Electron
Microscopy
Sciences

INSTRUCTIONAL MANUAL
65240-Series
Mini-Buck Calibrator

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Highlights

- To display the Version of the software code: Press the ON and OFF keys simultaneously.
- An audible beep will be made by pressing the keys pads at the start and stop of bubble test. **NOTE:** This beeping feature may be turned off by holding the ON key for five seconds
- Each flow measurement is a true running average with the current test being added to the previous test and divided by the number of tests performed at that time. Average test number is displayed after each bubble test as A-1, A-2 etc. **NOTE:** To reset the averaging, press the ON key. This will clear the results and display the current test.
- When unit is first turned on, it will display “8888” briefly, as a system check, and then, when ready, will display “0000”.
- The circuit board has advanced technology for improved accuracy and is able to maintain calibration with longer battery life. **NOTE:** Up to 100 hours of usage on an overnight charge.
- “EEEE” is displayed if the reading has changed by +/-5% from previous reading or is out of the flow range.

Design and Basic Features

- The mini-Buck Calibrator® utilizes the principle of measuring the flow rate of gases over a fixed volume per unit of time: The timing device is a Quartz controlled timer and the fixed volume is located in the flow cell center tube.
- A microprocessor measures the time for a frictionless soap film to travel from the first sensor to the second sensor (infra-red which detects the passage up to the tube) and then calculates the volume per unit of time.
- The results are displayed in flow rate, cc/min. for the #65240-60 and #65240-61; and for the #65240-63, the results are displayed in Liters Per Minute, all on a four-digital liquid crystal display. **NOTE:** The decimal point floats to present the data in the proper range.
- The timer is capable of detecting a soap film less than 80 microsecond intervals. This speed allows under steady flow conditions an accuracy of +/- 0.5% of any display. The unique flow cell can create a soap film over a range of:

  0.1 - 300 cc/min for Catalog #65240-60 – mini-BUCK™ (Low Flow)

  1- 6000 cc/min for Catalog #65240-61 – mini-BUCK™ (Medium Flow)

  0.100 - 30 LPM for Catalog #65240-63 – mini-BUCK™ (High Flow)

- The flow cell is spill proof when properly filled.

Precautions and Warnings

- DO NOT use chemical solvents on flow cell, calibrator case and/or faceplate.
- Use only soap and water to remove any dirt.
- NEVER pressurize the flow cell with more than 25 inches of water pressure.
- ALWAYS unplug the A/C adapter from the calibrator when not in use. If it is left connected, it could damage the battery supply.
- When not in use, it is recommended to use hose-fitting covers to reduce evaporation of soap in the flow cell.

Physics and Accuracy of Measurements

In order to familiarize the user with air flow calibration, this introduction serves as an explanation of the physics of measurement and the accuracy of subsequent gaseous flow measurements.

Physics of Measurement

Ideally, All gases obey the ideal gas equation, PV = nRT, at room temperature. The equation is broken down as such:

P = the pressure in newtons per square meter
V = the volume in cubic meters
n = the number of moles of gas
R = the gas constant, 8.31 J K^{-1} mol^{-1}
T = the temperature in degrees Kelvin

Mini-Buck Calibrator uses the technique known as the soap film bubble test to measure flow rates. This test uses frictionless soap film suspended perpendicularly to the air flow up a small bore tube. The film forms a complete seal across the tube, causing the soap film to move along the tube at exactly the same rate as the air flow. A volume can be calculated by using a measured distance and tube bore size and the flow rate can then be determined by the movement of soap film across a fixed volume per unit of time. (This technique is classified as a Primary Standard.)

The measurement can be substantiated by comparing the four variables of the Ideal Gas Law against this detection technique. The volume (v) is known and fixed therefore cannot change or be considered variable. The mass (m) of the gas being measured is not changed in this technique since the soap film is simply suspended across the tube cross section and moves with the gas flow rate. Mass is not affected. Pressure and Temperature are expressed by Boyle's Law $P_1V_1 = P_2V_2$ and Charles Law $V_1/T_1 = V_2/T_2$. Pressure is virtually the same from the ambient during a test, as the soap film is virtually frictionless. And, when all elements are at ambient, Temperature has no influence in this type of flow measurement. This includes the calibrating device, the flow of gas and room temperature. These are the usual test conditions.

Conclusion: The mini-Buck Calibrator® serves as a primary standard calibration method since, for all practical purposes, the detection method of measuring flow rates of gases over a fixed volume per given unit of time is independent of all variables in the Ideal Gas Law.

Reference: Lippman, Morton, "The Industrial Environment – its Evaluation and Control," [U.S. Department of Health, Education and Welfare], NIOSH, 1973, Chapter 11, 101 pp

Accuracy of Gaseous Flow Measurements

Two parameters need to be considered in order to properly evaluate the accuracy of flowing gases. First, the steadiness of the flow rate must be known. Just about every type of pump creates some pulsing of the flowing gases. Second, the rate of flow can drift up and down over some range. Current battery-powered personal air sampling pumps use various techniques to dampen pulsing and special circuitry to monitor pump speed, thereby, attempting to generate constant and steady flows.

With the mini-Buck Calibrator® the technique of using a soap film seal to measure flow over a predetermined volume in a known time, is automated by a microprocessor, operating at 6 megahertz per second, detects the passing of the soap film seal over the established flow tube volume and automatically calculates the rate of flow. The typical apparatus, a 1,000 ml buret using a stopwatch, can be significantly reduced in size since the microprocessor can detect and measure the speed at 80 microsecond intervals. Compare this speed to a technician's response time: With good precision on a stopwatch, s/he could be repeatable within 50,000 microsecond (0.05) seconds, still 625 times slower than the microprocessor.

Consider this analysis: 1,000 cc buret NIST traceable; 0.01 second stopwatch crystal controlled with clock accurate to +/- 15 sec per month; 1,000 cc/min. steady flow source (constant flow +/- 1 cc/min.).

Example: Measure the flow rate using 1,000 cc buret by a skilled technician. All devices are at a constant room temperature.

Test #	1	2	3
Time	60.06 sec	60.00 sec	59.94 sec
Actual Flow Rate	999.0 cc/min	1000 cc/min	1000 cc/min

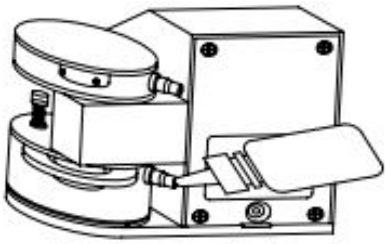
NOTE: At 1,000 cc/min of flow +/- 0.06 is equal to 1 cc/min change or +/- 0.1 accuracy. Repeatability is strictly a function of the technicians' skill.

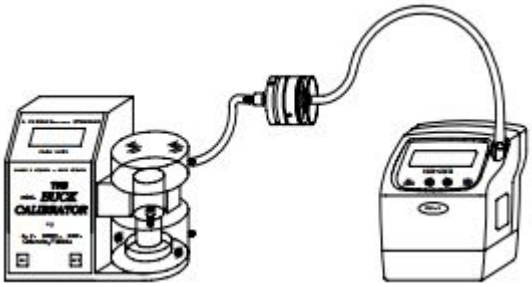
Mathematically, it would seem 0.1% accuracy could be obtained using this large volume and a skilled technician with a 1,000 cc/min steady source. Of course, if the volume is smaller than 1,000 cc or the flow is faster, the percent of the accuracy is further reduced by this manual method.

Therefore, the accuracy of measuring air flow relies on quality measurement tools such as NIST traceable buret and crystal control stopwatch. A constant air flow source and a reliable method of detection are the final requirements to achieve repeatable and accurate flow readings.

Start Up Procedure

1. If unfamiliar with device, read the "Principle of Operation" section.
2. Note that soap volume is not critical (a measured amount is not necessary). The soap only needs to create a bubble, so just pour a small amount of soap through the bottom nipple to thoroughly cover the bottom of the flow cell and attach air source to nipple (bottom nipple for pressure, top nipple for vacuum). **NOTE:** Excessive amount of soap may cause a continuous stream of bubbles to go up the center tube at high flows. **NOTE:** Tip the Min-BUCK with the bottom hose pointed to the floor for excess soap to be expelled. The proper amount of soap should remain.





3. Wet flow cell by connecting a pump flowing at 1000 to 2000 cc/min. for Catalog #65240-61 – mini-BUCK™ (Medium Flow) and 5 LPM for #65240-63 – mini-BUCK™ (High Flow). Initiate soap film up center tube by rapidly pressing button down and releasing. Repeat this procedure until bubble doesn't break. The tube is now wet and tests at any range may be conducted. One minute warm up time is all that is required of the mini-Buck.

Calibration of Air Flow Sources with The mini-Buck

These instructions apply to all models. The range for each are:

0.1 - 300 cc/min for Catalog #65240-60 – mini-BUCK™ (Low Flow)

1- 6000 cc/min for Catalog #65240-61 – mini-BUCK™ (Medium Flow)

0.100 - 30 LPM for Catalog #65240-63 – mini-BUCK™ (High Flow)

The instructions relate to industrial hygiene air sampling and basically applies to any gases flow rate measurements.

1. Start the pump and allow about 5 minutes to stabilize. Perform this step before connecting to flow cell as air flow dries center tube if bubbles are not initiated at intervals.
2. Connect sampling medium to pump with proper hose adapters for connecting tubing to flow cell. The flow cell hose connectors will accept two common sizes of vinyl tubing (1/4" and 5-1/6"). A "Luer" fitting is incorporated in the upper hose connector. **NOTE:** The upper port is for vacuum and the bottom for pressure. When the upper port is connected to vacuum, the lower port must be open to the atmosphere. Conversely, when the lower port is connected to pressure, the upper port must be open to free air. Never make bubble test with bottom hose connected in series (in line with sampling filter).
3. Wet the flow cell as described in the Start Up Procedure (pg 3, #3).
4. Begin Calibration: depress plunger into cell and quickly release. Different flow rate can require quicker or slower release of the button.
5. Carefully observe the bubble passing through the sensor zone. Only a single straight bubble, perpendicular to the tube wall, is necessary for an accurate test. If several bubbles go up to the tube at once it will not effect the test data because the first sensor will not reset until the final sensor has been tripped. Watch the bubble pass up the tube to ensure a good test has been conducted.
6. Observe the display. A number will be displayed. The decimal point will be appropriately placed. Read Understanding the Display Results on features concerning data display.
7. After a 3 second delay from the time the final sensor is tripped, another test can be performed.
8. Repeat Steps 5 through 8 for minimum of 3 tests.

NOTE: If difficulty is encountered in making a clean single soap film rise up the center tube:

- Check level of soap in flow cell. (Start Up Procedure, pg 3, #2)
- If soap is cloudy, not clear, change the soap solution and clean flow cell.

Understanding the Display Results

Display	Duration/When Displayed	Meaning
8888	3 seconds on initiation	Turning on
0000 (no decimal points)	after the 8888 appears	Ready
- - - -	Test in progress	Test in progress
A-	Appears after each test	**
EEEE	If the previous reading and current reading are different by more than +/- 5%, a series of EEEE's will flash four times on the display and then display the actual last rest result.	

****NOTE:** During sequential tests, the previous reading is added to the current test as a running total. The letter A– appears after each test display the number in the averaging. The next flow readings will start this averaging technique over again. If individual readings are desired without averaging, the "ON" button may be pushed to reset the unit to "0000" following each test. The flashing numbers on the display after a test are for three seconds duration. The purpose is to allow sufficient time for the soap to return to the bottom reservoir.

Power Supply and Battery Saver

- The battery supply utilizes 4 NiCad AA Cell batteries.
- The unit will operate up to 100 hours on a fully charged battery.
- Low battery light will indicate when the power supply is too low for accurate results.
- When batteries are low, the unit may also be operated directly from the AC charger.
- Low battery light will indicate the power supply is too low for accurate results and it is time to recharge the battery.
- Using the standard charger, the battery pack takes a minimum of 16 hours to fully charge.
- The mini-Buck comes with an Automatic Shut Off – After 7 minutes of non-use, it will shut off automatically.
- If stored for a period of 30 days or more, unit will require a 16 hour charge

Calibrator Maintenance

Cleaning the Flow Cell

1. Remove the three screws holding the flow cell to the bottom of the case.
2. Remove the flow cell and gently flush with tap water. **NOTE:** To prevent scratching the acrylic flow cell, wipe only with a soft cloth.
3. DO NOT allow center tube (where sensors detect soap film) to be scratched or get dirty.
4. NEVER clean with ACETONE. Use only soap and warm water.
5. If unit is to be stored for a time, clean unit thoroughly and allow flow cell to air dry. **NOTE:** Shake any access water from cell prior to reattaching to base of mini-BUCK.
6. If the unit needs more cleaning, remove the bottom plate. To ease removal, put a few drops of soap into slot between base and flow cell, then gently insert a flat screw driver into the ridge between the bottom plate and chamber until the bottom plate is removed. To realign, note scribe mark near one of the screw inserts on bottom plate and align this mark with scribe mark on flow cell near air hose inlet. **NOTE:** Wet O-ring with soap prior to installation.
7. To reassemble, realign flow cell in case with hose nipples pointing to back of case and reinstall the three bottom screws.

Calibrator Verification

The calibrator is factory-calibrated using a standard traceable to National Institute of Science and Technology (NIST). To verify the calibration, calibrate against a glass one liter buret at 1000 cc/min. for maximum accuracy. Since the detection technique of “fixed volume per unit of time” is used, the calibrator is linear throughout the entire range.