Agilent Veriflow 500 Electronic Flowmeter

Flow Range: 1–500 sccm
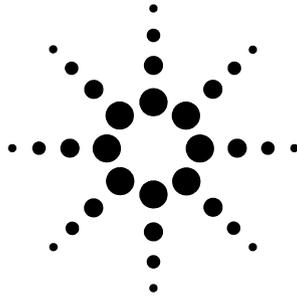
Operation Guide

Agilent Technologies

Notices

Manual Part Number

Edition

Restricted Rights Legend

Warranty

CAUTION	A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING	**A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.**

Electronic Flowmeter

Instrument Set Up

Please read this manual before proceeding to familiarize yourself with the electronic flowmeter.

1 Remove the flowmeter from the shipping container. Inspect the unit and its packing for any sign of shipping damage. Notify your supplier of any damage found. Locate your Calibration Certificate and file it in a safe place.

2 The NiCad batteries will naturally self-discharge over a period of time. Give your unit a good 12 to 18 hour charge before the first use. When possible, use your A/C adapter/charger during operation to keep the battery fully charged and prepared for extended periods of portable use.

3 Connect the gas supply to the left-hand (inlet) hose barb. See Figure 1.

| CAUTION | This instrument employs a very delicate thermal mass sensor and is designed for use with CLEAN, DRY, NON-CORROSIVE GASES ONLY! Avoid flows in excess of 500 sccm and sudden bursts of high pressure, which may damage the sensor and cause "H+F" to be displayed on the flowmeter. If "H+ F" appears on the display, lower or shut down the gas stream. |

Figure 1   Front view of gas connections

| NOTE | The Veriflow 500 operates best in an upright position on a horizontal surface, but can be handled gently during operation. |

4 Press **ON** to turn on the unit. The display will scroll a message and default to standard cubic centimeters per minute (sccm) flow reading mode.

Accurate reading tips

The flowmeter is very sensitive and will actually read minuscule gas diffusion and air currents in the environment if the inlet or outlet is open. When no flow is present, an **H-F** or positive flow reading generally indicates the need to auto-zero the unit (see "Auto Zero" on page 9).

NOTE	Purge the unit with the selected gas prior to zeroing. Zeroing does not affect calibration.

Use the Auto-Zero feature:

- At the beginning of a use session
- After the unit has been transported
- If there has been a noticeable environmental change

Always allow the time necessary to purge lines and tubing with the selected gas, and for flow changes to stabilize within a system. The flowmeter allows you to monitor this process. The display will remind you to purge the system whenever a new gas is selected.

NIST traceability

This flowmeter uses Mass Flow technology, which is factory-calibrated against a true volumetric primary flow standard that has been certified for NIST traceability. Temperature and pressure corrections are applied to obtain the standardized flow data. Your instrument is calibrated to 22 °C/760 Torr. The temperature and pressure transducers employed to obtain the standardized readings are calibrated against NIST-traceable standards. Always correct compared data when comparing and correlating results obtained from different flow measurement technologies.

Equipment Compatibility

This unit has a low-resistance, pulse-free flow path for the best performance in the intended applications and to promote equipment compatibility. At 500 sccm, the flowmeter produces about 0.0144 psi (0.0993 kPa) as the upper limit of backpressure to be encountered within the Electronic flowmeter's functional range (0.036 psi = 1 inch of water). The back pressure produced shows a very linear drop in relation to the flow rate induced. So at 250 sccm, the back pressure would be about 0.2 inches of water, or about 0.0072 psi (0.0496 kPa), and so on as the flow reduces further. At 100 sccm, the pressure drop introduced by the flowmeter is less than 0.1 inch of water, in marked contrast to other units of this type.

Comparing Measurements to Results from Other Devices

If comparing and correlating the flowmeter results with other flow measurement techniques, it may be necessary to correct the comparable flow data to 22 °C/760 Torr. The correlation may be made by correcting volumetric data to reflect an atmospheric pressure of 760 Torr and a temperature of 22 °C. This is the measurement used when calibrating the electronic flowmeter.

CAUTION If used concurrently with a soap film bubblemeter for comparison purposes, always run this electronic flowmeter in line and the bubblemeter down stream and vented to atmosphere. Soap film solution (or any condensed moisture) will damage the delicate sensor in your electronic flowmeter, and such damage is not covered under your warranty. Do not expose to flows over 500 sccm and use with clean, dry, non-corrosive gases only!

Operation

This flowmeter measures mass flow in standard cubic centimeters per minute (sccm). Mass Flow technology gives the user the advantage of flow measurements that are much less susceptible to influences of the environment because they are reasonably independent of the volumetric variances of a gas due to ambient temperature and pressure conditions, thus allowing more consistent day-to-day flow measurement.

CAUTION If the instrument is operated in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.

General operation

The Veriflow Electronic Flowmeter has three buttons (Figure 2).

On	Mode	Set
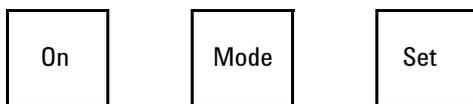
Figure 2   Embossed button detail

ON: A quick press of the **ON** button powers up the unit. Press and hold (until the display reads **OFF**) to turn the unit off manually. Also use **ON** to reset the unit to display flow readings after using the **MODE** and **SET** functions.

MODE: Repeated presses will display the following general menus and sub-menus:

- Flow mode (sccm, cm/s with a sub-menu to select column id, or split flow ratio)
- Gas selection (H_2, N_2, air, and argon [95%] methane [5%])

- Options contains the printer function in the sub-menu. Use the **SET** button to turn the printer function on and off.
- Unit identification information

SET: Use **SET** to scroll through and set the desired value or choices given within the selected mode or menu.

To use the Flowmeter

1 Connect the flow source to the flowmeter inlet port.

2 Press **ON**.

3 Select the gas type (see "To select the gas type" below).

4 Set the desired flow mode (see sections "To use sccm flow reading mode" and "To use split flow ratio mode" below).

5 Allow time for the gas lines to purge.

6 Read the display.

To select the gas type

The flowmeter is calibrated for N_2, He, H_2, air, and argon [95%] methane [5%]. To select the gas to be measured:

1 Use **MODE** to reach the Gas Selection menu.

2 Press/Scroll **SET** to select the desired gas.

3 Press **ON** to return to flow readings (you will be reminded to purge with that gas).

NOTE	Employing a Mass Flow methodology, the readings are unaffected by altitude/ pressure, but extremes of temperature can affect performance. The most reliable readings are obtained within ±10 °F (–12 °C) from ordinary room temperature (17–27 °C or 60–80 °F).

To use sccm flow reading mode

This is the default mode of operation. The LCD begins displaying flows for the gas that was previously selected (see "General operation" on page 6) in prior use when turned on.

sccm flow reading measures mass flow and is unaffected by the volume of the gas.

sccm flow readings (Figure 3) are displayed in resolutions of:

- 0.1 sccm below 100 sccm
- 1.0 sccm above 100 sccm

Figure 3   sccm flow reading example

To use this mode:

1 Press **MODE** to reach the Flow Mode menu.

2 Press **SET** to select sccm.

3 Press **ON** to display readings.

To use split flow ratio mode

The flowmeter will display split ratios (split vent:column flows) of up to a maximum value of 500:1 in resolutions of 0.1 below 100:1 and 1.0 above 100:1 (example in Figure 4).

To display a Split Flow Ratio:

1 Press **MODE** to reach the Flow Mode menu.

2 Press **SET** to select Split Ratio.

3 Press **MODE** again and **SET** column flow as instructed.

4 Press **SET**, then connect the flowmeter inlet to the split vent as instructed.

Figure 4   Split ratio display

To use linear velocity mode

The flowmeter can be connected to a capillary column and set to produce cm/s readings. Two capillary column adapters are included for this purpose (see "Capillary Column Adapters" on page 13).

Cm/s readings are calculated from flow data that is corrected to 22 °C/760 Torr.

To set the unit for Linear Velocity mode:

1 Select gas if needed, and purge (see **SET** under "General operation" on page 6).

2 Press **MODE** once to reach the Flow Mode menu.

3 Press **SET** once to select Linear Velocity.

4 Press **MODE** once to reach id select menu.

5 Press/Scroll **SET** to view and select the desired id (choice of: .10, .18, .20, .25, .28, .32, .53, .75).

6 Press **ON** to return to flow display in cm/s (see Figure 5).

Figure 5   cm/s example

Linear velocity readings below 100 cm/s are displayed to a resolution of 0.1 cm/s. Linear velocity readings above 100 cm/s are displayed to a resolution of 1.0 cm/s and up to a maximum value of 999 cm/s.

Auto Zero

CAUTION Purge the flowmeter with the gas selected BEFORE checking or using the Zero function! There is a separate zero calculation for each calibrated gas. The selected gas must be in use when zero is checked/set.

For the best and most consistent results, it is recommended that you check the ZERO setting at the beginning of each use. To zero set the Flowmeter:

1 Press **MODE** three times to reach the ZERO FUNCTION.

2 Press **SET** once.

3 Follow the displayed instructions.

Auto power off

The flowmeter will shut itself off automatically after 8 minutes of no activity/flow to conserve power while away from the charger and (when connected) to allow charging while not in use.

Low battery indicator

When the display in Figure 6 appears, the unit will run another 2–3 hours at its present battery power level.

Figure 6   Low battery display

Zero Kit Installation

Zeros are carefully set during the initial factory calibration for each of the gases. Frequent resets are ordinarily NOT necessary, but allowing a thorough purging with the selected gas for accurate measurement is ALWAYS required. Refer to Figure 7.

NOTE When the flow is off, an **"H-F"** or some positive reading display usually indicates the need to purge contaminating gas (usually air) from the sensor. If you are sure the unit is purged, the flowmeter needs to be re-zeroed for the selected gas.

To install the Zero Kit:

1 Connect the supply tubing (A) to the gas source (GC or ?).

2 Connect the opposite end of the supply tubing to the white adapter (B) if using 1/8th-inch or less id tubing. Alternatively, 5/32-inch to ¼-inch supply tubing may be connected directly and completely over the left (supply/inlet) of the 3-way valve. If using the white adapter, insert snugly into the inlet of the 3-way valve.

3 Connect the 3-way valve to the flowmeter inlet using the white connection tubing (C) already in place on the right side outlet of the valve.

4 The valve handle points in the direction of the branch of the valve that is off. Use the valve to divert the flow to the center outlet (as in Figure 7) while zeroing the unit (see "Auto Zero" on page 9).

NOTE	Do not use the left position of the valve handle. This shuts the supply flow off, and disturbs EPC systems and flow controllers that may be in use.

Using the valve kit will contribute a slight pressure drop, which may be of consequence in your particular application/system. The flowmeter should be thoroughly purged with the selected gas prior to setting the zero, as well as during use.

5 Block the flowmeter outlet to prevent the contamination of the sensor with air (which will immediately attempt to back fill into the unit from the outlet when the flow is shut off). This is especially true when using Hydrogen or Helium. It is highly recommended to attach a descending piece of tubing from the outlet of the flowmeter to prevent the escape of the lighter than air gasses during the procedure.
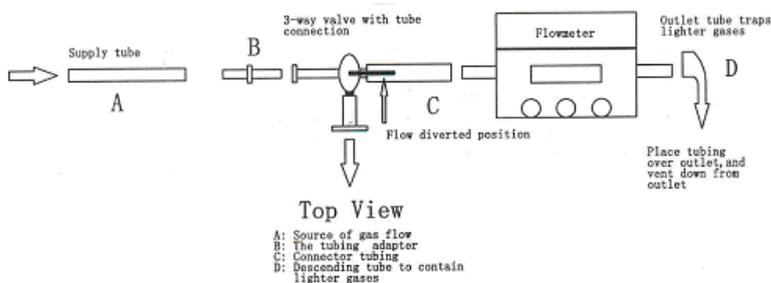
Figure 7 Top view of Zero Kit installation

Specifications

Flow range	1 to 500 sccm maximum with all calibrated gases
Sensor type	True Mass Flow w/Permalloy sensor & Silicone Substrate
Calibrated gases	Hydrogen, Helium, Nitrogen, Air, and 5% Argon Methane
Calibration standards	NIST traceable volumetric primary standard cylinders corrected to dry gas flow at 22 °C, 760 Torr
Accuracy	±2% of the reading, or 0.25 mL/min (whichever is greater)
Pressure tolerance	20 psi (~138 kPa) maximum (when used in line)
Power	Recharging battery pack and /or AC adapter output of 5 volts regulated DC, 500 mA

NiCad Battery Pack and Recharging

For portability and convenience, your flowmeter will operate for extended periods on its internal rechargeable battery pack (NiCad 3.6 V, 600 mAh). Prior to first use, charge your unit for about 18 hours with the included A/C adapter to provide a full initial charge.

This unit is designed to be used with its power supply whenever practical, but is also capable of portable, independent use as needed. It is not designed as a primary battery powered unit, so keep it charged up by connecting its charger overnight and on weekends.

Serial Port Communication

This flowmeter features full RS232 communication ability with a computer, a terminal, or if the printer function is selected from the Options mode, sends a flow data printout directly to any serial printer via the built-in DB9-pin communication port (see Figure 8). The printer feature is turned on from the Options mode using the **SET** button, and while on, will supersede normal 2-way RS232 communication.

| NOTE | The computer receives data from the flowmeter on pin 2 and transmits data to the unit on pin 3. Communications are done at 9600 baud, 1 starbit, 8 data bits, 1 stop bit, and no parity. |

Communication between the printer and flowmeter is done via the RS232 serial interface using ASCII messages.
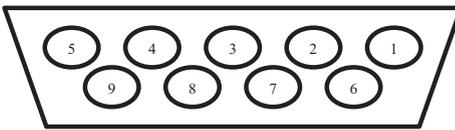
Rear view
1. nc   6. DSR
2. RX   7. nc
3. TX   8. CTS
4. nc   9. nc
5. Ground

Figure 8   Electronic Flowmeter RS232 Serial Interface DB-9

When on, the unit will send continuous results enabling a permanent printed record. In this mode, all messages to the unit will be disabled. If "Printer" is set to off (the power up default mode), the following applies:

- Two types of messages can be sent to the unit. Query messages ask the unit for information, and must begin with a "?". Command messages tell the unit to do something, and must begin with a "!". See Table 1.
- Both types of messages must end with a carriage return character for the unit to respond. The Flowmeter's response will also always end with a carriage return.

- The unit will respond to an invalid message that it does not understand with a "–" character. The response to a valid, understood message will be the requested information or a "+" sign to indicated the received message was acted upon.
- The results of a command can be checked with a query to confirm that the desired change has occurred. Give the unit about 50 to 100 ms to process and respond to messages.

Table 1   ASCII Messages

Message	Result
?R	Requests the next new results from the current mode of operation.
?G?	Requests total number of gases available in the unit.
?G0	Requests the name of the gas currently selected.
?Gn	Requests the name of the gas number n in the unit.
?M?	Requests total number of operational modes available in the unit.
?M0	Requests the name of the current operational mode selected (Zero Mode = 'AZ", and Measuring Column Flow = "CF").
?Mn	Requests the name of operational mode number n in the unit.
?!?	Requests total number of columns for linear velocity calculations available.
?I?	Requests the I.D. (in mm) of the currently selected column.
?I0	Requests the I.D. (in mm) of the currently selected column.
?In	Requests the diameter in mm of column number n in the unit.
?X?	Requests the total number of LCD contrast levels available in the unit.
?X0	Requests the current LCD contrast level selected.
?B	Requests the condition of the battery ("G" for good and "L" for low and needs recharging.)
?V	Requests the software version installed.
?D	Requests the calibration date for the unit.
?U	Requests the manufacturer's Internal Unit Number for the unit.
!P0	Command to turn the unit on/off.
!R1	Commands unit to give continuous results updates.
!R0	Commands unit to stop giving continuous results updates.
!Z1	Puts the unit into Zero Mode (unit will not respond if in split ratio mode).
!Z0	Ends Zero Mode and stores the new zero value (only valid while in Zero Mode).
!C0	Sets the column flow for the split ratio mode (only valid when the last command given was to put the unit into split ratio mode, and a column flow obtained).

Table 1   ASCII Messages (continued)

Message	Result
!In	Command to set the current column number to n

The following two commands are valid under the following conditions:
- Flowmeter not in Zero Mode
- Flowmeter is not setting up column flow for entry into split ratio mode

!Gn	Commands the unit to change to gas number n (this command is also not valid if already in split ratio mode, because it will affect the stored column flow which must be re-measured when changing gases).
!Mn	Puts the unit into operational mode n (if the new mode is split ratio, a new column flow must be measured first).

Capillary Column Adapters

Column adapters are provided with your instrument to connect the inlet to the end of a capillary column as shown in Figure 9.

Use the shortest supply tube practical and allow sufficient time to purge the line with the selected gas before relying on the readings. A high-flow "flush" with the selected gas, when practical, can expedite this process when working with very low flows.
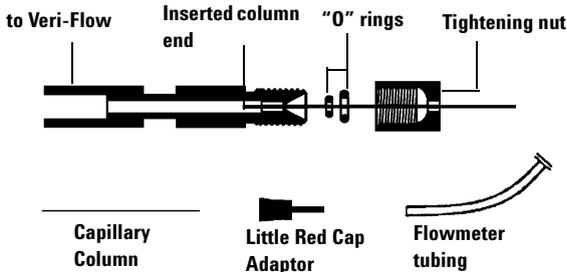
Figure 9   Column adapters

Recalibration, Repair, and Service

CAUTION There are no user-serviceable parts or adjustments within the flowmeter case. Opening the case voids your warranty, and tampering with internal parts may necessitate factory service and/or recalibration.

The manufacturer recommends an annual cycle of periodic recalibration for the flowmeter where required to satisfy quality control protocols such as GLP or ISO 9000.

Calibration data is entered into ROM within the unit using proprietary calibration procedures and programming. The flowmeter must be returned to an authorized facility for recalibration. Call your supplier.

The case and display may be cleaned with a damp cloth. Do not use solvents of any type. Avoid rough handling and direct exposure to sun or temperature extremes.

CAUTION USE WITH CLEAN, DRY, NONCORROSIVE GASES ONLY. AVOID THE INTRODUCTION OF MOISTURE!

To recalibrate the flowmeter or to have it repaired, contact Agilent or an Agilent-recommended recalibration and repair facility. For a list of these facilities as well as more information on flowmeter recalibration, visit the Agilent Web site at www.agilent.com/chem/fmrepair.

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If the Agilent Veriflow 500 Electric Flowmeter is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.

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