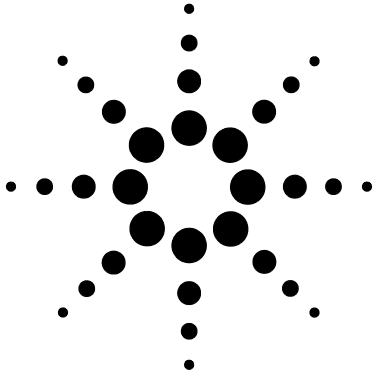

Agilent Optiflow Digital Flowmeters

HFM-420

HFM-570

HFM-570-FC

HFM-650

HFM-650-FC

Operation Guide

Agilent Technologies

Notices

Manual Part Number

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Safety Notices

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.

Setup and Operation

This operation manual applies to the following instruments:

- Agilent Optiflow 420 Digital Flowmeter, model number HFM-420
- Agilent Optiflow 570 Digital Flowmeter, model number HFM-570
- Agilent Optiflow 570 Mobile Digital Flowmeter, model number HFM-570-FC
- Agilent Optiflow 650 Digital Flowmeter, model number HFM-650
- Agilent Optiflow 650 Mobile Digital Flowmeter, model number HFM-650-FC

Instrument Setup

Please read through this entire manual to familiarize yourself with the operation of the instrument before proceeding. Use the same degree of care as you would with any precision instrument.

1 Remove the instrument from the shipping container.

WARNING **Be careful not to damage the glass flow tube.**

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2 Inspect the instrument. If there is any visible damage, contact your supplier immediately.

Preparing the Agilent Optiflow 570 Mobile and 650 Mobile Digital Flowmeters for use

1 Open the case by sliding the circular tab on the front of the case in the direction of the arrow.

2 Completely open the lid of the instrument on its hinge (280 degrees) so that the lid becomes the base. See Figure 1.

Figure 1 Correct instrument orientation (Optiflow 650 Mobile Digital Flowmeter shown)

Installing the Agilent Optiflow 420 and 570 model tubing assembly

1. Connect the latex tubing to the exit on the back of the glass flow tube.
2. Feed the latex tubing through the slot on the front of the flowmeter and route it out the back.
3. Insert the glass flow tube between the arms of the large sensor block assembly.
4. Feed the latex tube through the plastic clamp on the back of the flowmeter. See Figure 2.

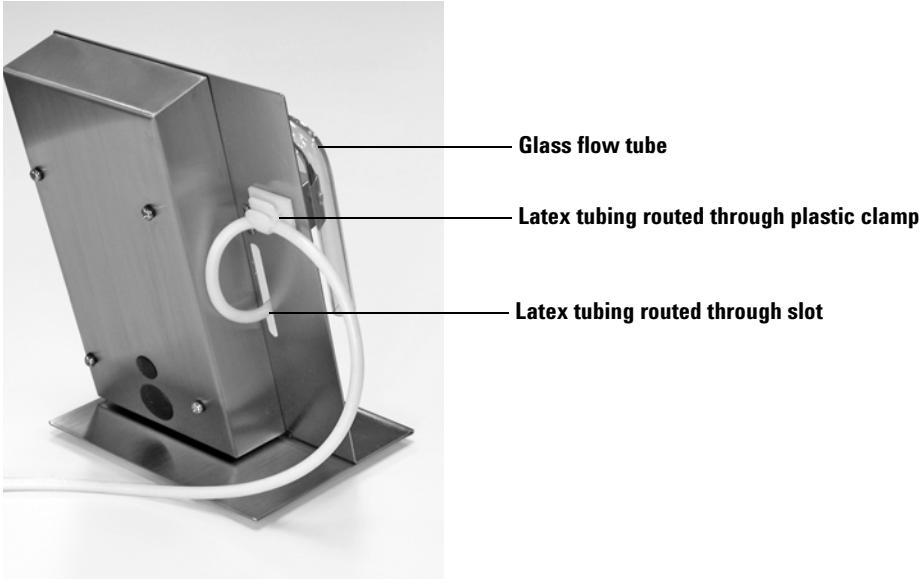

Figure 2 Correct positioning of latex tube

Installing the Agilent Optiflow 650 model tubing assembly

1 Insert the glass flow tube between the arms of the large sensor block assembly (refer to Figure 3).

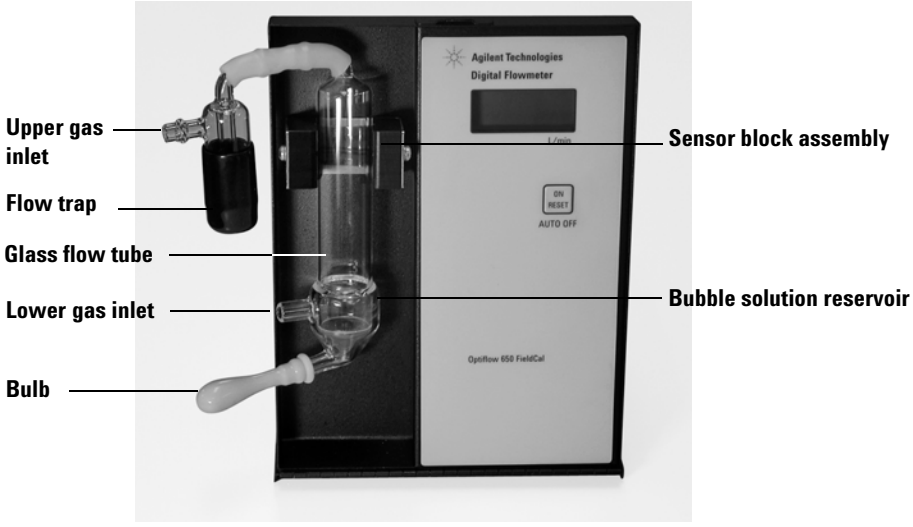

Figure 3 The Agilent Optiflow 650 Mobile Digital Flowmeters tubing assembly

2 If needed, install the glass flow trap as shown in Figure 3.

3 Attach the tubing assembly to either the upper or lower gas inlet. Use the upper gas inlet to measure vacuum, or the lower gas inlet to measure flows.

Testing the instrument

1 Place the unit on a horizontal surface and press **ON/RESET** momentarily. For Optiflow 570 model flowmeters, you will see the result shown in Figure 4. For Optiflow 420 and Optiflow 650 model flowmeters, you will see the result shown in Figure 5.

Figure 4 LCD segment check display for Optiflow 570 model flowmeters

Figure 5 LCD segment check display for Optiflow 420 and Optiflow 650 model flowmeters

2 Compare the display on your flowmeter to the appropriate display above. Any discrepancies indicate a malfunction. Contact your supplier.

After a brief period, a **0** displayed indicates the instrument is ready to use. If any fault messages appear on the display after the LCD segment check, see “Fault Conditions” on page 17 for recommendations. Fault messages are indicated by an **F** appearing on the display with a number.

Preparing the glass bubble meter

1. Gently remove the latex bulb from the glass bubble meter flow tube.
2. Fill the latex bulb with Snoop solution and reinstall the latex bulb onto the glass bubble meter. Snoop is recommended for its optical properties and lack of residue after drying.

NOTE Snoop is a leak detection bubble solution available from Agilent Technologies.

CAUTION Never close or transport the instrument unless all of the liquid Snoop solution from the flow tube and latex bulb is removed. Optical and electronics malfunctions may result from resulting liquid spillage.

3. Adjust the liquid level so that it is just below the glass inlet tube by using the small clamp provided (see Figure 6). The instrument is now ready to use.

Figure 6 Clamp properly installed (570 Digital Flowmeter shown)

Operation

The instrument is calibrated and should be operated with a completely wet flow tube. Erroneous results and faults are more likely if the tube is not completely wet. Be careful not to allow Snoop solution to enter the latex hose and possibly contaminate the instrument whose flow you are measuring.

CAUTION Agilent Optiflow Digital Flowmeters are designed for measuring gas flow rates in laboratories. If the instrument is operated in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.

To operate the flowmeter:

1 Connect the flexible latex tubing from the glass inlet tube to your gas source.
   - Make this connection with the shortest tubing length possible.
   - Avoid kinks and bends for the most accurate flow measurements.

CAUTION Be careful not to stress the glass bubble meter inlet tube while connecting the latex tubing.

CAUTION Keep instrument away from open flame when measuring flammable gas! Make sure that area is properly ventilated! Do not expose the latex to high temperatures.

2 In general, slide the glass bubble meter to its lowest position on the stand (see Figure 7) for faster flow rates (10 mL/min or greater for Optiflow 420, Optiflow 570, and Optiflow 570 Mobile flowmeters; 500 mL/min for Optiflow 650 and Optiflow 650 Mobile flowmeters). For low flow rates, slide the glass bubble meter to its highest position on the optical blocks (refer to Figure 8).

Figure 7 Positioning of Optiflow 570 Mobile Digital Flowmeter's bubble meter for faster flow rates

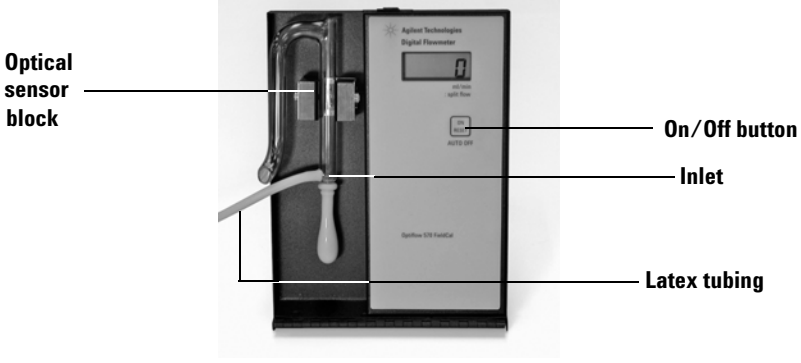

Figure 8 Positioning of the Optiflow 570 Mobile Digital Flowmeter's bubble meter for lower flow rates

3 Start with a slow flow rate and gradually increase flow to desired flow rate.

CAUTION When the clamp is not used, do not squeeze the latex bulb while there are bubbles being tracked by the optical sensors. Squeezing the latex bulb tends to accelerate the bubbles in the bubble meter and can cause an artificially high result.

4 Generate a single flat bubble for proper flow measurements.
   - To generate a single flat bubble, squeeze the latex bulb gently until a single bubble is formed.
   - To generate a continuous series of bubbles:
     a Place the enclosed latex bulb clamp on the latex bulb with the U open end up.
     b With gas flowing, lightly tighten the clamp until the bubbles begin to form.
     c Adjust the clamp so that bubbles are going through the glass tube one at a time.

5 When the bubble passes the lower sensor in the sensor block, the TIMING IN PROGRESS symbol (the + sign) should go on. It should remain on only as long as there are bubbles between the lower and upper sensors. If it remains on after all bubbles have left the sensor block area, or if a bubble pops while between the sensors, press **RESET** momentarily. After the bubble passes the upper sensor in the sensor block, the display will read out the gas flow rate. This reading will be held until the next bubble comes along or the unit is turned off.

Several other messages may appear on the display.

–L–	The measured flow is below the meter's operating range.
–H–	The measured flow is above the meter's operating range.
–b–	Indicates a bad flow result. To clear, create new bubbles or press **ON/RESET**.

Operating at very low flow rates

At very low flow rates (less than 1 mL/min for Optiflow 420, Optiflow 570, and Optiflow 570 Mobile flowmeters; 20 mL/min for Optiflow 650 and Optiflow 650 Mobile flowmeters), the instrument may turn itself off before the bubble has a chance to reach the lower sensor. To prevent this, press **ON/RESET** just after making the bubble to establish a new INSTRUMENT TIME ON cycle.

Operating in Split Flow Mode (Optiflow 570 models only)

This mode of operation allows you to get direct readouts of split flow from the digital flowmeter. To get into split flow mode (SFM):

1 Press **ON/RESET** twice quickly. Upon entering SFM, you will see a display as in Figure 9. The **C:1.0** means that the instrument is currently programmed for a capillary column flow rate of 1.0 mL/min.

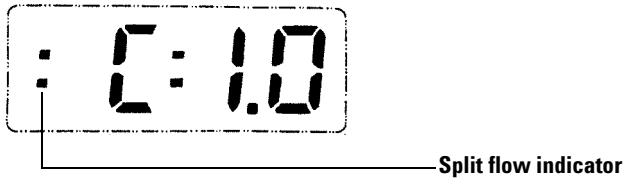

Figure 9 SFM display

2 If your column flow rate is different than 1.0 mL/min, then you need to program your actual column flow rate into the flowmeter. This is accomplished while the display still shows **C:1.0** by pressing **ON/RESET** one time for each desired step of 0.1 mL/min. If you press **ON/RESET** continuously, the display will step automatically at a fast rate.

3 When your column flow rate is displayed, release **ON/RESET**. After about 2 seconds, the display will show **:0** with the split flow indicator colon activated on the left side of the display.

4 Attach the flow meter latex hose to the split vent and read the flow normally. The flowmeter will divide the measured split vent flow by the programmed column flow rate and will display this result. For example, if the programmed column flow rate was 3.0 mL/min, and the measured split vent flow rate was 300 mL/min, the display would show a split flow ratio of 100.

5 To get back to volumetric flow measurement mode, press **ON/RESET** twice quickly. In either mode a single **ON/RESET** press acts as a RESET and the mode will not change. All other functions are the same in either mode.

Split Flow Mode specifications

- Programmable flow range: 0.1–9.9 mL/min in 0.1 mL/min increments
- Split flow range: 0.05–999

Operating in Capillary Linear Velocity Mode (Optiflow 420 model only)

This mode of operation allows you to get direct readouts of linear velocity from the digital flowmeter. To access Linear Velocity Mode (LVM):

1 Connect the column to the flowmeter. See Figure 10.

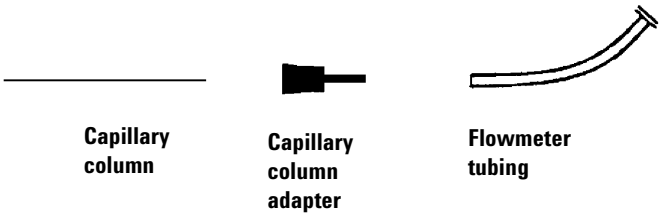

Figure 10 Capillary column to flowmeter union

2 Once the capillary column is connected to the flowmeter, press **ON/RESET** twice, quickly.

3 Verify the programmed column ID.

Upon entering LVM, a display similar to Figure 11 appears. The **:100** means that the unit is currently programmed for a capillary column inner diameter of 0.10-mm ID.

Figure 11 LVM display.

4 If your column ID is different than 0.10-mm ID, then program the actual column diameter into the flowmeter as follows:

   a While the display still shows a **:100**, press **ON/RESET** to increment the column ID in steps of 10 µ (0.01 mm). Press and hold **ON/RESET** to step automatically at a fast rate.

   b When the correct column diameter is displayed, release **ON/RESET**. After about 2 seconds, the display will show **:0** with the linear velocity flow indicator colon activated on the left side of the display (see Figure 11).

   c To exit this mode, press **ON/RESET** twice quickly.

Auto-ranging

The microprocessor automatically adjusts the resolution of the display to the gas flow rate being calibrated. The ranges are listed in Table 1 for each model.

Table 1 Flowmeter ranges

Flowmeter model	Flow	Resolution	Accuracy
Optiflow 420	0.10–9.99 mL/min	0.01 mL/min	±3%
	10.0–50.0 mL/min	0.1 mL/min	
Optiflow 570/570 Mobile	0.500–1.999 mL/min	0.004 mL/min	±3%
	2.00–9.99 mL/min	0.01 mL/min	
	10.0–99.9 mL/min	0.1 mL/min	
	100–700 mL/min	1 mL/min	
Optiflow 650/650 Mobile	5.0–99.9 mL/min	0.1 mL/min	±2%
	0.100–0.999 L/min	0.001 L/min	
	1.00–5.00 L/min	0.01 L/min	

Auto-averaging

The microprocessor automatically auto-averages results at higher flow rates for increased accuracy and to make the display more stable and easier to read.

Optiflow 570 and 570 Mobile

For flows under 200 mL/min, flows are displayed for each individual bubble. Between 200 and 350 mL/min, the instrument displays the flow average of two bubbles. For flows above 350 mL/min, the instrument will display the average of three flows.

Optiflow 650 and 650 Mobile

For flows under 2.00 L/min, flows are displayed for each individual bubble. Between 2.00 and 3.00 L/min, the instrument displays the flow average of two bubbles. Above 3.00 L/min, the flow average of four bubbles is displayed.

For best results, simply press **ON/RESET** when you have set the flow to the desired rate and allow the proper number of bubbles to pass through the optical sensor block. The result displayed will then be accurate to ±2% of the result displayed. If needed, generate a series of bubbles using the U clamp as described on page 10.

Auto power off

To conserve battery life, the flowmeter turns itself off after its INSTRUMENT TIME ON cycle ends. This cycle lasts long enough so that a bubble traveling at the lowest flow rate will have enough time to get to the lower sensor when the glass bubble meter is in its highest position, and the instrument was just turned on or reset. This cycle resets/begins whenever:

- The unit is activated by pressing **ON/RESET** momentarily.
- A bubble passes either sensor.

The display will hold the last flow result for the entire INSTRUMENT TIME ON cycle.

If a fault message is displayed, the instrument automatically turns off after about 10 seconds unless **ON/RESET** is momentarily pressed. If pressing **ON/RESET** clears the fault, the display will indicate **0**.

To manually turn off the instrument, press **ON/RESET** until the word **OFF** appears on the display, then release the button.

Installing a new battery (Optiflow 570 Mobile and 650 Mobile Flowmeters)

When you see the LO BAT symbol on the display, install a new battery in the unit as soon as possible. Use a standard 9-volt alkaline battery. To install a new battery:

1. Place the cabinet on a flat surface.
2. While holding the cabinet down, grasp the front panel and pull upwards, away from the cabinet.
3. Gently remove the old battery from its holder and replace with a new one.
4. Replace the front cover by aligning the snap features with the round pegs and pressing down on the front panel. Some slight adjusting of the snap features may be necessary if the front panel does not snap directly into place. The spring metal snap features can be slightly spread apart with a pair of pliers or another tool.

Installing a new battery (Optiflow 420, 570, and 650 Flowmeters)

To install a new battery:

1. Remove the four screws holding the back cover in place and remove the back cover.
2. Gently remove the old battery from the holder and replace with a new one.
3. To determine if the battery is properly installed, press the ON/RESET button momentarily to start a “TIME ON CYCLE”. If the instrument powers up properly, then turn the instrument off and replace the back cover. Replace the four screws and lightly tighten them in place.

NOTE

An indication of a VERY weak battery is if the unit appears to turn on when **ON/RESET** is momentarily pressed, but the display goes blank when the button is released. Operating this instrument when the LOBAT symbol is present may result in erroneous results. Any fault messages obtained when the LO BAT symbol is activated may be due to a weak battery. Install a new battery and retest the instrument before concluding that the unit is defective.

Fault Conditions

Internal malfunctions result in the display of a FAULT NUMBER. See Table 2. Note also that a very weak battery can cause faults. After following the recommendations, press **ON/RESET** momentarily to see if the fault has cleared.

NOTE F2 or F4 faults may result if the instrument is used in direct sunlight. Calibrate in a shaded area or turn the instrument away from the direct sunlight.

Table 2 Fault numbers and recommendations

Fault	Possible cause	Recommendation
F1	• Instrument turned on when a bubble is in front of the lower sensor. • Some sort of obstruction blocking the lower sensor.	• Press **ON/RESET** to clear. • Turn the instrument on without the glass tube in the sensor block. If the instrument still displays an F1 error, a more serious failure is indicated and your supplier should be contacted. • Clean the bubble flowmeter and make sure there are no obstructions in the lower sensor path within the sensor block. A blast of air is usually sufficient to remove any obstruction. If this does not remedy the situation, a more severe failure is indicated. Contact Agilent.
F2	• Very high ambient light level interfering with the operation of the lower sensor.	• Reduce the ambient light level at the instrument location. If this does not remedy the situation, a more severe failure is indicated. Contact Agilent.
F3	• Same as F1 above, but applies to upper sensor.	
F4	• Same as F2 above, but applies to upper sensor.	
F5	• A bubble or other obstruction blocks the lower sensor path for too much time after normal operation was established.	• Press **ON/RESET** to clear. • Clean the bubble flowmeter and make sure there are no obstructions in the lower sensor path within the sensor block. If this does not remedy the situation, a more severe failure is indicated. Contact Agilent.
F6	• Same as F5 above, but applies to upper sensor.	
F7	• Internal fault 7.	• Contact Agilent.
F8	• Internal fault 8.	• Contact Agilent.
F9	• Too many bubbles within the sensor block at a time. • Imperfectly formed bubbles passing through the sensor block.	• Press **ON/RESET** momentarily to reset the unit and begin your flow measurements again. • Allow more space between the bubbles and make sure that they are properly formed.

Maintenance/Repair

Replacing the bubble solution

To maintain the accuracy of the instrument, replace the bubble solution when it becomes cloudy or dirty.

Cleaning the flowmeter

Clean the glass bubble meter periodically on both the inside and outside. This will help prevent possible fault conditions.

WARNING **Care is required to prevent injury from broken glass.**

1. Remove the glass flow tube by gently spreading the sensor clamp assembly and slipping the tube out. Be careful not to damage the gas inlet tube.
2. Remove the bulb and any attached tubing from the tube assembly before cleaning.
3. Clean the disassembled tube assembly by placing it in a ultrasonic cleaning bath for a few minutes, or clean using a glass cleaner or weak acetic acid (such as white vinegar).

CAUTION Ensure that no liquids get inside of the unit or into the sensor assembly. They are NOT submersible. Never use abrasive cleaners or anything that may scratch the glass tubing.

4. Clean the flowmeter body using a clean, dry cloth.
5. Reverse the above process to reinstall the glass flow tube. If it is loose, remove the flow tube again and gently squeeze the sensor clamp assembly together slightly to give it greater holding pressure.

   Accessories can be obtained from Agilent at www.agilent.com/chem.

Calibration, Recalibration, and Repair

Each instrument is individually calibrated to a set of NIST standards. All of the information concerning the standard and the conditions that were present at the time of calibration are provided on the MANUFACTURER'S CERTIFICATE OF CALIBRATION. These instruments are very stable by design and the operator cannot adjust the calibration setting.

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.

GLP (Good Laboratory Practices) require periodic recalibration of any measuring device used in the laboratory. For information concerning this service, contact Agilent Technologies.

ISO Guides for periodic recalibration and qualification

To insure the integrity of a measuring device being used to set up a quality control instrument, as in the case of a GC, there are two protocols in the ISO series that address periodic recalibration or qualification of measuring tools.

ISO-9001 Section 4.11

(b) identify, calibrate and adjust all inspection, measuring and test equipment and devices that can affect product quality at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to nationally recognized standards;

(i) ensure that the handling, preservation and storage of inspection, measuring and test equipment is such that the accuracy and fitness for use is maintained;

Draft International Standard ISO/DIS 10012-1 management of measuring equipment definitions; Section 3.23, qualification:

3. For measuring equipment, qualification normally includes calibration, any necessary adjustment or repair, subsequent recalibration, ...and labeling.

Requirements; Section 4.11, Intervals of qualification:

Measurement standards and measuring equipment shall be qualified at appropriate intervals (usually periodic), established on the basis of their stability, purpose and usage. The intervals shall be such that qualification is again carried out prior to any probable change in accuracy that is of significance in the use of the equipment.

Guidance; Section 411a, Intervals of qualification:

The purpose of periodically requalifying measuring equipment is to, as far as possible, prevent it from being used when there is a significant possibility of it producing erroneous results.

A note on the Digital Flow Calibration Instrument:

> Most measuring devices will have some drift inherent in their systems. However, Humonics manufactured instruments are, by design, extremely stable. In order to provide a recalibration cycle to facilitate the ISO-9000 series of quality control protocols and adhere to Good Laboratory Practices, Humonics has very conservatively established a 2-year cycle of periodic recalibration for the flow-measuring instrument it manufactures.

Replacement Parts

Table 3 lists replacement parts available from Agilent.

Table 3 Part number and descriptions of replacement parts

Part number	Description	
HFM-420-B	Bubble meter repair kit, Optiflow model 420	
HFM-570-B	Bubble meter repair kit, Optiflow model 570	
HFM-570FC-B	Bubble meter repair kit, Optiflow model 570FC	
HFM-650-B	Bubble meter repair kit, Optiflow model 650 (includes glass tube and trap)	

Table 3 Part number and descriptions of replacement parts

Part number	Description	
HFM-650FC-B	Bubble meter repair kit, Optiflow model 650FC (includes glass tube and trap)	
HFM-650-FT	Flow trap kit, Optiflow model 650 and 650FC	
HFM-BULB	Replacement bulbs (12/pack)	
325-0506	Capillary column adapter	
9300-0311	Snoop, 8 oz.	

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If the Agilent Optiflow Digital Flowmeters are used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.

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