achieved by momentarily grounding pin 4 to tare as shown above.

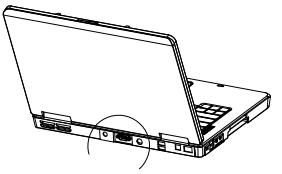
RS-232 Digital Input Signal

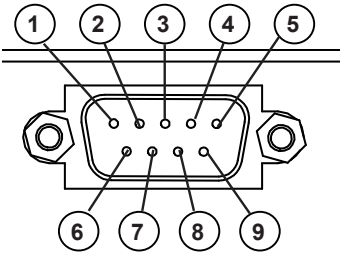
To use the RS-232 input signal, connect the RS-232 Output Signal (Pin 5), the RS-232 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown below. (See page 25 for details on accessing RS-232 input.)



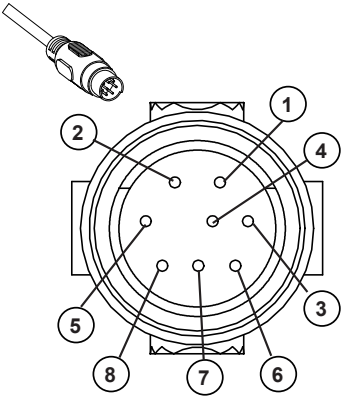


Serial Cable End

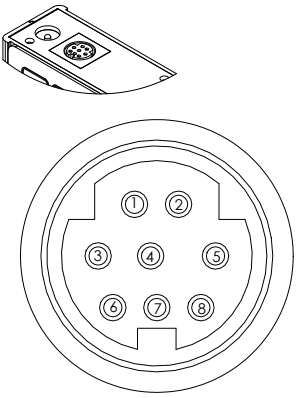




PC Serial Port



8 Pin MiniDIN Cable End



8 Pin MiniDIN Connector

9 Pin Serial Connection		8 Pin MiniDIN Connection	
Pin	Function	Function	Pin
5	Ground	Ground	8
3	Transmit	Receive	3
2	Receive	Transmit	5

DB9 to Mini-DIN Connection for RS-232 Signals

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 5), the RS-232 Input Signal (Pin 3), and Ground (Pin 8) to your computer serial port as shown on page 8. (See page 25 for details on accessing RS-232 output.)

Standard Voltage (0-5 Vdc) Output Signal

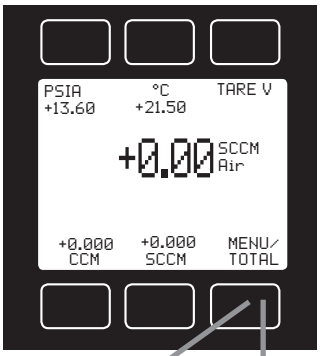
Agilent Precision Flow Meters are equipped with a 0-5 Vdc will have this output signal available on Pin 6. This voltage is usually in the range of 0.010 Vdc for zero flow and 5.0 Vdc for full-scale flow. The output voltage is linear over the entire range. Ground for this signal is common on Pin 8.

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.***

DISPLAYS AND MENUS

The device screen defaults to **Main** display as soon as power is applied to the meter.

Main

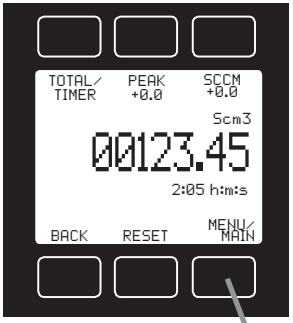


The **Main** display shows pressure, temperature, volumetric flow and mass flow.

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

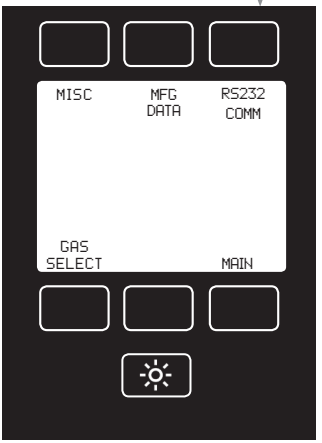
By hitting the **MENU** button at the bottom right of the screen you will enter the **Select Menu** display.

Totalizer



Pushing the **TOTAL** button once will bring up the **Totalizing Mode** display. Pushing **MENU** will bring up the **Select Menu** display.

Select Menu



Select Menu

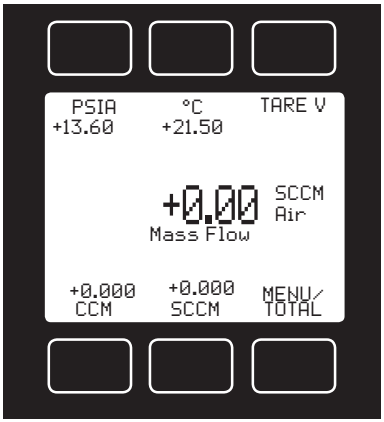
From **Select Menu** you can change the selected gas, interact with your RS-232 settings or read manufacturer's data.

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

Display On/Off:

Pushing the lowest center button will turn the display backlight on or off.

MAIN



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

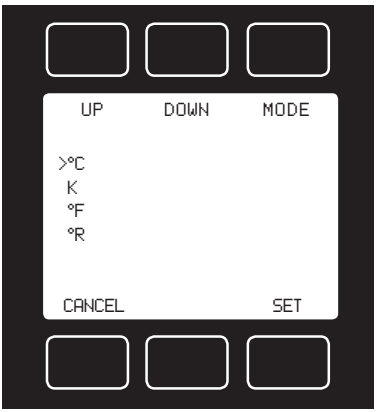
The following parameters are displayed in the Main mode.

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)

Note: *Agilent meters have additional pressure options accessed by pushing PSIA and MISC2. See page 23.*



Gas Temperature: Agilent Precision Flow Meters 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.

Tare: Pushing the **TARE V** button tares the flow meter and provides it with a reference point for zero flow. This is an important step in obtaining accurate measurements. It is best to zero the flow meter each time it is powered up. If the flow reading varies significantly from zero after an initial tare, give the unit a minute or so to warm up and re-zero it.

If possible, zero the unit near the expected operating pressure by positively blocking the flow downstream of the flow meter prior to pushing the TARE button.

Zeroing the unit while there is any flow will directly affect the accuracy by providing a false zero point. If in doubt about whether a zero flow condition exists, remove the unit from the line and positively block both ports

before pressing the TARE button. If the unit reads a significant negative value when removed from the line and blocked, it was given a false zero. It is better to zero the unit at atmospheric pressure and a confirmed no flow condition than to give it a false zero under line pressure.

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.

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 15.

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

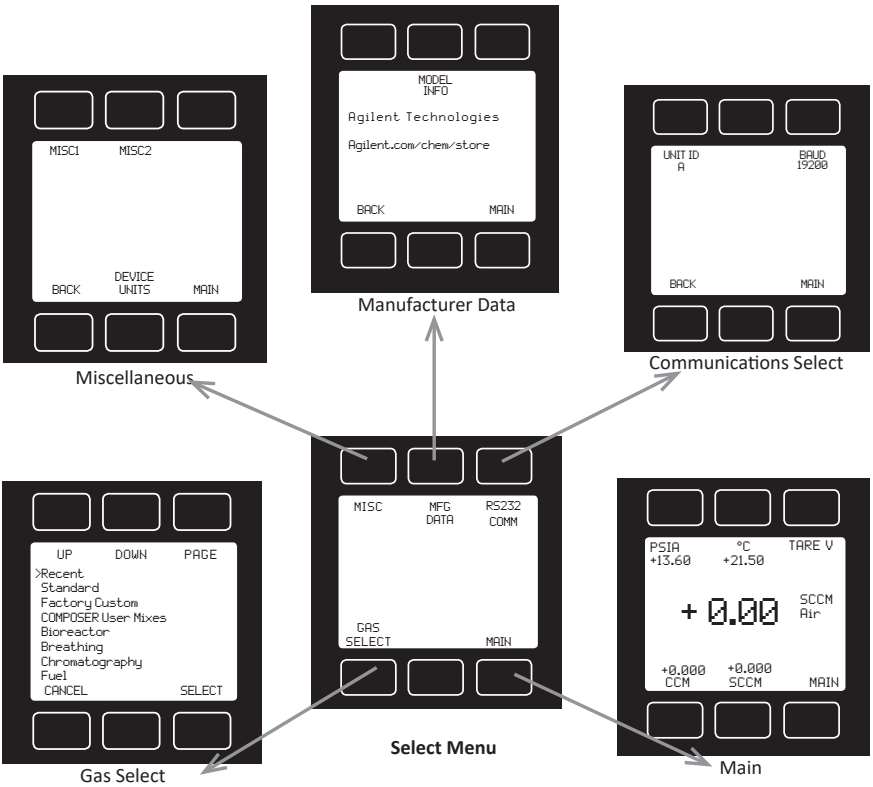
Flashing Error Message: An error message (**MOV** = mass overrange, **VOV** = volumetric overrange, **POV** = pressure overrange, **TOV** = temperature overrange) flashes when a measured parameter exceeds the range of the sensor. When any item flashes, neither the flashing parameter nor the mass flow 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 Agilent.

SELECT MENU

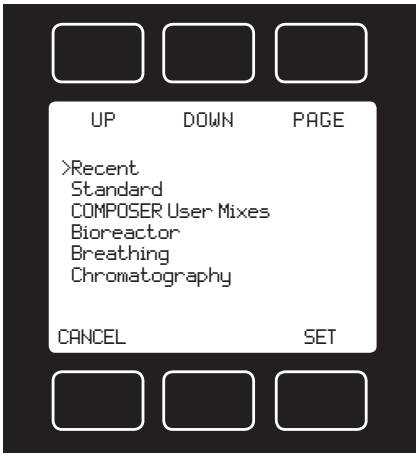
From Select Menu you can change the selected gas, interact with your RS-232 settings or read manufacturer's data.

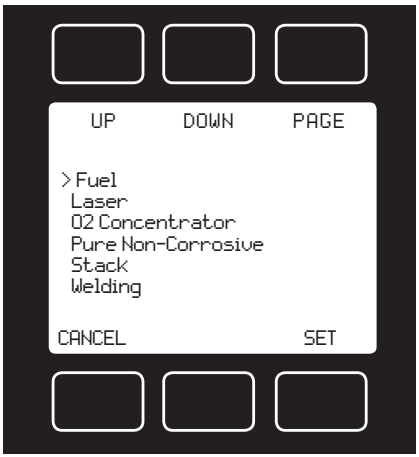
Press the button next to the desired operation to bring that function to the screen.



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

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.

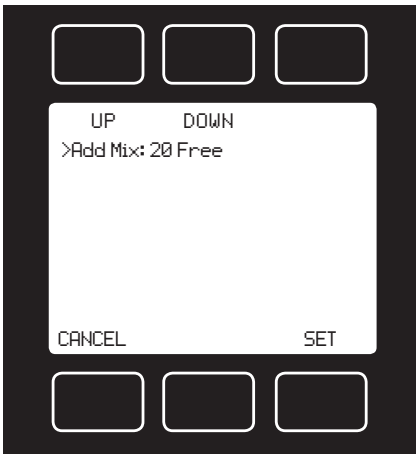
» Recent: Eight most recent selections
» Standard: Gases and mixes standard on earlier Agilent instruments (page 28)
» COMPOSER User Mixes: Gas mixes programmed by the user (page 16)
» Bioreactor (page 30)
» Breathing (page 31)
» Chromatography (page 33)
» Fuel (page 32)
» Laser (page 32)
» O2 Concentrator (page 33)
» Pure Non-Corrosive (page 28)
» Stack (page 33)
» Welding (page 29)

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.

See pages 28 -33 for a full list of gases in each category.

COMPOSER

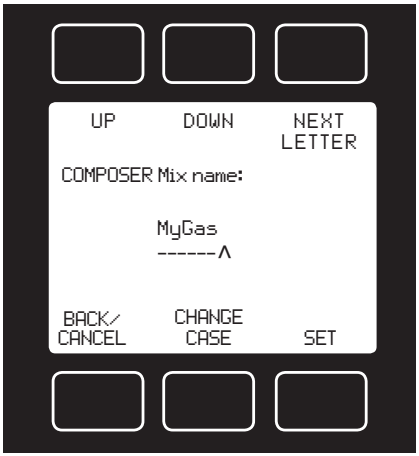


Composer allows you to program and save up to 20 custom gas mixes containing 2 to 5 component gases found in the gas lists (pages 28-33). The minimum resolution is 0.01%.

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.

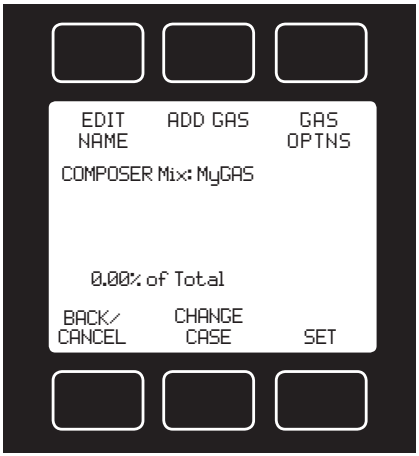


CHANGE CASE – Toggles the letter case. Letters remain in selected case until CHANGE CASE is pushed again.

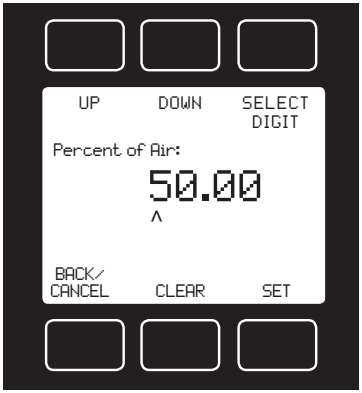
Press SET to save the name.

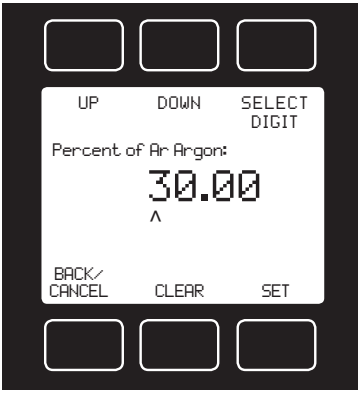
After naming the mix, press **ADD GAS** and select the gas category and the component gas.

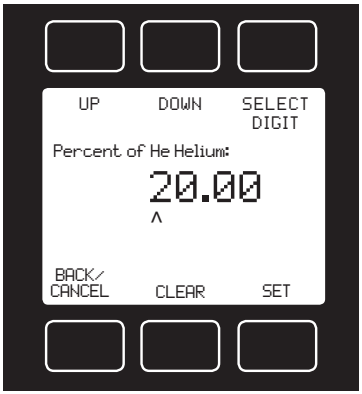
Select the digit with arrow and adjust the % with the UP and DOWN buttons. Press set to save. Add up to 4 more gases as needed. The total must equal 100% or an error message will appear.

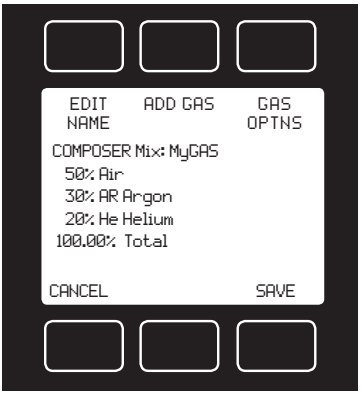


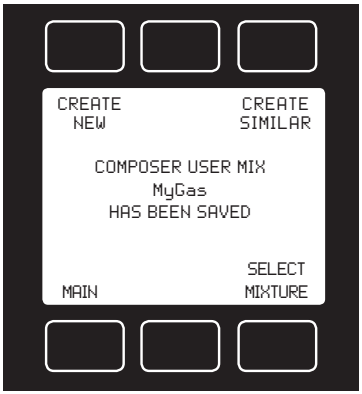
GAS OPTNS allows you to adjust the percentage of the constituents or delete a gas from the mix. Gas mixes cannot be adjusted after they have been saved.









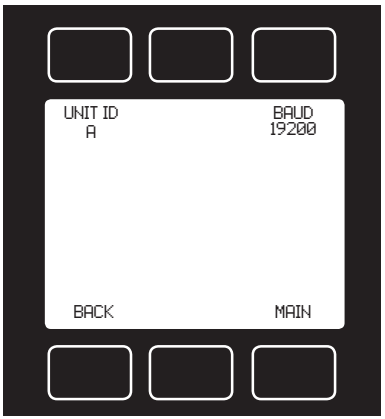


Once the mix has been saved, you may press **CREATE SIMILAR** to compose an additional mix based on the mix you have just saved. <u>This CREATE SIMILAR option is not available after leaving this screen.</u>

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.

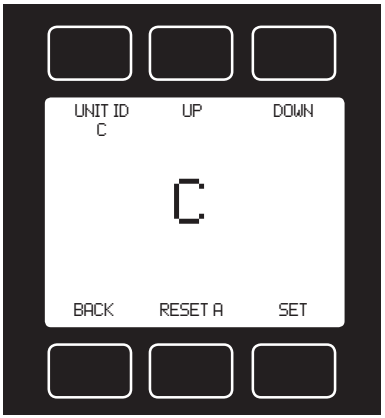
Unit ID – Valid unit identifiers are the letters A-Z and @. The identifier allows you to assign a unique address to each device so that multiple units can be connected to a single RS-232 computer port.

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.

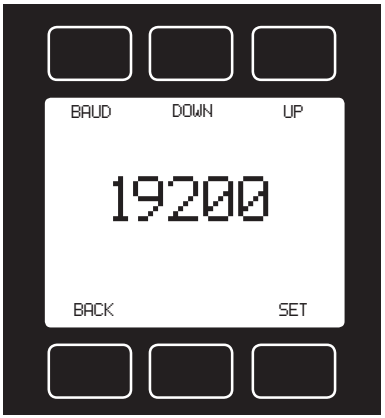
See RS-232 Communications (page 25) for information about the streaming mode.



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.

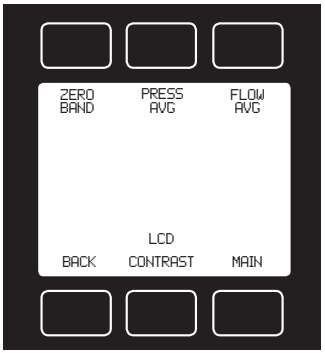
Press the Select button until the arrow is in front of **Baud**. Use the UP and DOWN buttons to select the baud rate that matches your computer. The choices are 38400, 19200, 9600, or 2400 baud.

Any baud rate change will not take effect until power to the unit is cycled.



MISCELLANEOUS

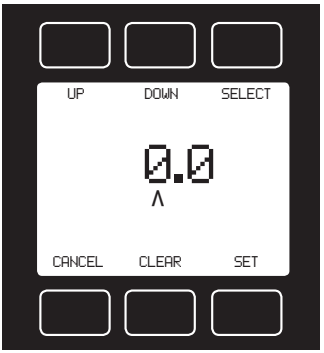
Miscellaneous is accessed by pressing the **MISC** button on the Select Menu display. Next select either **MISC1** or **MISC2.**



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).



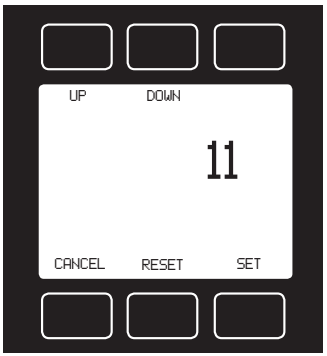
Press **ZERO BAND.** Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.

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.

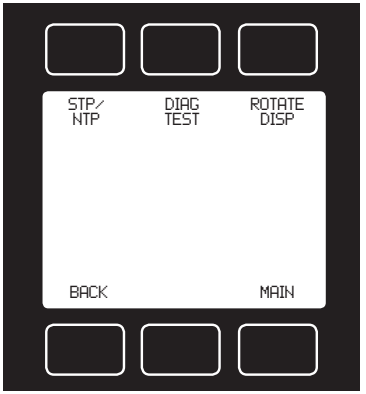
Press **PRESS AVG.** Then use SELECT to choose the digit with the arrow and the UP and DOWN buttons to change the value. Press SET to record your value. Press CLEAR to return to zero.



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 30, with zero being the lightest and 30 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.

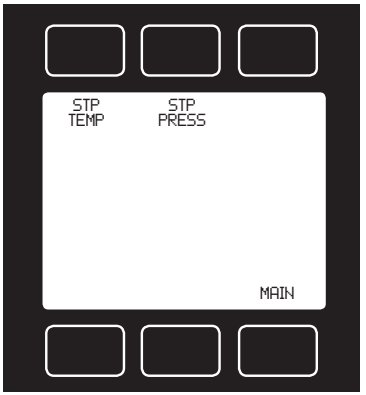


MISC2 will display as shown at left.

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.

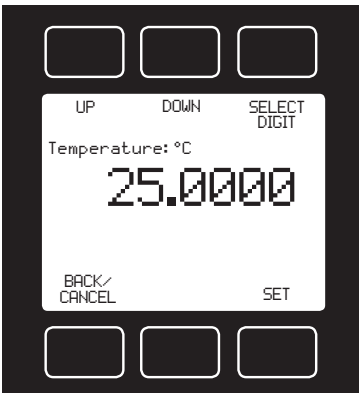
Selecting **MAIN** will revert screen to the Main display. If the **SET** selection is already the currently stored value, a message indicating that fact will appear.

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

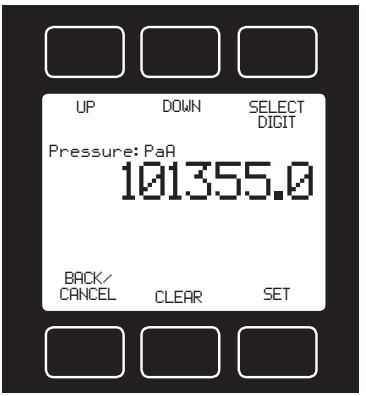
The arrow position will automatically default to the currently stored value.

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

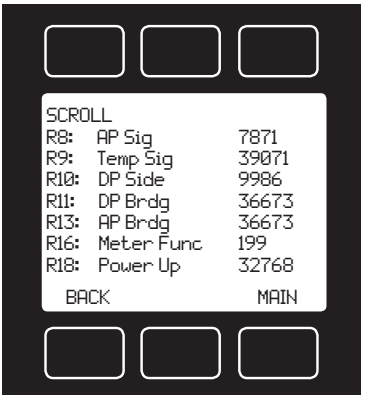
Pressing **SET** again will revert screen to the Main display. If the **SET** selection is already the currently stored value, a message indicating that fact will appear.



STP TEMP Display



STP PRESS Display



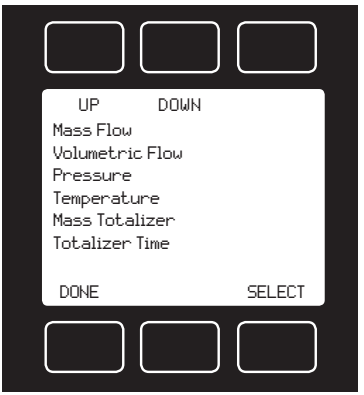
DIAG TEST: This diagnostic screen displays the initial register values configured by the factory, which is useful for noting factory settings prior to making any changes. It is also helpful for troubleshooting with Agilent customer service personnel.

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

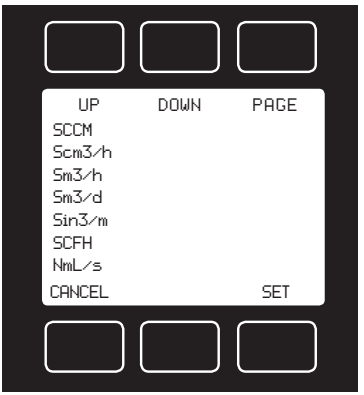
Pressing the **SCROLL** button will cycle the display through the register screens. An example screen is shown at left.

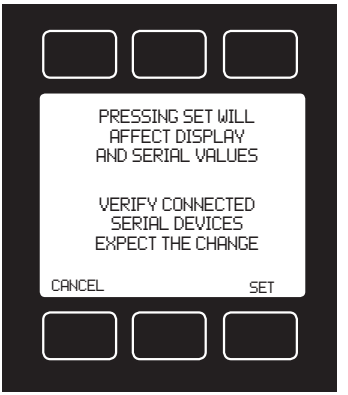
Press **ROTATE DISP** and SET to **Inverted 180°** if your device is inverted. The display and buttons will rotate together.

DEVICE UNITS



Press **DEVICE UNITS** to access menus of units of measure for each parameter (and totalizer if so equipped).
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 34 and 35 for a full list of available units.





MANUFACTURER DATA

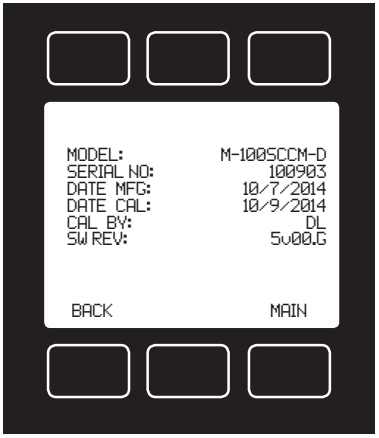
Manufacturer Data is accessed by pressing the **MFG DATA** button on the Select Menu display.

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.

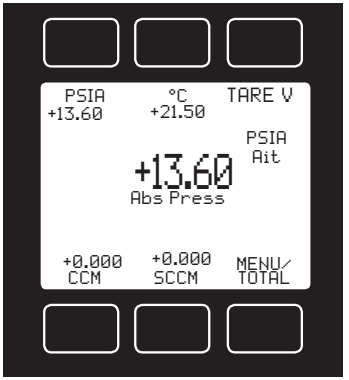
Press BACK to return to the MFG DATA display.

Push MAIN to return to the Main display.



PRESSURE MENU

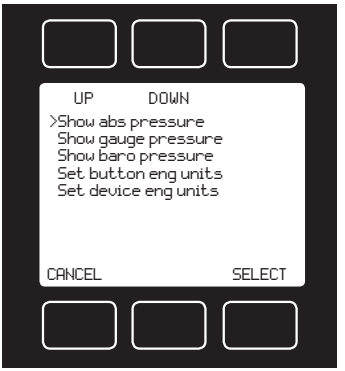
Agilent portable meters are programmed with additional pressure read options. Pressing the pressure button once (upper left) will move the pressure reading to the main display. Pressing the button a second time will open a menu of pressure read options. Scroll **UP** or **Down** and press **Select** to make a change.

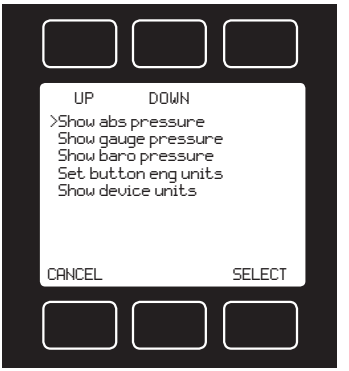


When the pressure button is already using the device engineering units, the bottom menu option displays as "**Set device eng units**".

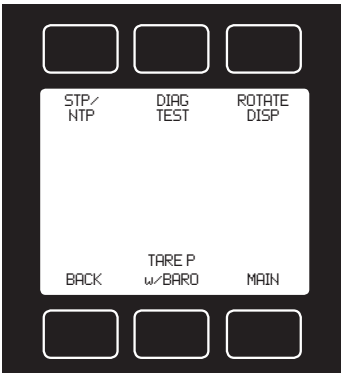
When the pressure button is using something different than device engineering units (e.g., bar instead of PSI), the bottom menu option displays as "**Show device units**".

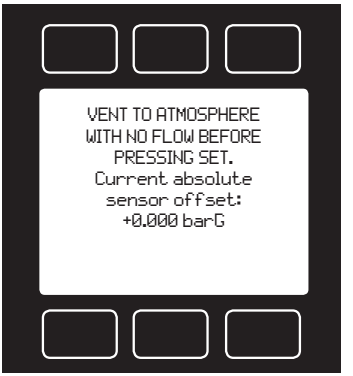
The serial data line changes only when device engineering units are changed, and the instrument will prompt you to accept these changes to the serial line**.**





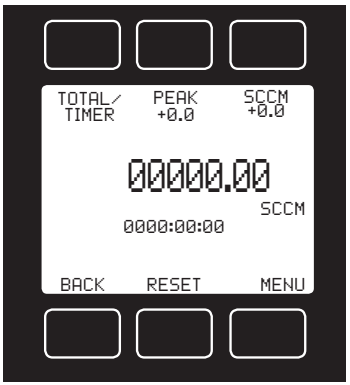
TARE P w/BARO: The stream absolute pressure sensor can be tared to the barometric pressure sensor. In this case, the absolute pressure is offset by the differential between the two readings. **TARE P w/BARO** can be accessed from the **MISC2** display.





TOTALIZING MODE

The Totalizing Mode screen displays the total flow (normally in the units of the main flow screen) that has passed through the device since the last time the totalizer was cleared. The Totalizing Mode screen is accessed by pushing the TOTAL button on the MAIN display.



TOTAL/TIMER: Pushing the TOTAL/TIMER button will cycle the large numbers on the display between total mass and time elapsed.

Rollover – The customer can also specify at the time of order what the totalizer is to do when the maximum count is reached. The following options may be specified:

No Rollover – When the counter reaches the maximum count it stops counting until the counter is cleared.

Rollover – When the counter reaches the maximum count it automatically rolls over to zero and continues counting until the counter is cleared.

Rollover with Notification – When the counter reaches the maximum count it automatically rolls over to zero, displays an overflow error, and continues counting until the counter is cleared.

TOTAL MASS: The counter can have as many as seven digits. At the time of order, the customer must specify the range. This directly affects the maximum count. For instance, if a range of 1/100ths of a liter is specified on a meter which is totalizing in liters, the maximum count would be 99999.99 liters. If the same unit were specified with a 1 liter range, the maximum count would be 9999999 liters.

ELAPSED TIME: The small numbers below the mass total show the elapsed time since the last reset in hours, minutes and seconds. The maximum measurable elapsed time is 9999 hours 59 minutes 59 seconds. The hours count resets when RESET is pushed, an RS-232 clear is executed or on loss of power. Press ELAPSED TIME to show this as the primary display.

PEAK: PEAK will display the most recent peak flow rate until totalizer is reset.

RESET – The counter can be reset to zero at any time by pushing the RESET button. To clear the counter via RS-232, establish serial communication with the meter or controller as described in the RS-232 section of the manual. To reset the counter, enter the following commands:

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

RS-232 Output and Input

Agilent Precision Flow Meters come with integrated multi-drop RS-232 connectivity.

Compatible Programs:

Many serial communication type software packages including PuTTy and LabVIEW are also compatible with these instruments. To set up serial communication it is important to note which COM port the device is connected to and the baud rate on the device (default 19200). It may also be useful to make sure the program will move to the next line when pressing “Enter” or “Return”. The number of data bits should be set to 8, and the number of stop bits should be set to 1. Parity and flow control should be disabled. Not all programs have these options and care should be taken to determine the proper communication setup with the desired program.

Sending a Command

In this section, a command will be denoted with a different font. For example, command<CR> . <CR> will be used to symbolize a carriage return. How a carriage return is entered is dependent on the serial communication program being used. With Serial Terminal, this can commonly be accomplished by pressing “Enter” or “Return”. Parenthesis denote a value that must be filled in by the user. For example, (unit ID)<CR> should be changed to A<CR> when using a device with Unit ID “A”. It may also be useful to note that commands are case insensitive. For example, A<CR> is equivalent to a<CR>.

Polling Mode

All devices are sent in Polling Mode with Unit ID A unless otherwise requested. Polling a device will return a data frame of the current measurements in the device in units shown on the display. See Data Format, later in this section, for more information. Each unit may be polled individually using the command (unit ID)<CR>.

A device’s Unit ID may be changed using the command (current unit ID)@=(desired unit ID)<CR>. The Unit ID can also be changed via the front panel using the RS-232 communication select menu. Care should be taken not to assign the same unit ID to more than one device on a single COM port. Up to 26 units may be connected simultaneously as Unit IDs between A and Z are allowed.

Streaming Mode

In Streaming Mode, a device will automatically output the data stream at a pre-determined rate. The default rate is set to 50 ms and can be changed via register values for units with software version 4v30 or newer. Only one unit on a given COM port may be in streaming mode at a time.

To change a unit from Polling Mode to Streaming Mode, type (unit ID)@=@<CR>. This is equivalent to changing the unit ID to “@”. If data does not appear, check all the connections and COM port settings.

When sending a command to a unit in streaming mode, the flow of information will not stop while the user is typing; and the typed text may not be readable depending on the terminal settings. If the unit does not receive a valid command, it will ignore it. If in doubt, simply perform another carriage return and start again.

To change a unit from Streaming Mode to Polling Mode, type `@@=(unit ID)<CR>`. If entered correctly, the data stream will stop and the device will now be in polling mode.

Data Format

The data frame on the screen represents the current measurements in the device in the units shown on the display. By default, mass flow meters are configured to output six columns of data.

All data is displayed in the "device units" selected on the unit. Devices come standard with units of PSIA, °C, and either SLPM/LPM or SCCM/CCM, depending on the flow range of the device. Note that the "button units" available on portable units will not affect the serial output. The first column is the unit ID. This column will be excluded if the device is in streaming mode. The next columns are absolute pressure, temperature, volumetric flow rate, mass flow rate, and selected gas, respectively.

For example, suppose a meter with unit ID A was ordered with units of SCFM or the "device units" are currently selected as SCFM. If air is selected, at atmospheric temperature, the data frame may read:

A	+014.70	+025.00	+02.004	+02.004	Air
Unit ID	Pressure	Temp	Vol. Flow	Mass Flow	Gas

Agilent Mass Flow Meter Data Format

On units with the totalizer function, the totalized flow will be displayed in column six, with the selected gas moving to column seven. Additional columns, including status codes, may be present to the right of the gas selection column.

Changing the gas selection using Gas Select via RS-232

To change the selected gas, type `(unit ID)G(gas number)<CR>`. For a complete list of gas numbers available on the device, see "Gas Lists with Viscosities, Densities and Compressibilities" in this manual. This list is also available on the gas select menu on the unit. For example, Helium has a gas number of 7. To change the selected gas on unit "A" to Helium, type `AG7<CR>`. On devices with GP software, use the command `(unit ID)$$G(gas number)<CR>` instead.

Operating Principle

Agilent Precision Flow Meters 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 Agilent products may notice small discrepancies between the gas property tables of your old and new units. Agilent 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 Agilent meter and your in-house standard, in addition to calling Agilent, 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:
Agilent Precision Flow Meters 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, A-25, A-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).	

Totalizer Units

Volumetric	Standard	Normal	Notes
uL	SuL	NuL	microliter
mL	SmL	NmL	milliliter
L	SL	NL	liter
US GAL			US gallon
cm3	Scm3	Ncm3	cubic centimeter
m3	Sm3	Nm3	cubic meter
in3	Sin3		cubic inch
ft3	Sft3		cubic foot
	kSft3		1000 cubic feet
uP	micropoise, a measure of viscosity; no conversions are performed to or from other units		

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

TROUBLESHOOTING

Display does not come on or is weak.
Check power and ground connections. Please reference the technical specifications (pages 40 - 41 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. Avoid installations that can subject the sensor to excessive pressure differentials (see page 7). 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 meter and contact Agilent.

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

Meter reads negative flow when there is a confirmed no flow condition.
This is an indication of an improper tare. If the meter is tared while there is flow, that flow is accepted as zero flow. When an actual zero flow condition exists, the meter will read a negative flow. Simply re-tare at the confirmed zero flow condition. Also note that while the meter is intended for positive flow, it will read negative flow with reasonable accuracy, but not to the full scale flow rate (it is not calibrated for bi-directional flow) and no damage will result.

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. Agilent Precision Flow Meterare 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.

Flow flutters or is jumpy.
The meters are very fast and will pick up any actual flow fluctuations such as from a diaphragm pump, etc. Also, inspect the inside of the upstream connection for debris such a Teflon tape shreds.
Note: Agilent Precision Flow Meters feature a programmable geometric running average (GRA) that can aid in allowing a rapidly fluctuating flow to be read (see "Pressure Averaging" and "Flow Averaging" page 19).

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.

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 10, 11 and 25 for more information on RS-232 signals and communications.

Slower response than specified.
Agilent Precision Flow Meters 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 20.

Jumps to zero at low flow.
Agilent Precision Flow Meters 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 20.

Discrepancies between old and new units.
Please see "Standard Gas Data Tables" explanation on page 27.

Maintenance and Recalibration

General: Agilent Precision Flow Meters 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 meter 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 size is 20 microns.

Recalibration: The recommended period for recalibration is once every year. A label located on the back of the meter lists the most recent calibration date. The meter 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 meter. The Serial Number, Model Number, and Date of Manufacture are also available on the Model Info display (page 22).

Cleaning: Agilent Precision Flow Meters require no periodic cleaning. If necessary, the outside of the meter can be cleaned with a soft dry cloth. Avoid excess moisture or solvents.

For repair, recalibration or recycling of this product contact:

Agilent Technologies.
Agilent.com/chem/store

Battery Life and Recharge Instructions

Agilent Precision Flow Meters use a Li-Ion 3.7V cell located in the top section of the device. **The Li-Ion cell must not be removed**.

Normal battery life of a fully-charged cell is 18 hours with a monochrome display when the display contrast is set to 10. Dimming the contrast will increase battery life. Operating the device with the display backlight off will also increase battery life

The battery can be charged through either the micro-USB port or the mini-DIN connector. When the device is connected to external power it will function normally while the battery is charging. **Note:** If the battery has no charge, a charge time of one minute will be required before the unit can be turned on. Charge rates will be fastest through the micro-USB port using the included power supply or equivalent. The device will charge fastest when it is turned off.

Recharge Time: 3.5 hours with 2A USB supply. The micro-USB port is for charging purposes only.

The green/red indicator LED on top of the device will light up green to indicate that the unit is charging. The green LED will turn off when the battery is charged and the power switch is turned to "I" for ON.

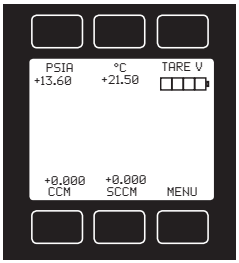
The indicator LED flashes red when the device has about 1 hour of battery life remaining. The LED will flash red at a faster rate when the device has about 15 minutes of battery life remaining. It is highly recommended that the device be charged immediately. When the battery charge runs out with a color display, the display will shut off and device performance is no longer guaranteed. When the battery charge runs out on a monochrome display, the display contrast will turn to 0 and device performance is no longer guaranteed.

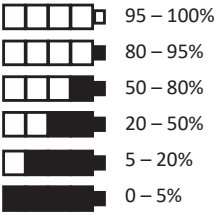
Output signals from the meter are passed through the mini-DIN connector on top of the device. Rechargeable battery units do not support 0-10V analog output.
Receiver resistance must be below 250Ω.

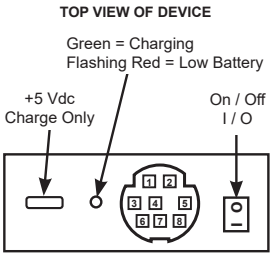
Turn the power switch on top of the device to "O" for OFF when it is not in use.

Caution: If the device is left ON until the battery can no longer power it, the charge indicator will fall out of sync with the actual charge. The device can be re-synced by fully charging the battery once.

A Battery Charge Indicator appears below Tare on the display:







CAUTION! ***Do not operate or store the device outside of the -10° to +50°C temperature range. If internal sensors detect that the temperature is outside of this range, the display contrast will turn to 0 and the meter's performance is no longer guaranteed.***

The safe charging temperature range is 0° to +45°C. If internal sensors detect temperatures outside of this range, the battery will not charge.

Technical Data for Agilent Precision Mass Flow Meter
0 to 500 sccm Full Scale

Standard Operating Specifications

Performance	Precision Mass Flow Meter
Accuracy at calibration conditions after tare	± (0.8% 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 Measurable Flow Rate	128% Full Scale
Typical Response Time	10 ms (Adjustable)
Warm-up Time	< 1 Second
Battery Life	Monochrome display at 10 Contrast: 18 hours
Recharge Time	3.5 hours with 2A USB supply and device turned off

Operating Conditions	Precision Mass Flow Meter
Mass Reference Conditions (STP)	25ºC & 14.696 psia
Operating Temperature	−10 to +50 ºCelsius
Humidity Range (Non–Condensing)	0 to 100%
Maximum Internal Pressure (Static)	145 psig
Maximum Allowable Instantaneous Differential Pressure Across Device (Inlet to Outlet)	75 psid
Proof Pressure	175 psig
Mounting Attitude Sensitivity	None
Ingress Protection	IP40
Wetted Materials	303 & 302 Stainless Steel, Viton®, Heat Cured Silicone Rubber, Glass Reinforced Polyphenylene Sulfide, Heat Cured Epoxy, Aluminum, Gold, Silicon, Glass.

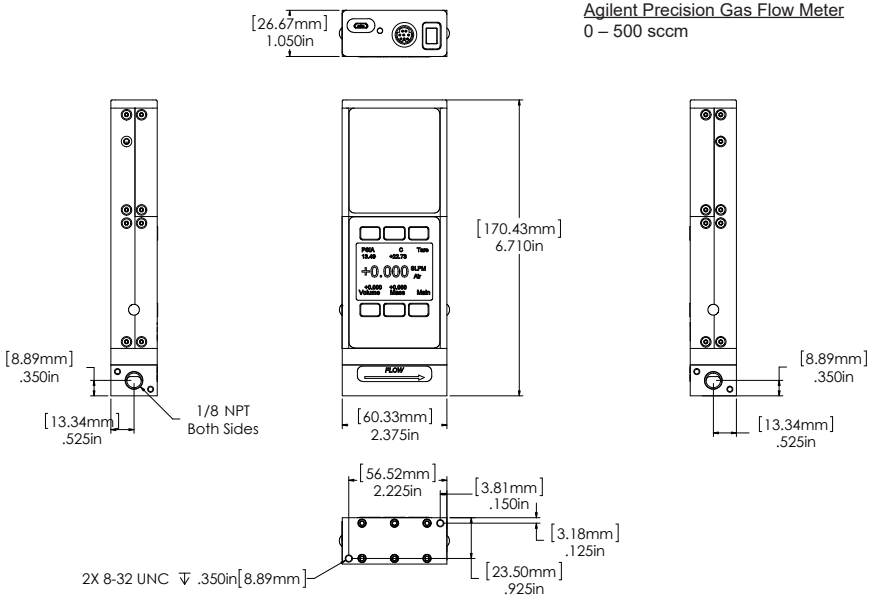
Communications / Power	Precision Mass Flow Meter
Monochrome LCD Display with integrated touchpad	Simultaneously displays Mass Flow, Volumetric Flow, Pressure and Temperature
Digital Output Signal[1] Options	RS-232 Serial
Analog Output Signal[2] Options	0-5 Vdc / 1-5 Vdc / 4-20 mA (Receiver resistance must be below 250Ω)
Electrical Connection Options	Micro-USB-B / 8 Pin Mini-DIN
Supply Voltage	+5 Vdc (Micro-USB-B) / +7 to +30 Vdc (8 Pin Mini-DIN)

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

Features	Precision Mass Flow Meter
Gas Select	**Gas Select** provides **98 Preloaded Gas Calibrations:** See the following page for a complete list.
Composer	**Composer** is a feature of Gas Select that allows users to defines up to 20 user gas compositions with up to 5 constituent gases per mix.

Full Scale Flow Mass Meter	Pressure Drop at FS Flow (psid) venting to atmosphere[1]	Mechanical Dimensions	Process Connections[2]
500 sccm	1.0	6.8”H x 2.4”W x 1.1”D	1/8” NPT Female

Agilent Precision Gas Flow Meter
0 – 500 sccm



500 sccm approximate shipping weight: 1.5 lb

Serial Number: _____

Model Number: _____

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