

Wallace & Tiernan[®]

an eVOQUA brand

TMS 561 Turbidimeter

BOOK NO. WT.050.610.001.UA.IM.0814

W3T228730

TMS 561 TURBIDIMETER

WT.050.610.001.UA.IM.0814

TMS 561 TURBIDIMETER

EQUIPMENT SERIAL NO. _____

DATE OF START-UP _____

START-UP BY _____

Prompt service available from nationwide authorized service contractors.

ORDERING INFORMATION

In order for us to fill your order immediately and correctly, please order material by description and part number, as shown in this book. Also, please specify the serial number of the equipment on which the parts will be installed.

WARRANTY

Seller warrants for a period of one year after shipment that the equipment or material of its manufacture is free from defects in workmanship and materials. Corrosion or other decomposition by chemical action is specifically excluded as a defect covered hereunder, except this exclusion shall not apply to chlorination equipment. Seller does not warrant (a) damage caused by use of the items for purposes other than those for which they were designed, (b) damage caused by unauthorized attachments or modifications, (c) products subject to any abuse, misuse, negligence or accident, (d) products where parts not made, supplied, or approved by Seller are used and in the sole judgment of the Seller such use affects the products' performance, stability or reliability, and (e) products that have been altered or repaired in a manner in which, in the sole judgment of Seller, affects the products' performance, stability or reliability. **SELLER MAKES NO OTHER WARRANTY OF ANY KIND, AND THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS OF THE MATERIAL OR EQUIPMENT FOR ANY PARTICULAR PURPOSE EVEN IF THAT PURPOSE IS KNOWN TO SELLER.** If Buyer discovers a defect in material or workmanship, it must promptly notify Seller in writing; Seller reserves the right to require the return of such defective parts to Seller, transportation charges prepaid, to verify such defect before this warranty is applicable. In no event shall such notification be received by Seller later than 13 months after the date of shipment. No action for breach of warranty shall be brought more than 15 months after the date of shipment of the equipment or material.

LIMITATION OF BUYER'S REMEDIES. The **EXCLUSIVE REMEDY** for any breach of warranty is the replacement f.o.b. shipping point of the defective part or parts of the material or equipment. Any equipment or material repaired or replaced under warranty shall carry the balance of the original warranty period, or a minimum of three months. Seller shall not be liable for any liquidated, special, incidental or consequential damages, including without limitation, loss of profits, loss of savings or revenue, loss of use of the material or equipment or any associated material or equipment, the cost of substitute material or equipment, claims of third parties, damage to property, or goodwill, whether based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory; provided, however, that such limitation shall not apply to claims for personal injury.

Statements and instructions set forth herein are based upon the best information and practices known to Evoqua Water Technologies, but it should not be assumed that every acceptable safety procedure is contained herein. Of necessity this company cannot guarantee that actions in accordance with such statements and instructions will result in the complete elimination of hazards and it assumes no liability for accidents that may occur.



725 Wooten Road
Colorado Springs, Co 80915

TMS 561 TURBIDIMETER

INTRODUCTION

The Evoqua Water Technologies TMS 561 Turbidimeter allows for the on-line measurement of the turbidity of potable and wastewater as well as process water. The White Light (WL) version of the TMS 561 has been designed to meet the design criteria specified by the US EPA on turbidity measurement. The infrared (IR) TMS 561 units are designed to meet the design criteria specified in ISO 7027 and DIN 27027 for the measurement of the turbidity of a sample. Both models have long life lamps; some models have ultrasonic cleaning.

A pressure regulator on the incoming line is a standard on all TMS 561 Turbidimeters and will reduce pressure up to 1380kPa (200 PSI) down to 104kPa (15 PSI).

The TMS 561 Turbidimeter series instruments have a wide variety of options available. Refer to the table below to determine which factory installed options are available.

Model No. & Description	RS-485	Backlight	Ultrasonic Cleaning	Range NTU	Flow Alarm
TMS 561-BW Turbidimeter WL	Standard	Standard	N/A	0-1000	Option
TMS 561-BR Turbidimeter IR	Standard	Standard	N/A	0-1000	Option
TMS 561-CW Turbidimeter WL	Standard	Standard	Standard	0-100	Option
TMS 561-CR Turbidimeter IR	Standard	Standard	Standard	0-100	Option
TMS 561-DW Turbidimeter WL	Standard	Standard	Standard	0-1000	Option
TMS 561-DR Turbidimeter IR	Standard	Standard	Standard	0-1000	Option

This manual has been produced to enable the user to obtain maximum service from the equipment and comprises installation, operation, and maintenance instructions and spare parts information. Minor changes may be made to the equipment that are not immediately reflected in the manual; if such a change appears to have been made to your equipment, contact Evoqua Water Technologies for information.

Our guarantee is conditional upon the equipment being used in accordance with the instructions herein and it is therefore recommended that these instructions be read and fully understood before the equipment is placed in service.

TMS 561 TURBIDIMETER

WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR DAMAGE TO THE EQUIPMENT, THIS EQUIPMENT SHOULD BE INSTALLED, OPERATED, AND SERVICED ONLY BY TRAINED, QUALIFIED PERSONNEL WHO ARE THOROUGHLY FAMILIAR WITH THE ENTIRE CONTENTS OF THIS INSTRUCTION BOOK.

NOTE: When ordering material, always specify model and serial number of apparatus.

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TMS 561 TURBIDIMETER

DECLARATION OF CONFORMITY

Application of Council Directive

Standard to which Conformity is Declared:

- Product Safety
- Tested and passed CE EN61010-1:1990 + A1:1992 (73/32 EEC)
 - Tested and passed ETL (tested to UL61010B-1), 1st Edition, 1994, Dated January 24, 2003
 - Tested and passed ETLc (tested to CSA C22.2#1010.1-92)

Immunity - Tested and passed EN61326:1997+A1: 1998

Including:

IEC 61000-4-2
IEC 61000-4-3
IEC 61000-4-4
IEC 61000-4-5
IEC 61000-4-6
IEC 61000-4-8
IEC 61000-4-11

Emissions - Tested and passed EN61326:1997+A1: 1998

Including:

CISPR 11 Radiated Emissions Class B
CISPR 11 Conducted Emissions Class B
EN 61000-3-2
EN 61000-3-3

Manufacturer's Name: Evoqua Water Technologies

Manufacturer's Address: 725 Wooten Road, Colorado Springs, CO 80915

Importer's Name:

Importer's Address:

Type of Equipment: Process Turbidimeter

Model No: TMS 561

TMS 561 TURBIDIMETER

VERY IMPORTANT SAFETY PRECAUTIONS

This page provides very important safety information related to safety in installation, operation, and maintenance of this equipment.

WARNING

TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR DAMAGE TO EQUIPMENT THROUGH MISUSE, OBSERVE THE FOLLOWING PRECAUTIONS:

THIS EQUIPMENT SHOULD BE INSTALLED, OPERATED, AND SERVICED ONLY BY TRAINED, QUALIFIED PERSONNEL WHO ARE THOROUGHLY FAMILIAR WITH THE ENTIRE CONTENTS OF THIS INSTRUCTION BOOK.

USE ONLY EVOQUA WATER TECHNOLOGIES LISTED PARTS, EXCEPT FOR COMMERCIALY AVAILABLE PARTS IDENTIFIED BY COMPLETE DESCRIPTION ON PARTS LIST. THE USE OF UNLISTED PARTS CAN RESULT IN EQUIPMENT MALFUNCTIONS, HAVING HAZARDOUS CONSEQUENCES.

DO NOT DISCARD THIS BOOK UPON COMPLETION OF INSTALLATION. INFORMATION PROVIDED IS ESSENTIAL TO PROPER AND SAFE OPERATION AND MAINTENANCE.

ADDITIONAL OR REPLACEMENT COPIES OF THIS INSTRUCTION BOOK ARE AVAILABLE FROM:

Evoqua Water Technologies
725 Wooten Road
Colorado Springs, CO 80915
Phone: (800) 524-6324

NOTE

Minor part number changes may be incorporated into Evoqua Water Technologies products from time to time that are not immediately reflected in the instruction book. If such a change apparently has been made in your equipment and does not appear to be reflected in your instruction book, contact your local Evoqua Water Technologies sales office for information.

Please include the equipment serial number in all correspondence. It is essential for effective communication and proper equipment identification.

TMS 561 TURBIDIMETER

REGIONAL OFFICES

INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from Evoqua Water Technologies, Colorado Springs, CO contact the office indicated below.

UNITED STATES

725 Wooten Road
Colorado Springs, CO 80915
TEL: (800) 524-6324

CANADA

If the equipment was purchased directly from Evoqua Water Technologies, Canada, contact the nearest office indicated below.

ONTARIO

Evoqua Water Technologies Ltd.
2045 Drew Road
Mississauga, Ontario
L5S 1S4
(905) 944-2800

QUEBEC

Evoqua Technologies des Eaux Itee
505 Levy Street
St. Laurent, Quebec
H4R 2N9
(450) 582-4266



TMS 561 TURBIDIMETER



TMS 561 TURBIDIMETER

SECTION 1 - TECHNICAL DATA

Measurement Range	0 - 1000 NTU (Models BW, BR, DW & DR) 0 - 100 NTU (Models CW & CR)
Accuracy	±2% of reading or ±0.02 NTU below 40 NTU, whichever is greater ±5% of reading above 40 NTU
Resolution	0.0001 NTU (below 10 NTU)
Response Time	Adjustable from 5 seconds to 500 seconds
Display	Multi-Line Liquid Crystal Backlit Display
Alarms	Two Programmable, 120-240VAC 2A Form C Relay
Analog Output	Powered 4-20 mA, 600 Ω drive, galvanically isolated
Communications Port	Bi-directional RS-485
Maximum Water Pressure	Integral pressure regulator is rated 200 psi (1380 kPa). Also refer to Flow Rate.
Flow Rate	100 ml/min. to 1 liter/min. (.026 to .26 Gal/min)
Operating Temperature	34°F to 122°F (1°C to 50°C)
Wetted Materials	Nylon, Borosilicate Glass, Silicon, Polypropylene, Stainless Steel
Sample Temperature Range	34°F to 122°F (1°C to 50°C)
Power Supply	100 - 240 VAC, 47 - 63 Hz, 80VA
Insulation Rating	Double Insulated, Pollution Degree 2, Over-voltage Category II
Environmental Conditions	Not recommended for outdoor use. Altitude up to 6560 feet (2000 meters). Up to 95 % RH (non-condensing)
Enclosure Rating	Designed to meet IP 66 /NEMA 4X
Regulatory Compliance and Certifications	White Light Version compliant to U.S. EPA 180.1 Infrared Version compliant to ISO 7027 CE Approved, ETL listed to UL 61010B-1 ETL Certified to CSA 22.2 No. 1010-1-92
Shipping Weight	2.5 kg (5.5 lbs.)
Warranty	One year from date of shipment



TMS 561 TURBIDIMETER



SECTION 2

SECTION 2 - INSTALLATION

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2.1 Unpacking and Inspection of the Instrument and Accessories

The table below indicates the items included in a standard turbidimeter shipment.

ITEM	PART NO.	QTY.
TMS 561 Turbidimeter	AAC5717 (TMS 561 - BW without Flow Alarm) AAC5735 (TMS 561 - BW with Flow Alarm) AAC5720 (TMS 561 - BR without Flow Alarm) AAC5738 (TMS 561 - BR with Flow Alarm) AAC5723 (TMS 561 - CW without Flow Alarm) AAC5741 (TMS 561 - CW with Flow Alarm) AAC5726 (TMS 561 - CR without Flow Alarm) AAC5744 (TMS 561 - CR with Flow Alarm) AAC5729 (TMS 561 - DW without Flow Alarm) AAC5747 (TMS 561 - DW with Flow Alarm) AAC5732 (TMS 561 - DR without Flow Alarm) AAC5750 (TMS 561 - DR with Flow Alarm)	1
Desiccant Pouch	AAC1544	1
Spare Cuvette (with Models BW & BR)	NOTE: Replacements are available by ordering a 3-pack kit--part no. AAC1613.	1
Ultrasonic Cuvette (with Models CW, CR, DW & DR)	AAC5789	1
Tubing Kit [includes: (1) shut-off clamp, (1) backpressure valve, (2) connecting tubings with fittings for flow-through assembly, (1) drain vent screw (used in pressurized systems)]	AAC5816	1

Remove the instrument from the packing carton. Carefully inspect all items to ensure that no visible damage has occurred during shipment. If the items received do not match the items ordered, please contact Evoqua Water Technologies immediately.

2.2 Display

Figure 2.1 illustrates all the items that can appear on the display. The upper row of the display (1) is used for reporting the turbidity levels and to provide user guidance in the customer setting routine. The lower row of the display (2) is used to communicate error messages and provide user guidance. The display has two icons (3) that are used to indicate the use of access code and offset mode. In addition, mode arrows (4) are used to indicate the current instrument operating mode; **AUTO** (normal operation), **CAL** (calibration) and **CONFIG** (configuration).

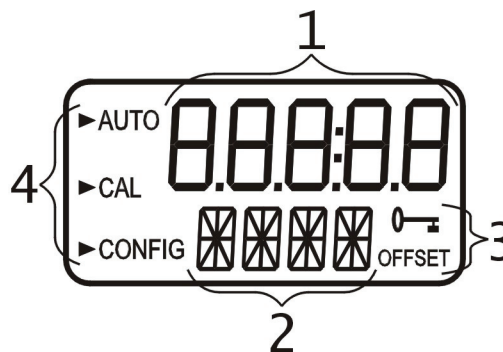


Figure 2.1 - Display Used in the Instrument

All items used on the display are shown in Figure 2.1.

2.3 Touch Pad

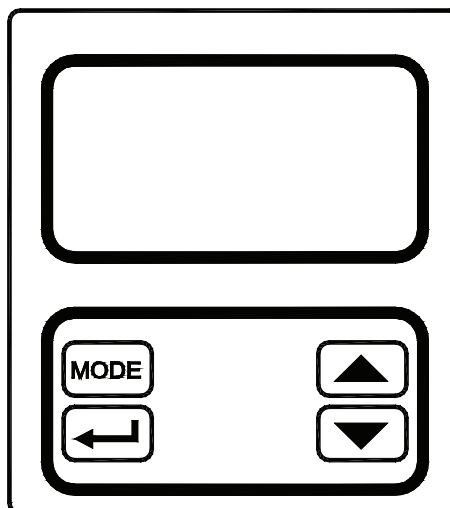


Figure 2.2 - The TMS 561 Turbidimeter Touch Pad

Figure 2.2 illustrates the touch pad. The touch pad has four buttons: **MODE/EXIT**, **↵**, **▲**, and **▼**. The **MODE/EXIT** button is used to cycle between the three operational modes of the instrument: **CAL**, **CONFIG**, and **AUTO** (Measurement) mode. The **↵** button enters the option (or mode that is highlighted or chosen). The **▲** and **▼** buttons are used to change settings.

2.4 Vapor Purge

The TMS 561 Turbidimeter is equipped with a continuous vapor purge system. A replaceable desiccant pouch in the lower portion of the instrument dries the air. System heat is used to warm the air. A fan inside the instrument continuously circulates heated dry air around the optical well and the flow through cuvette. This feature eliminates the need for a dry purge line.

The TMS 561 Turbidimeter monitors the replaceable desiccant pouch condition continuously. The LCD display will show **DESC** on the lower line in the event that the desiccant pouch needs replacement. Replacement desiccant pouches (AAC1544) are available from Evoqua Water Technologies Refer to paragraph 4.2.2, Replacing or Installing the Desiccant Pouch.

The desiccant can activate an alarm to notify the operator of a saturated desiccant. Refer to paragraph 3.4.7.6, Desiccant Alarm.

2.5 Safety

This manual contains basic instructions that must be followed during the commissioning, operation, care, and maintenance of the instrument. The safety protection provided by this equipment may be impaired if it is commissioned and/or used in a manner not described in this manual. Consequently, all responsible personnel must read this manual prior to working with this instrument.

In certain instances, NOTES, or helpful hints, have been highlighted to give further clarification to the instructions. Refer to each section's List of Contents to easily find specific topics and to learn about unfamiliar terms.

2.6 Installation and Commissioning

Prior to use for the first time, the supplied desiccant pouch will need to be installed. Refer to paragraph 4.2.2, Replacing or Installing the Desiccant Pouch.

2.6.1 Mounting and Site Selection

The instrument is designed for wall mounting. If wall mounting is not practical, the instrument can be mounted on any suitable plumb vertical surface. For ease of service there should be about 20 cm (8") free area above the instrument; this will ensure enough room for calibration and cuvette maintenance. Choose a location that is easily accessible for operation and service and ensure that the front display rests at a reasonable viewing level. The overall mounting dimensions of the instrument are shown in Dwg. 50.610.100.010. The recommended mounting screws are M6 (1/4") for the instrument enclosure and M4 (3/16") for the field terminal box. The TMS 561 Turbidimeter is designed to have the field terminal box cradled under the sensor portion of the instrument. It is recommended that the field terminal box be mounted first, and then the rest of the instrument be mounted on top. See Dwg. 50.610.100.020 at the rear of the book for a mounting template.

It is critical that the instrument be mounted as close as possible to the sampling point to ensure a quick response time (within two to three meters (six to 10 feet) of the sampling point).

2.6.2 Plumbing

The recommended plumbing for the instrument is shown in Dwg. 50.610.120.010. The instrument is designed to require very little head pressure to operate. The flow through cuvette is rated for a flow of 100ml/min. - 1 liter/min. (0.026 - 0.26 Gal/min), and a maximum pressure of 1380 kPa (200 PSI.). The maximum allowable fluid temperature is 50°C (122°F).

The instrument is equipped to be plumbed using 4.75 mm (3/16") ID, 8 mm (5/16") OD flexible tubing. Opaque tubing should be used if the tubing will be exposed to sunlight, to prevent algae growth.

In Dwg. 50.610.120.010, there are two flow clamps shown. The one on the input side is a shutoff clamp used during cuvette maintenance. The other device is a backpressure valve. Backpressure may be required to prevent air from coming out of solution, which may be observed as tiny air bubbles.

The instrument is equipped with an internal foot valve, which opens in case the flow through cuvette ruptures, to prevent damage to the sensor. The stem of the emergency drain can be connected to a 16 mm (5/8") tube (not supplied) to direct the flow of water to a convenient drain in the event of a cuvette breakage. Keep the length of this emergency drain to a minimum.

NOTE: The foot valve system can handle up to 1 liter per minute (0.4 gallon per minute). Flow rates higher than this will cause the instrument to flood in the event of a ruptured cuvette.

2.6.2.1 Drain Vent

The TMS 561 Turbidimeter has been fitted with a drain vent in the "OUT" bulkhead fitting. This fitting allows for atmospheric equalization, thus helping to alleviate bubble formation in the cuvette. See Dwg. 50.610.120.010.

Upon initial flow, minor leakage may occur through the drain vent. This will subside once normal flow is established.

For some high-pressure systems, where the vent hole continuously leaks, a 6-32 seal screw is provided that should be inserted into the vent hole and tightened.

The sensor drain tubing should be routed to a suitable drain. It is not recommended to reintroduce the drain sample to the process stream.

2.6.2.2 Wetted Materials

Evoqua Water Technologies accepts no responsibility for damage caused by the introductions of vapors, fluids or other materials into the instrument process stream which are not compatible with the instrument's wetted materials. A list of the wetted materials can be found in the specifications in Section 1 - Technical Data of this manual.

2.6.3 Electrical Connections

All of the electrical connections to the instrument are made through the field terminal box, which should be located directly under the sensor portion of the instrument. The connections are labeled within the terminal box and are self-descriptive (see Dwg. 50.610.130.010). Please follow all local and government recommendations and methods for installation of electrical connections to and between the instrument and other peripheral devices.

Plugs are inserted into the alarm and 4-20mA/RS-485 cable bulkheads when shipped, to ensure a watertight seal. These plugs should be removed and discarded when cabling to either of these connections.

The power cable bulkhead will accept cable diameters from 5.8mm (.230") up to 10 mm (.395"). All terminals are designed to accept wires in the range of 14-28 AWG. All wires should be stripped to a length of 6 mm (1/4"). A strain relief strap is provided to reduce tension on the power terminals.

It is the user's responsibility to assure that the watertight seal is maintained after the terminal box has been wired for operation. If any of the bulkheads are not tightened properly around a cable or plug, the ratings of the instrument will be jeopardized and there is a possibility of creating a shock hazard.

NOTE: Only qualified electricians should be allowed to perform the installation of the instrument as it involves a line voltage that could endanger life.

2.6.3.1 Power

The instrument is equipped with a 100-240 VAC, 47-63 Hz switching power supply; please verify that the line voltage falls within these specifications. It is recommended that a circuit breaker be placed prior to the power connection to allow for service. While making connections, refer to Dwg. 50.610.130.010.

NOTE: The TMS 561 Turbidimeter is not supplied with a power cord.

2.6.3.2 RS-485 Connection

The RS-485 half-duplex (2-wire) digital interface operates with differential levels that are not susceptible to electrical interferences. This is why cable lengths up to 3000 feet can be implemented. The last device on each bus may require terminating with a 120-ohm resistor to eliminate signal reflection on the line. Do not run RS-485 cables in the same conduit as power.

To prevent damage to the instrument, ensure that power is disconnected prior to making connections. For ease of connecting, remove the plug in terminal block. Connections are labeled beneath this termination.

2.6.3.3 Relays

The Alarm 1 and Alarm 2 relays are mechanical relays rated at 240 VAC 2A. Please note that the relays are labeled NO (Normally Open), NC (Normally Closed) and C (Common). As these alarms are configured fail-safe, the normal condition is with power applied to the TMS 561 Turbidimeter and in a non-alarm condition. Operation of these alarms is covered in paragraph 3.4.4, Configuring the Alarms.

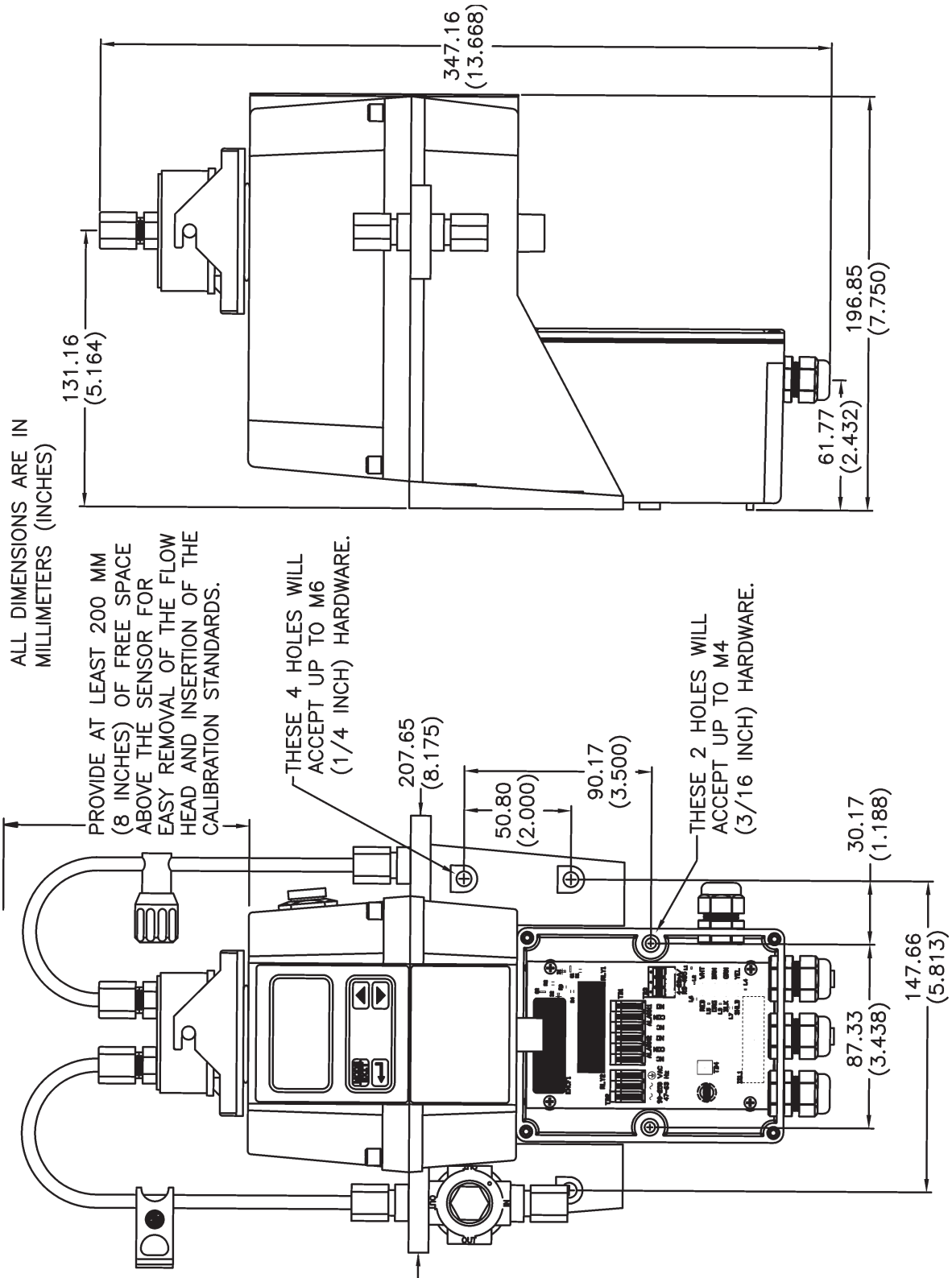
2.6.3.4 4-20 mA

The 4-20 mA output is driven by a 15 VDC power source and can drive recorder loads up to 600 ohms. This 4-20 mA output is isolated from line power and earth ground. Do not run 4-20 mA cables in the same conduit as power. Operation of this output is covered in paragraph 3.4.2, Setting the 4-20 mA.

NOTE: The installation of the 4-20mA isolator will render the RS-485 non-operational.

Ensure each instrument is not powered when connecting the 4-20 mA. To prevent damage to the instrument, ensure that power is disconnected prior to making connections. For ease of connecting, remove the plug in terminal block. Polarity of the connections are labeled beneath this termination.

TMS 561 TURBIDIMETER

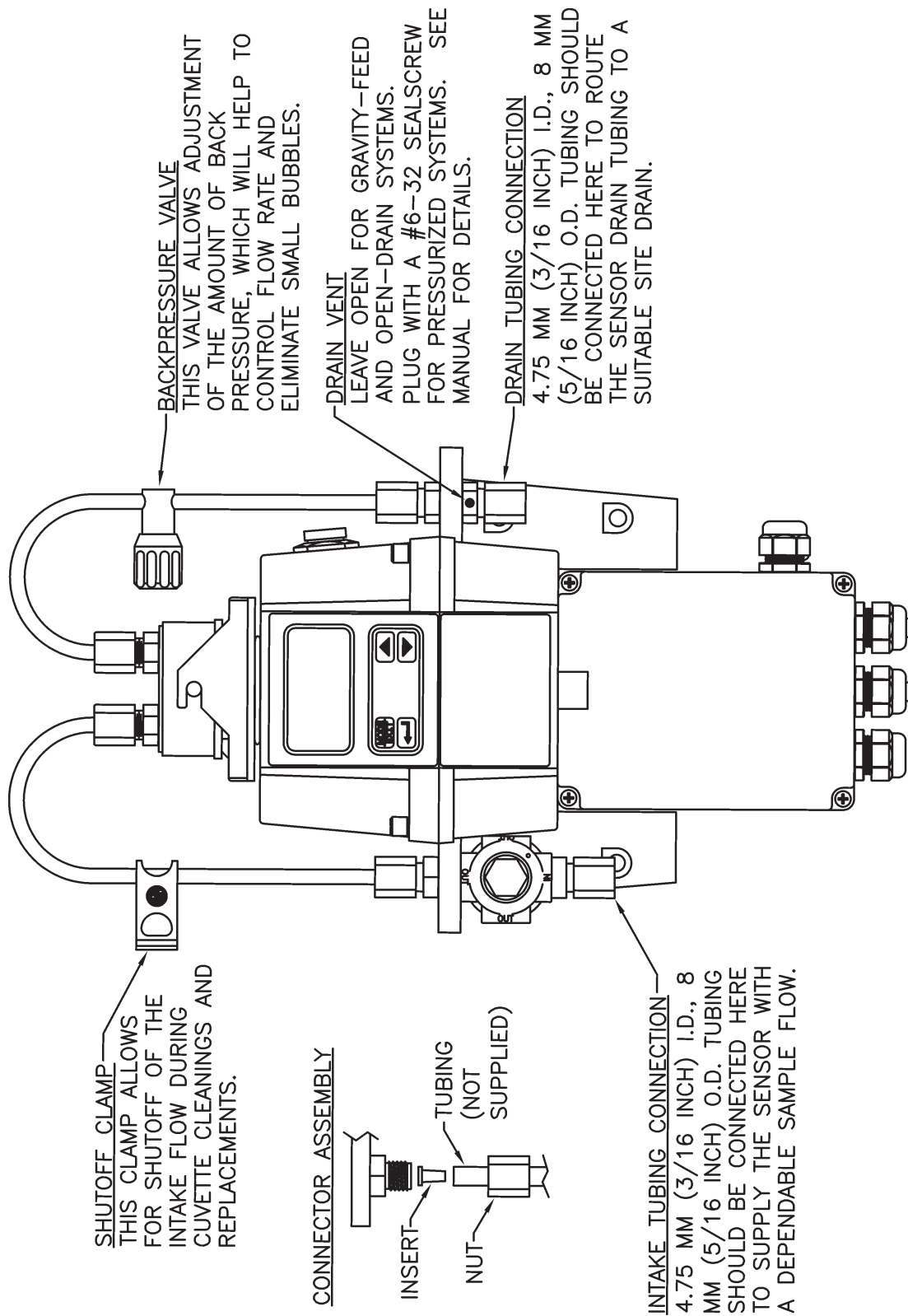


TMS 561 TURBIDIMETER - OVERALL MOUNTING DIMENSIONS

50.610.100.010

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TMS 561 TURBIDIMETER

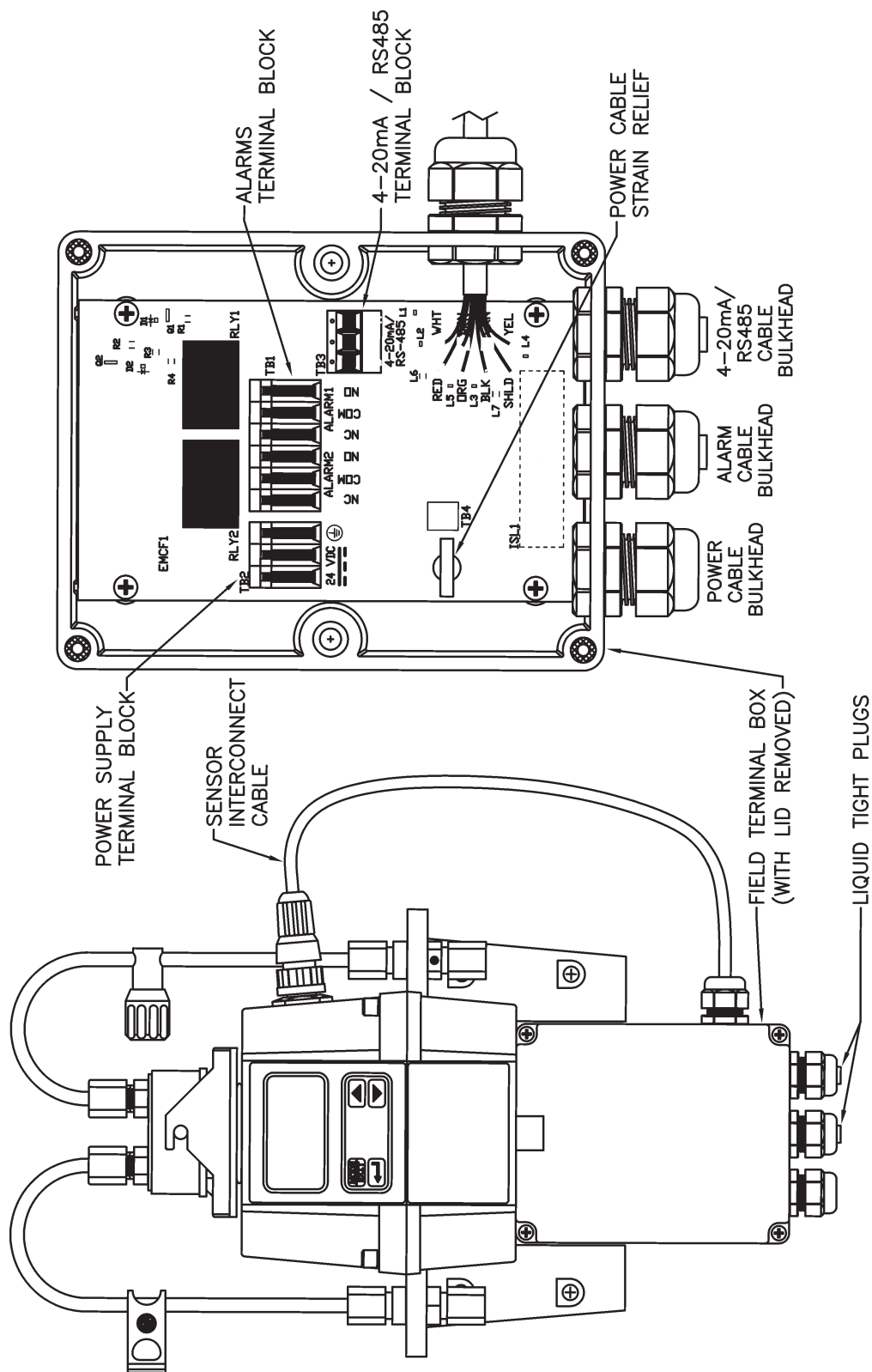


TMS 561 TURBIDIMETER - RECOMMENDED PLUMBING

50.610.120.010

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TMS 561 TURBIDIMETER



TMS 561 TURBIDIMETER - ELECTRICAL CONNECTIONS

50.610.130.010

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SECTION 3

SECTION 3 - OPERATION

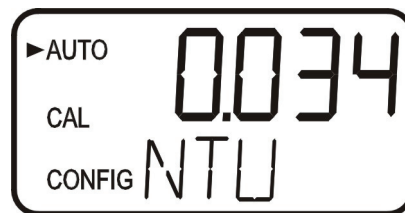
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3.1 Operation

This process turbidimeter allows for the measurement of the turbidity of process water on-line. The turbidity of the process water is usually reported in **Nephelometric Turbidity Units (NTU)**, but may be reported in **Formazin Nephelometric Units (FNU)**. Readings above 1000 NTU (100 for models CW & CR) are outside the range of this instrument. Readings above 1100 NTU (110 for models CW & CR) will cause the display to flash indicating an over range condition.

During normal operation, the instrument will have the arrow beside **AUTO** highlighted with the current scale displayed on the lower row of the display and the measured reading on the upper row of the display (see illustration below).



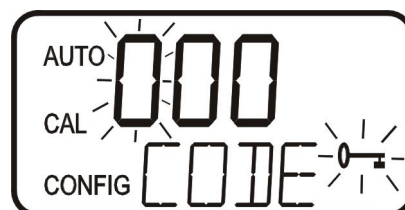
3.1.1 Routine Measurement

The following steps describe how to measure the turbidity of a sample using this instrument:

- Apply power to the instrument and allow the unit to warm up (typically 45 minutes to one hour on initial commissioning).
- When a continuous process stream is flowing through the instrument, the instrument will display the measured turbidity level of the sample by displaying it on the LCD screen. In addition, the equivalent signal is provided on the analog (4-20 mA) output, or the digital output, depending on the options selected.

3.1.2 Security Access Feature

The instrument is equipped with a security access code feature that can be activated in the configuration mode. If the security feature is enabled, the screen shown in the illustration below will appear when the **MODE/EXIT** button is pressed.



The security code (333) must be entered to gain access to **CAL** or **CONFIG** menus. Notice that the first number in the code is flashing; the flashing indicates that this is the number to be changed. Use the \blacktriangle or \blacktriangledown arrows to select the first of the three numbers in the code and then press the \blacktriangledown button to accept the first number of the code. Now enter the second number in the code. Proceed as with the first number followed by \blacktriangledown . Then repeat the process for the third number in the access code, and finish with the \blacktriangledown button.

If the valid access code is selected, the instrument will be directed to the calibration mode. If the wrong access code is selected, the instrument will return to the **AUTO** mode. Refer to paragraph 3.4.6, Setting the Security Access, for more information.

3.2 Instrument Calibration

The instrument was calibrated and tested prior to leaving the factory. Therefore, it is possible to use the instrument directly out of the box. Under normal conditions, re-calibration is recommended at least once every three months.*

***NOTE:** The EPA recommends that on-line turbidimeters be calibrated with a primary standard at least once every three months if they are to be used for EPA reporting.

Relay contacts are held at the last valid condition and will not change state while the instrument is in the calibration and/or in the configuration mode. While in the calibration mode, the instrument has a time-out feature that automatically returns the system operation to the **AUTO** mode after a 15-minute period of inactivity.

3.2.1 Calibration Standards

If the TMS 561 Turbidimeter will be used over the entire range of .02 to 1000 NTU a complete calibration as described below will be required. If instrument accuracy is only required below 10 NTU, such as potable water, a calibration may be performed using only a 10 NTU and a 0.02 NTU standard. To calibrate starting at the 10 NTU, Press the \boxtimes button to bypass the 1000 NTU and proceed to paragraph 3.2.2, Calibration Procedures, step a.

It is recommended a full calibration be done once a year, even if the instrument will only be used in the 0.02 to 10 NTU.

It is recommended that the following materials be used during calibration to achieve the full-scale accuracy stated in this manual:

- 0.02 NTU PrimeTime Calibration Standard available from Evoqua Water Technologies.

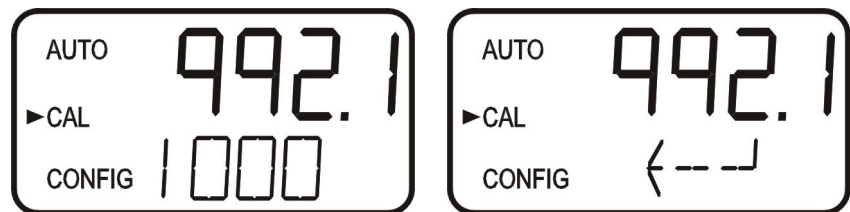
- 10.0 NTU PrimeTime Calibration Standard available from Evoqua Water Technologies.
- 1000 NTU PrimeTime Calibration Standard available from Evoqua Water Technologies.

It is well known that diluted Formazin is unstable. If Formazin is used to calibrate the instrument, ensure that a fresh stock suspension of Formazin is used to achieve the accuracy quoted for the instrument. The PrimeTime primary calibration standards (refer to Section 5 - Accessories and Replacement Parts List) are more stable than Formazin and have a minimum shelf life of 12 months. Prior to recalibration, review the expiration dates, to ensure that the standards have not expired.

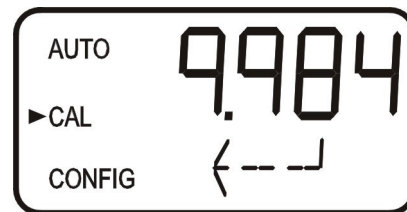
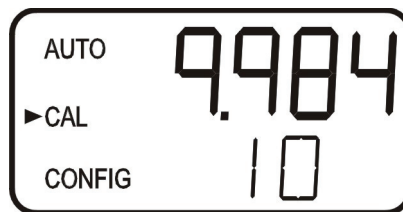
NOTE: The range of Models CW & CR is .02 to 100 NTU. For calibrating these models replace the 1000 NTU standard with a 100 NTU standard.

3.2.2 Calibration Procedures

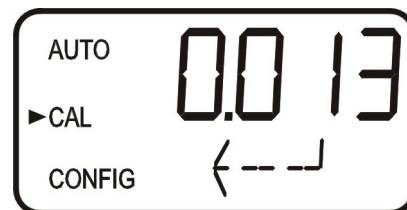
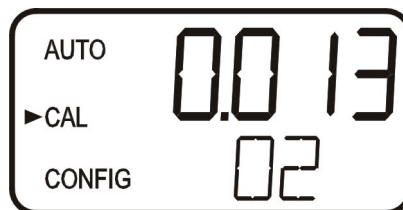
- Select the calibration function of the instrument by pressing the **MODE/EXIT** button once. The arrow beside **CAL** will be illuminated on the display. The lower display shows alternating **1000** (the value of the standard that is requested) and \downarrow . The upper display shows the real-time reading to allow the standard to be indexed. Refer to paragraph 3.3.1, Indexing Calibration Cuvettes.



- Remove the flow through unit.
- Insert the requested 1000 NTU standard. Index the standard to the lowest value on the upper display.
- Press the \downarrow button to accept the calibration.
- The lower display will count down the progress of the calibration step.
- The lower display will now change to show alternating **10** and \downarrow , requesting the 10.0 NTU standard.



- g. If the alternating **10** and ← is not displayed, push the ▲ and ▼ buttons until this display is shown.
- h. Insert the requested 10.0 NTU standard. Index the standard to the lowest value on the upper display.
- i. Press the ← button to accept the calibration.
- j. The lower display will count down the progress of the calibration step.
- k. The lower display will now change to show **02** and ←, requesting the 0.02 NTU standard.



- l. Insert the requested 0.02 NTU standard. Index the standard to the lowest value on the upper display.
- m. Press the ← button to accept the calibration.
- n. The lower display will count down the progress of the calibration step.
- o. The instrument will return to **AUTO** mode at the end of the calibration.

NOTE: When calibrating the 0.02 NTU standard, if the display shows 0.00 prior to pressing the ← button, continue the calibration. After calibration, index the standard again. Repeat the indexing and calibration of the 0.02 NTU standard until the lowest indexed value attainable is 0.01 NTU. Refer to paragraph 3.3.1, Indexing Calibration Cuvettes, for more information.

NOTE: During calibration, the fan inside the instrument is turned off to extend the life of the desiccant. The fan will be turned on during calibration countdowns and after returning to the AUTO mode, or after five minutes, whichever comes first. It is recommended that the measurement chamber be kept covered during the calibration period and that the flow-through cuvette be replaced immediately after the calibration to prevent premature contamination of the desiccant.

3.2.3 Calibration Error

If the screen shown below, is displayed after calibration, the internal diagnostics have determined that the calibration standards were either bad or that they were inserted in the wrong order. Either check the standards and recalibrate or restore the factory calibration (refer to paragraph 3.3.2, Restoring Factory Settings, for more information). The instrument cannot be used without performing one of these operations.



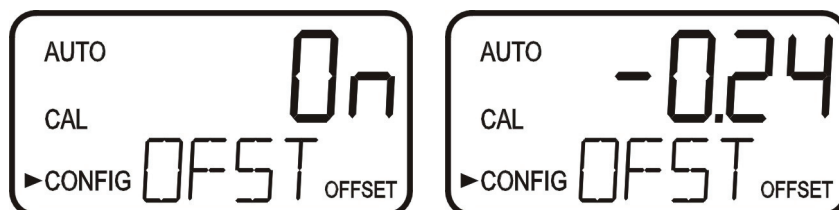
To recalibrate press the MODE key and start the calibration sequence again. To restore the factory calibration, push and hold the \blacktriangle button. Now push and release the \blacktriangledown then the \blacktriangledown button.

3.3 Instrument Offset

In certain instances, an offset factor may be used to calibrate the instrument rather than performing a physical calibration of the instrument (as described in paragraph 3.2.2, Calibration Procedures). This procedure is not recommended in lieu of regular instrument calibration but it can be used in situations where the number of instruments used makes regular calibration prohibitive. This calibration technique will make the instrument accurate only at turbidity levels in the immediate vicinity of the grab sample and not in the full range of the instrument. Note that the **OFFSET** icon will be illuminated whenever an offset is used. The maximum offset is ± 1.00 NTU. If instrument variation is greater than 1 NTU a full calibration is recommended.

- Collect a grab sample of the process water that is being monitored by the instrument and record the turbidity reported by the instrument.
- Take the grab sample and measure its turbidity using a laboratory turbidimeter (contact Evoqua Water Technologies for examples of laboratory turbidimeters).
- Compare the turbidity reported by the instrument to that obtained in the laboratory. If the readings are very close, then no offset adjustment or calibration is required and the procedure may be stopped at this step. However, if the readings are substantially different (but less than 1 NTU), continue on in this procedure to utilize the offset option to improve the turbidity reading of the instrument so that it will agree with the laboratory reading between calibrations.

- d. Select the offset function of the instrument by pressing the **MODE/EXIT** button until the arrow beside **CONFIG** is illuminated on the display. Refer to the following screen.
- e. Push the \downarrow button until **OFST** is displayed on the lower row.
- f. At this point, the lower row of the display will indicate the operational status of the offset function (**ON** or **OFF**). This status may be changed by using the \uparrow and \downarrow buttons. Once the desired operational status of the offset function is set, press the \downarrow button to accept it. If the option is turned off, return to **AUTO** mode by pressing **MODE/EXIT**.



- g. If the option was turned **ON**, the upper row will display the offset required. This will add or subtract the value of the offset to the measured NTU value. As an example, if the TMS 561 Turbidimeter measures the process at 0.16 NTU, but the laboratory instrument read the sample at 0.12 NTU, adding an offset of -0.04 would result in the TMS 561 Turbidimeter displaying 0.12 NTU.

Select the desired offset level using the \uparrow and \downarrow buttons. Once the desired level is set, press the \downarrow button to accept it.

- h. This completes the offset configuration.
- i. At this point, the instrument will continue to the configuration (**CONFIG**) mode of the instrument or press **MODE/EXIT** to return to the **AUTO** mode.

3.3.1 Indexing Calibration Cuvettes

To achieve the greatest accuracy, and account for normal scratches and aberrations in cuvette glass when calibrating, Evoqua Water Technologies recommends indexing the cuvettes.

Standards and standard kits purchased from Evoqua Water Technologies are supplied with indexing rings. Please disregard the instructions that accompany the indexing rings.

The following steps allow repeatable indexing of calibration standards:

- a. With the instrument in **AUTO** mode, insert the standard.

- b. Slowly rotate the standard, inside the optical well, one complete revolution (360°). While rotating the standard slowly, observe the measured turbidity and locate the position of the cuvette having the lowest reading.
- c. With the calibration standard positioned at the location having the lowest turbidity reading, install the Indexing Ring over the cap on the standard so that the pointer of the Indexing Ring faces directly forward.

When using the standards in future, always insert the standard so that the pointer of the indexing ring faces forward. Slowly rotate the standard back and forth about 5° to find the lowest point. The standard is now indexed and ready for use.

3.3.2 Restoring Factory Settings

If the instrument is unable to perform a calibration due to a low lamp output or a calibration using the wrong standards, the instrument will display **CAL** on the lower row of the display and **Err** on the upper row. The operator has two choices to correct this problem. If the operator can determine whether a poor calibration or a low lamp caused the problem, he/she can remedy the problem and recalibrate. If all else fails, the operator may restore the factory calibration and configuration settings by performing the following operation: Push and hold the **▲** button. Now push and release the **↵** then the **▲** button. Factory calibration and factory configuration have now been restored.

NOTE: Restoring the factory settings allows the use of the TMS 561 Turbidimeter with reduced accuracy. The original problem still exists and must be determined and corrected before accurate operation of the TMS 561 Turbidimeter will be resumed.

3.4 Instrument Configuration (CONFIG mode)

The instrument has been designed to be customizable according to individual needs at any time during normal operation. This mode has been split into sub-menus to facilitate instrument configuration. This paragraph describes how to use each of the sub-menus to configure the instrument. While in the configuration mode, the instrument has a time-out feature that automatically returns the system operation to the **AUTO** mode after a 15-minute period.

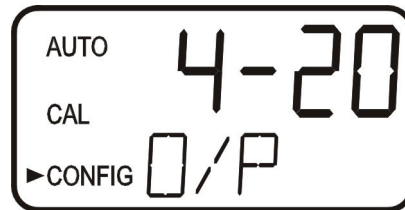
Enter the **CONFIG** mode of the instrument by pressing the **MODE/EXIT** button until the arrow beside **CONFIG** is illuminated, then press the **↵** button.

NOTE: To exit the CONFIG mode, press the **MODE/EXIT** button.

3.4.1 Selecting the Output (O/P)

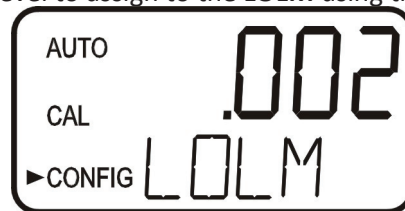
The first configuration selection is the **O/P**. The selections are **4-20** for the 4-20 mA output, **485** for the RS-485, and **OFF** if no outputs are required. Select the desired output by using the \blacktriangle and \blacktriangledown buttons. Once the desired output has been set, press the \blacktriangledown button to accept it. The next prompts will depend on the output selected.

3.4.2 Setting the 4-20 mA



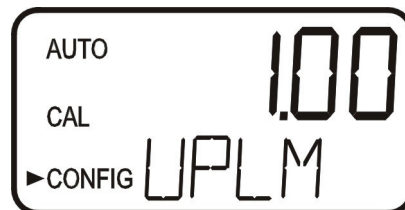
If the 4-20 mA output was turned on, prompts to set the lower (**LOLM**) and upper (**UPLM**) turbidity limits corresponding to the 4 mA and 20 mA output levels will be displayed. The first prompt will be the turbidity limit assigned to the 4 mA output level:

Select the turbidity level to assign to the **LOLM** using the \blacktriangle and \blacktriangledown buttons.



Once the desired level has been set, press the \blacktriangledown button to accept it.

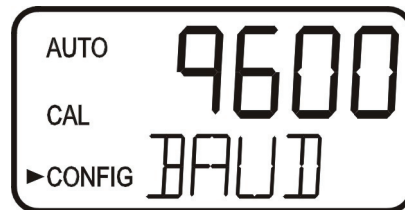
The next, prompt will be the turbidity level assigned to the 20 mA output level (**UPLM** on the lower row of the LCD display). Select the turbidity level to assign to the **UPLM** using the \blacktriangle and \blacktriangledown buttons. Once the desired level has been set, press the \blacktriangledown button to accept it.



3.4.3 Configuring the RS-485 Port

If the I/O selection is changed to **485**, prompts will appear for setting the baud rate and the address.

Select the correct baud rate (1200, 2400, 4800, 9600, or 19200) for operation of the I/O port by pressing the \blacktriangle or \blacktriangledown button to change the displayed baud rate.



Press the \blacktriangledown button to continue on and select the desired instrument address using the \blacktriangle or \blacktriangledown button. Once the selection is satisfactory, press the \blacktriangledown button.



To enable the Modbus or Wallace & Tiernan® RS-485 mode, select **ASCII** or **RTU**, refer to Appendix A for more information.

3.4.4 Configuring the Alarms

Two relays are provided that are designed to operate as two independent programmable alarms. Input three types of information to fully program each alarm:

1. The alarm function (HI, LO, or OFF)
2. The alarm set point (level at which the alarm activates)
3. The delay time for the alarm: the time that the set point must be exceeded prior to alarm activation and the time before restarting the alarm (prevents ringing in the relay)

These items are described below:

- Alarm Function (HI, LO, or OFF): The alarms can either be turned OFF or programmed to operate in one of two different manners:
 - HI alarm: the relay changes state when the measured turbidity level is higher than the programmed alarm level for a prescribed amount of time.

- LO alarm: the relay changes state when the measured turbidity level is lower than the programmed alarm level for a prescribed amount of time.

NOTE: The relays automatically change state when an internal system failure is detected.

- Alarm Set Point: The level at which an alarm activates is called the alarm set point. On the instrument, the alarm set point is designated as “S/P”. The set point is adjustable to any valid turbidity level over the range of the instrument in steps of 0.01 NTU.
- Alarm Delay Time: The alarm delay times are used to prevent ringing of the alarm when the measured turbidity level is close to the set point. The function of the delay times is as follows:
 - Delay On: The turbidity level must exceed the alarm set point continuously for at least this number of seconds before the alarm activates.

If the delay on time is set at five seconds and the process turbidity exceeds the set point continuously for only four seconds, the alarm will not be activated. However, if the process turbidity exceeds the set point continuously for five seconds or more, the instrument will activate the alarm.

- Delay Off: The turbidity level must not exceed the alarm set point continuously for at least this number of seconds prior to deactivation of the alarm.

If the delay off time is set to five seconds and the process has exited out of the alarm condition, the alarm will be reset only if the process is out of the alarm condition for a continuous five seconds. Otherwise, the instrument will still signal an alarm condition.

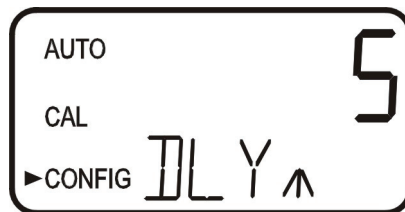
3.4.4.1 Alarm 1

- Alarm 1 Function: The **ALM1** is displayed and the display indicates the current function of Alarm 1 (**HI**, **LO**, or **OFF**). Use the ▲ or ▼ buttons to cycle through and select the desired function. Press the ↵ button to accept the selection.

If the alarm was turned off, a prompt will appear to set up Alarm 2 (refer to paragraph 3.4.4.2, Alarm 2). If one of the other functionalities was selected, a prompt will appear to set the delay times.

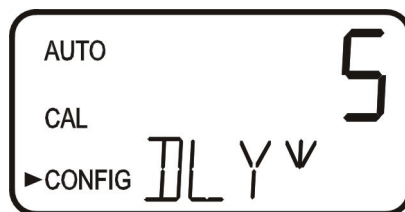
- Alarm 1 Set Point: Select the set point for this alarm; this is indicated by “S/P” shown on the lower row of the display. Select the desired alarm level by using the ▲ and ▼ buttons. Once the desired set point is set, press the ↵ button to accept it.

- Alarm 1 Delay Times:
 - Delay On: The following display will appear to allow for the selection of the number of seconds currently set for the “delay on” time.



The current selected number of seconds will be shown. Select the desired number of seconds for the “delay on” time for this alarm using the ▲ and ▼ buttons. Once the desired delay time is set, press the ↵ button to accept it.

- Delay Off: Next, the following display will appear to allow for the selection of the number of seconds currently set for the “delay off” time.



The current selected number of seconds will be shown. Select the desired delay off time for this alarm using the ▲ and ▼ buttons. Once the desired delay time is set, press the ↵ button to accept it. After the settings for Alarm 1 are completed, set up information on Alarm 2.

3.4.4.2 Alarm 2

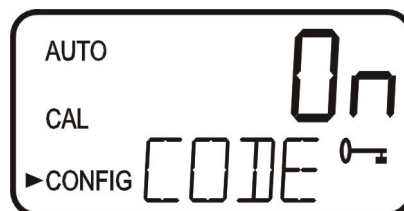
Repeat the procedure listed in paragraph 3.4.4.1, Alarm 1, to set up the parameters for Alarm 2. If the alarm is turned **OFF**, the next selection for the speed of response (**RESP**) is shown. If one of the other functionalities is selected, a prompt to set the delay times and the set point, as with Alarm 1, will be displayed.

3.4.5 Offset Calibration

Refer to paragraph 3.3, Instrument Offset, for more information of this selection.

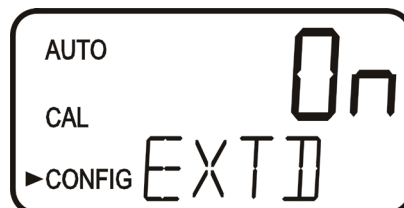
3.4.6 Setting the Security Access

The instrument is equipped with a security access. If this option is turned on, the user is required to input the access code into the instrument to get to any mode other than **AUTO**. The only code is **333**. This code may not be changed. Refer to paragraph 3.1.2, Security Access Feature, for more information. The security key icon will be visible and flashing on the display whenever the access option is selected using the ▲ or ▼ buttons (**ON** or **OFF**).



3.4.7 Extended Settings

The last few settings are grouped together to prevent them from being adjusted by accident. To gain access to the extended settings, select **ON** using the ▲ or ▼ button and press the ↵ button.



3.4.7.1 Speed of Response

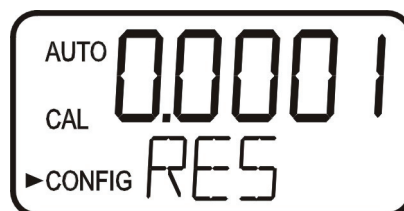
The speed of response for both displayed and output values of NTU can be adjusted in this menu. One hundred speeds are available. Although the displayed number is a relative speed, the approximate response time, in seconds, is the displayed number multiplied by 5. Select the desired speed of response using the ▲ and ▼ buttons. Press the ↵ button to accept it.

To avoid reading air and other anomalies, select the slowest speed (highest number). Select the fastest response where monitoring of rapid changes is needed.



3.4.7.2 Displayed Resolution

The instrument is equipped with the ability to display several levels of resolution. The instrument can display up to four digits to the right of the decimal place for turbidity readings below 10 NTU. If the last digit or two is not stable, adjust the resolution to hide these digits. Upon entering the **CONFIG** mode, the lower row of the display will show **RES** and the upper row of the display will show the number of digits that will be displayed.



Change the resolution by pressing the \blacktriangle or \blacktriangledown button. When the desired digit resolution has been selected, press the \blacktriangledown button.

3.4.7.3 LCD Backlight Brightness

The LCD backlight brightness may need to be adjusted. This may be of particular interest if multiple instruments are located in the same area and it is desired for the entire group to have the same appearance. Ten levels are available.



Change the brightness by pressing the \blacktriangle or \blacktriangledown button. When the desired brightness has been selected, press the \blacktriangledown button.

3.4.7.4 Setting the Units

The most common unit is **NTU** (Nephelometric Turbidity Units) however the instrument can display in **FNU** (Formazin Nephelometric Units). Make a selection using the \blacktriangle and \blacktriangledown buttons. All instruments are shipped from the factory set in NTU mode.



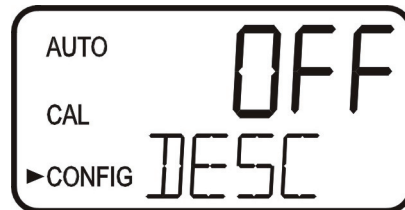
3.4.7.5 Ultrasonic Cleaning (Models CW, CR, DW & DR)

This allows for a selection menu to turn off the ultrasonic cleaning function if desired. The default mode is on. Make a selection using the ▲ and ▼ buttons.



3.4.7.6 Desiccant Alarm

When the humidity detector in the TMS 561 Turbidimeter indicates that the internal environment is close to the point where humidity could cause condensation, the instrument will display **DESC** as a warning. If desired, a desiccant warning can activate the alarms and send the 4-20mA to 2mA. To activate the alarms when the desiccant fails, select **ON** in the **DESC** menu. The default for this menu is **OFF**. Make selections using the ▲ or ▼ buttons then press the ↵ button to return to **AUTO** mode.



3.4.8 Saving Configuration Settings

If extended settings is set to **OFF**, pressing the ↵ button will save all settings and the TMS 561 Turbidimeter will automatically return to the normal **AUTO** mode of the instrument.

If extended settings is set to **ON**, after the last menu of the extended settings, pressing the ↵ button will save all settings and the TMS 561 Turbidimeter will automatically return to the normal **AUTO** mode of the instrument.

The **CONFIG** menu may be used at any time to reset or change any of the parameters. The **CONFIG** menu may be exited at any point in the menu by using the **MODE/EXIT** key. Any features that have been modified will be saved.

3.5 Additional Features and Options

3.5.1 Backlit LCD

The backlit LCD allows for easier readability of the LCD display in low light or no light conditions. The backlight is intended for continuous operation. The brightness is adjustable from a menu in the **CONFIG** mode.

3.5.2 Ultrasonic Cleaning (Models CW, CR, DW & DR)

This factory-installed option is used to continuously clean the flow-through cuvette. It is not intended to clean cuvettes that are already dirty, or replace manual cleaning entirely. The system will increase the time between cleanings dramatically. Please note that the system requires the use of a special cuvette (AAC5789). This cuvette must be used for the system to operate correctly.

The system works by sending an ultrasonic frequency through spring-loaded pins into a piezo transducer bonded to the bottom of a flow through cuvette (see Figure 3.1).

The system can detect that an incorrect cuvette is installed, that an error has occurred in the transducer, or that the transducer is not making contact with the spring connections. This error is indicated by **CLN** being posted to the lower screen. Since this is an error condition, the alarms will be set and the 4-20 mA will be sent to 2 mA.

If the correct cuvette is installed, and the error is still posted, try rotating the flow through unit slightly to improve the connection. If this fails to work, the cuvette may have to be replaced. The detection for this cuvette only operates in **AUTO** mode. If the system is operating correctly, **AUTO** will flash on the display.

NOTE: The cuvette must be completely dry before it is inserted into the sensor. If there is any visible moisture present on the cuvette or transducer, there is a great risk of damaging the sensor electronics and the transducer. Be sure to clean and dry the cuvette completely just before inserting it into the sensor.

After installing a cuvette, there will be a 30-minute period where the lower screen will post **DRY** to the lower screen. During this time, the ultrasonic circuit will not operate to allow the Vapor Purge system to remove all moisture from the ultrasonic transducer. The Vapor Purge system can NOT remove large droplets of water, only residual moisture. The **DRY** message is normal and is not considered an alarm condition; therefore no alarms will be implemented. If the cuvette is removed during this period, no **CLN** alarm is posted until the 30-minute **DRY** period times out.

NOTE: For the Vapor Purge system to function properly, all instrument seals must be maintained and the desiccant pack must be in good condition (no DESC display).

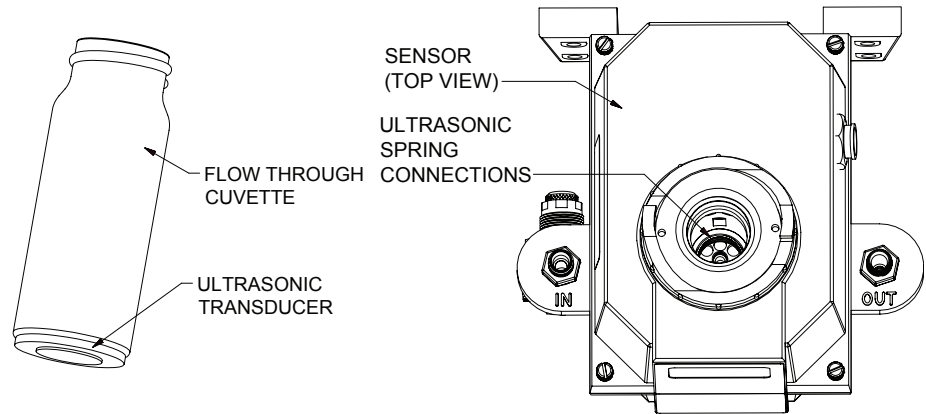


Figure 3.1

3.5.3 RS-485 Outputs

The TMS 561 Turbidimeter has the capability to operate in four different RS-485 modes. Included is a mode for interfacing into the Online SCADA System software package (refer to paragraph 3.5.3.1, Online SCADA System), and a simple communication mode. A third operating mode is the Wallace & Tiernan® RS-485 communications. A fourth operating mode is the Modbus communications. All modes will automatically configure and do not require any changes or selections. Refer to Appendix A for more information.

3.5.3.1 Online SCADA System

The TMS 561 Turbidimeter can operate as a small SCADA system with an optional PC software package, called Online SCADA System. This system allows for an interface with up to 255 TMS 561 Turbidimeter's for the purpose of data logging. This system will interface directly with common database and spreadsheet software.

3.5.3.2 Simple Communication

The TMS 561 Turbidimeter can provide basic communications over simple programs such as the Hilgraeve HyperTerminal that is included with most Microsoft Windows packages. The user could also use Visual Basic or other programs. The communication parameters are 8 bits, no parity and 1 stop bit.

The master computer will send out:

- Byte #1 the attention character ":" in ASCII or 3A Hex
- Byte #2 the address of the TMS 561 Turbidimeter being queried
- Byte #3 & 4 CR LF or 0D 0A in hex

The TMS 561 Turbidimeter will respond with:

- The same attention character “:” in ASCII or 3A Hex
- The address of the TMS 561 Turbidimeter
- The Reading
- The Unit (NTU)

A sample communication would look like this:

(Master computer requesting a report from address #1) : **1 CRLF**

(TMS 561 Turbidimeter set to address #1 Response) : **001 0.0249 NTU**

3.5.3.3 Modbus or Wallace & Tiernan® RS-485 Communication

Modbus or Wallace & Tiernan® RS-485 protocol communication is available on all models. The information is covered in Appendix A.

3.5.4 Flow Controller

The flow controller limits the flow, in high-pressure systems, to safe flow limits of less than 1 liter/minute.

3.5.5 Remote Panel Meter

The remote panel meter allows for remote indication of the NTU reading using the 4-20 mA loop. No external power is required as the meter is run off of the 4-20 mA source.

3.5.6 Flow Switch

The flow switch for the TMS 561 is a factory-installed option. This option indicates a “Low Flow” condition by switching both relays to the fail state and setting the 4-20 mA signal to 2 mA. There is also a screen indication of the low flow condition.

3.5.6.1 Unpacking

The flow switch is rotated 90° at the factory for ease of shipping. It must be mounted perfectly vertical to the ground, as shown in Figure 3.2, when installed to operated correctly. To rotate the switch, it may be necessary to loosen the flow switch nut located inside the field terminal box. Ensure that the nut is tight prior to operation.

TMS 561 TURBIDIMETER

3.5.6.2 Plumbing

Connect the supplied tubing as shown in Figure 3.2. The inset in the figure shows how to assemble the connectors. Please note that intake and drain tubing is not provided.

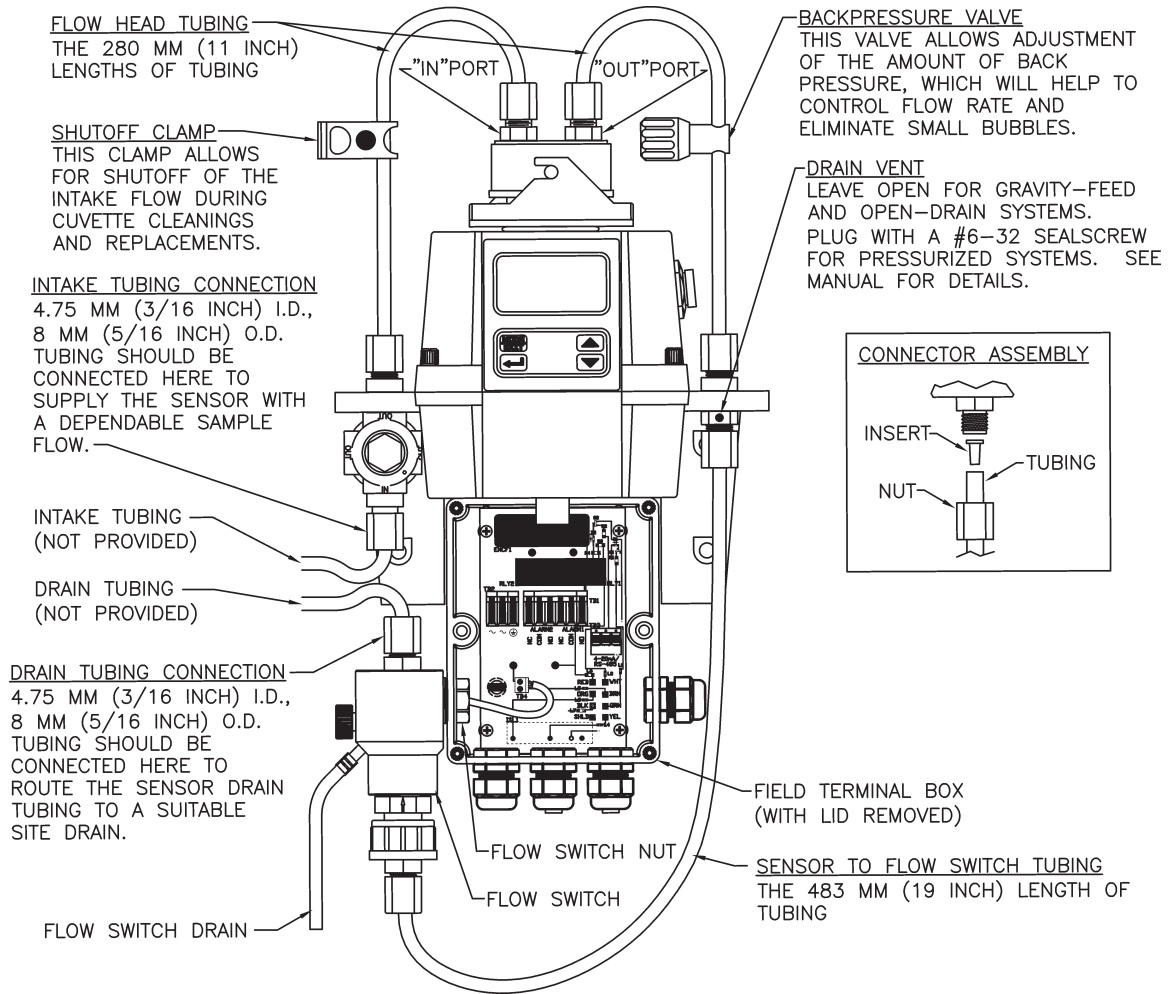
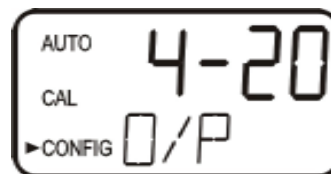


Figure 3.2

3.5.6.3 Configuration

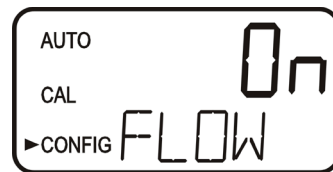
From the **AUTO** mode press the **MODE/EXIT** button twice. The selection arrow should now point to **CONFIG**.



When the flow switch option is added to the instrument, an additional menu is added. This menu will display **FLOW** on the lower row of the display to indicate the selection for the flow switch.



The selections are **ON** or **OFF** which can be selected with the \blacktriangle or \blacktriangledown buttons. To enable the flow option, select **ON**.



Press the \blacktriangle to continue in the **CONFIG** mode or press the **MODE/EXIT** button to exit.

3.5.6.4 Operation

The flow switch must be plumbed as shown in the displayed plumbing diagram to operate correctly. The flow switch will require a minimum flow of 350 milliliters per minute (12 oz/min.) to be considered a normal flow. For a “Low Flow” condition to occur, the flow must fall under the 300 ml/min. for about 2½ minutes continuously. The alarm condition will reset automatically after flow is restored for about 2½ minutes. The alarm condition can also be quickly restored manually by cycling through the modes once (hit **MODE/EXIT** three times).

The TMS 561 will continue to monitor and report readings during a low or no-flow condition, however they may not be valid if new samples of water have not been sent through the instrument’s flow through unit for monitoring.

Under a “Low Flow” condition, both relays will change to alarm state, the 4-20 mA will change to 2 mA and the word **FLOW** will appear on the lower portion of the screen alternately with **NTU** and any other messages.

SECTION 4

SECTION 4 - SERVICE

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Technical and Customer Assistance	4.1.4
Routine Maintenance	4.2
Cleaning the Flow-Through Cuvette	4.2.1
Replacing or Installing the Desiccant Pouch.....	4.2.2
Replacing the Source Lamp	4.2.3

4.1 Troubleshooting and Maintenance

4.1.1 TMS 561 Turbidimeter Fault Detection

The TMS 561 Turbidimeter performs continuous diagnostic monitoring. It has three levels of fault detection: warnings, errors, and failures. Any faults are displayed in a queue form in the bottom row of the LCD.

A warning is simply a screen indication of a problem. No alarms are activated. If the desiccant alarm is turned off and the desiccant becomes saturated, a screen warning of **DESC** will appear.

An error indicates a failure or a problem that can be corrected by the operator. These errors consist of lamp out (**LAMP**), 4-20 mA loop open (**MA**), bad calibration (**CAL**), desiccant replacement required (**DESC**), and, if enabled, no flow (**FLOW**) (if equipped with the flow switch). If the TMS 561 Turbidimeter is equipped with ultrasonic cleaning, an additional message will indicate that the transducer is not making contact or the flow-through has been removed (**CLN**). If any of these conditions occurs, both alarm relays will be activated and the 4-20 mA output will be held at 2 mA. If any of these errors occur, the instrument will still display readings, however, the accuracy is not known and the instrument readings should not be trusted.

A failure is a system fault. This is NOT a problem that the operator can correct, and the unit must be returned to the factory for service. These failures consist of failures in the CPU, A/D, EEPROM, or other devices internal to the instrument (**FAIL**). If a failure occurs, the instrument will not operate. At best it will display the word FAIL on the lower row and both alarm relays will be activated and the 4-20 mA output will be held at 2 mA (if 4-20 mA is selected).

If any fault conditions occur, the message indicating the fault will be shown on the lower row of the display.

4.1.2 System FAIL Message

Normally, this condition indicates that the instrument will require servicing. Contact the Evoqua Water Technologies Technical Services Department.

4.1.3 Diagnostic Chart

FAULT CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Lower display shows MA.	4-20 mA loop open.	Check wiring. Refer to paragraphs 2.6.3.4 and 3.4.5.3.
Lower display shows DESC.	Desiccant pouch bad.	Change desiccant pack. Refer to paragraph 4.2.2.
Lower display shows LAMP.	Lamp failed.	Replace lamp. Refer to paragraph 4.2.3.
Lower display shows FLOW.	Sample flow has stopped.	Restore flow. Contact Evoqua Water Technologies about factory-installed option.
Lower display shows FAIL.	Major system fault.	Refer to paragraphs 4.1.1 and 4.1.2.
Readings are higher than expected.	Bubbles in solution.	Ensure that the drain vent is open and is not obstructed. Refer to paragraph 2.6.2.2. Apply backpressure. Refer to paragraph 2.6.2 and to Dwg. 50.610.120.010. For severe cases of bubbles, a stilling chamber is available. Call Evoqua Water Technologies
	Condensate or leaky cuvette.	Check flow through cuvette for condensate or leaks.
	Flow-through cuvette dirty.	Clean cuvette. Refer to paragraph 4.2.1.
	Instrument out of calibration.	Recalibrate. Refer to paragraph 3.2.
Readings are erratic.	Bubbles in solution.	See above.
	Debris in flow-through.	Clean debris from cuvette.
Readings are lower than expected.	Instrument out of calibration.	Recalibrate. Refer to paragraph 3.2.
Upper display shows O-r.	Sample Over-Range.	Check sample. Must be over 1000 NTU.

4.1.4 Technical and Customer Assistance

If for any reason assistance regarding this instrument is required, please do not hesitate to contact Evoqua Water Technologies

4.2 Routine Maintenance

4.2.1 Cleaning the Flow-Through Cuvette

Measurement cuvettes used for both grab sample and the flow-through should be clean and free of marks or scratches. Cleaning is accomplished by cleaning the interior and exterior with a detergent solution and then rinsing several times with distilled or de-ionized water. The cuvette can be replaced by first shutting off the flow using the provided shut-off clamp, unscrewing the old cuvette, and replacing with a fresh clean one.

4.2.2 Replacing or Installing the Desiccant Pouch

The TMS 561 Turbidimeter continuously checks the condition of the desiccant tray. When the desiccant gets in such a condition that it may cause problems, the instrument will display **DESC** on the lower portion of the display to indicate the presence of humidity (refer to section 3.4.7.6, Desiccant Alarm).

Proper use of the supplied desiccant is essential in maintaining the performance of the instrument. The desiccant has been designed to have a long life; however, replacement of the desiccant pouch will be required from time to time.

It is essential that all enclosure seals be maintained to ensure adequate desiccant life. Inspect the seal each time the desiccant pouch is replaced. Replace any parts found to be defective.

The desiccant should be replaced when the instrument displays **DESC**. New sealed desiccant pouches and indicator cards are available. To initially install or remove the old desiccant, simply unscrew the four corner thumbscrews and remove the electronics half of the instrument. Open the bag protecting the new desiccant pouch and replace (or install for a new instrument) in the instrument base assembly. (See Figure 4.1.)

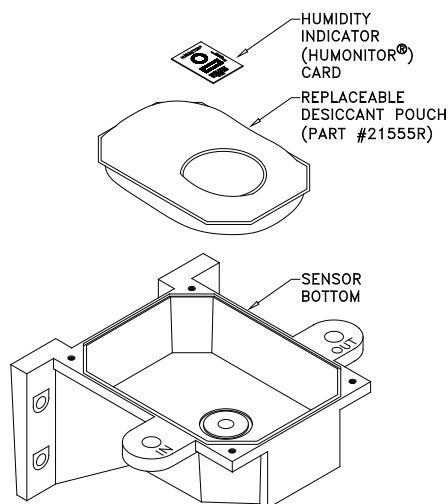


Figure 4.1

NOTE: Once the bag is opened, install the desiccant pouch immediately to prevent premature degradation of the desiccant.

NOTE: Place the desiccant pouch in a sealed plastic bag whenever the instrument head is removed for more than 60 seconds. The pouch will rapidly degrade if not properly stored during instrument maintenance or service.

To speed up the recognition, by the instrument, of the new desiccant, it will be necessary to reset the instrument by disconnecting the sensor interconnect cable for two seconds and then reconnecting it.

4.2.3 Replacing the Source Lamp

The source lamps in the TMS 561 Turbidimeters are designed for long life. The IR lamp is rated for 10 years and the white light version is rated for seven years. If the lamp should need replacement, call Evoqua Water Technologies for assistance.



TMS 561 TURBIDIMETER



SECTION 5

TMS 561 TURBIDIMETER

SECTION 5 - ACCESSORIES AND REPLACEMENT PARTS LIST

The items shown below are recommended accessories and replacement parts.

To order any accessory or replacement part, please contact USF/W&T. If for any reason technical assistance regarding this instrument is required, please do not hesitate to contact the Evoqua Water Technologies Technical Services Department.

Accessory	Catalog Number	
	White Light	Infrared
PrimeTime Calibration Kit, .02, 10 & 100 NTU	AAC1526	AAC1526
PrimeTime Calibration Kit, Full Range, .02, 10 & 1000 NTU	AAC1532	AAC1532
Replacement Desiccant Pouch	AAC1544	AAC1544
Electronic Service Module for Models BW & BR	AAC5792	AAC5795
Electronic Service Module for Models CW & CR	AAC5798	AAC5801
Electronic Service Module for Models DW & DR	AAC5804	AAC5807
Software for data collection and reporting	AAC1505	AAC1505
Flow Regulator	AAC1922	AAC1922
Tubing Kit (containing 1-shutoff clamp, 1-backpressure valve, 2-connecting tubings with fittings for flow through assembly, drainvent)	AAC5816	AAC5816
Flow-Through Assembly	AAC1547	AAC1547
Back Pressure Pinch Valve	AAC1607	AAC1607
Ultrasonic Cuvette (for Models CW, CR, DW & DR)	AAC5789	AAC5789
Cuvette (3 pack) (for Models BW & BR)	AAC1613	AAC1613
Lamp Assembly	AAC5813	AAC5810

SECTION 6

MODBUS AND WALLACE & TIERNAN® RS-485 COMMUNICATION

1 MODBUS

1.1 Overview

The TMS 561 Turbidimeter can be configured for a communication protocol called Modbus. A company called Modicon, for use with their programmable controllers, developed the Modbus protocol. Since that time Modbus has evolved into common communication protocol in industry.

The communication method involves using a master-slave technique, in which there is one master and several slaves. The TMS 561 is a slave device. Only the master can initiate queries. These queries are directed to an individual slave device and the appropriate slave responds with the requested data.

A broadcast message can be sent to all slaves. The slave devices do not answer these broadcasts.

There are two transmission modes. These modes are known as RTU (Remote Terminal Unit) and ASCII (American Standard Code for Information Interchange).

The TMS 561 can be setup in a network of up to 255 slave devices. Each device must have a different address (1-255). The TMS 561 can be set for either RTU or ASCII mode.

1.2 Electrical Connections

All of the electrical connections to the instrument are made through the field terminal box, which should be located directly under the sensor portion of the instrument. The connections are labeled within the terminal box and are self-descriptive (see Figure 1). Please follow all local and government recommendations and methods for installation of electrical connections to and between the instrument and other peripheral devices.

A plug is inserted into the RS-485 cable bulkhead when shipped, to ensure a watertight seal. This plug should be removed and discarded when cabling to this connection.

The bulkhead will accept cable diameters from 5.8mm (.230 in.) up to 10 mm (.395 in.). The terminals are designed to accept wires in the range of 14-28 AWG. All wires should be stripped to a length of 6 mm

It is the user's responsibility to assure that the watertight seal is maintained after the terminal box has been wired for operation. If any of the bulkheads are not tightened properly around a cable or plug, the ratings of the instrument will be jeopardized and there is a possibility of creating a shock hazard.

NOTE: Only qualified electricians should be allowed to perform the installation of the instrument as it involves a line voltage that could endanger life.

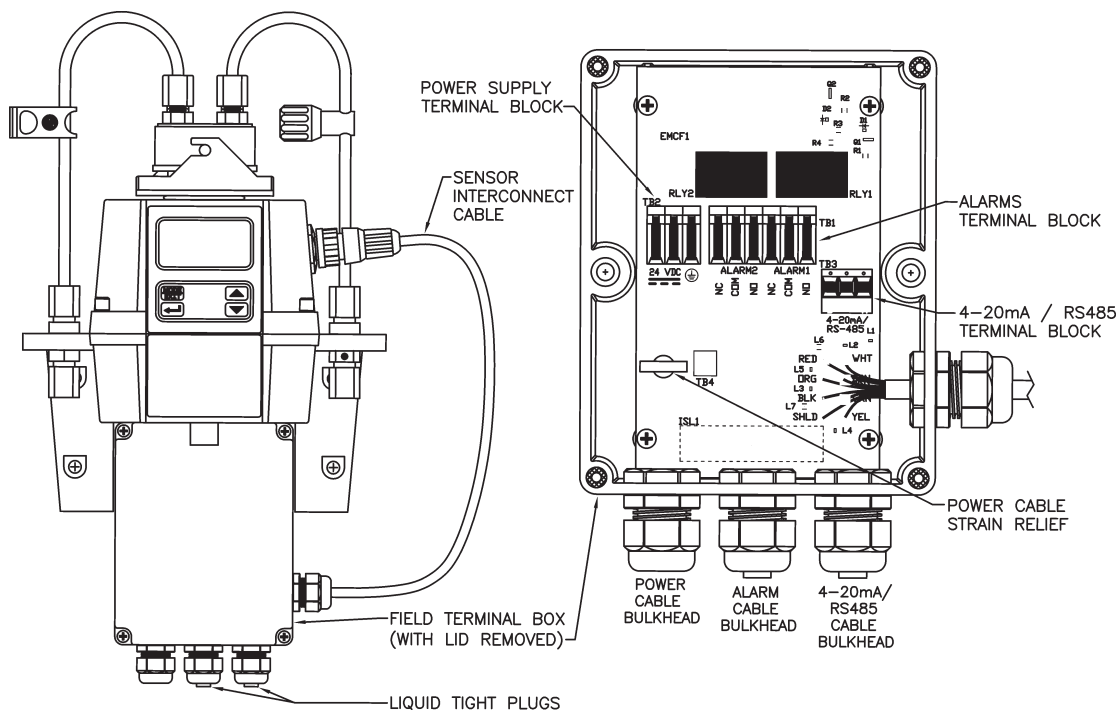


Figure 1.1 - Electrical Connections for the Instrument

1.2.1 RS-485 Connections

The RS-485 half-duplex (2-wire) digital interface operates with differential levels that are not susceptible to electrical interferences. This is why cable lengths up to 3000 ft can be implemented. The last device on every bus may require a 120-ohm termination resistor to eliminate the possibilities of signal reflection on the line. Do not run RS-485 cables in the same conduit as power.

Ensure each instrument is not powered when connecting the RS-485 line. To prevent damage to the instrument, ensure that power is disconnected prior to making connections.

1.3 Operation

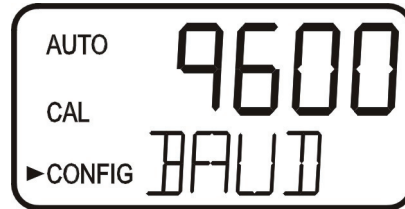
1.3.1 Selecting the Output (O/P)

The first configuration selection is the O/P. The selections are **4-20** for the 4-20 mA output, **485** for the RS-485 and **OFF** if no outputs are required. Select the desired output by using the **▲** and **▼** buttons. Once the desired output has been set, press the **↵** button to accept it. The next prompts will depend on the output selected.

1.3.2 Configuring the RS-485 Port

If the instrument is equipped with this option, and the I/O selection is changed to **485**, prompts will appear for setting the baud rate and the address.

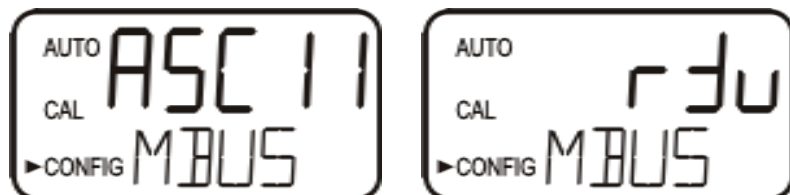
Select the correct baud rate (1200, 2400, 4800, 9600, or 19200) for operation of the I/O port by pressing the \blacktriangle and \blacktriangledown buttons to change the displayed baud rate.



Press the \blacktriangle button to continue on and select the desired instrument address (1-255) using the \blacktriangle and \blacktriangledown buttons. Once the selection is satisfactory, press the \blacktriangle button.

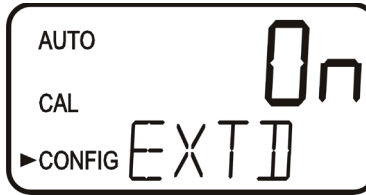


Select the operating mode either ASCII or RTU using the \blacktriangle and \blacktriangledown buttons. Press the **MODE** key to complete the Modbus setup.

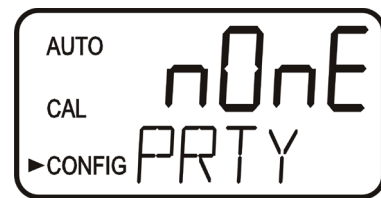
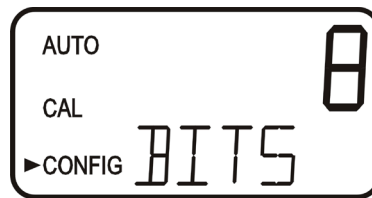


For Modbus some applications, especially involving the ASCII operation mode, it may be necessary to set a different protocol than the default setting (8 bits, 1 stop bit, no parity). Menus are available for this in the Extended Settings portion of the configuration **CONFIG** mode.

While in the **CONFIG** mode, press the \blacktriangle button, several times until the Extended Settings is as shown below. Select **On** using the \blacktriangle and \blacktriangledown buttons.



Press the \downarrow button a few times until the menus appear for **BITS**, **PRTY** (Parity) and **STOP** (Stop Bits). Set each one to the desired setting using the \uparrow and \downarrow buttons.



1.4 The Modbus RS-485 Output & Commands Implemented

The default communication parameters are 8 bits, no parity and 1 stop bit. Please note that all Modbus communication is via RS-485. The instruments can support a two wire multidrop network of 255 units. If the connection is to the master an RS-232 serial port, an RS-485 to RS-232 converter is required.

1.4.1 Coils

These single-bit values are readable and changeable from the master. The data will be returned with the lowest addressed coil in the LSB of the data. Unused bits in the data will be set to 0. True is a 1 and False is 0.

1.4.1.1 Valid Command(s)

Code	Name	Broadcast
0x01	Read Coil Status	No
0x05	Force Single Coil	Yes

1.4.1.2 Format

16-bit word format

MSB															LSB
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

1.4.1.3 Valid Addresses

00001 – 00XXX

1.4.1.4 Definitions

Address	Function	Default
00001	Offset added	False
00002	Flow alarm selected	False
00003	Access code enabled	False
00004	Ultrasonic cleaning enabled (if available)	True

1.4.2 Input Status

These single-bit values are readable from the master. The data will be returned with the lowest addressed input status in the LSB of the data. Unused bits in the data will be set to 0.

1.4.2.1 Valid Command(s)

Code	Name	Broadcast
0x02	Read Input Status	No

1.4.2.2 Format

16-bit word format

MSB															LSB
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

1.4.2.3 Valid Addresses

10001 – 10XXX

1.4.2.4 Definitions

Address	Function
10001	Instrument error
10002	Alarm 1 active
10003	Alarm 2 active
10004	Calibration error

1.4.3 Holding Registers

These 16-bit values are readable and changeable from the master. The data is stored and transmitted with the MSB first and then the LSB.

1.4.3.1 Valid Command(s)

Code	Name	Broadcast
0x03	Read Holding Registers	No
0x06	Preset Single Register	Yes
0x16	Preset Multiple Registers	Yes

1.4.3.2 Format

Float – stored in two consecutive addresses, with the first address containing the least significant word (lower part of mantissa) and the second address containing the most significant word (sign, exponent, and upper part of mantissa).

1.4.3.3 Valid Addresses

40001 – 40XXX

1.4.3.4 Definitions

Address	Type	Register	Value	Default	Function
40001, 40002	Float	Offset value	---	0.0	0.0 - 2.0
40003	Int	Decimal places	0	2	XXXXX.
			1		XXXX.X
			2		XXX.XX
			3		XX.XXX
			4		X.XXXX
40004	Int	Response time	---	10	1-100 seconds
40005	Int	Units (scaling)	1	1	NTU
			2		FNU
40006	Int	LCD backlight	---	8	1 - 10 (brightest)
40007	Int	Not used	---	---	---
40008	Int	Output option	0	0	None
			1		4-20 mA
			2		RS-485 (if available)
40009, 40010	Float	4-20 mA minimum value	---	0.02	0.0 to max range of instrument
40011, 40012	Float	4-20 mA maximum value	---	10.0	0.0 to max range of instrument
40013	Int	RS-485 baud rate	0	3	1200
			1		2400
			2		4800
			3		9600
			4		19200
40014	Int	RS-485 data bits	0	1	7 bits
			1		8 bits
40015	Int	RS-485 parity	0	0	None
			1		Even
			2		Odd
40016	Int	RS-485 stop bits	0	0	1 stop bit
			1		2 stop bits
40017	Int	Instrument address	---	1	1 - 255
40018	Int	Modbus serial mode	0	0	RTU
			1		ASCII
40019	Int	Not used	---	---	---
40020	Int	Alarm 1 function	0	0	Off
			1		Low alarm
			2		High alarm

1.4.3.4 Definitions (Cont'd)

Address	Type	Register	Value	Default	Function
40021, 40022	Float	Alarm 1 set point	---	1.0	0.0 to max range of instrument
40023	Int	Alarm 1 delay on	---	1	1 - 30 seconds
40024	Int	Alarm 1 delay off	---	---	1 - 30 seconds
40025	Int	Not used	---	---	---
40026	Int	Alarm 2 function	0	0	Off
			1		Low alarm
			2		High alarm
40027, 40028	Float	Alarm 2 set point	---	1.0	0.0 to max range of instrument
40029	Int	Alarm 2 delay on	---	1	1 - 30 seconds
40030	Int	Alarm 2 delay off	---	1	1 - 30 seconds
40031, 40032*	Float	Sensor reading	---	---	The meter reading
40033, 40034*	Float	Sensor reading raw	---	---	Sensor reading to six significant places
40035*	Int	Version major	---	---	Software version major number
40036*	Int	Version minor	---	---	Software version minor number
40037*	Int	Version revision	---	---	Software version revision number
40038*	Int	Model number	---	---	Product number
40039*	Int	Model suffix number	---	---	0 if no options
40040*	Int	Reading status	1	---	Good
			2		Over-range
			3		Under-range
			6		Error
40041*	Int	Instrument error summary (bit-mapped)	0x0000	---	Normal
			0x0001		Error (see error register for details)
			0x0002		Alarm 1 active
			0x0004		Alarm 2 active
			0x0008		Calibration error
40042*	Int	Errors (bit-mapped)	0x0000	---	Normal
			0x0001		Replace desiccant
			0x0002		Break in 4-20 mA current loop
			0x0004		Calibration error
			0x0010		Data over-range
			0x0020		Flow switch alarm (if applicable)
			0x0040		Lamp failure
			0x0080		Ultrasonic cleaning problem (if applicable)
			0x0100		General error
			0x0200		General error

***NOTE:** Duplicate of 30XXX addresses (input registers). These values in these registers cannot be changed from the master.

1.4.4 Input Registers

These 16-bit values are readable by the master. The data is stored with the MSB first and then the LSB.

1.4.4.1 Valid Command(s)

Code	Name	Broadcast
0x04	Read Input Registers	No

1.4.4.2 Format

Float – stored in two consecutive addresses, with the first address containing the least significant word (lower part of mantissa) and the second address containing the most significant word (sign, exponent, and upper part of mantissa).

1.4.4.3 Valid Addresses

30001 – 30XXX

1.4.4.4 Definitions

Address	Type	Register	Value	Function
30001, 30002	Float	Sensor reading	---	The meter reading
30003, 30004	Float	Sensor reading raw	---	Sensor reading to six significant places
30005	Int	Version major	---	Software version major number
30006	Int	Version minor	---	Software version minor number
30007	Int	Version revision	---	Software version revision number
30008	Int	Model number	---	Product number
30009	Int	Model suffix number	---	Options (value is option dependant 1-9)
30010	Int	Reading status	1	Normal
			2	Over-range
			3	Under-range
			6	Error
30011	Int	Instrument error summary (bit-mapped)	0x0000	Normal
			0x0001	Error (see error register for details)
			0x0002	Alarm 1 active
			0x0004	Alarm 2 active
			0x0008	Calibration error
30012	Int	Errors (bit-mapped)	0x0000	Normal
			0x0001	Replace desiccant
			0x0002	Break in 4-20 mA current loop
			0x0004	Calibration error
			0x0010	Data over-range
			0x0020	Flow switch alarm (if applicable)
			0x0040	Lamp failure
			0x0080	Ultrasonic cleaning problem (if applicable)
			0x0100	General error
			0x0200	General error
30013	Int	PCB Revision	0	Revision 1
			1	Revision 2

1.4.5 Exception Responses Implemented

Code	Name	Meaning
00	---	No error
01	ILLEGAL FUNCTION	The function code is not allowed in the device.
02	ILLEGAL DATA ADDRESS	The data address is not allowed in the device
03	ILLEGAL DATA VALUE	A value contained in the query field is wrong for the device

2 RS485 - INTERFACE WITH WALLACE & TIERNAN® PROTOCOL

2.1 Selection of the RS485 with Wallace & Tiernan® protocol

To select the Wallace & Tiernan® protocol, set DIP switch number 2 in the ON position. The position is marked in Figure 2.1.

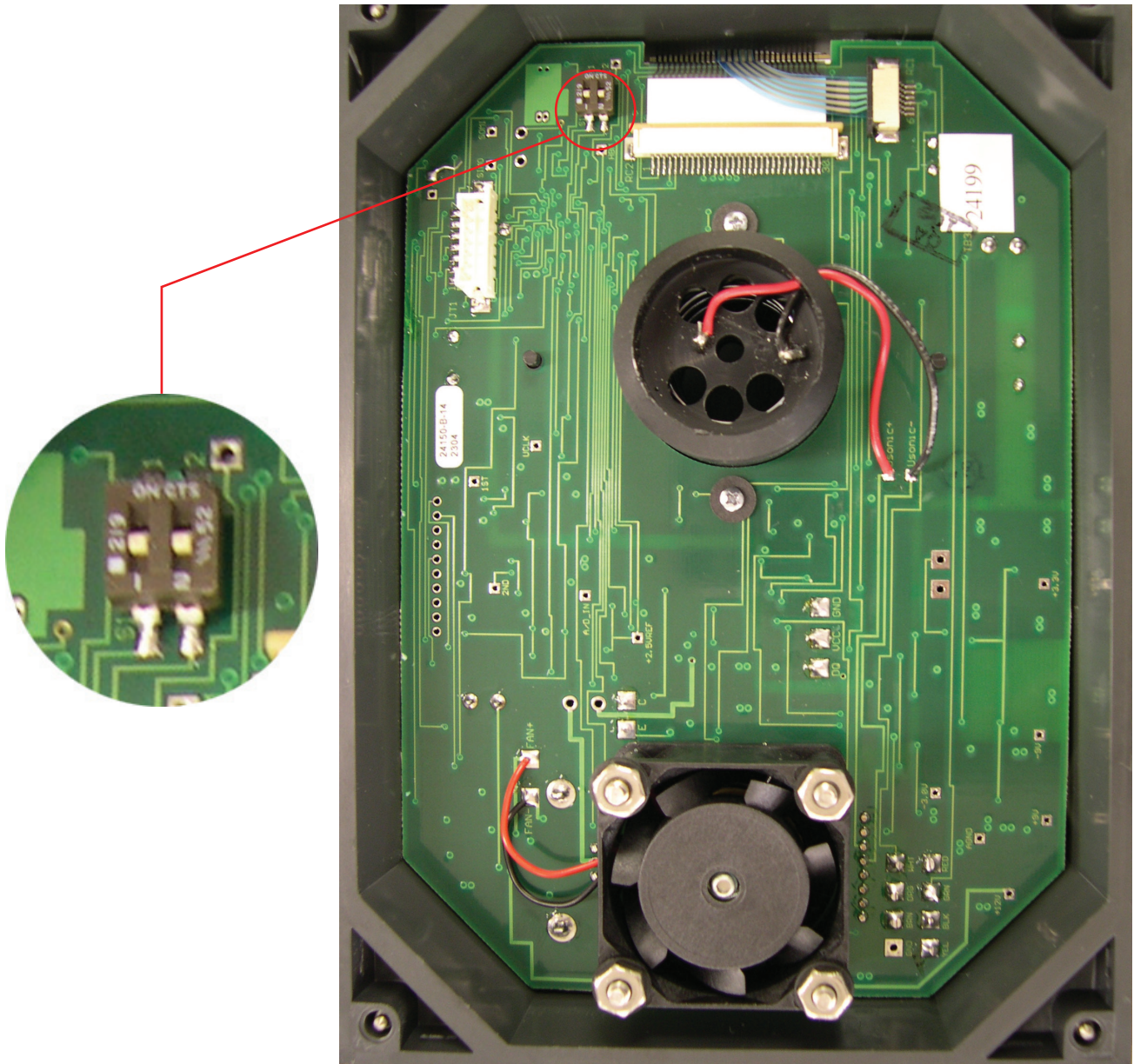


Figure 2.1

2.2 Description of RS 485 Bus Interface

The interface is designed as a symmetrical two-wire bus line to EIA RS485 (DIN 66259 Part 4 bzw. ISO 8482), which enables data transfer at 19.2 KBaud and distances up to 1200 m.

Characteristics:

- Data transfer - bidirectional
- Two-wire connection (half duplex)
- Bus structure (addressable interface, up to 32 devices)

The interface works with differential voltage signals, reducing interference susceptibility.

The bus system consists of a maximum of 32 passive devices and one active controller. Only the active controller (computer system) is entitled to start communication. The TMS is always a passive device.

2.2.1 Cable

A shielded and twisted 2-wire cable (twisted pair) should be used. The shield improves the electromagnetic compatibility. A non-shielded cable can be used if no electromagnetic interference is expected.

The surge impedance of the cable should be between 100 and 130 W, the cable capacitance should be <60pF/m. A suitable selection would be 24AWG shielded 2-wire twisted cable

If using a shielded cable, minimize interference by connecting the shield on both sides with low inductance (large cross sections on short cables) for ground protection.

2.2.2 Interface Connection

The bus cable is always wired as connection from device to device (wired in parallel). The bus lines should be routed directly to the terminals or the plug of the bus device.

Unshielded stubs (e.g., bus devices in switch cabinets) should be avoided. Unshielded stubs longer than one foot are not permissible.

The bus cable for communication has to be connected at terminals A and B in the field terminal box:

- Bus line A (brown): Terminal A
- Bus line B (white): Terminal B

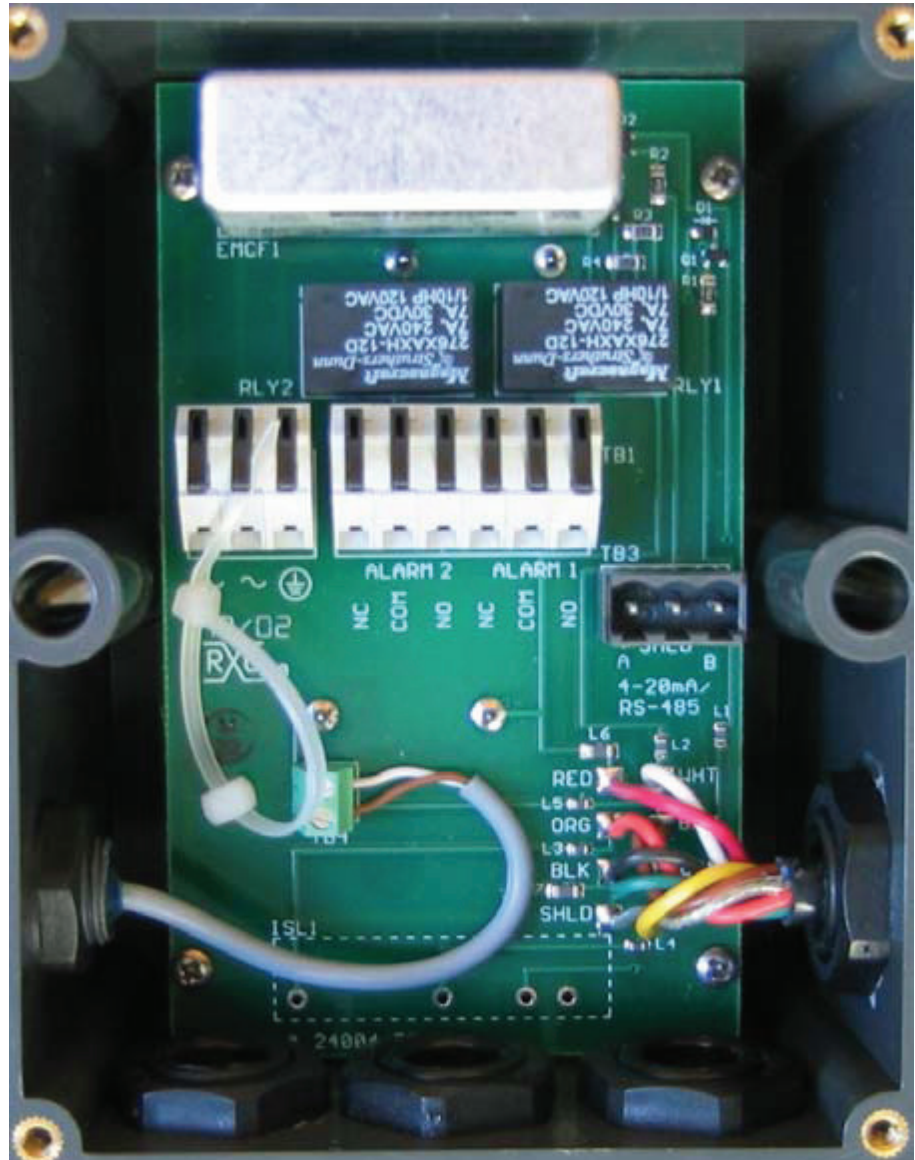


Figure 2.2

NOTE: The RS485 interface of the turbidimeter is galvanically isolated from line power and ground. Each unit occupies one bus address (00-31).

Galvanically isolated RS485 bus system

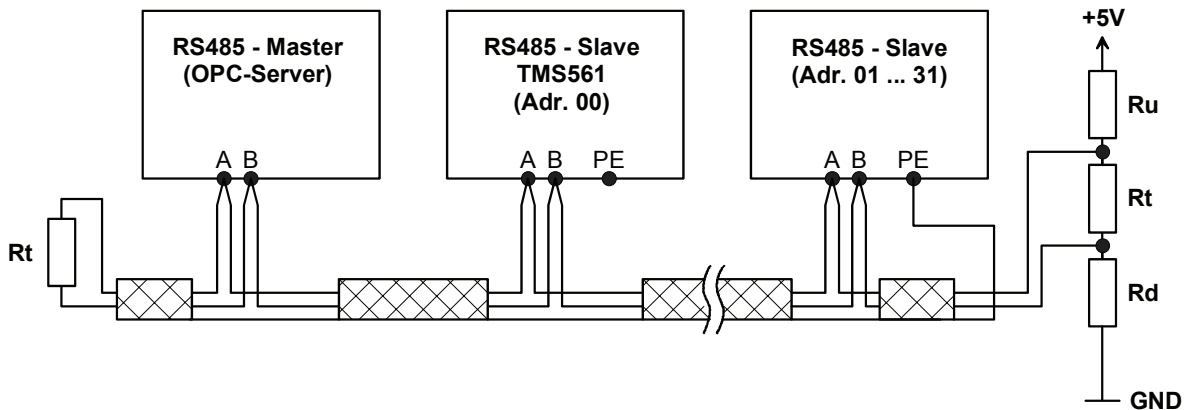


Figure 2.3



CAUTION: As soon as one bus user is not galvanically isolated from line power and ground (like ChemWeb-Server, MFA, PCU, ...), the bus system must be built as a non-galvanically isolated system.

Non-Galvanically isolated RS485 bus system

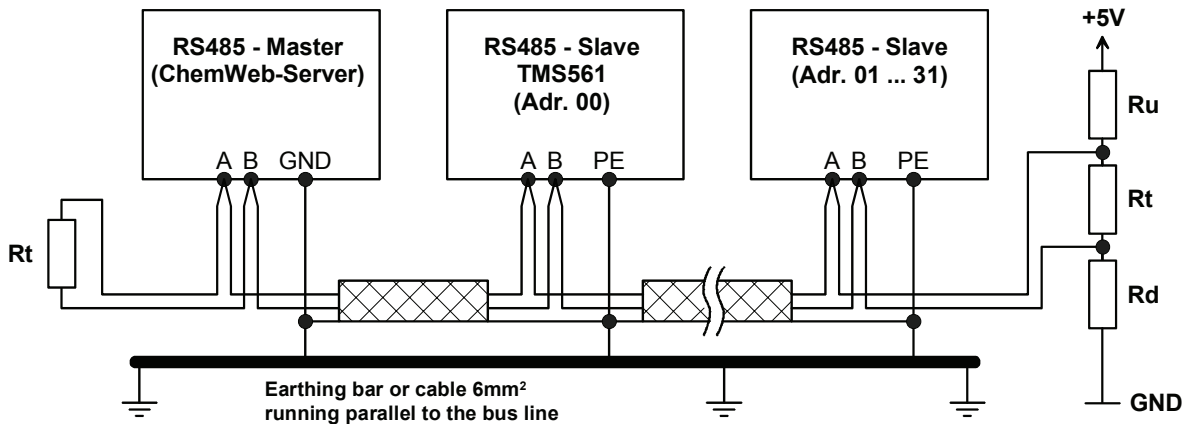


Figure 2.4

NOTE: Both ends of the bus cable must be connected to a dynamic load R_t (150Ω). Symmetry is achieved at only one point on the bus with a 5V power supply. The resistors R_d and R_u (390Ω each) connect to ground and +5V. These values are satisfactory for transmission of up to 19200 Baud and a maximum bus length of 1200 m.

Bus ends should be terminated in the same way at both galvanically isolated and non-isolated bus systems.

2.3 Specification of the Bus Interface

1. Synchronization mode: Asynchronous
2. Transmission rate: 19200 Baud
3. Data format (asynchronous):
 - Start bit: 1 Bit
 - Data bit: 8 Bit
 - Parity bit: even
 - Stop bit: 1 Bit
4. Signal polarity: Differential voltage interface
 Logical '1' = (A-B \geq 0.2V)
 Logical '0' = (A-B \leq -0.2V)
5. Handshake: no handshake required. Request control uses fixed blocks
6. Transmission code: Wallace & Tiernan®-Protocol (master-slave) multipoint
7. Galvanically isolated

2.4 Compatible RS485 Master from Evoqua Water Technologies

2.4.1 Wallace & Teirnan® OPC-Server

OPC (OLE for Process Control) is a Windows-based software standard widely used in the area of process automation. It enables control and data exchange with all components in a system, independent of manufacturer.

The Wallace & Tiernan® OPC Server enables process data from the Wallace & Tiernan® RS485 bus devices to be transmitted to OPC client applications (SCADA systems).

2.4.2 ChemWeb-Server

The ChemWeb Server is a compact, stand-alone, electronic unit, which includes an integrated analog, ISDN, or GSM modem. The ChemWeb-Server allows remote access to process units via a network and/or the internet.

The ChemWeb-Server can be accessed from any computer with internet connection and standard internet browser (IE 6.0 compatible).

2.4.3 PLC interconnection

Wallace & Tiernan® Profibus DP Gateway

The Profibus DP Gateway converts the proprietary RS485 bus with Wallace & Tiernan® protocol to the standard Profibus DP interface.

The Gateway can communicate with a maximum of 24 slaves and can request a maximum of 164 Bytes from each unit.

SECO S7

SECO S7 is a serial adapter used between the RS485 with Wallace & Tiernan® protocol and the PLC “SIMATIC S7-300” from Evoqua.

2.5 Transmission Protocol

For the communication between master (active controller, e.g., ChemWeb-Server) and slave (passive device), two different kinds of frames are used:

- Request - Frame
- Set - Frame

The slave answers to these frames with the following frames:

- Answer frame
- Positive acknowledge
- Negative acknowledge

The bytes of these frames always have the same format:

- 1 Start bit (always ‘0’)
- 8 Data bits
- 1 Parity bit (even)
- 1 Stop bit (always ‘1’)

2.5.1 Description of the Bytes of the Frames

Synchronization bytes (SYN)

The synchronization bytes are used for the synchronization of the device units to the others.

Start byte (SB)

Marks the beginning of a frame. The value depends on the type of frame:

- | | |
|------------------------|-----|
| • Request frame | 10H |
| • Set frame | 68H |
| • Answer frame | 68H |
| • Positive acknowledge | A2H |
| • Negative acknowledge | DCH |

Slave address (SA)

Each device on the RS485 bus requires a unique bus address (slave address). The address can be a number between 0 and 31.

Destination address (ZA)

The destination address determines the transmission variable in the address reference list that is to be read or written.

Check byte (KB)

The check byte determines which information is to be read from the slave. Also, the data format is defined.

Data format of the check byte (Bit 0...3):

Bit	3210	Dec.	Format:
	0000	0	Default (to address reference list)
	0001	1	Default (to address reference list)
	0010	2	Boolean
	0011	3	Boolean
	0100	4	unsigned Character
	0101	5	signed Character
	0110	6	unsigned Integer
	0111	7	signed Integer
	1000	8	unsigned long Integer
	1001	9	signed long Integer
	1010	10	Floating Point
	1011	11	Floating Point
	1100	12	ASCII
	1101	13	ASCII
	1110	14	Mixed data format
	1111	15	Mixed data format

Additional information of the check byte (Bit 4...7)

Bit	7654	Function
	1000	Min. value of the variable
	0100	Max. value of the variable
	0010	Default value of the variable
	0001	additional information of the variable

If no bit is set in bit 5...7, the current value is written or read, or else the corresponding additional information is sent by the slave.

Special case

If the check byte returns a value of 00Hex, data has been received correctly. Other check byte values identify errors in data transmission.

Value:	Function:
01H	End of address table
02H	Wrong data format
04H	Additional information not available
08H	Variable to set not within min and max limits
10H	reading access not permitted
20H	reading access permitted but wrong password
40H	writing access not permitted
80H	writing access permitted but wrong password
C0H	writing access not permitted (e.g. wrong operation mode)

Number byte (AB)

The AB byte defines the number of bytes to read or write.

Frame check (FC)

The check sum of the control bytes of a frame are stored in the frame check.

$$FC = (\text{unsigned char}) SB + SA + ZA + KB + AB$$

Data unit (DU)

The data unit includes the data information to be sent by the slave or by the master.

Data check (DC)

The check sum of the data bytes of a frame is stored in the data check (DC).

$$DC = (\text{unsigned char}) \sum DU$$

End byte (EB)

The end byte marks the end of a frame. Value is always 16 Hex.

2.5.2 Request Frame

The request frame is necessary to read data or additional information from a slave.

Format of the request frame:

Byte:	0-2	3	4	5	6	7	8	9
Name:	SYN	SB	SA	ZA	KB	AB	FC	EB

Byte:	Name:	Function:
0-2	SYN	Synchronization bytes
3	SB	Start byte 10H
4	SA	Slave address
5	ZA	destination address (parameter)
6	KB	check byte
7	AB	number of bytes
8	FC	frame check
9	EB	end byte 16H

With the request frame, single words or values covering multiple addresses can be read. The request frame may also contain additional information.

If the contents of a single destination address are requested, the number byte is set to **00H**. In the answer frame, the data format and the number of bytes are entered from the address reference list to the check byte and the number byte. A data format eventually entered in the request frame is ignored. If a number byte is set in the request frame (request covering more addresses), the data format in the answer frame is set to 04H (unsigned char). The number byte of the answer frame receives the value of the number byte of the request frame. A data format eventually entered in request frame is ignored.

If the additional information of a destination address is requested, the check byte must include the identification for this additional information. The data format and the number byte are ignored. The check byte and the answer byte are set according to the reference list.

Valid request frames are answered with an answer frame. Invalid request frames are answered with “negative acknowledge”.

EXAMPLE: Requesting the content of destination address 02H from Slave 07H:

00H 00H 00H	10H	07H	02H	00H	00H	19H	16H
SYN	SB	SA	ZA	KB	AB	FC	EB

2.5.3 Set Frame

The set frame is used for writing data to a slave.

Format of the set frame:

Byte:	0-2	3	4	5	6	7	8	9-X	Y	Z
Name:	SYN	SB	SA	ZA	KB	AB	FC	DU	DC	EB

Byte:	Name:	Function:
0-2	SYN	Synchronization bytes
3	SB	Start byte 68H
4	SA	Slave address
5	ZA	destination address (parameter)
6	KB	check byte
7	AB	number of bytes
8	FC	frame check
9-X	DU	Data bytes
Y	DC	Data check
Z	EB	end byte 16H

With the set frame, single words or values covering multiple addresses can be written. Set Frames may also contain additional information

If the contents of a single destination address are written, the number byte must correspond to the number byte of the address reference list. The data format must be set to “default” or to the data format from the address reference list.

If more variables are to be set covering more addresses, the data format must be set to “default”. The number byte means the number of bytes to write, only whole variables have to be written.

Valid set frames are answered with a “positive acknowledge”. Invalid set frames are answered with “negative acknowledge”.

EXAMPLE: Setting the content of destination address 02H from Slave 07H to 904(Dec.):

00H 00H 00H	68H	07H	02H	06H	02H	79H	03H 88H	8BH	16H
SYN	SB	SA	ZA	KB	AB	FC	DU	DC	EB

2.5.4 Answer Frame

The answer frame is transmitted by the slave when a request frame is sent by the master.

Format of the answer frame:

Byte:	0-2	3	4	5	6	7	8	9-X	Y	Z
Name:	SYN	SB	SA	ZA	KB	AB	FC	DU	DC	EB

Byte:	Name:	Function:
0-2	SYN	Synchronization bytes
3	SB	Start byte 68H
4	SA	Slave address
5	ZA	destination address
6	KB	check byte
7	AB	number of bytes
8	FC	frame check
9-X	DU	Data bytes
Y	DC	Data check
Z	EB	end byte 16H

If no data format and no number of bytes (AB) are set in the request frame in the check byte, the data format and the number of bytes are entered into the answer frame from the address list.

EXAMPLE: Request frame

00H 00H 00H	10H	07H	02H	00H	00H	19H	16H
SYN	SB	SA	ZA	KB	AB	FC	EB

Answer to the example Request frame:

00H 00H 00H	68H	07H	02H	06H	02H	79H	03H 88H	8BH	16H
SYN	SB	SA	ZA	KB	AB	FC	DU	DC	EB

2.5.5 Positive and Negative Acknowledge

The “positive acknowledge” is transmitted by the slave if a set frame from the master has been executed correctly. A “negative acknowledge” is transmitted by the slave if a set frame or a request frame could not be executed correctly.

Format of the positive/negative acknowledge:

Byte:	0-2	3	4	5	6	7	8	9
Name:	SYN	SB	SA	ZA	KB	AB	FC	EB

Byte:	Name:	Function:
0-2	SYN	Synchronization bytes
3	SB	Positive: Start byte A2H Negative: Start byte DCH
4	SA	Slave address
5	ZA	destination address
6	KB	check byte
7	AB	number of bytes
8	FC	frame check
9	EB	end byte 16H

The check byte value is 00Hex for positive acknowledge and is an error code for negative acknowledge (See table in Special Case page 7 for these values).

EXAMPLE: Positive acknowledge

00H 00H 00H	A2H	07H	02H	00H	00H	ABH	16H
SYN	SB	SA	ZA	KB	AB	FC	EB

Negative acknowledge

00H 00H 00H	DCH	07H	02H	02H	00H	A5H	16H
SYN	SB	SA	ZA	KB	AB	FC	EB

2.6 Address Reference List TMS 561 (1.1.41)

Adr	Description	Used tag name	Code	Format	Length	Range	Unit	Access	Factor	Notes, Codes
0	Manufacturer	Manufacturer		ASCII	12	-	-	r	-	"HFS"
1	Version	Version		ASCII	10	-	-	r	-	"1.1."
2	Password	Password		UINT	2	0...999	-	rw	1.0	Implemented but not used
3	Model	Model		ASCII	10	-	-	r	-	"20063.4"
4	Reading	Reading		FLOAT	4	-	NTU, FNU	r	1.0	NTU reading
5	Units			ASCII	5	-	-	r	-	"NTU", "FNU"
6	Reading full			FLOAT	4	-	NTU, FNU	r	1.0	NTU reading to six significant digits
7	Reading status			UCHAR	1	-	-	r	-	0x00 - Unknown 0x01 - Good 0x02 - Overrange 0x03 - Underrange 0x06 - Error
8	Error status			UINT	2	-	-	r	-	0x0001 - Errors 0x0002 - Alarm 1 active 0x0004 - Alarm 2 active 0x0008 - Calibration error
9	Warning code			UINT	2	-	-	r	-	0x0004 - Alarm 1 active 0x0008 - Alarm 2 active
10	Error code			UINT	2	-	-	r	-	0x0001 - Desiccant 0x0002 - Break in the analog loop 0x0004 - Calibration error 0x0010 - Overrange condition 0x0020 - Flow alarm 0x0040 - Lamp too dim 0x0080 - Cleaning device not working 0x0100 - MSP A/D not working 0x0200 - Humidity sensor problem
11	Error flag			BOOL	1	-	-	r	-	TRUE if an error exists
12	Alarm 1 status	Alarm1Status		BOOL	1	-	-	r	-	TRUE if the alarm is active
13	Alarm 2 status	Alarm2Status		BOOL	1	-	-	r	-	TRUE if the alarm is active
14	Calibration error			BOOL	1	-	-	r	-	TRUE if there is a calibration problem
15	Desiccant error	Desiccant error		BOOL	1	-	-	r	-	TRUE if the desiccant needs replacing
16	Scaling structure - Measurement			UINT	2	-	-	r	-	Current reading, scaled
17	Scaling structure - Minimum			UINT	2	-	-	r	-	Selected min value, scaled
18	Scaling structure - Maximum			UINT	2	-	-	r	-	Selected max value, scaled
19	Scaling structure - Units	UnitString		ASCII	5	-	-	r	-	Current reading units, space-padded, non-zero terminated
20	Scaling divisor			UCHAR	1	-	-	r	-	A divisor for adjusting scaling factors back to their proper values
21	Use offset	OffsetFlag	OFST	UCHAR	1	0x00, 0xFF	-	rw	-	0x00 - Do not use 0xFF - Use this
22	Offset value	OffsetValue	OFST	UINT	2	-1.0...1.0	-	rw	0.01	Value added to turbidity result to offset it
23	Use flow alarm	FlowAlarmFlag		UCHAR	1	0x00, 0xFF	-	rw	-	0x00 - Do not use 0xFF - Use this
24	Use access code	AccessCodeFlag	CODE	UCHAR	1	0x00, 0xFF	-	rw	-	0x00 - Do not use 0xFF - Use this Access code is 333 to get into CONFIG mode
25	Use autocleaning	AutocleanFlag	CLN	UCHAR	1	0x00, 0xFF	-	rw	-	0x00 - Do not use 0xFF - Use this
26	Measurement decimal places	Resolution	RES	UCHAR	1	0 - 4	-	rw	-	0 - XXXXX. 1 - XXX.XX 2 - XX.XXX 3 - X.XXXX 4 - X.XXXX
27	Measurement filter time constant	Response	RESP	UCHAR	1	1 - 100	Sec.	rw	-	IIR filter time constant
28	Units selection	UnitsValue	UNIT	UCHAR	1	0, 1	-	rw	-	0x00 - NTU 0x01 - FNU
29	LCD backlight	LcdBacklight	BRT	UCHAR	1	1 - 10	-	rw	-	1 - off2 - Minimum backlight level 10 - Maximum backlight level
30	Output type			UCHAR	1	0x00 - 0x03	-	rw	-	0x00 - None 0x01 - Analog output 0x02 - Digital output 0x03 - Analog and digital output (special hardware)
31	Analog output minimum	OutputAnalogMin	LOLM	UINT	2	0.02 - 10.00	NTU, FNU	rw	0.01	Measurement level for setting 4 mA
32	Analog output maximum	OutputAnalogMax	UPLM	UINT	2	0.02 - 10.00	NTU, FNU	rw	0.01	Measurement level for setting 20 mA

Notes to the data format: **BOOL** - boolean, **UCHAR** - unsigned char, **SCHAR** - signed char, **UINT** - unsigned integer, **SINT** - signed integer, **ULONG** - unsigned long, **SLONG** - signed long, **FLOAT** - float, **ASCII** - ascii code, **MIX** - mixed data format

Notes to access: r - read, w - write, rw - read/write

Remarks: *1) Modul depend

2.6 Address Reference List TMS 561 (1.1.41) (Cont'd)

Adr	Description	Used tag name	Code	Format	Length	Range	Unit	Access	Factor	Notes, Codes
33	Address		ADDR	UCHAR	1	0 - 31	-	rw	-	Network address
34	Alarm 1 type	Alarm1Type	ALM1	UCHAR	1	0 - 2	-	rw	-	0 - Alarm off 1 - Low alarm 2 - High alarm
35	Alarm 1 level	Alarm1Level	S/P	UINT	2	M. d.*1)	-	rw	0.1	Measurement level that will trigger an alarm
36	Alarm 1 delay on	Alarm1DelayOn	DLY/\	UCHAR	1	1 - 30	-	rw	-	Alarm on hysteresis
37	Alarm 1 delay off	Alarm1DelayOff	DLY/\	UCHAR	1	1 - 30	-	rw	-	Alarm off hysteresis
38	Alarm 2 type	Alarm2Type	ALM2	UCHAR	1	0 - 2	-	rw	-	0 - Alarm off 1 - Low alarm 2 - High alarm
39	Alarm 2 level	Alarm2Level	S/P	UINT	2	M. d.*1)	NTU, FNU	rw	0.1	Measurement level that will trigger an alarm
40	Alarm 2 delay on	Alarm2DelayOn	DLY/\	UCHAR	1	1 - 30	Sec.	rw	-	Alarm on hysteresis
41	Alarm 2 delay off	Alarm2DelayOff	DLY/\	UCHAR	1	1 - 30	Sec.	rw	-	Alarm off hysteresis
42	Desiccant error or warning	HumidityFlag	DESC	BOOL	1	0x00, 0xFF	-	rw	-	0x00 - Use as warning 0xFF - Use as error
43	Use tech mode			BOOL	1	-	-	r	-	TRUE if in tech mode
44	Flow alarm available			BOOL	1	-	-	r	-	TRUE if flow alarm hardware installed
45	Alarm 1 relay	Alarm1Flag		BOOL	1	-	-	r	-	TRUE if the relay is supposed to be on
46	Alarm 2 relay	Alarm2Flag		BOOL	1	-	-	r	-	TRUE if the relay is supposed to be on
47	Reading independent variable			FLOAT	4	-	-	r	1.0	Independent variable with calibration coefficients applied
48	Reading independent variable uncorrected			FLOAT	4	-	-	r	1.0	Independent variable without calibration coefficients applied
49	Sample volts	ReadSplVolts		FLOAT	4	0.0 - 3.0	Volts	r	1.0	Sample voltage read
50	Temperature	ReadingTemperature		FLOAT	4	0 - 50	°C	r	1.0	Internal temperature
51	Range 1 calibrated			BOOL	1	-	-	r	-	TRUE if the range is calibrated
52	Range 1 gain			UCHAR	1	2 - 253	-	r	-	The lower the number, the more gain
53	Range 1 cal reading 1			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The reading for the first calibration point
54	Range 1 cal reading 2			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The reading for the second calibration point
55	Range 1 slope value			FLOAT	4	-	-	r	1.0	The slope calibration coefficient
56	Range 1 offset value			FLOAT	4	-	-	r	1.0	The offset calibration coefficient
57	Range 1 default gain			UCHAR	1	2 - 253	-	r	-	Factory default gain
58	Range 1 default slope			FLOAT	4	-	-	r	1.0	Factory default slope coefficient
59	Range 1 default offset			FLOAT	4	-	-	r	1.0	Factory default offset coefficient
60	Range 1 desired cal reading 1			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The desired reading for the first calibration point
61	Range 1 desired cal reading 2			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The desired reading for the second calibration point
62	Range 2 calibrated			BOOL	1	-	-	r	-	TRUE if the range is calibrated
63	Range 2 gain			UCHAR	1	2 - 253	-	r	-	The lower the number, the more gain
64	Range 2 cal reading 1			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The reading for the first calibration point
65	Range 2 cal reading 2			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The reading for the second calibration point
66	Range 2 slope value			FLOAT	4	-	-	r	1.0	The slope calibration coefficient
67	Range 2 offset value			FLOAT	4	-	-	r	1.0	The offset calibration coefficient
68	Range 2 default gain			UCHAR	1	2 - 253	-	r	-	Factory default gain
69	Range 2 default slope			FLOAT	4	-	-	r	1.0	Factory default slope coefficient
70	Range 2 default offset			FLOAT	4	-	-	r	1.0	Factory default offset coefficient
71	Range 2 desired cal reading 1			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The desired reading for the first calibration point
72	Range 2 desired cal reading 2			FLOAT	4	0.0 - 3.0	Volts	r	1.0	The desired reading for the second calibration point
73	IIR alpha term			FLOAT	4	0.0 - 100.0	%	r	1.0	The alpha term calculated based on the response time selected
74	Gain			UCHAR	1	2 - 253	-	r	-	The signal measurement current gain
75	Range			UCHAR	1	0, 1	-	r	-	0 - Range 1 being used 1 - Range 2 being used
76	Humidity	Humidity		UCHAR	1	0 - 100	%RH	r	-	Relative humidity measurement
77	Humidity error set point	HumidityErrorLevel		UCHAR	1	0 - 100	%RH	rw	-	Declare a desiccant error if above this value. The default value is 30.
78	POST (Power On Self Test)			UCHAR	1	-	-	r	-	Power On Self Test - an 8 is normal

Notes to the data format: **BOOL** - boolean, **UCHAR** - unsigned char, **SCHAR** - signed char, **UINT** - unsigned integer, **SINT** - signed integer, **ULONG** - unsigned long, **SLONG** - signed long, **FLOAT** - float, **ASCII** - ascii code, **MIX** - mixed data format

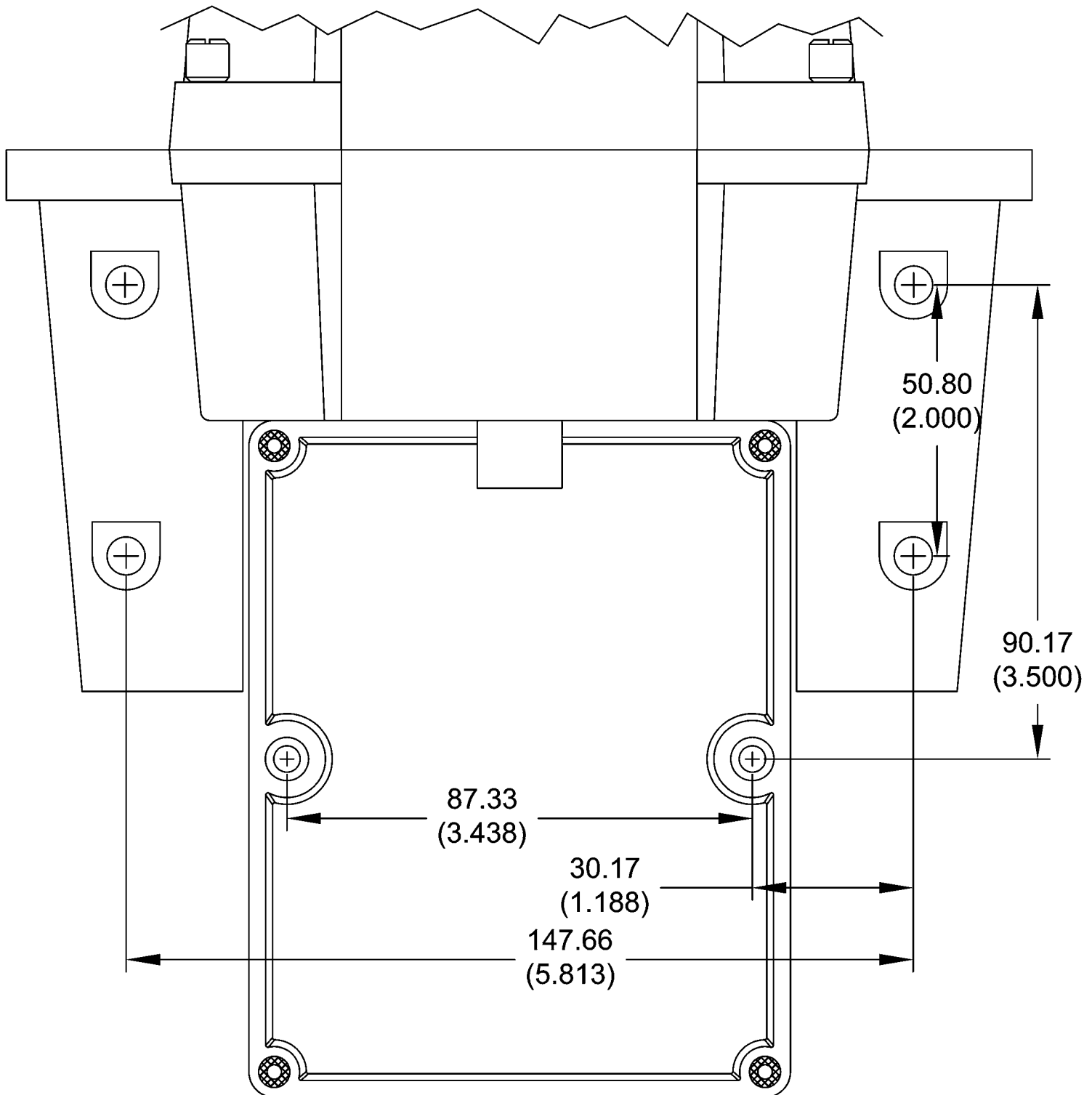
Notes to access: **r** - read, **w** - write, **rw** - read/write

Remarks: *) Modul depend

SECTION 7

MOUNTING TEMPLATE

ALL DIMENSIONS ARE IN MILLIMETERS (INCHES)



NOTE:

SEE THE MOUNTING INSTRUCTIONS IN THE MANUAL FOR MOUNTING HARDWARE SIZES.
PROVIDE AT LEAST 200 MM (8 INCHES) OF FREE SPACE ABOVE THE SENSOR FOR EASY REMOVAL OF THE FLOW HEAD AND INSERTION OF THE CALIBRATION STANDARDS.

TMS 561 TURBIDIMETER - MOUNTING TEMPLATE

50.610.100.020

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