

# User's Guide



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## TBE-10 Series Turbidity Transmitters



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It is the policy of OMEGA Engineering, Inc. to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

**WARNING:** These products are not designed for use in, and should not be used for, human applications.

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## ***Safety Definitions and Information***

Do not attempt to install or use your Omega product until you have read the safety instructions in this section. Save this manual and keep it in an easily accessible place.

### ***Warning!***

*Warning* means that failure to follow this safety statement may result in extensive product damage, serious personal injury, or death.

### ***Caution***

*Caution* means that failure to follow this safety statement may result in minor or moderate personal injury, property or equipment damage.

### ***Notice***

*Notice* is a statement that informs about installation, operation, maintenance, performance issues, or general tips which are important but do not create a hazard or safety concern.

## ***Unpacking***

1. Separate the TBE-10 device from packaging materials and check for any visual signs of damage. If you determine there has been damage caused by shipping, file a claim with the shipping company. If the sensor appears to have been improperly assembled or does not operate properly, return it for replacement or repair (see Limited Warranty information at the end of this manual).
2. Carefully remove all items from the shipping package and compare the contents to those listed on the shipping documents. If there is a discrepancy, contact the manufacturer.

### ***Caution***

*Before connecting or using the TBE-10 sensor, read this manual.*

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## Quick Setup Guide

### Caution

*As with any precision-engineered device, always use the TBE-10 Turbidity Transmitter in accordance with the manufacturer's instructions.*

### Choose Location

The best location to install the TBE-10 sensor is to a tee or saddle in the process line.

### Install Electrical Connection

Attach the five-pin electrical cable to the sensor and tighten the threaded cord grip.

### Position Sensor

Install the sensor horizontally in the process line preferably with the electrical connection facing the floor (see Figure 2, page 15).

### Connect

Connect the opposite end of the electrical cable to PLC, DCS, or data logger.

### Notice

*In the following manual, you will find complete connection, operating, set-up, and maintenance instructions.*

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## Product Description

TBE-10 is an in-line optical sensor that mounts directly to the process line, providing real-time information about the process.

TBE-10 can accurately detect the point of transition from water to product, which is the primary application. Depending on the degree of solids difference between two materials, it can also detect a product-to-product transition. And for products such as skim, 1 percent, 2 percent and whole milk, TBE-10 can act as a monitor of milk fat percentage and an indicator of product quality.

The most common calibration entered into TBE-10 includes points for water, skim milk, 1 percent milk, 2 percent milk, whole milk and a maximum response standard equal to 20 mA.

The 3A authorized TBE-10 also has uses in the brewing, pharmaceutical, and juice processing industries. The device accurately monitors turbidity and product concentration and can help processors recover as much product as possible before a cleaning cycle begins. It can also help to ensure equipment adds costly chemicals at the appropriate time.

The TBE-10 sensor assists in determining if fluid should be added to recovery tanks or sent to the drain, and is an excellent monitor of BOD loading on waste lines. Solid construction means the TBE-10 sensor stands up to the high temperatures and temperature fluctuations.

## Principle of Operation

Utilizing advanced optical technology, TBE-10 sends a beam of infrared light into the process and measures the backscatter, which is proportional to solids concentration. The device's internal microprocessor then converts the scatter to a linearized 4-20 mA output, which easily links to a PLC, DCS or data logger.

## Features

- 3A Authorized to 46-03 standard
- Real-time process control
- Detects phase transitions
- Stainless steel construction
- Sapphire lens
- Sanitary clamp connections
- NEMA 6 /IP67 enclosure
- Easy to install, set up and maintain



Figure 1: TBE-10 Turbidity Transmitter

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## Technical Specifications

### Mechanical

- Materials: 316-series stainless steel housing and fittings; sapphire and FDA-approved silicone product contact surface
- Dimensions: 3.0" diameter x 3.7" length (approx.)
- Weight: 3 lbs. (approx.)
- Ratings: NEMA 4X (water-tight, corrosion proof); authorized to carry 3-A symbol (Standard 46-03)
- Optical Lens: uncoated, optical sapphire (aluminum oxide) min. thickness = 2.3mm
- Lens Seal: 60 durometer, FDA-approved silicone rubber (meets ZZR-765-E, Class 2 A&B)
- Lens Surface Finish: 0.1 microns

### Performance/Electrical

- Accuracy: +/-0.2% of span at 4 mA (water)
- Repeatability: +/-1.0% of span in any target fluid
- Process Temp Range: 32° to 250°F (continuous)
- Ambient Temp Range: 40° to 120°F
- Process Temp Shock: withstands instantaneous changes of up to 125°F (e.g. From 40° to 165°F during CIP, or from 125° to 250°F during SIP)
- Temperature Effect: 0.9% of span/10°F change (process and/or ambient) maximum
- Process Temperature Limits: vacuum to 200 psig at rated temperature
- Output: 4-20 mA, 3 or 4 wire
- Power: 18-24 VDC, at 35 mA
- Connection: M12 5-pin, water-tight, with quick-disconnect cabling

## Preliminaries

### Standard Shipments

Unless specified otherwise, TBE-10 sensors are shipped with a standard calibration covering a span of 4-20 mA and representing clean water at 4 mA and a maximum white standard at 20 mA. A calibration document is included in the shipment to inform you of the calibration date and details.

### Unpack and Check Contents

Upon receipt of the shipment, carefully remove all items from the shipping package and compare the contents to the shipping documents.



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Also check:

- The TBE-10 sensor and other components for any damage that may have occurred during shipping.
- To make sure the sapphire lens is clean and undamaged. (If the lens needs to be cleaned, clean it gently with a mild soap solution and a soft, clean cloth.)
- The sensor's electrical connector; it should easily mate with the connector pins on the sensor body.
- To make sure the threaded collar allows a snug, secure fit when fully engaged.

## ***Electrical Connections***

TBE-10 has a 5-pin electrical connector. If you purchased the molded, NEMA-6 electrical connector and cable from Omega, simply connect the cable as provided.

If you are using the Hirschmann connector (Part Number 932 878-100 ELST 512 PG9 ([www.hirschmann-usa.com](http://www.hirschmann-usa.com))) and need to make a cable connection, please read the following steps.

The most common wiring scheme for TBE-10 is a 3-wire connection:

- Pin 2 is the mA output
- Pin 3 is the 18 to 24 VDC power supply
- Pin 4 is the ground (negative side of the supply).

A 4-wire connection can also be used to connect TBE-10. In this wiring scheme, connect

- Pin 1 (the negative side of the mA output)
- Pin 2 (positive side of the mA output)
- Pin 3 (18 to 24 VDC power supply)
- Pin 4 (ground).

Pin 1 is the negative side of the mA output and is connected internally to Pin 4. This makes it more convenient if you want to make a 4-wire connection.

### ***Notice***

*Pin 5, located in the center of the connector is not used.*

Once you make the connections inside the electrical connector, tighten the threaded cord grip on the connector. This helps keep moisture from entering.

---

## Operation

Once TBE-10 is calibrated and you make the proper electrical connections, the sensor is ready for operation. Before attaching the sensor to the process line, however, it is advisable to perform a quick check of the unit's operation.

### Notice

*You must connect the sensor output to a digital display, multimeter or some other electronics that allows you to monitor the TBE-10's mA output.*

## Applying Power

To view the unit's internal electronics board, remove the screw lid on the housing (see Figure 3, page 16). When you apply power to the TBE-10 sensor, the green LED on the unit's internal electronics board blinks.

### Notice

*When the sensor is operating within the current calibration range, the Green LED on the sensor's electronics board blinks alone. When over-range, the Red and Green LEDs blink, and when below range, the Green and Yellow LEDs blink.*

## Test Output

1. Place a white paper towel on a table.
2. With the lens facing down, place the sensor on the towel. This should produce an output of approximately 17 mA. The actual output may range from 16 to 19 mA; this is normal.
3. Lift the sensor straight up, approximately 2 inches above the towel. This should yield a signal of 4 to 4.5 mA.
4. Slowly lower the sensor back to the towel; the mA output will increase as the sensor gets closer to the towel, eventually reaching approximately 17 mA.

If the sensor performs as stated in the previous test, it is ready for installation. If not, call Omega for technical assistance.

The TBE-10 is designed to meet CIP requirements. When cleaning the TBE-10, make sure to follow the same requirements as the installation piping.

## Installation

TBE-10 has a conventional sanitary clamp connector that attaches directly to a tee or saddle in the process line or vessel. TBE-10 comes in standard 1.5, 2, 2.5 and 3 inch sizes.

---

You can install TBE-10 in a wide variety of configurations, including vertical and horizontal process lines and tanks. To optimize the performance of the sensor, it is important to:

- keep the deadleg as short as possible on the tee connection, and
- choose an installation site that minimizes air or sediment from collecting on the sensor's lens.

### Deadleg

To minimize deadleg, cut the tee back so the TBE-10 lens is as close as possible to the process stream. In most cases, it is possible to cut the tee back and have a resulting deadleg of 1 to 2 inches. The shorter the deadleg the better.

### Installation Site

Select an installation site and orientation that minimizes the possibility of air or sediment interfering with the sensor's readings.

#### Vertical

Vertical sections of process lines are excellent installation sites, whether the flow is down or up.

#### Horizontal

Another excellent installation site is a 90-degree elbow on a horizontal line. In this case, position the TBE-10 device so the fluid flows directly at the sensor's lens.

#### Straight Sections

If installed on a straight section of horizontal process line, place TBE-10 so it looks sideways into the process stream, not up or down.

#### Installations Not Recommended

Two installations not recommended are:

- on the top of horizontal process lines, where air has a tendency to accumulate, and
- on the bottom of horizontal process lines, where sediment can accumulate.

### Clamp Connection Gasket

The clamp connection requires a gasket between TBE-10 and the tee. In most cases, the customer provides the gasket and the tee. Customers can purchase these products from Omega if necessary.

### Connect

Connect the sensor to the process pipe with the appropriate sanitary gasket and clamp. Orient the sensor so that the electrical connector points toward the floor (see Figure 2, page 15).

#### **Caution**

*The sapphire lens can be damaged if struck by sharp or hard objects or if the sensor is dropped during installation. Take care when connecting the sensor to the tee so the lens isn't damaged.*

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## Calibration Verification or Test with Your Samples

The factory normally calibrates TBE-10 according to customer specifications and in most cases, the factory calibration is sufficient for the application. However, if you want to verify the calibration or determine the sensor's response on your samples follow the steps below and record the response.

### Notice

*A common setup is to close off the bottom leg of the tee with an end cap, attach TBE-10 to the middle leg, and pour the sample in the top leg. (see Figure 2 page 15)*

1. Obtain samples of all products that this system will process. You will need enough of each to fill the internal volume of the test setup.
2. Connect TBE-10 to the required power supply. Attach the sensor to a suitable test stand.
3. Be sure to wire the TBE-10 device properly to either the receiver or to a Multi-meter so you can view the corresponding signal output from the unit. When you supply power to the TBE-10, the green LED on the electronics board blinks.

### Caution

*Be careful not to dilute or otherwise contaminate the samples between readings. Also, if the highest degree of accuracy is desired, make sure the samples are at the same temperature as they will be in the process line.*

4. Starting with the product containing the least amount of solids (lowest turbidity), completely fill the test volume.

### Caution

*Before taking any readings, make sure to cover the opening of the test cylinder to make sure no external light can enter the liquid. Any external infrared light could affect readings.*

5. Record the output for this product, then move to the next, ending with the product containing the greatest amount of solids.

### Notice

*When the sensor is operating within the current calibration range, the Green LED on the sensor's electronics board blinks alone. When over-range, the Red and Green LEDs blink, and when below range, the Green and Yellow LEDs blink.*

The resulting profile corresponds to the outputs from the unit at each of the various products. Use these values as the reference for programming a receiver or to verify calibration of the TBE-10 sensor. Changes in product properties (solids content) are a common cause for discrepancy. If observed, follow the Calibration Procedure below.

---

## Calibration Procedure

If you want to adjust the calibration, follow this procedure:

1. Obtain samples of all products that will be processed in this system. If using liquid sample, you need sufficient volume of each to fill the tee. Calibrate them in increasing order of concentration. TBE-10 allows you to choose a variety of calibrations, from a 2-point calibration to a 9-point calibration.
2. Be sure you wire the unit to either the receiver or to a Multi-meter so you are able to view the corresponding signal output from the unit.
3. Remove the screw lid on the housing by turning it counterclockwise. This allows access to the electronics board. Refer to Figure 3 on page 16 to locate the Calibration Switch, Entry Key and Offset Adjustment Keys.

### Caution

*Be careful not to damage the cover o-ring. If damaged, it must be replaced.*

4. As shown in Figure 2 on page 15, fill the tee with clean water, or another fluid that you desire to be the 4 mA reference (if a value other than 4 mA is desired for the base value, please see SENSOR OFFSET and SPAN CALIBRATION section below).
5. Observe the mA reading that TBE-10 produces with the 4 mA reference sample. If the output is 4 mA, there is no need to adjust. If you desire to change the zero point, turn the calibration switch to position "0". Press the UP or DOWN buttons until the desired mA offset reading is reached. Then press and hold the ENTRY key for approximately two seconds. This stores the new value as 4mA.
6. Remove the water or optional base product and fill the tee with the next highest solids content.

### Notice

*So as not to introduce error in calibration, it is critical to rinse the tee with water to clean any residue of the previous product from the face of the sensor and calibration tee.*

7. Turn the CALIBRATION SWITCH to position 1. Press and hold the ENTRY key for approximately two seconds. The sensor output is now set to 20 mA (or the span setting).
8. Repeat step 7, incrementing the CALIBRATION SWITCH by one, until you have calibrated all points (maximum is to switch position 8). As you add points, each addition becomes the new 20 mA top end. Each previously entered point is linearly re-scaled.
9. In general, a five (5) point calibration is sufficient to provide proper output resolution. You may use calibration point 0 to 8. Point 9 is reserved for the Sensor Span Output adjustment, described below.
10. To obtain output values, place the sensor again into each of the test liquids. With each product, record the resulting current output from the transmitter. The resulting profile corresponds to the outputs from the unit at each of the various products.
11. These values can now be used to program a receiver.

---

**Caution**

*For correct signal output scaling, make sure to leave the switch setting at the last calibration point during operation.*

## **Sensor Offset and Span Calibration**

The TBE-10 sensor is typically scaled at the factory with 4 mA output for the “base reference” material (first calibration point) and 20 mA for the material with highest turbidity value (last calibration point). For most applications, it is recommended that the unit be used in this configuration. The following procedure illustrates steps to verify or modify these values.

1. Remove the screw lid on housing.

**Caution**

*Be careful not to damage rubber o-ring. If o-ring is damaged it must be replaced.*

1. Refer to the Figure 3 on page 16 to locate the Calibration Switch, Entry Key and Offset Adjustment Keys.
2. If you wish to change the span value, place the Calibration switch in Position “9” and press the “UP” or “DOWN” offset adjustment keys until you obtain the desired value; then press and hold the ENRTY key for approximately 2 seconds to store value.
3. If you wish to change the “base reference” value, place the Calibration switch in Position “0” and press the “UP” or “DOWN” keys until you obtain the desired value; then press and hold the ENTRY key for approximately 2 seconds.

**Caution**

*Be sure to set the switch back to the position used for the last calibration value or the output scaling will be incorrect*

## **Clean Sweep**

Clean Sweep is a feature which resets the sensors programmed values back to factory defaults. This is usually used in cases where someone wants to completely recalibrate a unit. To Clean Sweep a unit, with the unit powered up, press and hold the UP, DOWN & ENTRY keys at the same time for about 3-5 seconds. Once the buttons are pushed, the Green LED will turn off and then back on solid, after which the Red LED will start to blink. Once the Red LED blinks, release the keys. When Clean Sweep has been completed the Green LED will flash. The Red LED may also blink which is ok.

**Notice**

*Once Clean Sweep has been performed, there is no way to get the previous values back.*

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Figure 4 on page 17 shows an example of a multi-point calibration. For this example, milk samples were used. Water = 4 mA, skim milk = 8 mA, 1% milk = 12 mA, 2% milk = 16 mA and whole milk = 20 mA. The calibration selector switch was at 0 position for water, 1 position for skim milk, 2 position for 1% milk, 3 position for 2% milk and 4 position for whole milk.

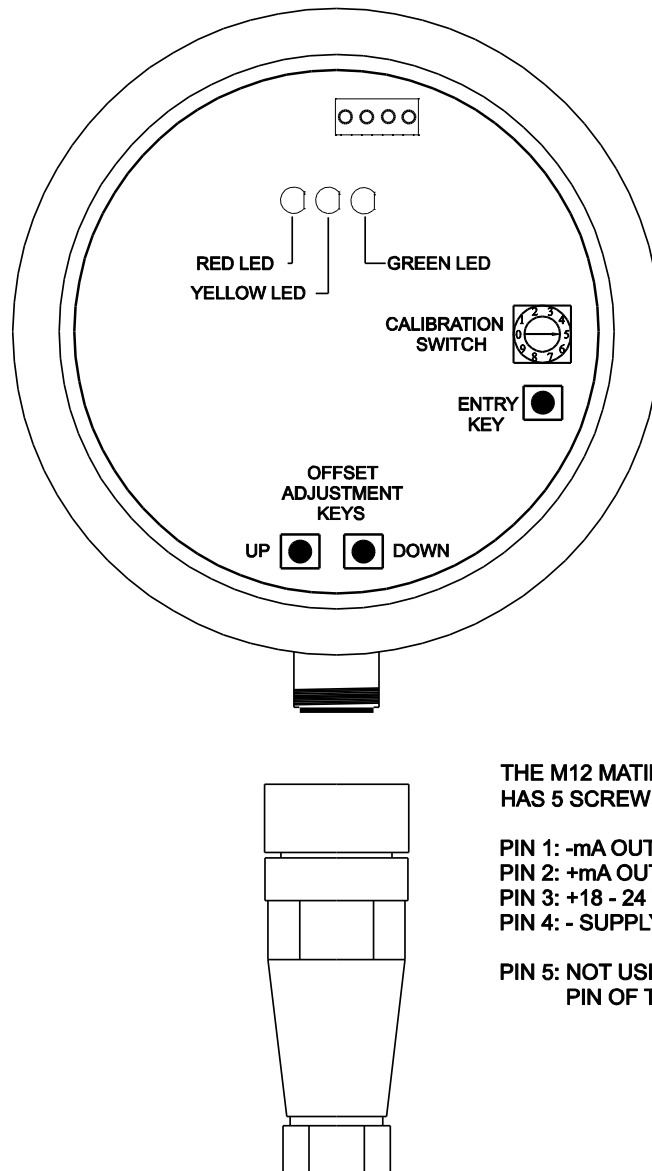
Figure 5 on page 18 shows a slightly different example of a multi-point calibration. In this case, a dairy customer wanted a greater degree of sensitivity near 1% milk fat; a 6-point calibration was used, which emphasized the 1% to 1.3% milk fat concentration. All that was necessary was to prepare samples of the proper concentration. The TBE-10 calibration linearizer divided the 4-20 mA span into five sections of 3.2 mA each, including the key range in the middle of the graph.

If questions arise at any time, please contact Omega.



**Figure 2: TBE-10 Sensor attached to a sanitary T, electrical connection facing floor**

## TBE-10 INTERNAL VIEW WITH COVER REMOVED



THE M12 MATING CONNECTOR  
HAS 5 SCREW TERMINALS:

PIN 1: -mA OUTPUT  
PIN 2: +mA OUTPUT  
PIN 3: +18 - 24 VDC SUPPLY  
PIN 4: - SUPPLY

PIN 5: NOT USED. IT IS THE CENTER  
PIN OF THE CONNECTOR

Figure 3: TBE-10 with cover removed showing LEDs, connector, calibration switch, entry key, adjustment keys, etc.



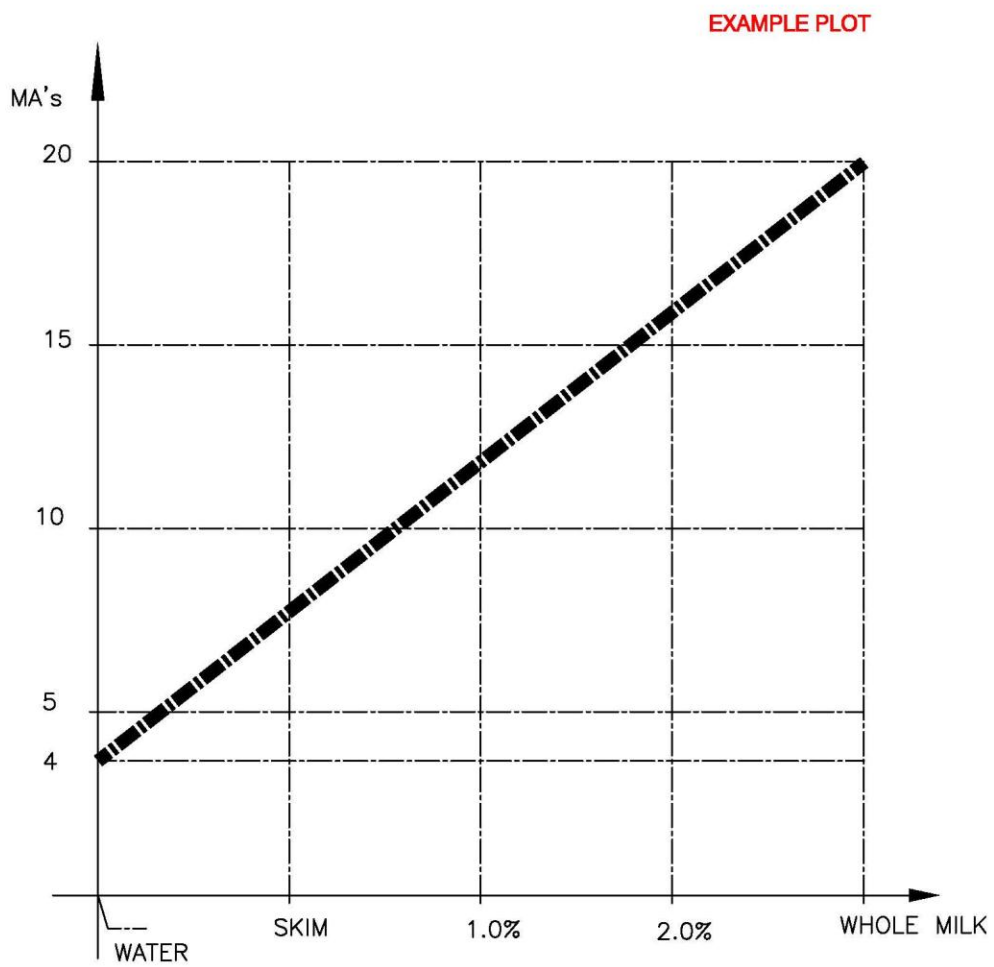


Figure 4: Calibration linearizer, 4 point

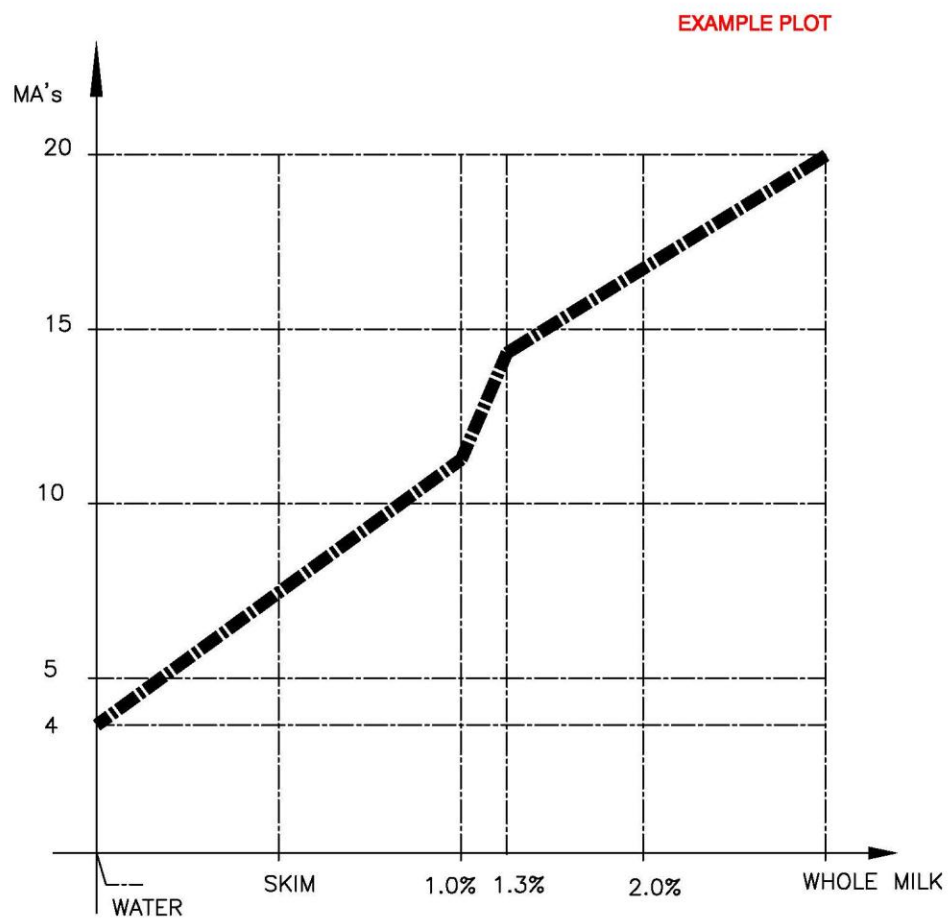


Figure 5: Recalibration

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MATERIAL USED TO CALIBRATE \_\_\_\_\_

DATE \_\_\_\_\_

CALIBRATED BY: \_\_\_\_\_

CALIBRATION POINT 1: \_\_\_\_\_ mA

CALIBRATION POINT 2: \_\_\_\_\_ mA

CALIBRATION POINT 3: \_\_\_\_\_ mA

CALIBRATION POINT 4: \_\_\_\_\_ mA

CALIBRATION POINT 5: \_\_\_\_\_ mA

CALIBRATION POINT 6: \_\_\_\_\_ mA

CALIBRATION POINT 7: \_\_\_\_\_ mA

CALIBRATION POINT 8: \_\_\_\_\_ mA

BASE LINE \_\_\_\_\_ mA

Figure 6: Factory calibration information

# TBE-10

MODEL #	TRICLAMP SIZE	DIMENSION "A"	WEIGHT
TBE-11	1.5	1.984"	2.75 LBS
TBE-12	2.0	2.516"	3.00 LBS
TBE-13	2.5	3.047"	3.10 LBS
TBE-14	3.0	3.579"	3.20 LBS

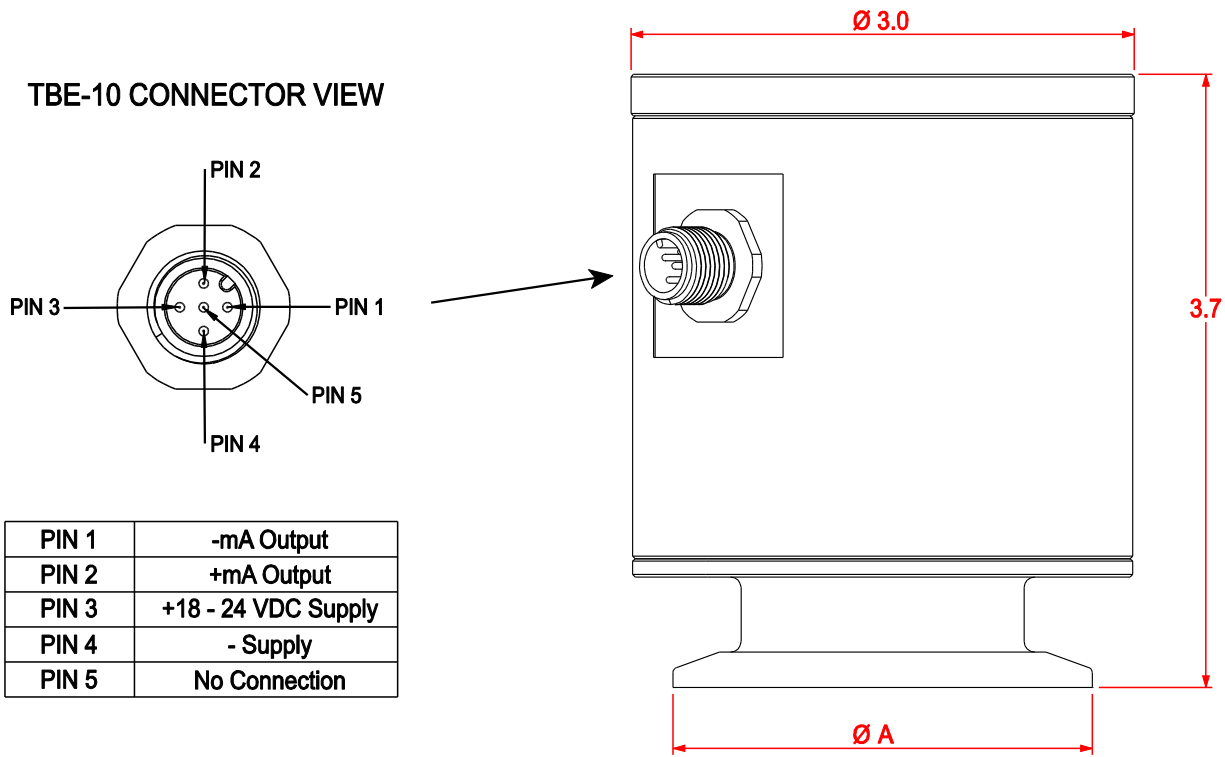


Figure 7: Dimensions, weights and connector diagram







## WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

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## RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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- ☑ Infrared Pyrometers

## **PRESSURE, STRAIN AND FORCE**

- ☑ Transducers & Strain Gages
- ☑ Load Cells & Pressure Gages
- ☑ Displacement Transducers
- ☑ Instrumentation & Accessories

## **FLOW/LEVEL**

- ☑ Rotameters, Gas Mass Flowmeters & Flow Computers
- ☑ Air Velocity Indicators
- ☑ Turbine/Paddlewheel Systems
- ☑ Totalizers & Batch Controllers

## **pH/CONDUCTIVITY**

- ☑ pH Electrodes, Testers & Accessories
- ☑ Benchtop/Laboratory Meters
- ☑ Controllers, Calibrators, Simulators & Pumps
- ☑ Industrial pH & Conductivity Equipment

## **DATA ACQUISITION**

- ☑ Data Acquisition & Engineering Software
- ☑ Communications-Based Acquisition Systems
- ☑ Plug-in Cards for Apple, IBM & Compatibles
- ☑ Datalogging Systems
- ☑ Recorders, Printers & Plotters

## **HEATERS**

- ☑ Heating Cable
- ☑ Cartridge & Strip Heaters
- ☑ Immersion & Band Heaters
- ☑ Flexible Heaters
- ☑ Laboratory Heaters

## **ENVIRONMENTAL MONITORING AND CONTROL**

- ☑ Metering & Control Instrumentation
- ☑ Refractometers
- ☑ Pumps & Tubing
- ☑ Air, Soil & Water Monitors
- ☑ Industrial Water & Wastewater Treatment
- ☑ pH, Conductivity & Dissolved Oxygen Instruments