

Low Level Verification Kit for 2111LL Low Level Sodium Monitor

Overview

The low level verification kit is designed to evaluate the performance of the Thermo Scientific Orion 2111LL low level sodium monitor. Samples with a concentration range from 0.01 ppb to 100 ppb are injected into the system using the low level verification kit and dynamic calibrator. Sodium is everywhere, so strictly follow procedures and wash labware thoroughly.

Required Equipment

- 2111LL Low Level Sodium Monitor (Cat. No. 2111LL / 2111LLEN)
- ROSS Sodium Electrode (Cat. No. 210048)
- ROSS Ultra Reference Electrode (Cat. No. 210058)
- Temperature Probe (Cat. No. 2001XT)
- Low Level Verification Kit (Cat. No. 216970-A01)
- Dynamic Calibrator (Cat. No. 15DC15 or 15DC20)
- Calibration Kit (Cat. No. 181148)
- Sodium Standard Solutions Kit (Cat. No. 181140)
- Syringes (minimum of 6), Fisher S7510-20, Fisher S7515-20 or other 20 mL syringe made from PE or PP and without rubber stoppers or gaskets
- Standards at various concentrations, prepared from 19.1 and 192 ppm standards
- High-purity labware made from HDPE or PP, such as Nalgene, including 2000 mL, 1000 mL, 100 mL and 250 mL volumetric flasks and 150 mL beakers
- Ultra pure water with confirmed sodium concentration below the lowest QC level to be verified
- Balance with 0.1 gram or better accuracy
- Stopwatch
- Gloves designed for purity applications (i.e. Nitrile with no powder or other coatings)
- Wash bottle

2111LL DKA Calibration

NOTE: Perform a DKA calibration on the 2111LL before performing the Low Level Verification Procedure.

NOTE: Begin the Low Level Verification Procedure only after the 2111LL has been running undisturbed for 24 to 48 hours after the last calibration and at least five days after initial startup, when the baseline has been established.

1. Put on gloves designed for purity applications, i.e. Nitrile with no powder or other coatings.
2. Etch the ROSS sodium electrode and thoroughly rinse with de-ionized water.
3. Install the ROSS sodium electrode, ROSS Ultra reference electrode and temperature probe into the flow cell.
4. Rinse and then fill a wash bottle with ultra pure water. Open the flow cell cap and use the wash bottle to rinse the flow cell with ultra pure water. All drops of water on the flow cell lid should be rinsed away.
5. Fill and drain the flow cell three times to remove any contamination.
6. Perform a DKA calibration according to the 2111LL User Guide. Use standard 1 (19.1 ppm) and standard 2 (192 ppm) to perform the calibration.
7. Open the flow cell cap and use the wash bottle to rinse the flow cell with ultra pure water. All drops of water on the flow cell lid should be rinsed away.
8. Fill and drain the flow cell three times to remove any contamination.

Low Level Verification Kit Installation

1. Shut off the sample flow by turning both the inlet valve and the shut off valve clockwise to the horizontal, closed position.
2. Disconnect the restrictor tube assembly on the reagent manifold block.
3. Screw the ¼-28 adapter into the reagent manifold block. Screw the Y-fitting into the adapter and make sure that the mounting holes on the Y-fitting are horizontally aligned.
4. Reconnect the restrictor tube to one of the Y-fitting openings.
5. Screw the micro valve into the other Y-fitting opening.
6. Turn on the sample flow by turning both the inlet valve and the shut off valve counterclockwise to the vertical, open position.

Dynamic Calibrator Installation

1. Position the dynamic calibrator near the 2111LL monitor and level with the flow cell.
2. Take care not to touch the syringe fitting on the open end of the low level verification kit tubing. Protect this fitting from contamination.
3. The system can remain set up like this for low level verification any time.

Preparation of Standards

NOTE: Wear gloves designed for purity applications, i.e. Nitrile with no powder or other coatings.

NOTE: Use only high purity labware made from HDPE or PP, such as Nalgene. Never use glass labware for standard preparation.

1. All equipment that will be used to prepare standards should be rinsed five times with ultra pure water and then filled with ultra pure water and left to soak overnight. After the overnight soak, discard the water and wash the equipment five times with ultra pure water. Make sure to rinse all bottle caps.
2. Add the stock standards to the volumetric flasks according to **Table 1**. Use the fixed volume 0.1 mL pipette and tips from the calibration kit.
3. Fill the volumetric flasks to fill line with ultra pure water, secure the flask caps and invert the flasks five times to mix the standards.
4. Use the standards within 5 days. Keep all flasks thoroughly sealed and never touch the inside of the lid or mouth of the flask when pouring standard. Keep standards refrigerated when not in use and allow standards to come to room temperature before performing the low level verification.

Table 1

Stock Standard	Volumetric Flask Volume	Preparation Description	Final Standard Concentration
Standard 1, 19.1 ppm	1000 mL	Dilute 0.6 mL of Standard 1 up to 1000 mL with ultra pure water	11.46 ppb
Standard 1, 19.1 ppm	100 mL	Dilute 0.6 mL of Standard 1 up to 100 mL with ultra pure water	114.6 ppb
Standard 2, 192 ppm	100 mL	Dilute 0.6 mL of Standard 2 up to 100 mL with ultra pure water	1152 ppb
Standard 1, 19.1 ppm	None	No preparation needed	19100 ppb

2111LL Flow Rate Determination

NOTE: Perform the 2111LL Flow Rate Determination right before the Low Level Verification Procedure to account for minor environmental changes that can significantly alter the verification results.

1. Weigh a 2 liter flask and record the weight in grams.
2. Remove the flow cell drain tube from the drain coupling, place the flask under the drain tube and collect liquid for at least 15 minutes. Use a stopwatch to precisely measure the liquid collection time.
3. Weigh the flask again and record the weight in grams.
4. Calculate the flow rate per minute by dividing the difference in weight by the collection time.
5. Perform steps 1 - 4 three times and calculate the average flow rate per minute.
6. Enter the calculated 2111LL flow rate value into **Table 2**.

NOTE: Ensure that there is a steady drain flow while collecting liquid. Often the liquid backs up in the flow cell and false data is obtained. If this occurs, extend the liquid collection time until the flow cell fully drains and use the new collection time to calculate the flow rate per minute.

Dynamic Calibrator S_{fs} Determination

NOTE: Perform the Dynamic Calibrator S_{fs} Determination before beginning the Low Level Verification Procedure.

NOTE: If using the Fisher S7510-20 syringe, a nominal S_{fs} value of 43.5 mL/min can be entered into Table 2 and this procedure can be omitted.

1. Measure the scale length of the syringe with a caliper or precision ruler. The scale length is the length from the 0 mL mark to the full scale of the syringe (20 mL mark).
2. Use the following formula to calculate the S_{fs} value of the syringe.

$$S_{fs} = (2.763 * 39.7) / L_2$$

where

S_{fs} = full speed flow rate of syringe (mL/min)

L_2 = scale length of syringe (inches)

2.763 = scale length of B-D syringe (inches)

39.7 = full speed flow rate of B-D syringe (mL/min)

3. Enter the calculated S_{fs} value into **Table 2**.

Syringe Preparation

NOTE: Wear gloves designed for purity applications, i.e. Nitrile with no powder or other coatings.

NOTE: Always use a new syringe for every injection.

1. Remove the plunger from the syringe tube if it is removable. Do not re-insert the plunger until instructed to do so.
2. Rinse the syringe thoroughly with ultra pure water. Fill and empty the syringe tube at least two times with ultra pure water.
3. Gently shake out the remaining water droplets from the syringe and syringe tube. Do not blot or wipe dry.
4. Rinse the syringe with the standard to be used and then empty the syringe.
5. Fill the syringe tube with standard until it overflows and immediately insert the plunger to reassemble the syringe.
6. Invert the syringe and expel any air bubbles.
7. Use the prepared syringe immediately.

Low Level Verification Procedure

NOTE: Begin the Low Level Verification Procedure only after the 2111LL has been running undisturbed for 24 to 48 hours after the last calibration or at least five days after initial startup, when the baseline has been established.

1. Prepare the standards according to the Preparation of Standards section and prepare the syringes according to the Syringe Preparation section.
2. Install a prepared syringe on the dynamic calibrator according to the dynamic calibrator instruction manual.
3. Set the dynamic calibrator range multiplier setting to $\times/1$ and the percent flow rate setting to 80%.
4. Attach the tubing to the syringe and remove the other end of the tubing from the micro valve installed on the 2111LL.
5. Turn on the dynamic calibrator and allow 2 to 3 mL of standard to flow from the tubing.
6. Turn off the dynamic calibrator.
7. Reattach the tubing to the micro valve installed on the 2111LL.
8. Set the dynamic calibrator according to the percent flow rate setting listed on **Table 2**.
9. Record the background sodium reading on the 2111LL and make sure that the reading is stable. Ensure that the initial baseline has been established before recording the reading.
10. Turn on the dynamic calibrator with the range multiplier setting at $\times/1$ for 1-2 seconds and then immediately set the range multiplier setting according to the value listed on **Table 2** and open the micro valve.
11. Record the sodium readings after 30 - 45 minutes or about $\frac{3}{4}$ of the syringe capacity, whichever comes first. Never use the readings if the syringe has less than 1 mL remaining.
12. Turn off the dynamic calibrator and close the micro valve.
13. Remove the tubing from the syringe and discard the used syringe.
14. Disconnect the tubing from the micro valve and use a new syringe filled with ultra pure water to rinse the tubing.
15. Leave the syringe filled with ultra pure water connected to the tubing, reconnect the tubing to the micro valve and install the syringe on the dynamic calibrator,
16. Set the dynamic calibrator range multiplier setting to $\times/1$ and the percent flow rate setting to 80%.
17. Open the micro valve.
18. Turn on the dynamic calibrator for 15 minutes to rinse the 2111LL and then turn off the dynamic calibrator.

19. Close the micro valve
20. Disconnect the syringe from the tubing and allow the tubing to drain.
21. Repeat steps 1-20 for each prepared standard.
22. Calculate the Q_{std} value and injection concentration for each standard using **Table 2**.

$$Q_{std} = 0.01 * \text{Percent Flow Rate} * S_{fs}$$

When using the percent flow rate value in the Q_{std} equation remember to convert the percent value to an actual value. For example, 80% is actually 0.8.

$$\text{Injection Conc.} = (Q_{std} * \text{Standard Conc.}) / (2111\text{LL Flow Rate} + Q_{std})$$

The background sodium reading is assumed to be zero.

23. Calculate the error for each standard using **Table 3**.

$$\text{Sodium Recovery} = \text{Observed Sodium Reading} - \text{Background Sodium Reading}$$

$$\text{Error (ppb)} = \text{Sodium Recovery} - \text{Injection Concentration}$$

$$\text{Error (\%)} = \text{Sodium Error} / \text{Injection Concentration}$$

Table 2

Standard Conc. (ppb)	Range Multiplier Setting	Percent Flow Rate Setting	2111LL Flow Rate (mL/min)	S_{fs} Syringe Full Speed (mL/min)	Q_{std} Syringe Injection Speed (mL/min)	Injection Conc. (ppb)
11.46	x/100	80.0%	40*	43.5**		
114.6	x/100	80.0%	40*	43.5**		
1152	x/100	80.0%	40*	43.5**		
19100	x/100	50.0%	40*	43.5**		

Table 3

Standard Conc. (ppb)	Injection Conc. (ppb)	Background Sodium Reading (ppb)	Observed Sodium Reading (ppb)	Sodium Recovery (ppb)	Error (ppb)	Error (%)
11.46						
114.6						
1152						
19100						

* Calculate the actual 2111LL flow rate value by using the 2111LL Flow Rate Determination procedure.

** If Fisher S7510-20 syringes are used, then the nominal S_{fs} value of 43.5 mL/min can be used in Table 2.

Performance Summary

The accuracy specification for the 2111LL is 0.01 ppb or 5%, whichever is greater

NOTE: It is essential to have the injected concentration equal or higher than the background sodium concentration. For the best results the injected concentration should not be less than 0.01 ppb.

The injection concentration (ΔC) can be calculated by using the equation:

$$\Delta C = (C_{\text{spl}} \cdot Q_{\text{spl}} + C_{\text{std}} \cdot Q_{\text{std}}) / (Q_{\text{spl}} + Q_{\text{std}}) - C_{\text{spl}}$$

Where:

C_{spl} = Background Sodium Reading

Q_{spl} = 2111LL Flow Rate

C_{std} = Standard Concentration

Q_{std} = Syringe Injection Speed

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