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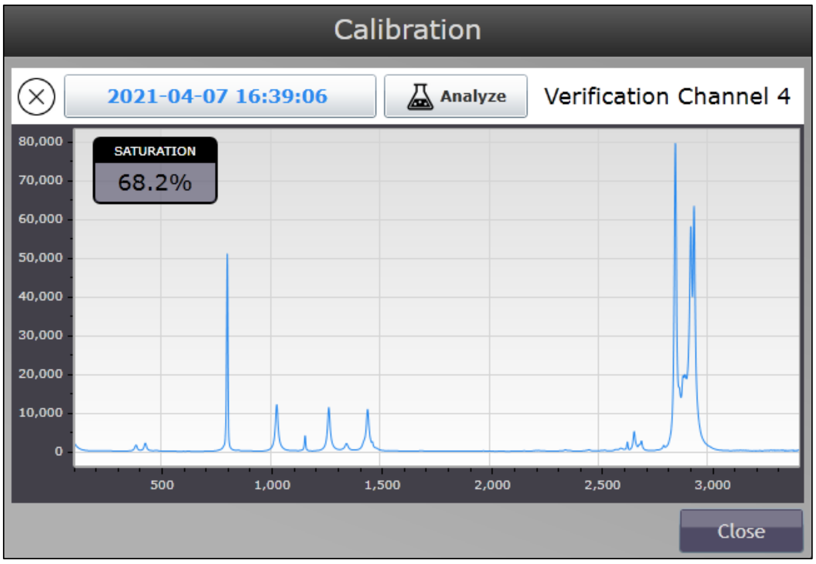
Operating Instructions
LNG parameters & calibration



Endress+Hauser
People for Process Automation

Table of Contents

1 About this document

1.1 Document function

This operating instruction contains information required for proper setup of parameters and performing calibration on liquified natural gas (LNG). It is important to closely review the sections of this manual to ensure the analyzer performs as specified.

1.2 Symbols

1.2.1 Safety symbols

Structure of Information	Meaning
⚠ WARNING **Causes (/consequences)** Consequences of noncompliance (if applicable) ▸ Corrective action	This symbol alerts you to a dangerous situation. Failure to avoid the dangerous situation can result in a fatal or serious injury.
⚠ CAUTION **Causes (/consequences)** Consequences of noncompliance (if applicable) ▸ Corrective action	This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or more serious injuries.
NOTICE **Cause/situation** Consequences of noncompliance (if applicable) ▸ Action/note	This symbol alerts you to situations which may result in damage to property.

1.3 List of abbreviations

Term	Description
Btu	British Thermal Unit
°C	Celsius
°F	Fahrenheit
GPa	Gigapascals
GPA	Gas Processors Association
HV	Heating Value
ISO	International Organization for Standardization
kJ	Kilojoule
kPa	Kilopascal
LNG	Liquefied Natural Gas
LOD	Limit of Detection
MJ	Megajoule
MolWt	Molar Mass
nm	Nanometer
psi	Pounds per Square Inch
psia	Pounds per Square Inch Absolute

1.4 Documentation

All documentation is available:

- On the media device supplied (not included in the delivery for all device versions)
- On the Endress+Hauser mobile app: www.endress.com/supporting-tools
- In the Downloads area of the Endress+Hauser website: www.endress.com/downloads

This document is an integral part of the document package, which includes:

Part number	Document type	Description
BA02180C	Operating Instructions	Instructions for standard installation and commissioning of the device
EA01470C	Installation Instructions	Reference for using the LNG analyzer performance verification kit manual

1.5 Registered trademarks

Modbus®
Registered trademark of SCHNEIDER AUTOMATION, INC.

1.6 U.S. export compliance

The policy of Endress+Hauser is in strict compliance with U.S. export control laws as detailed on the website of the Bureau of Industry and Security at the U.S. Department of Commerce.

2 Heating value outputs

- **Gross Ideal HV/unit volume or alias Gross HV (units are kJ/mole for ISO and Btu/mole for GPA).** Also known as "Higher", "Upper", "Total", or "Superior" HV. Assumes that water ends up as a liquid after combustion. Heating value, in this case, is short for "molar heating value".
- **Net Ideal HV/unit volume or alias Net HV (units are kJ/mole for ISO and Btu/mole for GPA).** Also known as "Lower" or "Inferior" HV. Assumes that water ends up as a gas after combustion. Calculated on an ideal basis.
- **Net Real HV/unit volume (units are kJ/mole for ISO and Btu/mole for GPA).** Similar to Net Ideal HV above, but compressibility is applied to report on a real basis.
- **Gross Real HV/unit volume or alias Real HV/unit volume (units are HeatingValue_Units).** Additional calculations are done to allow compressibility of the gas, so the ideal gas law is not assumed to be obeyed. A superior volumetric heating value.
- **Gross Ideal Wobbe Index or alias Ideal Wobbe Index (units are HeatingValue_Units).** Wobbe Index is the volumetric heating value divided by the square root of the specific gravity. One standard says Wobbe Index is defined only for a superior heating value, but later versions do not mention this. Regardless Wobbe Index as defined in this software currently is only available for superior heating values.
- **Gross Real Wobbe Index or alias Real Wobbe Index (units are HeatingValue_Units).** The real version of Ideal Wobbe Index. Both the heating value and the specific gravity used in the calculation are adjusted for compressibility.
- **Ideal Specific Gravity (unitless, usually agrees to 3 significant figures between ISO and GPA).** Note the GPA standard calls this Relative Density. This is not an alias though, so just use Ideal Specific Gravity regardless of the HV standard. The density of air is the denominator.
- **Real Specific Gravity (unitless, usually agrees to 3 significant figures between ISO and GPA).** GPA refers to this a relative density. The density of air is the denominator.
- **Molar Mass (MolWt) (Units are grams/mole, usually agrees to 4 significant figures between ISO and GPA).**
- **Gross Molar HV (units are HeatingValue_Units in the numerator and mole in the denominator).**

3 Raman RunTime parameters

In Raman RunTime, parameters can be changed on the Parameters tab on the Analysis screen as shown in Figure 1. The available parameters are specific to each method and are determined by the method developer.

Many of the exposed parameters have default values. For those parameters that do not have default values, a valid value should be entered. Parameters without default values can be identified by the presence of a **Trash** icon next to them. An example of this is the Manual Sample Temperature parameter. The sample temperature is normally provided using an external temperature sensor and is stored with the acquisition. If no value is provided for the Manual Sample Temperature, the system will use the temperature stored with the acquisition to produce temperature-corrected results. When a valid value is entered into the Manual Sample Temperature parameter, it overrides the value stored with the acquisition. To return to using external sample temperature, just delete the Manual Sample Temperature parameter.

NOTICE

- ▶ It is important to note that, once a value has been entered into any parameter that has no default value, the value can be changed, but it cannot be cleared. For the parameter Manual Sample Temperature, this means that, in order to have the system revert back to using the temperature stored with the acquisition, the parameter must be deleted by selecting the **Trash** icon for this parameter.

3.1 Default parameters

Parameters which are shown with a default value cannot be deleted. These parameters are shown with a **Reset** icon that allows the parameter to be reset to the default. Refer to the parameter descriptions in section 4 and pay special attention to the allowed values. Some parameters dictate the value which are valid for ISO or GPA. Take care when changing the parameters to use valid combinations of values.

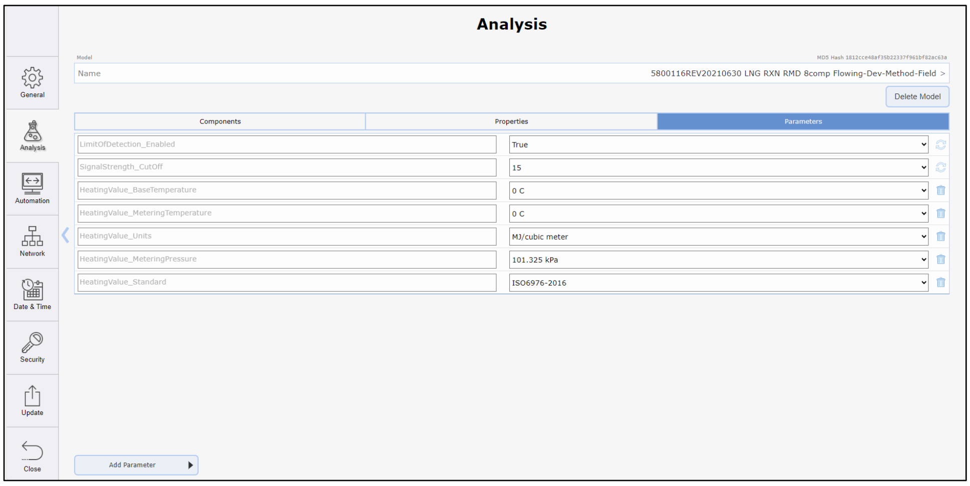


Figure 1. Default parameters A0056278

NOTICE

- ▶ The default Raman RunTime parameters are set at the factory. These parameter settings can be changed as needed. The reset icon to the right of the field will restore the default value.

3.2 Add parameters

Use the **Add Parameter** button to add a new parameter to the list of default parameters. The parameter name is case sensitive.

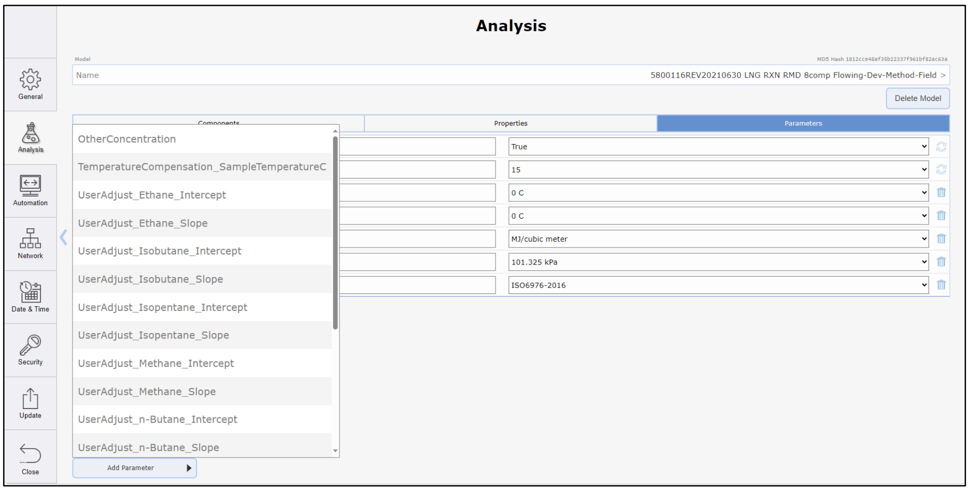


Figure 2. Add parameter A0056279

NOTICE

- ▶ The New Parameter option is for a future release and should not be used by the customer. Choosing another parameter already in the list is valid. No default is displayed but a valid value may be entered. When the parameter is not needed, it should be deleted using the **Trash** icon.

3.3 Limited parameters

A drop-down list of the possible values is displayed when the parameter only has a fixed number of valid entries as shown in Figure 3.

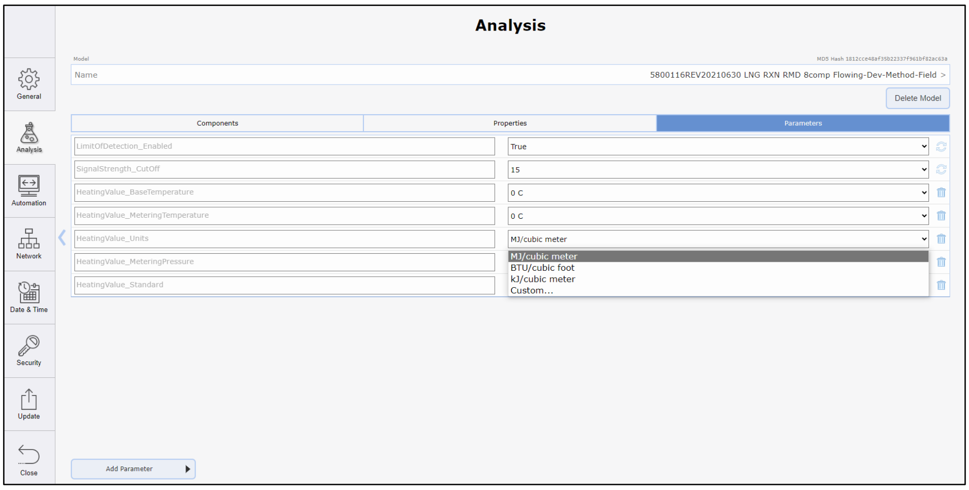


Figure 3. Limited parameters A0056280

4 Set the parameters for the method

4.1 Limit of Detection (LOD) enable

Set this value to True to force the reported component values to report as zero when a component is below its detection limit.

- **Key Name.** LimitOfDetection_Enabled
- **Possible Values.** True or False
- **Default.** True, Recommended: True

4.2 Signal strength cutoff

Signal strength is just a scaled sum of Raman peak areas. It is meant to distinguish between a full pipe and an empty pipe. Therefore, the signal strength cutoff must be set between full and empty pipe. If signal strength drops below the cutoff, all outputs are reported as zero. Note that signal strength is not a measure of instrument performance. The signal strength of a full pipe varies by installation and sample composition. An empty pipe typically has a signal strength of 0-3 and full pipe has a signal strength that is variable, with typical values ranging from 30 to 150.

- **Key Name.** SignalStrength_Cutoff
- **Possible Values.** Numeric, typically in the range of 5-25
- **Default.** 15 Recommended: about 2/3 between empty and full pipe

4.3 Other concentration

Mass balance by normalization is a standard part of the quantitative method. Using mass balance forces the sum of the concentrations of all measured components to add to 100 percent, with the assumption that there are no unmeasured components. Invisible components represent atoms or molecules which do not generate a Raman signal, or cannot be measured under the analysis conditions. If the concentration of these 'invisible' components is known, the sum of their concentrations can be input as the 'Other' concentration. The mass balance step is then calculated based on the value of 100 minus the Other concentration, and can result is an improvement in the accuracy of the method results. This feature is rarely used for LNG measurements.

- **Key Name.** OtherConcentration
- **Default.** None (essentially interpreted as zero)

4.4 Manual sample temperature

During normal operation, the sample temperature (for temperature compensation) is read from the acquisition data. The temperature value from the acquisition can come from MODBUS, OPC, or a direct sensor reading. However, if a manual sample temperature is provided, it will override the sample temperature provided from the acquisition. Deleting the manual temperature by using the **Trash** icon next to the key value will revert to using the temperature in the acquisition data.

- **Key Name.** TemperatureCompensation_SampleTemperatureC
- **Default.** None (this allows key deletion). Values entered should be in units of °C
- **Valid Range Acetone.** -20 °C to +50 °C

4.5 Heating value standard

The heating value standard is a published document containing both data and instructions for how to calculate various heating values and related quantities. Calculations are based on the composition and base temperature. Some quantities also require metering temperature and pressure. Each standard expects specific values for the temperatures and pressures caution should be used when selecting the desired standard. See instructions for those particular parameters.

- **Key Name.** HeatingValue_Standard
- **Allowed Values.** GPA2172-09/GPA2145-2009, GPA2172-09/GPA2145-2016, ISO6976-1995E, ISO6976-2016
- **Default.** None
- **Recommended.** ISO6976-2016

4.6 Heating value units

Heating value units vary according to standard, but translation abilities are provided by the predictor. However, it is important to note that the different standards produce slightly different results so a translation from the native units of one standard to the native units of another standard may not exactly agree with using the standard directly. The numerator and denominator are examined independently to determine if translation should occur.

- **Key Name.** HeatingValue_Units
- **Default.** None
- **Allowed Values.** MJ/cubic meter, kJ/cubic meter, Btu/cubic foot

4.7 Heating value base temperature

Each standard has several tables of combustion data which were collected using different base temperatures for the calorimeter. Choosing the base temperature determines which table of data is used. The ISO standard uses several base temperatures, while GPA standard uses only one.

- **Key Name.** HeatingValue_BaseTemperature
- **Default.** None
- **Allowed Values (GPA).** 60 °F
- **Allowed Values (ISO).** 0 °C, 15 °C, 20 °C, 25 °C, 288.15 K (same as 15 °C), and 15.55 °C

4.8 Heating value metering temperature

This parameter is used to calculate compressibility, which is used to convert from ideal gas law conditions to real, or extended, gas law conditions. Only certain values are allowed for each standard.

- **Key Name.** HeatingValue_MeteringTemperature
- **Default.** None
- **Allowed Values (GPA).** 60 °F
- **Allowed Values (ISO).** 0 °C, 15 °C, 20 °C, 25 °C

4.9 Heating value metering pressure

This parameter is used in a similar fashion to the metering temperature. It is used to convert from ideal to real heating value. Only certain values are allowed for each standard.

- **Key Name.** HeatingValue_MeteringPressure
- **Default.** None
- **Allowed Values (GPA).** 14.65 psi, 14.696 psi, 14.73 psi
- **Allowed Values (ISO).** 101.325 kPa only

4.10 Heating value output values

The heating value output values are a list of calculated values made available to RunTime by the method developer. Not all of the exposed values need to be used or displayed. RunTime can be configured to ignore any value by using the Parameters list under Analysis settings as shown below.

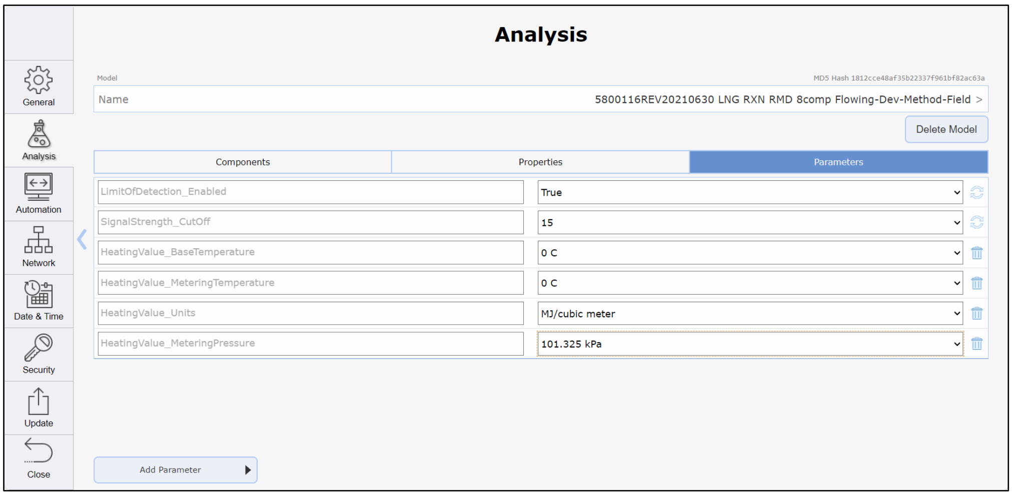


Figure 4. Heating value output values A0056281

5 Intensity calibration

Intensity calibration is used to standardize the instrument and optical path. If this intensity correction is not done carefully, incorrect results may be obtained. Therefore, the intensity calibration needs to be checked.

The normal verification available algorithm with the Raman RunTime software, which looks at specific peak ratios, is used. Acetone is used in pure form to simulate an LNG sample by associating different peaks in the spectrum with peaks in the LNG sample at similar Raman shift positions as the Raman verification standard. Perform an Intensity calibration before beginning the process described below. See the *Raman RunTime v6.5 Operating Instructions (BA02180C)* for more information.

The LNG Analyzer Verification Kit (p/n 70187812) is useful for field verification. It contains cleaning wipes, a Swagelock T-cell with Teflon ferrules, and ampules of acetone in sealed glass vials. A thermometer good to ± 0.5 °C is also required.

To run an acetone validation

1. After the intensity calibration is complete, a verification test can be performed.

- If acetone cannot be obtained, contact technical support for assistance.
- See the LNG Analyzer Performance Verification Kit Manual (EA01470C) for more information about the Calibration Kit.

2. Attach the T-cell so the probe is inserted into the end of the cell, leaving the top port free to add liquid.

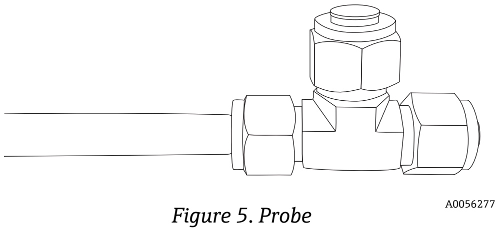


Figure 5. Probe

If the probe is held vertical, then it may be easier to add the validation fluid to the end opposite the probe. If the probe is held horizontal, then if may be easier to add the validation fluid to the middle port.

To ensure there are no bubbles on the window, tap the T-cell lightly.

CAUTION

▶ Do not put the probe in the middle port.

3. Measure the temperature of the fluid or the T-cell itself in °C.
4. Running the validation as part of the verification process
   - Load the cell and measure the temperature described in the steps above.
   - After running an Intensity Correction, the calibration screen will appear as shown in Figure 7. The **Verify** button is available in the Probe Calibration section of the dialog.

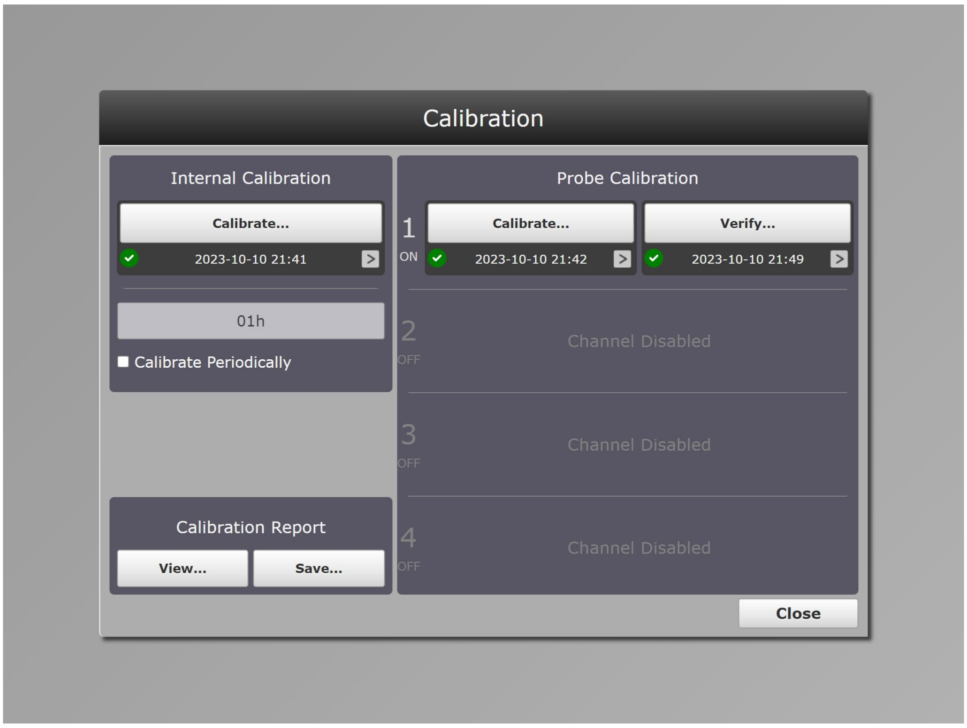


Figure 6. Calibration screen A0056282

NOTICE

▶ When performing a verification, there is a place to input the sample temperature. Enter the measured temperature here.

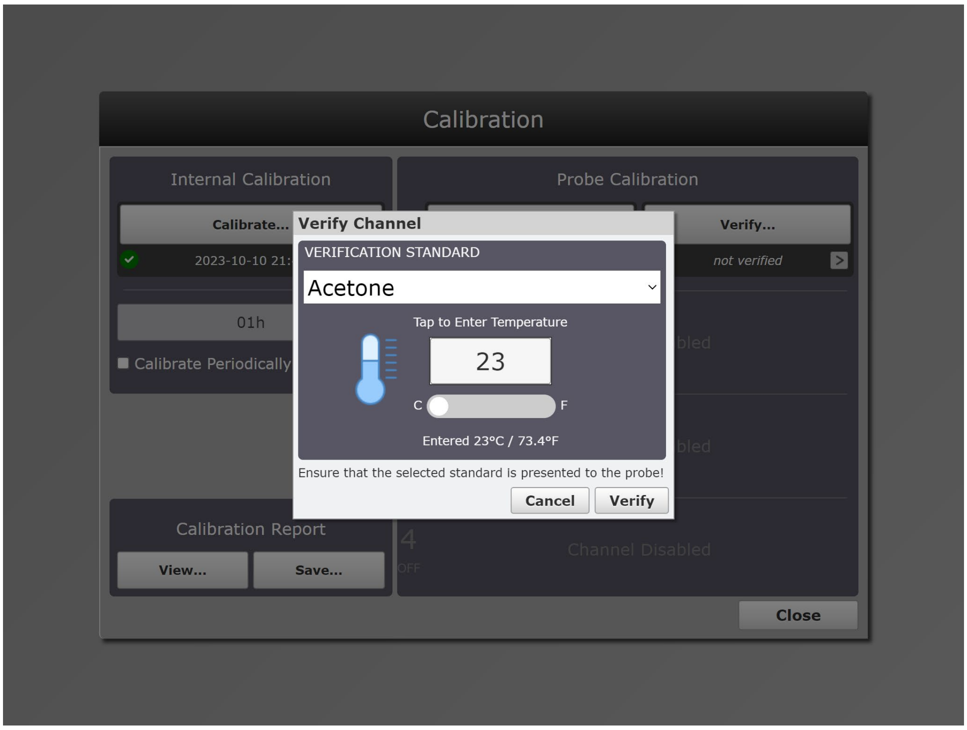


Figure 7. Verify channel A0056283

Following verification, the report will indicate if the channel has passed or not. An automatically generated report of the peaks used, tolerances, pass/fail, etc. is provided in the report.

6 Index