SD02912C/66/EN/01.22
70200791

Valid since version
V 01.05.07 (device software)

Special Documentation

Heartbeat technology for J22 and JT33 TDLAS gas analyzers

Heartbeat Verification + Monitoring application package

Endress+Hauser
People for Process Automation

Table of Contents

1 About this document

1.1 Document function

This manual is Special Documentation and does not replace the Operating Instructions included in the scope of product. It is a part of the Operating Instructions and serves as a reference for using the Heartbeat Technology function integrated in the measuring device.

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.

1.2.2 Symbols for certain types of information

Symbol	Meaning
	**Permitted:** Procedures, processes or actions that are permitted.
	**Forbidden:** Procedures, processes or actions that are forbidden.
	**Tip:** Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
▶	Notice or individual step to be observed
1., 2., 3. ...	Series of steps
	Result of a step

1.2.3 Symbols in graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections

1.3 Content and scope

This document contains descriptions of the additional parameters and technical data of the application package and detailed explanations regarding:
- Application-specific parameters
- Advanced technical specifications

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:

Document title	Documentation code
J22 Technical Information	TI01607C
J22 Safety Instructions	XA02708C
J22 Operating Instruction	BA02152C
JT33 Operating Instructions	BA02297C
JT33 Brief Operating Instructions	KA01655C
JT33 Technical Information	TI01722C
JT33 Safety Instructions	XA03137C
J22 and JT33 Description of Device Parameters	GP01198C
Web server for J22 and JT33 TDLAS gas analyzers Special Documentation	SD03032C
Validation of TDLAS gas analyzers	SD03286C

2 Safety

Each analyzer shipped from the factory includes safety instructions and documentation to the responsible party or operator of the equipment for the purpose of installation and maintenance.

⚠ WARNING

Technicians are expected to be trained and to follow all safety protocols, established by the customer in accordance with the area hazard classification, to service or operate the analyzer.

- ▶ This may include but is not limited to toxic and flammable gas monitoring protocols, lockout/tagout procedures, personal protective equipment (PPE) requirements, hot work permits, and other precautions that address safety concerns related to the use and operation of process equipment located in hazardous areas.

2.1 Personnel qualifications

Personnel must meet the following conditions for mounting, electrical installation, commissioning, and maintenance of the device. This includes but is not limited to:

- Suitably qualified for their role and the tasks they perform
- Understand the general principles and types of protection and markings
- Understand the aspects of equipment design which affect the protection concept
- Understand the content of certificates and relevant parts of IEC 60079-14
- General understanding of inspection and maintenance requirements of IEC 60079-17
- Familiar with the techniques used in the selection and installation of equipment referenced in IEC 60079-14
- Understand the additional importance of permit to work systems and safe isolation in relation to explosion protection
- Familiar with national and local regulations and guidelines, such as ATEX/IECEx/UKEX and cCSAus
- Familiar with lockout/tagout procedures, toxic gas monitoring protocols, and personal protective equipment (PPE) requirements

⚠ WARNING

Substitution of components is not permitted.

- ▶ Substitution of components may impair intrinsic safety and alter EX d ratings for non-intrinsic assemblies.

2.2 Product safety

The TDLAS gas analyzer is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition that is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the specific EU Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the analyzer system.

2.3 Designated use

The designated use of the measuring device is described in the Operating Instructions pertaining to the device.

2.4 IT security

Our warranty is valid only if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the device and associated data transfer, must be implemented by the operators in line with their security standards.

2.5 Device-specific IT security

The device offers a range of specific functions to support protective measures on the operator's side. These functions can be configured by the user and guarantee greater operational safety if used correctly. An overview of the most important functions is provided in the following section.

3 Product description

3.1 Product features

Heartbeat Technology offers diagnostic functionality through continuous self-monitoring, and the in-situ verification of TDLAS gas analyzers in the application.

3.2 Availability

Heartbeat Technology is compatible with all system integration options. Interfaces with digital communication are required to access the data saved in the device. The speed of data transmission depends on the type of communication interface used.

4 System integration

The Heartbeat Technology features are available using the local display module and the digital interfaces. The features can be used both using an asset management system and using the automation infrastructure (e.g., PLC).

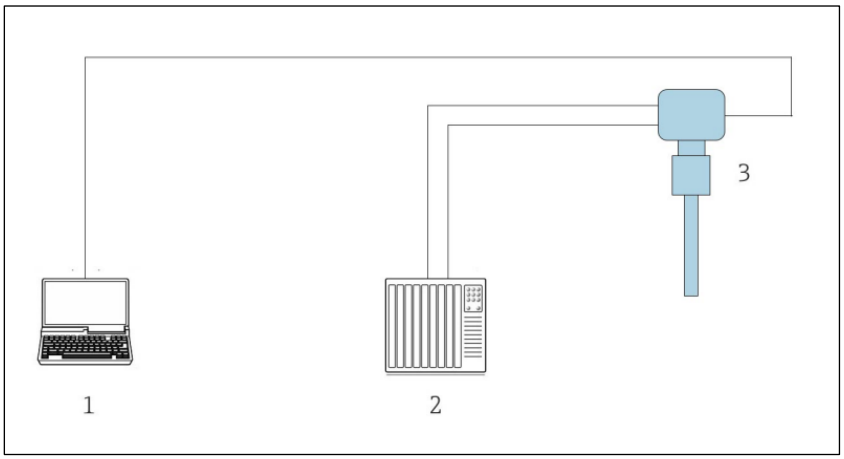


Figure 1: Connecting through Modbus RTU over RS485 protocol

#	Description
1	Computer with web browser for temporarily accessing the web server for settings and diagnostics
2	Automation / control system, such as PLC
3	TDLAS gas analyzer

4.1 Performing verification and creating a verification report

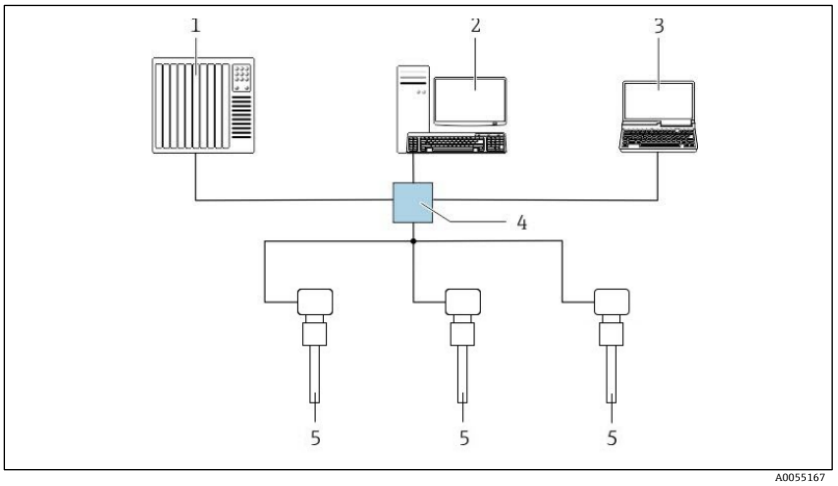


Figure 2: Connecting through Modbus TCP protocol

#	Description
1	Automation / control system (e.g., PLC)
2	Workstation for measurement operation
3	Computer with Web browser (e.g., Internet Explorer) for accessing the integrated device Web server
4	Ethernet switch
5	TDLAS gas analyzer

Run the **Heartbeat Verification** using one of the following interfaces:
- System integration interface of a higher-level system
- Local display
- Service interface CDI-RJ45 (CDI: Common Data Interface)

The device must be accessed externally from a higher-level system using the system integration interface in order to start a verification and signal the verification result (Passed or Failed). It is not possible to start the verification using an external status signal and relay the results to a higher-level system using the status output.

The detailed results of the verification (8 data records) are saved in the device and provided in the form of a verification report.

Verification reports can be created using the Web server integrated in the measuring device. Data exchange can take place automatically or be triggered by a user.

4.2 Integration into the PLC system

The measuring device's built-in verification can be activated using a control system and the results can be checked.

For further information on system integration, see the *Operating Instructions* → 🖹.

The following procedure must be implemented for this purpose:

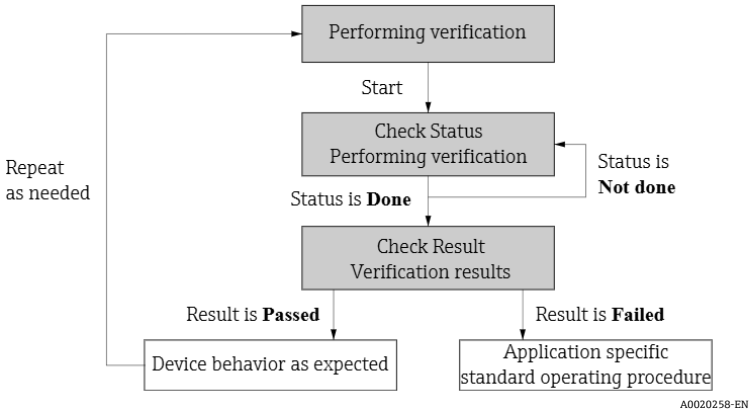


Figure 3: Automated data exchange for heartbeat verification

Verification result: The overall result of the verification is indicated in the Overall result parameter.

4.3 Data availability for the user

The data from the **Heartbeat Monitoring** and **Heartbeat Verification** function can be made available in a variety of ways.

4.3.1 Device

Heartbeat Monitoring

Configuration of the monitoring function: specify which diagnostic parameters are output continuously using the system integration interface.

Heartbeat Verification

The Heartbeat Verification result is displayed in the operating menu.

4.3.2 Asset management system

Heartbeat Monitoring

The user can read the monitoring measured variables in the operating menu.

Heartbeat Verification
- Start the verification
- Upload, archive and document the verification results including detailed results

4.3.3 PLC system

Heartbeat Monitoring

The user can read the monitoring measured variables in the system.

Heartbeat Verification

The Heartbeat Verification result is displayed in the operating menu.

4.4 Data management

The results of a **Heartbeat Verification** are saved as a non-volatile parameter set in the measuring device memory:
- 8 storage locations available for parameter data records
- New verification results overwrite old data following the FIFO [1] principle

The results can be documented in the form of a verification report using the web server integrated in the measuring device.

4.4.1 Data management using Web browser

The device can be operated and configured using a web browser. A pass-fail summary of results can be viewed directly in within the web server by using the Verification result button displayed below. In addition, it is possible to create a verification report as described below.

Viewing Verification results

Click the navigation button **Data management** → **Documents** → **Verification report** → **Verification result**

A pass-fail summary of the last verification is provided in the web browser without the need to upload the full report. When extended validation is performed, concentration measurement data is also captured.

Printing a verification report

A verification report is created in PDF format.

Prerequisite: A verification has already been performed.

User interface in the Web browser following login:

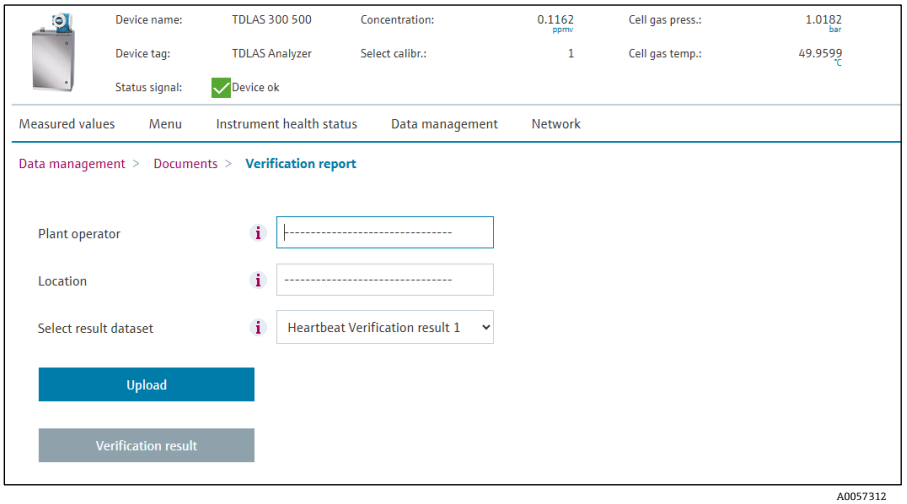


Figure 4: Printing a verification report

[1] First In – First Out

1. Click the navigation buttons **Data management** → **Documents** → **Verification report**.

   The input area for downloading verification reports is displayed.

2. Enter the necessary information in the **Plant operator** and **Location** fields.

   The information entered here appears in the verification report.

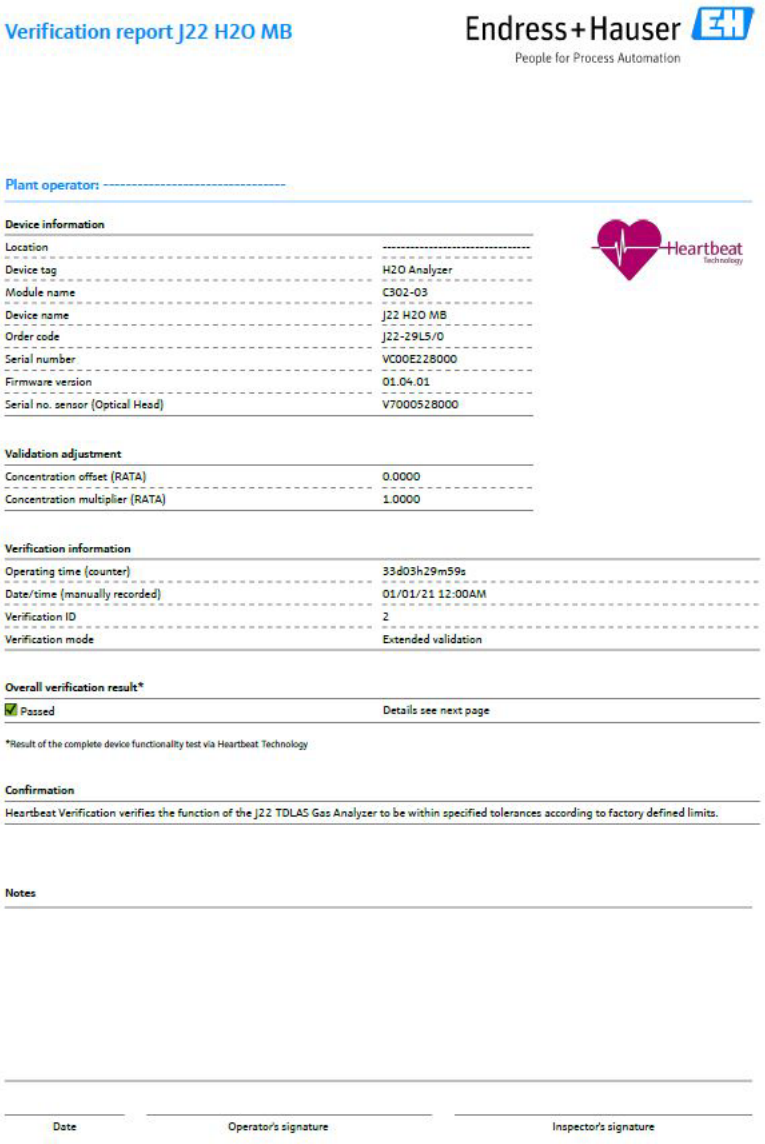
3. Select the result dataset.

   A result dataset is indicated as a time stamp in the drop-down list. If no verification has been performed, the message "No result data set" is displayed here.

4. Click **Upload**.

   The Web server generates a verification report in PDF format. The report might look different than the example in figure 5 based on what firmware version is used.

Starting point	Description of procedure
Perform verification Online connection to device required.	Perform verification and create a verification report.
Create the verification report using a verification data record	Select an existing verification data record and create the verification report.



Verification report J22 H2O MB

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Plant operator: ----------

Device information

Location	----------
Device tag	H2O Analyzer
Module name	C302-03
Device name	J22 H2O MB
Order code	J22-29L5/0
Serial number	VC00E228000
Firmware version	01.04.01
Serial no. sensor (Optical Head)	V7000528000

Heartbeat Technology

Validation adjustment

Concentration offset (RATA)	0.0000
Concentration multiplier (RATA)	1.0000

Verification information

Operating time (counter)	33d03h29m59s
Date/time (manually recorded)	01/01/21 12:00AM
Verification ID	2
Verification mode	Extended validation

Overall verification result*

☑ Passed	Details see next page

*Result of the complete device functionality test via Heartbeat Technology

Confirmation

Heartbeat Verification verifies the function of the J22 TDLAS Gas Analyzer to be within specified tolerances according to factory defined limits.

Notes

Date | Operator's signature | Inspector's signature

Figure 5: Example verification report

Online connection to device required.

5 Heartbeat verification

Heartbeat Verification checks the device function within the specified measuring tolerance on demand. The result of the verification is “Passed” or “Failed.”

The verification data will be saved in the device. A verification report is generated automatically on the basis of these data to ensure the traceable documentation of the verification results.

Heartbeat Technology offers three ways to perform Heartbeat Verification:
- *Standard verification* → 🖹. Verification is performed by the device without manual checking of external measured variables.
- *Extended validation* → 🖹. Verification is performed using validation reference gas.
- *Extended current output* → 🖹. Verification includes the entry of external measured variables.

5.1 Performance characteristics

Heartbeat Verification is performed on demand and supplements permanent self-monitoring with additional checks.

Standard verification additionally checks the following inputs and outputs:
- 4 to 20 mA current output, active and passive
- 4 to 20 mA current input, active and passive
- Relay output

Extended validation includes the features of standard verification and adds the ability to perform reference gas validation. Extended current verification supports verification for the 4 to 20 mA current, active and passive output module.

Heartbeat Verification does not check the digital inputs and outputs and does not output any result for them.

All verifications are based on references that are incorporated in the measuring device, traceable from the factory and redundant in the device. **Heartbeat Verification** confirms on demand the device function with the total test coverage (TTC).

5.2 Commissioning

The configuration (factory reference) required as part of **Heartbeat Verification** is recorded during calibration at the factory and is permanently stored in the measuring device. When verifying in the application, the current situation of the measuring device is compared against this factory reference.

Recommendation: During the process of commissioning the measuring device, an initial verification (and all additional verifications during the life cycle) is performed under process or reference conditions. See *Performing verification* → 🖹.

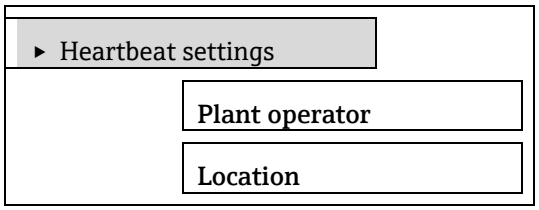
The results are saved as the initial situation in the life cycle of the measuring device up to the 8th verification.

5.2.1 Recording reference data

It is possible to manually record reference data relating to the operator and the location. These reference data appear on the verification report.

Navigation

Setup → Advanced setup → Heartbeat setup → Heartbeat base settings



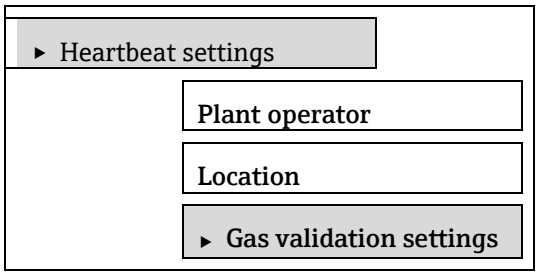
Parameter overview with brief description

Parameter	Description	User entry / Selection	Factory setting
Plant operator	Enter the plant operator.	Max. 32 characters such as letters, numbers or special characters (e.g., @, %, /)	–
Location	Enter the location.	Max. 32 characters such as letters, numbers or special characters (e.g., @, %, /)	–

5.2.2 Gas validation commissioning

Commissioning steps for gas validation must be setup prior to any extended validation of the device. The table below lists all possible gas validation settings however some parameters are order dependent and may not be displayed in the menu structure.

Expert menu → Diagnostics → Heartbeat technology → Heartbeat settings



Gas validation settings submenu

Parameter	Description	User entry / Selection	Factory setting
Select validation calibration	Select the calibration stream for validation. It should closely match the composition of the validation gas.	Stream 1, 2, 3, 4 Refer to the calibration certification provided with the analyzer for more information.	Stream 1
Validation Type	Select whether the validation gas flow is manual (user controlled) or auto (device controlled).	Validation manual gas Validation auto gas	Set up according to the order code
Num of validation points	Select the number of validation points.	1 or 2	Factory set per order
Validation gas purge time	Enter the validation gas purge time.	0 to 5 minutes	1.00 min
Meas. duration	Enter the duration for calculating the measurement statistics (mean, standard deviation).	0.25 to 60 minutes	1.00 min

Validation gas information	Enter a description or identifier for the source of validation gas (stream, bottle, bottle serial number).	Max. 32 characters such as letters, numbers, or special characters (e.g., @, %, /)	Unknown validation gas
Validation 1 concentration target	Enter the concentration of the analyte in the validation gas.	0 to 1000000 ppmv Validation gas concentration value dependent upon the concentration unit	0 ppmv
Validation 1 allowance	Set the deviation allowance between the validation concentration and the measured concentration.	0 to 100%	0.0000%
Validation 2 concentration target	Enter the concentration of the analyte in the validation gas.	0 to 1000000 ppmv Validation gas concentration value dependent upon the concentration unit	0 ppmv
Validation 2 allowance	Set the deviation allowance between the validation concentration and the measured concentration.	0 to 100%	0.0000%
Scheduled validation	Allow validation to automatically run based on a scheduled time of day	▪ Off ▪ On	Off
Validation internal num. days	Set the number of days between each scheduled validation	1 to 365	1
Validation start hour of day	Set the hour of the day when the validation will start	0 to 23	8
Last scheduled validation run	The last time validation was scheduled to run	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C).	Not done
Next scheduled validation run	The hour of the day when the next validation will start	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C).	Not done
Start validation	Select start to trigger a new validation. Select cancel to stop the current validation in progress.	▪ Cancel ▪ Start	Cancel

5.3 Operation

Parameter overview with brief description

Diagnostics menu → Heartbeat Technology → Performing verification

Parameter	Which verification mode?	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Date/time	▪ Standard verification ▪ Extended validation ▪ Extended current output	Should be set by user or service. Please confirm this before starting HBT verification.	Shows the date and time	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C).	Local conditions
Measurement duration	▪ Standard verification ▪ Extended validation ▪ Extended current output	Editable when the HBT verification is not in the busy state	Enter the duration for calculating the measurement statistics	0.25 to 60 m	1 m
Verification mode	▪ Standard verification ▪ Extended validation ▪ Extended current output	Can be edited if Heartbeat Verification is not active.	Select the verification mode. Standard verification is performed automatically by the device and without manual checking of external measured variables.	▪ Standard verification ▪ Extended validation ▪ Extended current output	Standard verification
External device info	▪ Extended current output	Extended current output or Extended validation must be selected.	Records the measuring equipment used for the verification.	Max. 32 characters such as letters, numbers or special characters	–
Start verification	▪ Standard verification ▪ Extended validation ▪ Extended current output	–	Start the verification. Start the verification with the **Start** option	▪ Start ▪ Cancel	Cancel
Switch gas valve	▪ Extended validation	Manual type validation	Indicate the user to manually switch external gas valve to start/stop flowing validation gas	▪ Start ▪ Cancel	Cancel
Progress	▪ Standard verification ▪ Extended validation ▪ Extended current output	–	Shows the progress of the validation.	0 to 100 %	Done
Measured value	▪ Extended current output	One of the following options is selected in the Start verification parameter: ▪ Output 1 low value ▪ Output 1 high value ▪ Output 2 low value ▪ Output 2 high value	Use this function to enter the measured values (actual values) for the external measured variable current output: Output current in [mA].	mA value	0 mA

Parameter	Which verification mode?	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Output values	▪ Extended current output	–	Displays the simulated output values (target values) for the external measured variable current output: Output current in [mA].	mA value	4.000 mA 20.000 mA
Measured concentration	▪ Extended validation	Extended validation is selected	Shows the measurement of the concentration	ppmv	–
Status	▪ Standard verification ▪ Extended validation ▪ Extended current output	–	Displays the current status of the verification.	▪ Done ▪ Busy ▪ Failed ▪ Not done ▪ Validation purging ▪ Switch gas valve ▪ Process purging ▪ Scrubbing	Not done
Verification result	▪ Standard verification ▪ Extended validation ▪ Extended current output	–	Displays the overall result of the verification. 🛈 Detailed description of results classification → 🖹	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

5.3.1 Initial verification

Initial verification can be performed in 3 ways:
- *Standard verification* → 🖹
- *Extended validation* → 🖹
- Extended current output → 🖹

5.3.2 Device behavior and interpretation

Result is Passed

- All test results are within the specifications.
- Verification generally delivers the result “Passed” in most applications.

Result is Failed

Failed verification occurs when either a misconfiguration of the analyzer has occurred, or one or more test results fall outside of specifications. Misconfiguration of the analyzer is addressed based upon a service ID of the event and should be reviewed with factory service. For occasions where test results are outside of their specifications, the related diagnostic messages should be reviewed for guidance about the type of failure. In addition, the user should take the following actions:

1. Establish defined and stable process conditions. In the case of extended validation with reference gases:
   - Gas validation settings should be reviewed. Lengthening the purge time and validation duration and expanding the allowance may help to complete a successful validation.
   - Verify that the validation gas stream matches the composition of the validation reference gas bottle.
   - Check the validation gas concentration target set in the analyzer to verify it matches the value for the gas bottle.
   - Consider the validation gas cylinder. Best practices for validation gas installation and handling of gas bottles are described in Validation of TDLAS Gas Analyzers SD03286C. If the gas cylinder requires replacement, note changes to concentration and update the settings within the analyzer.
2. Repeat verification. If the result of the verification “Passed”
   - If the result of the second verification is Passed, the result of the first verification can be ignored. In order to identify possible deviations, compare the current process conditions with the process conditions of a previous verification.
   - If the result of the verification is Failed again, review process conditions described above.
   - Provide Endress+Hauser Service with the verification result with the current process conditions.

5.3.3 Standard verification

Standard verification performs internal tests of the electrical components within the measurement device without manual checking of external measured variables.

Diagnostic behavior

The device signals that standard verification is being performed:
- ⚠**C302 Device verification in progress** diagnostic message will be displayed.
- Factory setting for diagnostic behavior: warning
- The device continues to measure.
- The last good value is output intermittently for 10 seconds.
- The signal outputs are not affected.
- Test duration: approx. 60 seconds.

To change the diagnostic behavior, navigate to Expert → System → Diagnostic handling → Diagnostic behavior

If Alarm is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs adopt the defined alarm condition.

- A category is assigned to the diagnostic message of the outputs in the **Diagnostic configuration** submenu: Expert → Communication → Diagnostic configuration.
- If the device does not have outputs, they are output as an error. To prevent an error from being output, assign the **No effect (N)** option to any outputs that are not present on the device.

Detailed information on diagnostics and troubleshooting and on diagnostic information and associated troubleshooting measures can be found in the *Operating Instructions* → 🖹.

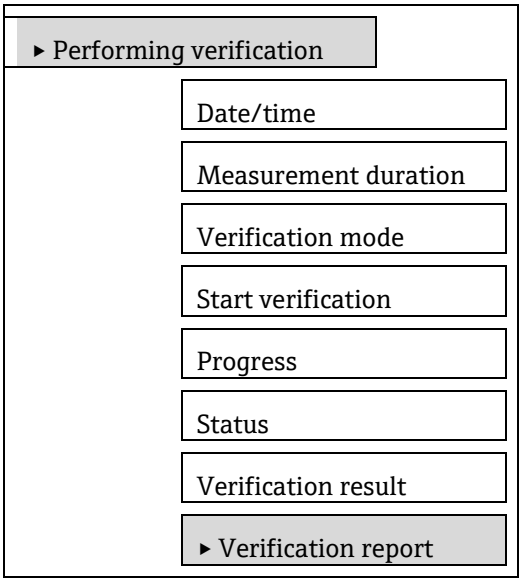
5.3.3.1 Performing standard verification

The date and time are saved with the current operating time and the verification results also appear in the verification report.

You must be logged into the display or web server with maintenance level access to run verification.

Main Menu → Expert → Diagnostics → Heartbeat technology → Performing verification.

Main Menu → Diagnostics → Heartbeat technology → Performing verification.



The menu structure is the same with the web server and the display.

1. Select the verification mode and choose **Standard verification**.
2. Start the verification test. In the Start verification parameter, select **Start**.

   ↳ While the verification is being performed, the progress of the verification is indicated as a % (bar graph indicator) in the Progress parameter.

Displaying the verification status and result

The current status of standard verification is displayed in the Standard verification→ 🖹:
- **Done.** The verification test is finished.
- **Busy.** The verification test is running.
- **Not done.** A verification has not yet been performed on this measuring device.
- **Failed.** A precondition for performing the verification has not been met, the verification cannot start (e.g., due to unstable process parameters). See ***Result is Failed*** → 🖹.

The result of the verification is displayed in the ***Overall result parameter*** → 🖹:
- **Passed.** All the verification tests were successful.
- **Not done.** A verification has not yet been performed on this measuring device.
- **Failed.** One or more verification tests were not successful. See ***Result is Failed*** → 🖹.

The overall result of the last verification can always be accessed in the menu.
- Navigation: Diagnostics → Heartbeat Technology → Verification results

- Detailed information on the verification result (test groups and test status) are displayed in the verification report in addition to the ***overall result*** → 🖹.
- If the device does not pass the verification, this is indicated in the verification report and the results are saved.
- Failure to pass verification facilitates a targeted search for the ***cause of the fault*** → 🖹16.

Verification report

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Plant operator	-	Use this function to enter the plant operator.	Max. 32 characters such as letters, numbers, or special characters (e.g., @, %, /).	-
Location	-	Use this function to enter the location where the measuring device is located.	Max. 32 characters such as letters, numbers, or special characters (e.g., @, %, /).	-
Select result dataset	-	Select the dataset to use when generating the verification report.	Heartbeat verification result 1	Heartbeat verification result 1

5.3.4 Extended Validation

The TDLAS gas analyzer extends Heartbeat Verification with the ability to validate against a gas standard to increase the system's test coverage.

The validation gas concentration value is input into the analyzer. The validation measurement is compared with a percent allowance of the gas concentration value to determine a pass or fail. Validation results can be viewed on the web server, tied to a validation warning alarm, and are saved as a Heartbeat Verification report.

Validation relies upon calibration gas of a known concentration value. Flow of the validation gas can be manually initiated or automatically conducted using internal validation solenoid valves. The validation method is specified at the time of order and can be confirmed through the order code. For additional guidance on gas validation please consult *Validation of TDLAS Gas Analyzers (SD03286C)*.

5.3.5 Manual validation

Manual validation relies on the operator initiating validation through the web server or local display module and manually opening a 3-way valve that blocks the process gas and allows validation gas to flow to the analyzer.

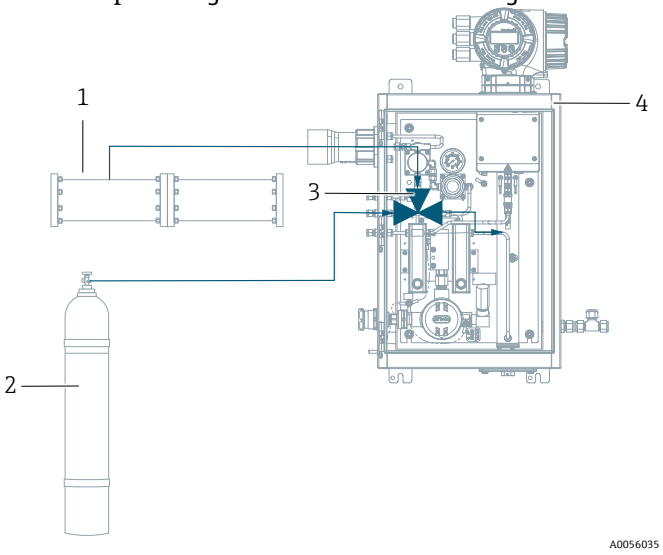


Figure 6: Example of manual validation of a TDLAS gas analyzer

#	Name
1	Process gas
2	Validation gas
3	Manual 3-way valve
4	Gas analyzer

5.3.6 Automatic validation, 1-point

Automatic validation is similar to manual validation however the manual 3-way valve is replaced by either electric or pneumatic air-operated solenoid valves located within the analyzer. Since the actuation of the valve is controlled by the analyzer, the validation can be assigned to start through the display web server to perform routine automatic validations at set intervals.

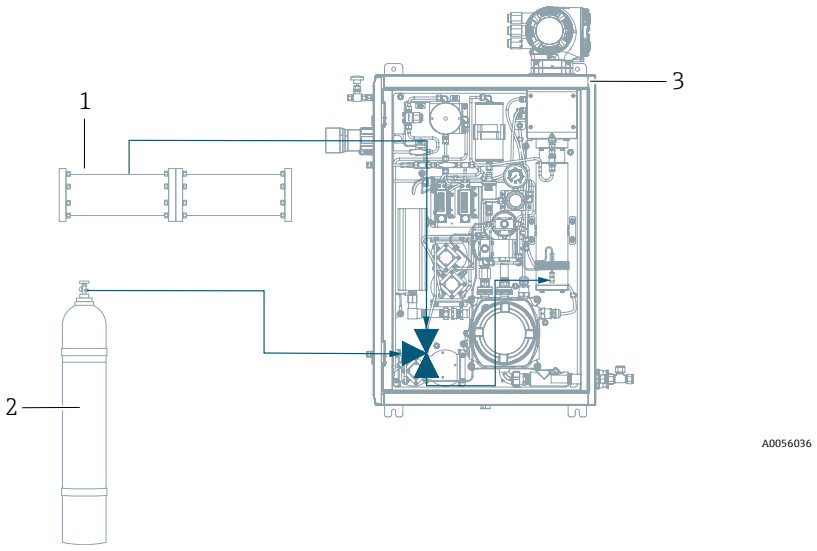


Figure 7: Example of automatic validation, 1-point of a TDLAS gas analyzer

#	Name
1	Process gas
2	Validation gas
3	Gas analyzer

5.3.7 Automatic validation, 2-point

This validation design is similar to 1-point automatic validation; however, a secondary validation point can be used for additional verification of the measurement. 2-point validation is often a regulatory requirement for analyzers used in flare monitoring and emissions applications. This option is only offered with pneumatic air-operated solenoid valves.

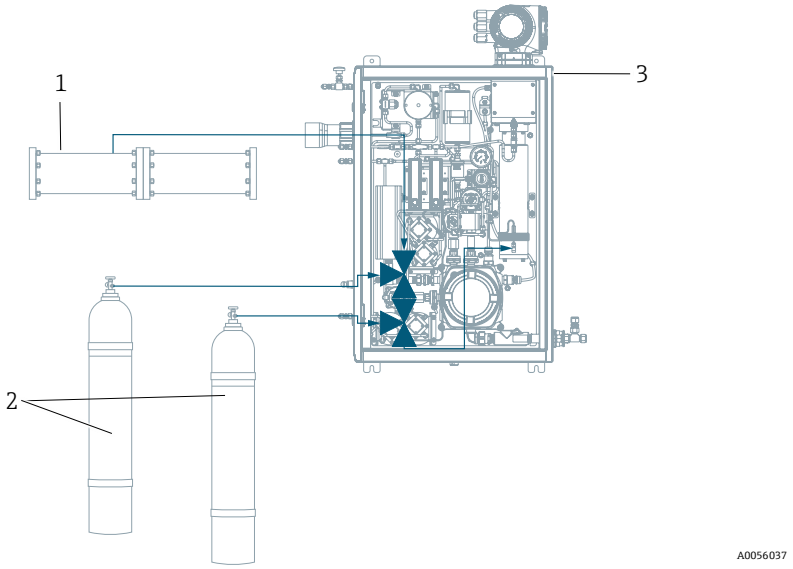


Figure 8: Example of automatic validation, 2-point of a TDLAS gas analyzer

#	Name
1	Process gas
2	Validation gases
3	Gas analyzer

5.3.7.1 Performing Extended validation

When Extended validation is selected, a gas validation is performed along with full standard verification of the analyzer. Additional verification of the outputs does not take place.

You must be logged into the display or web-server with maintenance level access to run verification.

Navigation:

Main Menu → Expert → Diagnostics → Heartbeat technology → Performing verification

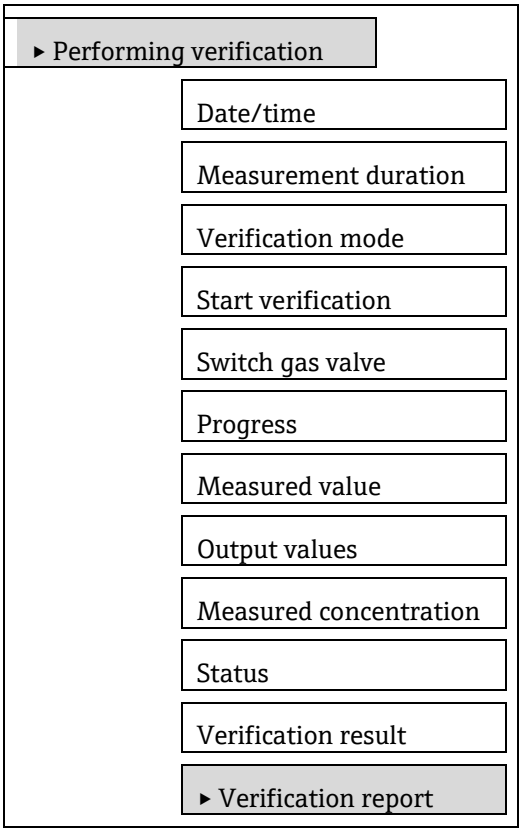
Main Menu → Diagnostics → Heartbeat technology → Performing verification

The date and time are saved with the current operating time. The verification results also appear in the verification report.

The Date/time field is used to manually record the date at the time of validation.

1. Confirm the date and time in the **date/time** field.
2. Select the **Verification mode** dropdown.
3. In the **Verification mode** parameter, select **Extended validation**.
4. In the **Start verification** parameter, select the **Start** option.

5. Select **Ok**.



While the extended validation is being performed, the progress is indicated as a % (bar graph indicator) in the Progress parameter.

Diagnostic behavior

Different diagnostic behaviors, along with the relevant diagnostic codes, can be displayed throughout the Extended validation process.

- The device signals that extended validation is being performed:
  - ⚠**C903 Validation active** diagnostic message will be displayed.
  - Factory setting for diagnostic behavior: warning
- The device continues to measure.
- ⚠**C302 Device verification in progress** diagnostic message will be displayed during the validation process.
- If extended validation fails, ⚠**S905 Validation failed** diagnostic message will be displayed.

When performing an Extended validation, there could be two main reasons for failure behavior:
- Misconfiguration, basically the analyzer is not configured for the validation properly. The service ID 1334 of the S905 event will indicate this issue
- Other reasons, service ID 1333 for which the remedy is already described. See ***Result is Failed*** → 🖹

To change the diagnostic behavior, navigate to Expert → System → Diagnostic handling → Diagnostic behavior

If Alarm is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs adopt the defined alarm condition.

- A category is assigned to the diagnostic message of the outputs in the **Diagnostic configuration** submenu: Expert → Communication → Diagnostic configuration.
- If the device does not have outputs, they are output as an error. To prevent an error from being output, assign the **No effect (N)** option to any outputs that are not present on the device.

Detailed information on diagnostics and troubleshooting and on diagnostic information and associated troubleshooting measures can be found in the *Operating Instructions* → 🖹.

For diagnostic behavior indicating validation failed, refer to Device behavior and interpretation → 🖹.

Displaying the extended validation status and result

The current status of verification is displayed in the ***Status parameter*** → 🖹:
- **Done.** The test is finished.
- **Busy.** The test is running.
- **Not done.** An extended verification has not yet been performed on this measuring device.
- **Failed.** A precondition for performing the validation has not been met, the validation cannot start (e.g., due to unstable process parameters). See ***Result is Failed*** → 🖹.

The result of the extended verification is displayed in the ***Output values parameter*** → 🖹:
- **Passed.** All the tests were successful.
- **Not done.** A has not yet been performed on this measuring device.
- **Failed.** One or more tests were not successful. See ***Result is Failed*** → 🖹.

The overall result of the last extended verification can always be accessed in the menu. Navigation: Diagnostics → Heartbeat Technology → Verification results

- Detailed information on the extended verification result (test groups and test status) are displayed in the verification report in addition to the overall result. See ***Interpreting and using the verification results*** → 🖹.
- If the device does not pass the extended verification, the results are saved nonetheless and indicated in the verification report.
- This facilitates a targeted search for the ***cause of the fault*** → 🖹.

5.3.8 Extended current output

The extended verification supplements standard verification with the output of various measured variables. During the verification process, these measured variables are recorded manually with the help of external measuring equipment, for example, and *entered in the measuring device* → 🖹. The value entered is checked and verified by the measuring device to ensure that it complies with the factory specifications. A status (passed or failed) is issued accordingly, is documented as an individual result of the verification, and is taken into account in the overall result.

Extended verification measured variables

Output current (current output)
- Simulation of the measured values for every output physically present on the device
- Simulation “Low value” and “High value”
- Measurement of the two values
- Entry of the two measured values in the verification screen

For more information on simulation, see the *Operating Instructions* → 🖹.

Measuring equipment requirements

Recommendations for the measuring equipment

DC current measuring uncertainty	±0.2 %
DC current resolution	10 µA
DC voltage measuring uncertainty	±0.1 %
DC voltage resolution	1 mV
Temperature coefficient	0.0075 %/°C

For more information on validation, consult your local sales channel.

5.3.8.1 Connecting the measuring equipment in the measuring circuit

WARNING

Danger to personnel using non-approved equipment in the hazardous area.

► Only use intrinsically safe measuring equipment in hazardous zones.

► Measure intrinsically safe circuits with approved equipment only.
► Outputs (passive) for the hazardous area may only be connected to suitable intrinsically safe circuits.

Determining the terminal assignment for the outputs

The terminal assignment depends on the specific device version. To determine the device-specific terminal assignment:
- See the adhesive label in the terminal cover
- Check the operating menu using the local display, Web browser or operating tool:
  - Setup → I/O configuration → I/O module 1 to n terminal numbers
  - Expert → I/O configuration → I/O module 1 to n terminal numbers

For detailed information on terminal assignment, see the *Operating Instructions for the device* → 🖹.

5.3.8.2 Active current output

For extended verification of the active current output, connect the ammeter to the transmitter by looping it in series into the circuit.

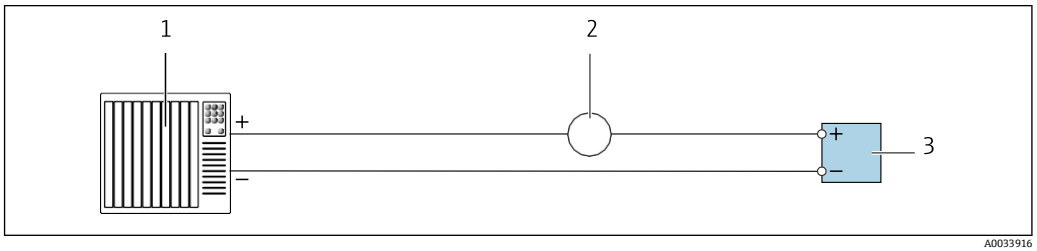


Figure 9: Extended verification of the active current output

#	Description
1	Automation system with current input (e.g., PLC)
2	Ammeter
3	Transmitter

If the automation system is switched off, the measuring circuit may be interrupted as a result. It is then not possible to perform a measurement. If this is the case, proceed as follows:
1. Disconnect the output cables of the current output (+/–) from the automation system.
2. Short the output cables of the current output (+ / -).
3. Connect the ammeter to the transmitter by looping it in series into the circuit.

5.3.8.3 Passive current output

For extended verification of the passive current output:
1. Connect the ammeter to the transmitter by looping it in series into the circuit.
2. Connect the power supply unit.

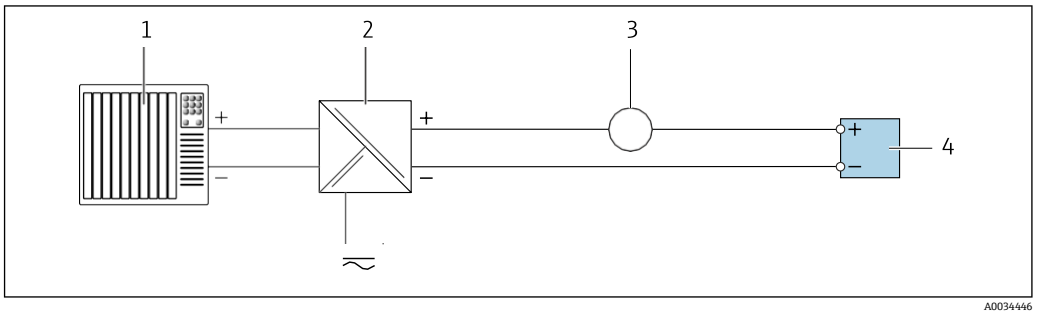


Figure 10: Extended verification of the passive current output

#	Description
1	Automation system with current input (e.g., PLC)

#	Description
2	Power supply unit
3	Ammeter
4	Transmitter

5.3.9 Diagnostic behavior

A diagnostic event signals that extended verification is being performed:
- The screen alternates between the status signal “C” (Function Check) and the operational display. *Verification is currently active in the device.*
- Different diagnostic behaviors, along with the relevant diagnostic codes, can be displayed depending on the device version.
- The output selected under the Start verification parameter is always displayed as either the current output low or high value option as selected by the user.

Diagnostic code	Diagnostic behavior	Options in Start verification
C491	Current output 1 to n simulation active	Output 1…n low value Output 1…n high value
C302	⚠C302 Device verification in progress	

An extended verification (simulation mode) may be started only if the process plant is not in the automatic mode.

If the **Start** option is selected in the **Start verification** parameter, the following diagnostic event is displayed on the display (second part of external verification):
- ⚠**C302 Device verification in progress** diagnostic message.
- Factory setting for diagnostic behavior: warning.
- The device continues to measure.
- The last good value is output intermittently for 10 seconds.
- Test duration (all outputs switched on): approx. 60 seconds.

- The diagnostic behavior can be changed if necessary. Navigate to Expert → System → Diagnostic handling → Diagnostic behavior
- If Alarm is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs and defines the alarm condition.
- A category is assigned to the diagnostic message of the outputs in the Diagnostic configuration submenu. Navigate to Expert → Communication → Diagnostic configuration
- If the device does not have outputs, they are output as an error. To prevent an error from being output, assign the No effect (N) option to any outputs that are not present on the device.

Detailed information can be found in the *Operating Instructions* → 🖹.

5.3.9.1 Performing extended current output verification

A full standard verification is performed in the course of the verification. The validity of the entered and measured values of the outputs is checked. Additional standard verification of the outputs does not take place.

User must be logged into the display or web-server with maintenance level access to run verification.

Main Menu → Expert → Diagnostics → Heartbeat technology → Performing verification.

Main Menu → Diagnostics → Heartbeat technology → Performing verification.

NOTICE

If the electrical connections have not been established and the ammeter is not looped in during verification, extended current output verification is not possible.

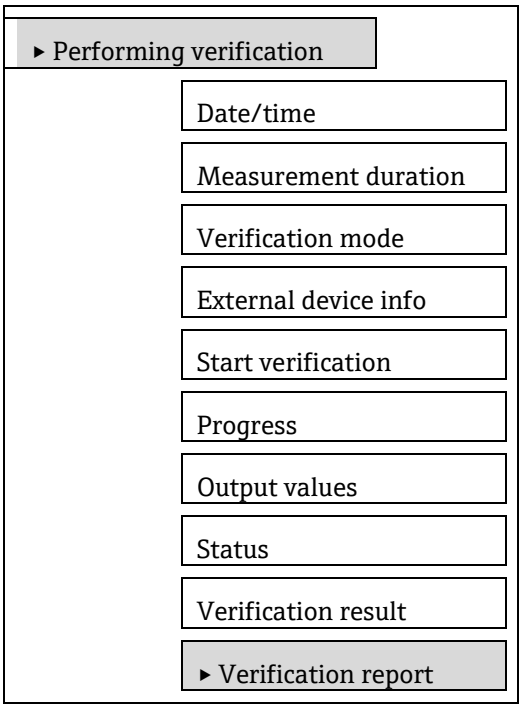
► Establish the electrical connection before starting the extended verification.
► Loop in ammeter before extended verification starts.

Before verification starts

The date and time are saved with the current operating time and the verification results and also appear in the verification report.

The **Date/time** field is used to manually record the data at the time of verification.

1. Verify the date and time.
2. Select **verification mode**. In the **Verification mode** parameter, select **Extended current output verification**.



3. Select additional parameter settings:
   a. In the **External device information** parameter, enter a unique ID (e.g., serial number) of the measuring equipment used (max. 32 characters).
   b. In the **Start verification** parameter, select one of the options available (e.g., the Output 1 low value option).
   c. In the **Measured values** parameter, enter the value displayed on the external measuring equipment.
4. Repeat previous steps until all the output options are checked.
5. Adhere to the sequence indicated and enter the measured values.

   The duration of the process and number of outputs depend on the device configuration, whether the output is switched on, and whether the output is active or passive.

   The value displayed in the ***Output values*** *parameter* → 🖹 shows the value simulated by the device at the selected output. See ***displaying the verification status*** → 🖹.
6. In the Start verification parameter, select **Start**.

   ↳ While the verification is being performed, the progress of the verification is indicated as a % (bar graph indicator) in the **Progress** parameter.

Displaying the verification status and result

The current status of verification is displayed in the *Status parameter* → 🖹:
- **Done.** The verification test is finished.
- **Busy.** The verification test is running.
- **Not done.** A verification has not yet been performed on this measuring device.
- **Failed.** A precondition for performing the verification has not been met, the verification cannot start (e.g., due to unstable process parameters). See *Result is Failed* → 🖹.

The result of the verification is displayed in the *Output values parameter* → 🖹:
- **Passed.** All the verification tests were successful.

- **Not done.** A verification has not yet been performed on this measuring device.
- **Failed.** One or more verification tests were not successful. See *Result is Failed* → 🖹.

The overall result of the last verification can always be accessed in the menu. Navigation: Diagnostics → Heartbeat Technology → Verification results

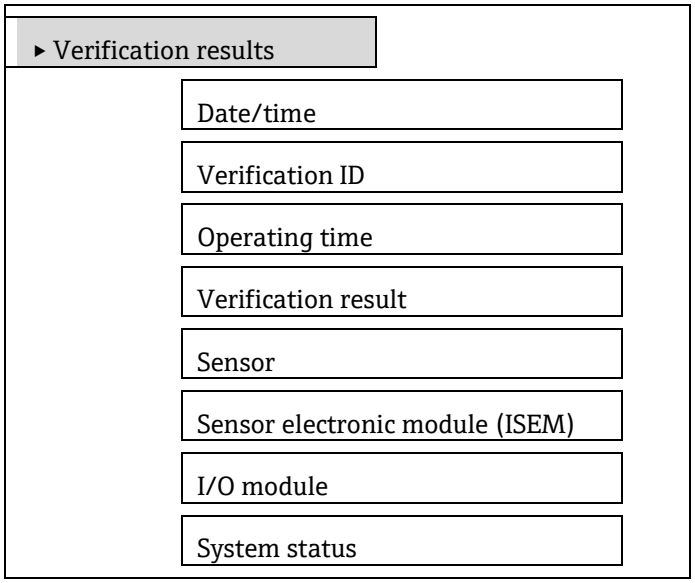
- Detailed information on the verification result (test groups and test status) are displayed in the verification report in addition to the overall result. See *Interpreting and using the verification results* →🖹.
- If the device does not pass the verification, the results are saved nonetheless and indicated in the verification report.
- This facilitates a targeted search for the *cause of the fault* → 🖹.

5.3.10 Verification results

Navigation

Diagnostics submenu → Heartbeat Technology → Verification results

Expert menu → Diagnostics → Heartbeat Technology → Verification results



Parameter overview with brief description

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Date/time	The verification has been performed.	Date and time.	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the *J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C)*.	-
Verification ID	The verification has been performed.	Displays consecutive numbering of the verification results in the measuring device.	0 to 65 535	0
Operating time	The verification has been performed.	Indicates how long the device has been in operation up to the verification.	Days (d), hours (h), minutes (m), seconds (s)	–
Verification result	The verification has been performed.	Displays the overall result of the verification. Detailed description of *results classification* → 🖹	■ Not supported ■ Passed ■ Not done	Not done

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
			■ Failed	
Sensor	The verification has been performed.	Shows the overall result for the “sensor” test group.	■ Not supported ■ Passed ■ Not done ■ Failed	–
Sensor electronic module (ISEM)	The verification has been performed.	Shows the overall result for the “sensor electronic module” test group.	■ Not supported ■ Passed ■ Not done ■ Failed	–
I/O module	The verification has been performed.	Shows the overall result for the “I/O module” test group.	■ Not supported ■ Passed ■ Not done ■ Failed	–
System status	The verification has been performed.	Shows the result of the system condition monitoring.	■ Not supported ■ Passed ■ Not done ■ Failed	–

Classification of results

Individual results

Result	Description
Failed	At least one individual test in the test group was outside the specifications.
Not used	The result is used for internal purposes.
Passed	All individual tests in the test group complied with the specifications. The result is also “Passed” if the result of an individual test is “Check not done” and the result of all other tests is “Passed”.
Not done	No test has been performed for this test group.
Not plugged	The result is displayed if no I/O module is plugged into the slot.

Overall results

Result	Description
Failed	At least one test group was outside the specifications.
Not used	The result is used for internal purposes.
Passed	All verified test groups complied with the specifications (result “Passed”). The overall result is also “Passed” if the result for an individual test group is “Check not done” and the result for all other test groups is “Passed”.
Not done	No verification was performed for any of the test groups (result for all test groups is “Check not done”).
Not plugged	The result is displayed if no I/O module is plugged into the slot.

Heartbeat Verification confirms the device function within the specified measuring tolerance on demand. Based on redundant references in the device which are traceable from the factory, Heartbeat Technology meets all the requirements concerning traceable device verification according to DIN ISO 9001: 2015 Chapter 7.1.5.2 a).

Test groups

Test group	Description
Sensor	Electrical components of the sensor (signals, circuits and cables).
Sensor electronics module (ISEM)	Electronics module for activating and converting the sensor signals.
System status	Shows the result of the system condition monitoring.
Gas validation 1 to n (if extended validation)	Shows the overall result for gas validation.

I/O module	Results of the input and output modules installed on the measuring device.

For more information on the test groups and individual tests:

The results for a test group (e.g., sensor) contain the result of several individual tests. All individual tests must be passed for the test group to pass.

The same applies to the overall result: All test groups must pass for the overall result to be passed. Information on individual tests is provided in the verification report.

Limit values

I/O module

Input; Output	Standard verification	Extended verification
Current output 4 to 20 mA, active and passive	▪ ±1 % ▪ ±100 µA (offset)	▪ Lower value 4 mA: ±1 % ▪ Upper value 20 mA: ±0.5 %
Current input 4 to 20 mA, active and passive	▪ –20 %: 24 V –20 % = 19.2 V ▪ In addition: –5 %: 19.2 V -5 %	Only standard verification possible.
Relay output	The number of switching cycles depends on the hardware.	Only standard verification possible.

5.3.11 Verification report

The results of the verification can be documented in the form of a verification report using the Web server. The verification report based on the data records saved in the measuring device after verification. As the verification results are automatically and uniquely identified with a verification ID and the operating time, they are suitable as traceable documentation of the verification.

First page: identification

Measuring point identification, identification of the verification results and confirmation of completion:
- **Plant operator.** Customer reference.
- **Device information:**
  - Information on the place of operation (location and device tag).
- Device specific information including order code, serial number, and firmware version.
- **Validation adjustment:**
  - RATA information on concentration such as a slope (multiplier) and offset adjustments.
- **Verification information:**
  - The operating time and verification ID are used to uniquely assign the verification results for the traceable documentation of the verification.
  - Storage and display of the date and time entry as well as the current operating time in the device.
  - Verification mode: standard verification or extended verification.
- **Overall verification result.** Overall result of the verification passed if all of the individual results are passed.

Report second page: Test Results

This page focuses upon test results for individual the measurement components within the analyzer as well electronics components and pass / fail status of the extended gas validation using validation gases. Report headers and their descriptions are listed below.

- **Sensor (optical head):** Pass / fail testing of spectrometer and measurement cell characteristics.

- **Sensor electronics module (ISEM):** Tests of electrical components and communication between the spectrometer and external electronics within the analyzer electronics enclosure. In the case of differential measurement, the separate MAC electronics module is also tested.
- **Gas validation 1/2:** When extended validation is performed, the overall results of either a one point or two point gas validation are listed as pass / fail.

- **System status:** Integrity of the overall measurement device is listed as pass / fail.

- **I/O module:** resulting tests of each input / output module are listed here. If modules are not present then, not supported may be displayed as a result.

Sensor (optical head)

Parameter / Individual test	Description	Result / Limit value
Cell gas pressure	Gas pressure within the sample cell during extended verification.	▪ Pass ▪ Fail
Cell gas temperature	Gas temperature within the sample cell during extended verification.	▪ Pass ▪ Fail
Spectrum integrity	Monitoring of spectrum for clipping or other process related issues during extended validation. Refer to event C902	▪ Pass ▪ Fail
Pressure sensor	Check of connection and communication with pressure sensor with related event F105	▪ Pass ▪ Fail
Peak track mid-point	Monitoring of the peak mid-point determined during factory calibration compared to value during extended verification.	▪ Pass ▪ Fail
Detector reference level	Monitoring of DC laser current value for out of range; related to event M108	▪ Pass ▪ Fail
Detector zero level	DC power when laser is turned off; related to event M107	▪ Pass ▪ Fail
Peak 1 index	Check of the absorption peak along the scan	• Pass • Fail
Peak 2 index	Check of a secondary peak position when measuring in 2F spectrum	• Pass • Fail
Optical head electronic temperature	Ambient temperature check of optical head electronics related to event S832 or S833	• Pass • Fail
Laser temperature control	Monitoring of laser temperature sensor setting.	• Pass • Fail

ISensor electronics module (ISEM)

Parameter/ individual test	**Description**	**Result/limit value**
Laser drive	Monitoring the analyzer for laser related events such as F101, M500, C500.	▪ Pass ▪ Fail
Telemetry data integrity	Monitoring the analyzer for events such as F106.	▪ Pass ▪ Fail
FPGA communication	Monitoring the analyzer for FPGA communications related event such as F300.	▪ Pass ▪ Fail
Calibration integrity	Monitoring the analyzer for events such as F82.	▪ Pass ▪ Fail
MAC electronics module	Monitoring of the measurement accessories controller (MAC) for events such as F304	▪ Pass ▪ Fail

Gas validation 1 / 2

Parameter / Individual test	**Description**	**Result / Limit value**
Gas validation 1 / 2	Final results of either one or two point gas validation when extended validation is performed	▪ Pass ▪ Fail

System status

Parameter/ individual test	**Description**	**Result/limit value**	**Interpretation/cause/remedial measures**
System status	System status monitoring	No value range ▪ Passed	Causes System error during verification.

		■ Failed ■ Not done	Corrective action ► Check diagnostic event in the **Event logbook** submenu.

I/O modules

Parameter/ individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Output 1 to n	Check of all the input and output modules installed at the measuring device → 16	No value range ■ Passed ■ Failed ■ Not done *Limit values* →	Causes ■ Output values out of specification. ■ I/O modules defective. Measures ► Check cabling. ► Check connections. ► Check load (current output). ► Replace the I/O module.

Report third page (and subsequent pages): measured values and visualization

This page within the report matches the pass / fail test data described above with the addition of actual numerical test values captured during the verification event. Minimum and maximum parameters within the limit of the measurement device are displayed along with a graphical representation of all values recorded.

Test item with value	Unit	Actual	Min.	Max.	Visualization
Sensor (Optical Head)					
Concentration	ppmv	2.6383	-100.0000	1000.000	
Cell gas pressure	bar	0.9705	0.7000	1.4000	
Cell gas temperature	℃	61.9053	-40.0000	80.0000	
Peak track midpoint delta	mA	0.0000	-5.0000	5.0000	
Detector reference level	mA	0.6994	0.0000	5.0000	
Detector zero level	mA	0.0000	0.0000	3.0000	
Peak 1 index		389.6071	0.0000	511.0000	
Peak 2 index		389.6071	0.0000	511.0000	
Optical head electronics temperature	℃	20.0000	-20.0000	85.0000	
Laser temperature	℃	23.0000			

Figure 11: Example of test item values and visualization of Sensor (Optical head) verification report data captured during extended validation.

Last page: process conditions

Information on the process conditions during the verification include:

To increase the comparability of the results, the process conditions that apply at the time of verification are recorded and documented as process conditions on the last page of the verification report. Information displayed will vary depending upon the type of verification, measurement device, and analyte.

Process conditions	Description
Cell length	Path length from the laser to the detector within the measurement cell.
Analyte type	The analyte of interest the analyzer has been calibrated for.
Select calibration	The calibration stream used for measurement. Refer to the calibration certificate provided with the analyzer.
Measurement statistics duration	Time duration used for the verification.
Concentration average	Average concentration of the analyte as determined during Extended validation.
Concentration standard deviation	Standard deviation of the measured analyte determined during Extended validation.
Cell gas pressure average	Average gas pressure measured in the sample cell during Extended validation.
Cell gas pressure standard deviation	Standard deviation of the gas pressure measured within the sample cell during Extended validation.
Cell gas temperature average	Average gas temperature measured during Extended validation.

Process conditions	Description
Cell gas temperature standard deviation	Standard deviation of the gas temperature measured during Extended validation.

5.3.12 Interpreting and using the verification results

Heartbeat Verification uses the self-monitoring function of the Proline electronics to check the measuring device functionality. During the verification process, the system checks whether the measuring device components comply with the factory specifications. Both the sensor and the electronics modules are included in the tests. **Heartbeat Verification** checks the function of the measuring chain from the sensor to the outputs.
Extended validation includes all internal checks of the measurement device functionality and adds the additional verification using validation gases. If a verification is passed, this confirms that the comparative values checked are within the factory specification and that the measuring device is working correctly.

Heartbeat Verification confirms on demand that the device is functioning within the specified measuring tolerance and the specified total test coverage TTC.

Recommended course of action if the result of a verification is Failed

If the result of a verification is Failed, begin troubleshooting by repeating the verification.

Ensure defined and stable process conditions to rule out process-specific influences as much as possible. When repeating the verification, compare the current process conditions to those of the previous verification to identify deviations.

The process conditions of the previous verification are documented on the last page of the verification report.

Additional remedial measures if the result of a verification is Failed

Take remedial action based on the verification results and the diagnostic information of the measuring device. Narrow down the possible cause of the error by identifying the test group that failed the verification. This information can be reported to local technical support. Detailed information can be found in the *Operating Instructions* → 🖹.

6 Heartbeat Monitoring

With Heartbeat Monitoring, additional measured values are output continuously and monitored in an external condition monitoring system so that changes to the measuring device and in the process can be detected at an early stage. The measured variables can be interpreted in a condition monitoring system. The information obtained in this way helps users to control measurements related to maintenance or process optimization.

6.1 Commissioning

Assign the diagnostic parameters to the outputs for commissioning. After commissioning, the parameters are available at the outputs. For digital communication, they are continuously available.

6.1.1 Description of the monitoring parameters

The following diagnostic parameters can be assigned to the various outputs of the measuring device for continuous transmission to a condition monitoring system.

Parameter	Description	Value range
Detector reference level	Signal from the optical detector	0 to 5 mA
Peak 1 index delta	Difference between target peak 1 value and current peak 1 value	–511.0 to 511.0
Peak 2 index delta	Difference between target peak 2 value and current peak 2 value	–511.0 to 511.0

For information on using the parameters and interpreting the measurement results see *Operation* → 🖹.

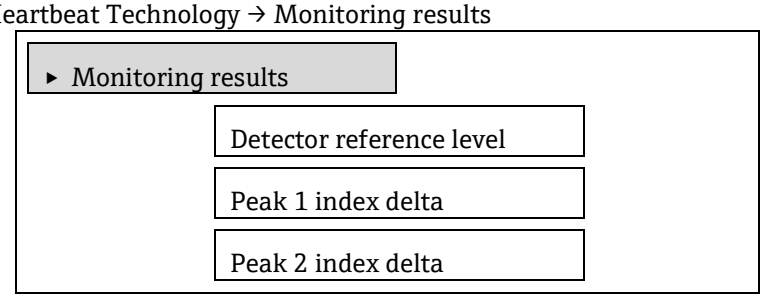
6.1.2 Displaying the monitoring results

The current value of the detector reference level and Peak 1 to n index delta diagnostic parameter is continuously displayed in the Expert menu.

In the case of measuring devices with a local display, the value can also be configured as a display value.

Navigation

Expert → Diagnostics → Heartbeat Technology → Monitoring results



Parameter overview with brief description

Parameter	Description	User interface
Detector reference level	Signal from the optical detector	0 to 5 mA
Peak 1 index delta	Difference between target peak 1 value and current peak 1 value	-511.0 to 511.0
Peak 2 index delta	Difference between target peak 2 value and current peak 2 value	-511.0 to 511.0

6.1.3 Configuration of the outputs and local display

With Heartbeat Verification + Monitoring, the user has additional *monitoring parameters available* → 🖹. The following examples illustrate how a monitoring measured variable is assigned to a current output or is displayed on the local display.

Example: Configuring the current output

Select the monitoring measured variable for current output

1. Ensure the following prerequisite is met:

   Select setup → I/O configuration.

   ↳ Configurable I/O module displays the **I/O module type** parameter with **Current output** option.
2. Select setup → Current output.
3. Select the monitoring **Measured Variable** for the current output in the Assign current output parameter.

Navigation

Setup menu → Current output → Assign current output

Example: Configuring the local display

Select the measured value that is displayed on the local display.
1. Select setup → Display → Value 1 display.
2. Select the measured value.

7 Modbus RS485 register information

7.1 Structure of the register information

The individual parts of a parameter description are described in the following section:

Parameter	Register	Data type	Access type	User interface/ Selection/User entry
Name of parameter	Indicated in decimal numerical format	■ Float length = 4 byte ■ Integer length = 2 byte ■ String length, depending on parameter	Possible type of access to parameter: ■ Read access using function codes 03, 04 or 23 ■ Write access using function codes 06, 16 or 23	Options List of the individual options for the parameter ■ Option 1 ■ Option 2 ■ Option 3 (+) (+) = Factory setting depends on country, order options or device settings **User entry** Specific value or input range for the parameter

NOTICE

If non-volatile device parameters are modified using the MODBUS RS485 function codes 06, 16 or 23, the change is saved in the EEPROM of the measuring device.

The number of writes to the EEPROM is technically restricted to a maximum of 1 million.
► Make sure to comply with this limit since, if it is exceeded, data loss and measuring device failure will result.
► Avoid constantly writing non-volatile device parameters using the MODBUS RS485.

7.2 Address model

The Modbus RS485 register addresses of the measuring device are implemented in accordance with the *Modbus Applications Protocol Specification V1.1*. In addition, systems are used that work with the register address model *Modicon Modbus Protocol Reference Guide* (PI-MBUS-300 Rev. J).

Depending on the function code used, a number is added at the start of the register address with this specification:
- 3 → Read access
- 4 → Write access

Function code	Access type	Register in accordance with Modbus Applications Protocol Specification
03 04 23	Read	XXXX Example: 9455 Concentration Unit
06 16 23	Write	XXXX Example: 2439 Concentration unit

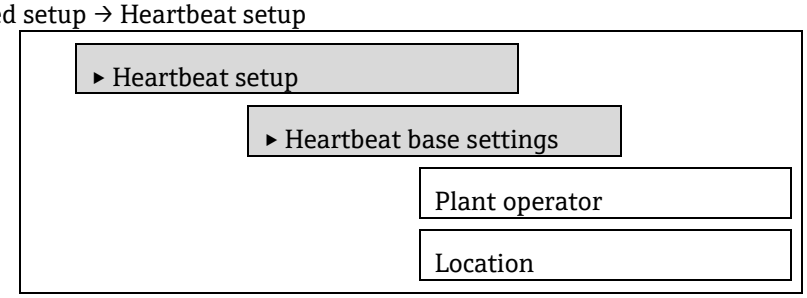
7.3 Overview of the Heartbeat operating menu

The following tables provide an overview of the structure of the Heartbeat Technology operating menu along with the parameters. The page reference indicates where the associated description of the submenu or parameter can be found.

7.3.1 Heartbeat setup submenu

Navigation

Setup menu → Advanced setup → Heartbeat setup



7.3.1.1 Register information

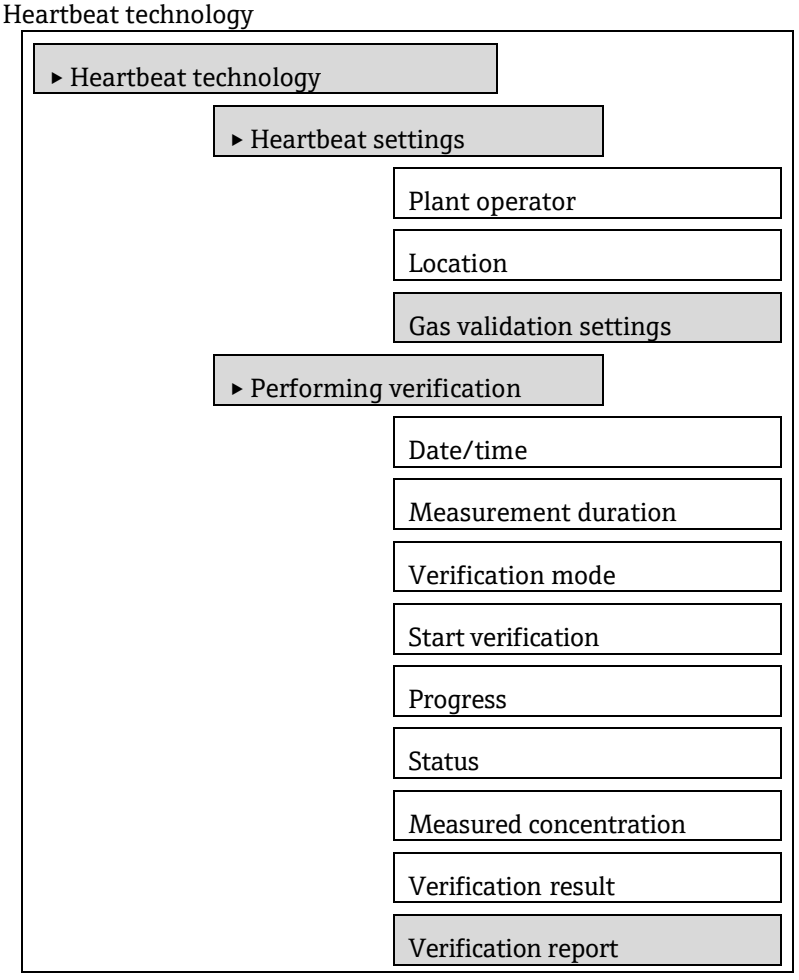
Heartbeat base settings submenu

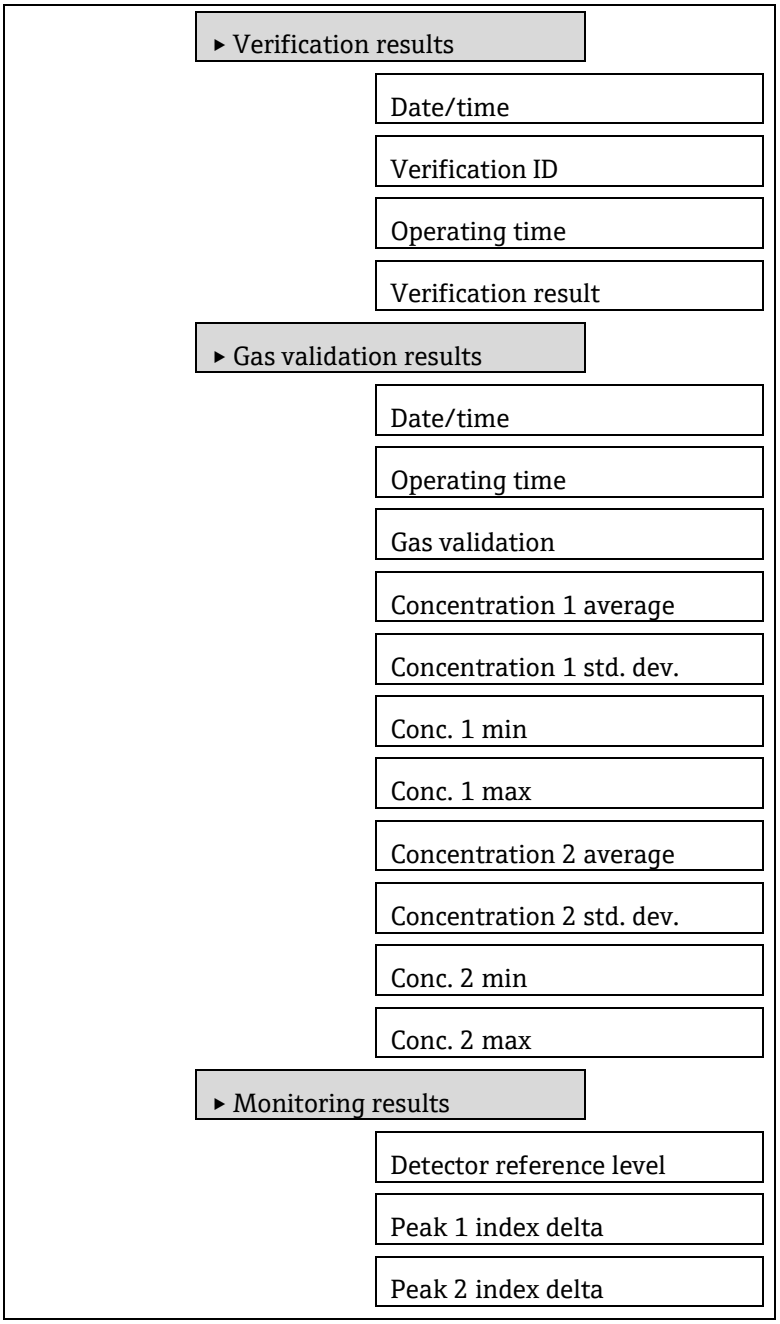
Parameter	Register	Data type	Access	Selection / User entry / User interface
Plant operator	3414 to 3429	String	Read / Write	Max. 32 characters such as letters, numbers or special characters (e.g., @, %, /)
Location	3430 to 3445	String	Read / Write	Max. 32 characters such as letters, numbers or special characters (e.g., @, %, /)

7.3.2 Heartbeat submenu

Navigation

Expert → Diagnostics → Heartbeat technology





7.3.2.1 Register information

Heartbeat settings

Navigation: Heartbeat Technology → Heartbeat settings

Parameter	Register	Data type	Access	Selection / User entry / User interface
Plant operator (2754)	3414 to 3429	String	Read / Write	Max. 32 characters such as letters, numbers or special characters (e.g., @, %, /)
Location (2755)	3430 to 3445	String	Read / Write	Max. 32 characters such as letters, numbers or special characters (e.g., @, %, /)

Gas validation settings

Parameter	Register	Data type	Access	Selection / User entry / User interface
Select validation calibration	4717	Integer	Read / Write	0 = 1 1 = 2 2 = 3 3 = 4
Validation type	26456	Integer	Read / Write	0 = validation manual gas 1 = validation auto gas
Num of validation points	30005	Integer	Read / Write	1:1 2:2
Validation gas purge time	33276 to 33277	Float	Read / Write	0 to 5 minutes
Measurement duration	6476 to 6477	Float	Read / Write	0.25 to 60 minutes
Validation gas information	47238 to 47253	String	Read / Write	Max. 32 characters such as letters, numbers, or special characters (e.g., @, %, /)
Validation 1 concentration target	47226 to 47227	Float	Read / Write	0 to 1000000 ppmv
Validation 1 allowance	47228 to 47229	Float	Read / Write	0 to 100%
Validation 2 concentration target	54316 to 54317	Float	Read / Write	0 to 1000000 ppmv
Validation 2 allowance	54318 to 54319	Float	Read / Write	0 to 100%
Scheduled validation	53763	Integer	Read / Write	0: Off 1: On
Validation interval num. days	53765	Integer	Read / Write	1 to 365
Validation start hour of the day	53764	Integer	Read / Write	0 to 23
Last scheduled validation run	46306 to 46327	String	Read	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C).
Next scheduled validation run	46317 to 46338	String	Read	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the *J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C)*.
Start validation	30015	Integer	Read / Write	0 : Cancel 1 : Start

Performing verification

Navigation: Heartbeat Technology → Performing verification

Parameter	Register	Data type	Access	Selection / User entry / User interface
Date/time	29656 to 29677	String	Read / Write	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C).
Meas. duration	6476 to 7477	Float	Read / Write	0.25 to 60 minutes
Verification mode	2366	Integer	Read / Write	0 = Standard verification 3 = Extended validation 4 = Extended current output
Start verification	2270	Integer	Read / Write	0 = Cancel 1 = Start
Progress	6797	Integer	Read	0 to 100 %

Parameter	Register	Data type	Access	Selection / User entry / User interface
Status	2079	Integer	Read	1 : Done 8 : Busy 0 : Failed 3 : Not done 9 : Validation purging 10 : Switch gas valve 11 : Process purging 12 : Scrubbing
Verification result	2355	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported 254 = Not plugged

Verification results

Navigation: Heartbeat Technology → Verification results

Parameter	Register	Data type	Access	Selection / User entry / User interface
Operating time	3346 to 3359	String	Read	Days (d), hours (h), minutes (m), seconds (s)
Verification ID	2315	Integer	Read	0 to 65 535
Date/time	2372 to 2391	String	Read	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the *J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C)*.
Verification result	2355	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported
Sensor (OH)	2384	Integer	Read	0 = Failed 2 = Passed **3 = Not done** 250 = Not supported
Sensor electronic module (ISEM)	2385	Integer	Read	0 = Failed 2 = Passed **3 = Not done** 250 = Not supported
Gas validation	5199	Integer	Read	0 = Failed 2 = Passed **3 = Not done** 250 = Not supported 254 = Not plugged
I/O module	2386	Integer	Read	0 = Failed 2 = Passed **3 = Not done** 250 = Not supported 254 = Not plugged
System status	5790	Integer	Read	0 = Failed 2 = Passed **3 = Not done** 250 = Not supported
Verification mode	2366	Integer	Read/Write	0= Standard verification 3= Extended validation 4 = Extended current output

Gas validation results submenu

The parameter values are based upon the results of the last extended validation and do not reflect the status of the measurement device. Subsequent extended validations will overwrite these parameters.

Parameter	Register	Data type	Access	Selection / User entry / User interface
Date/time	48598 to 48617	String	Read	This field appears in the system unit format defined in the main menu setup. Refer to the system units in the *J22 and JT33 TDLAS Gas Analyzer Device Parameters (GP01198C)*.
Operating time	48608 to 48614	String	Read	Days (d), hours (h), minutes (m), seconds(s)
Gas validation	44668	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported 254 = Not plugged
Concentration 1 average	48034 to 48035	Float	Read	0 to 1000000 ppmv
Conc. 1 std. dev.	36754 to 36755	Float	Read	0 to 1000000 ppmv
Conc. 1 min	48596 to 48597	Float	Read	0 to 1000000 ppmv
Conc. 1 max	48229 to 48229	Float	Read	0 to 1000000 ppmv
Concentration 2 average	54322 to 54323	Float	Read	0 to 1000000 ppmv
Concentration 2 std. dev.	54324 to 54325	Float	Read	0 to 1000000 ppmv
Conc. 2 min	54314 to 54315	Float	Read	0 to 1000000 ppmv
Conc. 2 max	54312 to 54313	Float	Read	0 to 1000000 ppmv

Monitoring results submenu

Parameter	Register	Data type	Access	Selection / User entry / User interface
Detector reference level	4720 to 4721	Float	Read	0 to 5 mA
Peak 1 index delta	30581 to 30582	Float	Read	-511.0 to 511.0
Peak 2 index delta	30672 to 30672	Float	Read	-511.0 to 511.0

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