

Sidestream CO₂ Flow Check

Check the flow rate in the Sidestream CO₂ extension as follows:

- 1 Connect the flowmeter to the sample line
- 2 Check on the flowmeter the flow that the Sidestream CO₂ extension pump draws. It should be 50 ml/min \pm 10 ml/min. If the value is not within tolerance check your setup again and perform another flow check. If it fails again, the sensor must be replaced. The sensor cannot be calibrated.

Example for an expected test result:

The expected test result for an altitude of 0 m (sea level) at approximately 760 mmHg ambient pressure is:

Test	Expected test results (x3)	Acceptance Range
Sidestream CO ₂ Flow Check	50 ml/min \pm 10 ml/min	40 ml/min - 60 ml/min

NOTE

The expected test results will differ depending on the conditions (i.e. altitude or ambient pressure).

Microstream CO₂ Performance Test

Allow five seconds between individual service procedures to ensure stable equipment conditions. When certain monitor procedures are running, service procedures are not possible and trying to start them will result in a message **Service Operation Failed** in the monitor's status line. Wait until the monitor completes the current operation, then restart the service procedure.

This test checks the performance of the Microstream CO₂ measurement. The Microstream CO₂ measurement can either be integrated into the IntelliVue MP5 monitor or, for other IntelliVue monitors, into the M3015A MMS Extension. The Microstream CO₂ performance test is required once per year or after 4000 hours of continuous use and when the instrument is repaired or when parts are replaced.

This test uses calibration equipment that you can order (see the *Parts* section for the part number). The procedure is summarized in the following steps. Refer to the documentation accompanying the equipment for detailed instructions.

Tools Required:

- Standard tools, such as screwdriver, tweezers
- Electronic flowmeter, M1026-60144 or Mass Flowmeter 453564178121
- Digital Barometer \pm 2mbar or better
- Gas calibration equipment:
 - Cal 1 gas 15210-64010 (5% CO₂)
 - Cal 2 gas 15210-64020 (10% CO₂)
 - Cal gas flow regulator M2267A
 - Cal tube 13907A
 - Calibration Line M3015-47301
- Leakage Test Kit M1013-64002 (451261014851) (only required for leakage test without M1026-60144 Flowmeter)
- Flexible Connecting Tube

You also need a local barometric pressure rating received from a reliable local source (airport, regional weather station or hospital weather station) which is located at the same altitude as the hospital.

The CO₂ calibration for the Microstream extension consists of the following steps:

- Leakage check, **either** with M1026-60144 Flowmeter **or** with 453564178121 Mass Flowmeter
- Barometric pressure check and calibration, if required.
- Pump check
- Flow check and calibration, if required
- Noise check
- CO₂ Cal check and calibration, if required
- CO₂ Cal verification

Perform all checks in the same session.

Leakage Check with M1026-60144 Flowmeter

The leakage check consists of checking the tubing between:

- the pump outlet and the mCO₂ outlet and
- the pump inlet and calibration line inlet.

Check the user's guide of the flowmeter for details on how to make a correct flow reading.

Part 1

- 1 Go into service mode and select **Setup CO₂** menu.
- 2 Connect a calibration line to the Microstream CO₂ input to start the pump running.
- 3 Check the ambient pressure and the cell pressure shown in the monitor's status line. The cell pressure should be approximately 20 mmHg lower than ambient pressure. (This test is only to check that the pump starts and is running, which is also indicated by the noise generated by the running pump.)
- 4 Connect the flowmeter outlet to the calibration line inlet using a flexible connecting tube.
- 5 Block the mCO₂ outlet using your fingertip and observe the flowmeter display. The value on the flowmeter (**x1**) should decrease to between 0 and 4 ml/min, accompanied by an audible increase in pump noise. If the value is within the tolerance limits, continue with part 2 of the leakage check.
- 6 If the value is outside the tolerance limits, there is a leakage between the pump outlet and the mCO₂ outlet.
- 7 Open the MMS Extension or MP5 and check the tubing connections at the pump outlet and the extension gas outlet. If the connections are good, then there is a leakage in the tubing and you must exchange the MMS Extension or the mCO₂ Assembly of the MP5 respectively.

Part 2

- 1 Disconnect the flowmeter from the Part 1 setup and connect the flowmeter inlet to the M3015A gas outlet or the MP5 mCO₂ gas outlet.
- 2 Leave the calibration line connected to the M3015A inlet or the MP5 mCO₂ inlet.
- 3 Block the inlet of the calibration line using your fingertip and observe the flowmeter display. The value on the flowmeter (**x2**) should decrease to between 0 and 4 ml/min, accompanied by an audible increase in pump noise. The cell pressure shown in the status line on the display should

decrease to between 300 and 500 mmHg. Do not block the inlet for longer than 25 seconds as this will lead to an “Occlusion” INOP. If the value is within the tolerance limits, there are no leakages and the leakage check is completed; proceed to the pump check.

- 4 If the value is not within the tolerance limits, there is a leakage between the calibration line inlet and the pump inlet.
- 5 Check the calibration line connections and open the M3015A or MP5 to check the tubing connections at the pump inlet and the M3015A or MP5 mCO₂ gas inlet. If the connections are good, try replacing the calibration line and repeating the leakage check. If the situation remains, there is a leakage in the tubing and the M3015A or the mCO₂ assembly of the MP5 must be exchanged.

Test	Expected test results
Leakage Check Parts 1 and 2	<p>x1 = value of part 1 leakage check on flowmeter (x1 < 4.0 ml/min)</p> <p>x2 = value of part 2 leakage check on flowmeter (x2 < 4.0 ml/min)</p>

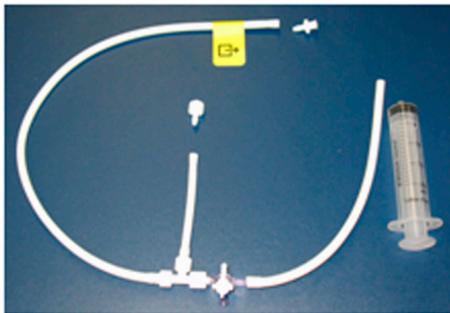
Leakage Check without M1026-60144 Flowmeter

Preparation of Leakage Test Kit:

Remove two Luer connectors from the Leakage Test Kit, as shown in the following picture.

NOTE

These Luer connectors are not required for the actual Leakage Check. However, you should keep them, as they are required for other tests (e.g. for the kit leak test as documented later in this section).

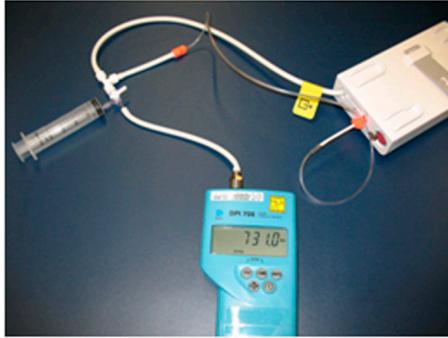


Test Setup:

- 1 Connect the Calibration Line (M3015-47301) to the inlet of the M8105A/M3015A (the M8105A/M3015A must be switched off, either by disconnecting from the host monitor or by switching off the monitor).

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- 2 Connect the leakage test tubing to the outlet of the M8105A/M3015A, to the digital barometer, to the calibration line, and the (empty) syringe as shown below. Make sure all connections have a tight fit!

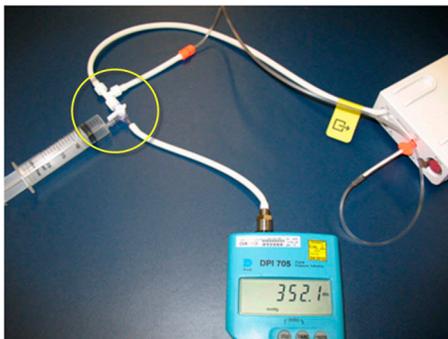


Test Procedure:

- 1 Open the 3-way stopcock for all three limbs.



- 2 Switch on the digital barometer (the digital barometer should now display the actual ambient pressure).
- 3 Now slowly draw at the syringe, as if filling the syringe, until the pressure (as displayed on the digital barometer) drops to approximately 350 mbar below ambient pressure. Then close the line to the syringe at the 3-way stopcock to syringe (circled in picture below).
- 4 Let the reading on the digital barometer stabilize for a moment and then perform the leakage check: for 30 seconds the change of the pressure reading should be less than 20 mbar.



5 If the leakage test is NOT passed, check all connections once more and repeat the test.

Test	Expected test results
Leakage Check	Reading on the digital barometer change is less than 20 mbar for 30 seconds (pass/fail)

NOTE

To ensure the integrity of the Leakage Test Kit (M1013-64002, 451261014851) the following Kit Leak Test Procedure must be performed:

- a. Form a loop with the leakage test kit as shown in the picture below.



- b. Connect the syringe to the 3-way stopcock and the digital barometer to the open tubing.
- c. Draw at the syringe until the digital barometer shows approximately 350 mbar below ambient pressure.
- d. Close the 3-way stopcock to the syringe and wait 5 - 10 seconds. In this time, the overall pressure should stabilize.
- e. After 1 minute, check the pressure. The pressure should not increase more than 8 mbar in 1 minute for the test to pass.
- f. If this test fails, exchange the leakage test kit.

Barometric Pressure Check and Calibration

Check the barometric pressure value in the M3015A MMS Extension or the MP5 as follows:

- 1 Go into service mode and select **Setup CO₂** menu.
- 2 Connect a calibration line to the Microstream CO₂ input. This activates the pump in the M3015A MMS Extension or the MP5.
- 3 The status line at the bottom of the screen displays “CO₂ pressure reading (ambient/cell) xxx/yyy” where xxx is the ambient pressure and yyy is the measured cell pressure. Check whether the ambient pressure value (**x3**) matches (within the acceptable tolerance of ± 12 mm Hg) the reference value you have received. If so, proceed to the leakage check.

If the value is not correct, calibrate as follows.

- a. Select **CO₂** then select **Barom.Press** to activate a table of values.

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- b. Select the value in the table which matches the reference value received from a reliable local source (airport, regional weather station or hospital weather station). (The values are displayed with a resolution of 2 mmHg up to 500 mmHg and a resolution of 1 mmHg from 500 mmHg to 825 mmHg.) Note: the selected value must be within $\pm 10\%$ of the current measured ambient pressure, otherwise an error message will occur at restarting the monitor.
- c. Confirm the barometric pressure setting.
- d. Check that the ambient pressure displayed in the status line at the bottom of the screen is the same as the value which you selected from the list in step b.

Test	Expected test results
Barometric Pressure Check	x3 = difference between the reference pressure and the measured ambient pressure displayed on the monitor (x3 < 12 mmHg)

Pump Check

1. Connect the flowmeter inlet to the mCO₂ gas outlet using a flexible connecting tube.
2. Connect the calibration line to the mCO₂ inlet.
3. Block the inlet of the calibration line using your fingertip and observe the cell pressure on the monitor display. The cell pressure (**x4**) should be more than 120 mmHg below the ambient pressure shown. If the pressure difference is less than 120 mmHg, the pump is not strong enough and you should replace it, irrespective of the Pump OpTime.

Test	Expected test results
Pump Check	x4 = difference in pressure between cell pressure and ambient pressure displayed on the monitor during occlusion (x4 > 120 mmHg)

Flow Rate Check and Calibration

Check the flow rate in the M3015A MMS Extension or the MP5 as follows:

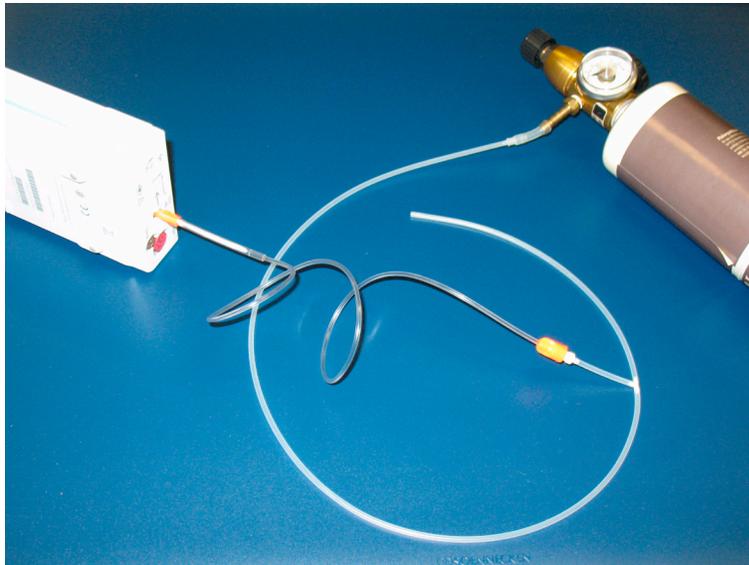
1. Connect the calibration line to the mCO₂ inlet and the flowmeter outlet to the calibration line.
2. Check on the flowmeter the flow that the M3015A MMS Extension or MP5 mCO₂ pump draws (**x5**). It should be 50 +15/-7.5 ml/min. If the value is within tolerance, proceed to the CO₂ Gas calibration check.
If the value is not within tolerance, calibrate as follows.
 - a. Adjust the flow in the instrument by selecting **Increase Flow** or **Decrease Flow** until it is as close as possible to 50 ml per minute as indicated on the flowmeter gauge.
 - b. When you are satisfied that the flow is set as close as possible to 50 ml per minute, select **Store Flow** and confirm the setting. If you do not store the adjusted flow within 60 seconds of the adjustment, the old flow setting is restored.

- c. If you cannot adjust the flow to within tolerance, replace the pump . If you still cannot make the flow adjustment, this indicates a fault in the measurement extension, which must be replaced.
 Note that the pump can only be replaced on M3015A with the old hardware Rev. A (i.e. Serial No. DE020xxxxx)

Test	Expected test results
Flow Rate Check	Flow rate is 50 +15/-7.5 ml/min

Noise Check

- 1 With the monitor in service mode, select **Setup CO₂** menu.
- 2 Connect the calibration line, the cal tube, the flow regulator and the 5% calibration gas to the mCO₂ inlet.



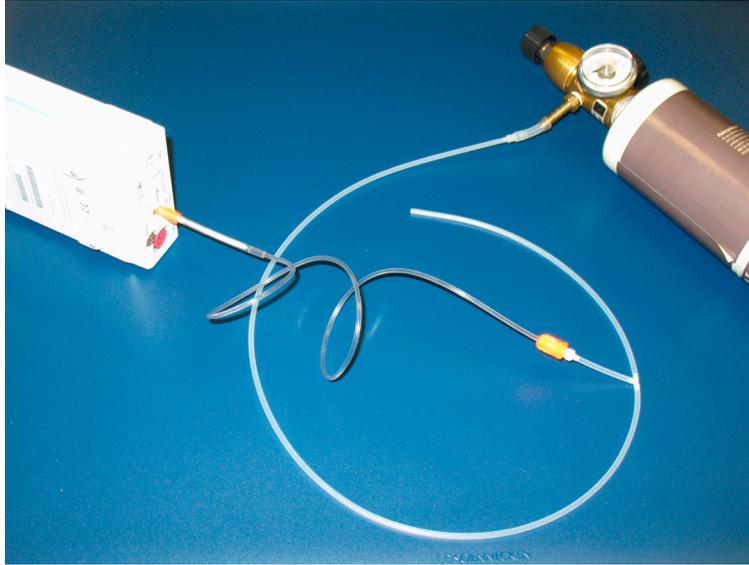
- 3 Open the valve to apply the 5% calibration gas and wait until the value is stable.
- 4 Check the noise index (**x6**) displayed next to the CO₂ value on the display (this indicates the level of noise on the CO₂ wave). If the value exceeds 3 mmHg, replace the measurement extension.

Test	Expected test results
Noise Check	x6 = noise index displayed on monitor (x6 <3.0)

CO2 Cal Check and Calibration

After switching the measurement extension on, wait at least 20 minutes before checking the calibration. Check the calibration of the CO₂ gas measurement as follows:

- 1 Connect the calibration line, the cal tube, the flow regulator and the 5% calibration gas to the mCO₂ inlet.



- 2 Calculate the expected measurement value in mmHg as follows:
 $0.05 \times (\text{ambient pressure}) = \text{value mmHg}$
for example $0.05 \times 736 = 36.8 \text{ mmHg}$ (with an ambient pressure of 736 mmHg)
- 3 Open the valve on the flow regulator to allow 5% CO₂ gas to flow into the extension. Allow the value to stabilize.
- 4 Check that the value on the instrument (measurement value on the main screen, **x7**) matches the calculated mmHg value $\pm 2.6 \text{ mmHg}$.
If the value is outside the tolerance, calibrate as described in step 8a to 8e below.
- 5 Disconnect the 5% calibration gas and connect the 10% calibration gas.
- 6 Calculate the expected measurement value and tolerance in mmHg as follows:
 $0.1 \times (\text{ambient pressure}) = \text{value mmHg}$
 $\pm 0.07 \times (\text{value mmHg}) = \text{tolerance}$
for example $0.1 \times 737 \text{ mmHg} = 73.7 \text{ mmHg}$ (with an ambient pressure of 737 mmHg)
 $\pm 0.07 \times 73.7 \text{ mmHg} = \pm 5.16 \text{ mmHg tolerance}$
- 7 Open the valve on the flow regulator to allow 10% CO₂ gas to flow into the extension. Allow the value to stabilize.
- 8 Check that the value on the instrument (**x8**) matches the calculated mmHg value within the calculated tolerance. If so, the measurement extension is correctly calibrated.
If the value is outside the tolerance, calibrate as follows.
 - a. Keep the same setup and connect the 5% calibration gas.
 - b. Select **Cal. CO₂**.
 - c. Select the value for the calibration gas. (The default value is 5.0%.)

- d. Open the valve on the calibration gas to allow CO₂ gas to flow into the extension. Allow the value to stabilize before the start of the calibration. Leave the valve open until the instrument gives a prompt that gas can be removed.
- e. The extension calibrates and prompts when calibration is successful.

Test	Expected test results
CO ₂ Cal Check	x7 = calculated mmHg value ±2.6 mmHg x8 = calculated mmHg value within calculated tolerance

Calibration Verification

- 1 Keep the same setup as described in “CO₂ Cal Check and Calibration” on page 88.
- 2 Reopen the 5% gas valve and allow the value to stabilize.
- 3 Check that the value displayed on the monitor is correct within the tolerance (see step above).
- 4 Disconnect the 5% calibration gas and connect the 10% calibration gas.
- 5 Open the valve on the flow regulator to allow 10% CO₂ gas to flow into the extension. Allow the value to stabilize.
- 6 Check that the value displayed on the monitor is correct within the tolerance (see step above).

If one or both values are not within tolerances, you must exchange the M3015A MMS Extension or the MP5 mCO₂ Assembly.

Test	Expected Test Results
Leakage Check parts 1 and 2	x1 = value of part 1 leakage check on flowmeter (x1 < 4.0 ml/min) x2 = value of part 2 leakage check on flowmeter (x2 < 4.0 ml/min)
Leakage Check without Flowmeter	reading on the digital barometer change is less than 20 mbar for 30 seconds
Barometric Pressure Check	x3 = difference between the reference pressure and the measured ambient pressure displayed on the monitor (x3 < 12 mmHg)
Pump Check	x4 = difference in pressure between cell pressure and ambient pressure displayed on the monitor during occlusion (x4 > 120 mmHg)
Flow Check	x5 = difference between measured value and 50.0 ml/min (x5 = 50 + 15 / -7.5 ml/min)
Noise Check	x6 = noise index displayed on monitor (x6 < 3.0)
CO ₂ Gas Calibration Check	x7 = difference between measured CO ₂ value and calculated value, based on 5% CO ₂ cal. gas. (x7 < 2.6 mmHg)
CO ₂ Cal Verification	x8 = difference between measured CO ₂ value and calculated value, based on 10% CO ₂ cal. gas. (x8 < ± {0.07 x value calculated})

Reset Time Counters

NOTE

This procedure only applies to M3015A with the old hardware Rev. A (i.e. Serial No. DE020xxxxx)

You must check the time counters on the Microstream CO₂ extension before calibrating the instrument. As well, when parts are replaced, the appropriate counters must be reset to zero.

The counters for CO₂ pump, IR Src and Last Cal are displayed in the status line. The values are updated when entering the **Setup CO2** menu.

Observe the following guidelines:

- When calibrating the CO₂ extension, if no parts have been replaced, check the displayed values of **Reset PumpOpTime** and **Reset IRSourceTime** selections to make sure that they are within suggested guidelines for use (15,000 hours of continuous use). If the counter time is greater than 15,000 hours, replace the appropriate part. See *Repair and Disassembly* for details.
- When calibrating the CO₂ extension, if parts have been replaced, reset the appropriate values using the **Reset PumpOpTime** and **Reset IRSourceTime** selections. See *Repair and Disassembly* for details.

Resetting the PumpOpTime generates the INOP: “CO₂ OCCLUSION”. To clear this INOP you must perform a flow check and store the flow in service mode (select **Store Flow**).

CO2 Pump / CO2 Scrubber Replacement

NOTE

This procedure only applies to M3015A with the old hardware Rev. A (i.e. Serial No. DE020xxxxx)

Refer to the Repair and Disassembly section for the replacement procedures.

Spirometry Performance Tests

These tests verify the performance accuracy of the M1014A Spirometry module.

Equipment Required

- Leak test kit (Part number: M1014-64100)
- calibrated barometer
- M2785A Pediatric/Adult Flow Sensor
- 500ml calibration syringe, Hans Rudolph model 5550 or equivalent

Flow Test

- 1 Connect the M1014A Spirometry Module to the host monitor and go into service mode.
- 2 Connect the flow sensor to the module.
- 3 Connect the 500ml calibration syringe to the flow sensor. Make sure the syringe is set to the “empty” position.
- 4 Press the **Setup** key on the module and select **Show all Values** in the **Setup Spirometry** menu.