TOTAL DISSOLVED GAS PRESSURE/TEMPERATURE PROBE

OPERATION & MAINTENANCE MANUAL

November 2006
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1 INTRODUCTION

This manual covers all the information required to measure Total Dissolved Gas Pressure (TDGP) and temperature with the T506.

The operator is an important factor in obtaining accurate field measurement of total gas pressure. We therefore suggest that this manual be studied carefully and consulted periodically during operations. It is designed to serve both as a start-up guide and as a permanent reference for the operation and care of the T506.

Throughout the operator’s manual you will see the following symbols.

- The check mark highlights a tip about a convenient feature of the T506

- The exclamation point calls your attention to a requirement or important action that should not be overlooked
UNPACKING AND INSPECTION

Check for the following items:

- Probe, dummy plug on cable end, pressure cap on membrane end
- Membrane cartridge
- Optional cable with oceanographic connector
- Optional battery box with interconnect cable
- In-Situ software CD with operator’s manual and TDG Logger software

Your T506 was carefully inspected before shipping. Check for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carriers involved if there is any such damage; do not attempt to operate the instrument.

SERIAL NUMBER

The serial number is engraved on the sensor housing on the body of the probe. We recommend that owners keep a separate record of this number. Should your probe be lost or stolen, the serial number is often necessary for tracing and recovery, as well as insurance claims. If necessary, In-Situ maintains complete records of original owner’s names and serial numbers.

WHAT WE PROVIDE

WARRANTY PROVISIONS

In-Situ Inc. warrants the T506 and In-Situ RuggedCable™ for one year, and warrants membrane cartridges for 30 days, from date of purchase by the end user against defects in materials and workmanship under normal operating conditions. To exercise this warranty, contact Technical Support for a return material authorization (RMA) as outlined on page 7. Complete warranty provisions are posted on our website at www.In-Situ.com.

Handle the probe with care. A severe blow can damage the internal pressure transducer.

DO NOT ATTEMPT TO TAKE THE PROBE APART. It contains special seals and delicate components. Disassembling voids all warranties.

TIP: Maintenance and calibration plans are available for U.S. customers. Consult your In-Situ Representative for more information.
HOW TO CONTACT US

Technical Support: 800 446 7488
Toll-free 24 hours a day in the U.S. and Canada

Address: In-Situ Inc.
221 East Lincoln Ave.
Fort Collins, CO 80524
USA

Phone: 970 498 1500
Fax: 970 498 1598
Internet: www.in-situ.com
e-mail: support@in-situ.com

TO OBTAIN REPAIR SERVICE (U.S.)

If the T506 fails to function properly, review this manual to make sure you are operating it correctly. If repair is required, you can help assure efficient servicing by following these guidelines:

1. Call or e-mail In-Situ Technical Support (support@in-situ.com). Have the product model and serial number handy.

2. Be prepared to describe the problem, including how the instrument was being used and conditions noted at the time of the malfunction.

3. If Tech Support determines that service is needed, they will ask that your company pre-approve a specified dollar amount for repair charges. When the pre-approval is received, Tech Support will assign an RMA (Return Material Authorization) number.

4. Clean the probe and cable. Decontaminate thoroughly if it has been used in a toxic or hazardous environment. See the Cleaning Guidelines and form on page 9.

TIP: Please keep your RMA number for future reference.
5. Carefully pack your probe in its original shipping box, if possible. Include a statement certifying that the instrument and cable have been decontaminated, and any supporting information.

6. Mark the RMA number clearly on the side of the box with a marker or label.

7. Send the package, shipping prepaid, to

   In-Situ Inc.
   Attn: Repairs
   221 East Lincoln Ave.
   Fort Collins, CO 80524

The warranty does not cover damage during transit. We recommend the customer insure all shipments. Warranty repairs will be shipped back prepaid.

**Outside the U.S.**

Contact your international In-Situ distributor for repair and service information.

**GUIDELINES FOR CLEANING RETURNED EQUIPMENT**

Please help us protect the health and safety of our employees by cleaning and decontaminating equipment that has been subjected to any potential biological or health hazards, and labeling such equipment. Unfortunately, we cannot service your equipment without such notification. Please complete and sign the form on page 9 (or a similar statement certifying that the equipment has been cleaned and decontaminated) and send it along to us with each returned instrument.

- We recommend a good cleaning solution, such as Alconox®, a glassware cleaning product available from In-Situ (Catalog No. 0029810) and laboratory supply houses.
Decontamination & Cleaning Statement

Company Name _____________________________________ Phone _______________________
Address ____________________________________________________________________________
City ___________________________ State ___________ Zip ____________________
Instrument Type __________________________ Serial Number _______________________
Contaminant(s) (if known) ____________________________________________________________
Decontamination procedure(s) used __________________________________________________
Cleaning verified by __________________________ Title __________________________
Date __________________________
The In-Situ Inc. T506 probe is a specially adapted submersible pressure transducer designed to monitor Total Dissolved Gas (TDG) pressure and temperature in a variety of natural waters. The probe utilizes a gas-permeable membrane tube, which is permeable to all gases including water vapor.

The T506 measures total dissolved gas pressure directly. This type of analysis is commonly called the Membrane Diffusion Method.

The T506 utilizes digital signal processing techniques to provide a calibrated and temperature-compensated output which is directly proportional to the applied dissolved gas pressure. Calibrated data is available via RS232 serial output. Precision electronics allow the probe to be powered from an unregulated 6 to 13 volt DC source without any effect on accuracy. The probe also features very low power consumption and is especially suitable for battery-powered instruments and data loggers.
Maintenance of the probe requires cleaning of the membrane cartridge occasionally to remove biofouling. Biofouling affects only the response time of the probe and not the calibration. Changing the membrane cartridge has no effect on the calibration. Changing membrane cartridges requires no tools or solutions and may easily be done in the field.

**SUPERSATURATION**

Supersaturation is the condition that exists when the total dissolved gas pressure in water is greater than the atmospheric pressure at the surface of the water. This can occur below dam spillways or waterfalls, in city water supplies or well water, or as the result of temperature variations or algae blooms. Faulty pump systems in hatcheries and fish farms are also a likely place for supersaturation problems to occur. Many fish kills in rivers and hatcheries have been traced to supersaturation.

**MEASUREMENT PRINCIPLE**

When the probe is immersed in water, gases effuse through the tubing wall until the gas pressure inside the tube is equal to the gas pressure outside the tube. This condition is called *equilibrium* and when reached, the T506 will output the total dissolved gas pressure in the water, in atmospheres (Atm), and temperature in degrees Celsius.
PROBE DESCRIPTION

The T506 contains a precision pressure transducer, temperature sensor, conditioning electronics, a membrane cartridge, and an oceanographic plug for cable connection. The membrane cartridge consists of a sensing membrane—approximately 1.5 meters of very small bore silicone tubing. One end of the tube is sealed, the other end is connected to the pressure transducer which converts the internal tube pressure to an electrical signal. The tube is permeable to all gases including water vapor.

The optional battery box consists of a 9V battery and cable connections to the probe and an RS232 serial port.
PRODUCT SPECIFICATIONS

The sensor measures Total Dissolved Gas Pressure and Temperature

Pressure
- Range: 2.000 Atm
- Resolution: 0.001 Atm
- Accuracy: ±0.002 Atm over operating temperature range

Temperature
- Output: -5°C to +40°C
- Resolution: 0.1°C
- Accuracy: ±0.25°C
- Equilibrium Time: 5 minutes to 90% of final value in 11°C water

Signal Output: Digital
Digital Output: RS232 ASCII strings (9600, 8, N, 1)
- xx.x deg C, x.xxx Atm

External Power: 6.0 to 13.0 VDC
Power Consumption: 7 mA (continuous), approx. 10 hrs from In-Situ battery box accessory

Materials: Delrin®, silicone, stainless steel
Media Compatibility: Fresh, salt or brackish waters

Maximum Depth
- Measurement: 53 meters (173 ft)—limit of accurate measurement
- Pressure sensor: 60 meters (196 ft)—damage to the sensing element may occur beyond this depth, voiding warranty

Operational Temperature: 0°C to +45°C (32°F to 113°F)
Storage Temperature
- With membrane: 0°C to +60°C (32°F to 140°F)
- Without membrane: -40°C to +60°C (-40°F to +140°F)
**ACCESSORIES AND REPLACEMENT PARTS**

<table>
<thead>
<tr>
<th>Accessory/Replacement Part</th>
<th>Catalog No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane cartridge</td>
<td>70-020</td>
</tr>
<tr>
<td>Cable assembly</td>
<td>70-070</td>
</tr>
<tr>
<td>Includes oceanographic grade underwater connector</td>
<td></td>
</tr>
<tr>
<td>RuggedCable™, non-vented (custom length charged by foot)</td>
<td>0052060</td>
</tr>
<tr>
<td>Cable is terminated for connection to battery box</td>
<td></td>
</tr>
<tr>
<td>Battery box/interconnect cable assembly</td>
<td>70-068</td>
</tr>
<tr>
<td>Includes 9V alkaline battery and DB9-pin connector to serial port</td>
<td></td>
</tr>
<tr>
<td>RuggedReader® handheld</td>
<td>0057550</td>
</tr>
<tr>
<td>TDG Logger software for use with RuggedReader</td>
<td>70-071</td>
</tr>
<tr>
<td>Cable reel, small steel</td>
<td>2214-0004</td>
</tr>
<tr>
<td>Refurbishment of returned membrane cartridge*</td>
<td>70-020RW</td>
</tr>
<tr>
<td>9V alkaline battery</td>
<td>2101-0001</td>
</tr>
</tbody>
</table>

*Call Tech Support for an RMA number; see page 7 for details.*
3 GETTING STARTED

This section provides a quick overview of the initial steps necessary to get the T506 ready to measure gas pressure and temperature.

INSTALL THE MEMBRANE CARTRIDGE

If the membrane cartridge is packed separately, attach it to the T506 probe body as follows:

1. Remove the guard from the probe by turning counterclockwise.
2. Unscrew the pressure cap at the sensor end of the probe and remove it.

**TIP:** The pressure cap protects the sensitive pressure element when the membrane cartridge is not installed. Retain the cap for protection during membrane cleaning or servicing.
3. Grasp the membrane cartridge at the end with the “dimples.” Attach it to the threads on the probe in place of the pressure cap.

4. Reattach the guard.
ATTACH CABLE

Using In-Situ’s optional non-vented cable assembly 70-070, connect as follows:

1. Remove the “dummy plug” from the cable end of the T506 body by gripping the plug and pulling it straight out. **DO NOT TWIST THE PLUG.**

*TIP:* The dummy plug protects the connector pins and should always be in place when cable is not attached to the probe.
2. To attach the cable: Align the two bumps on the cable receptacle with the larger pin on the T506. Push firmly together. **DO NOT TWIST.**

When properly connected, the parts will “click” together.
3. When fully connected, “burp” the cable receptacle to expel excess air by rolling your finger over the rubber part of the receptacle.

4. Slide the retaining collar over the two ridges on the receptacle.
5. **Gently** screw the collar onto the threaded portion of the plug on the T506. Tighten finger-tight.

**Warning:**

*Do not use excessive force when attaching the cable collar to the T506. Too much force will crack the collar.*
POWER & COMMUNICATION CONNECTIONS

To provide power and communication using In-Situ’s optional battery box with interconnect cable 70-068:

1. First, align the notch on the cable’s lock ring with the groove on the connector (see photo below, left).

2. Align the groove on the cable connector with the tab on the battery box connector (see photo, below right).

3. When aligned, press the cable connector into the battery box connector and tighten the lock ring.

---

The T506 is powered continuously when plugged into the battery box. Disconnect when not in use to conserve power.
4. Attach the DB9-pin connector on the battery box to an RS232 serial port on a computer or handheld device.

**TIP:** If connecting to a PDA other than the RuggedReader, a serial cable and a null modem adapter may be required.
DISPLAYING READINGS ON THE IN-SITU RUGGEDREADER®

When the T506 is connected to a serial port, it immediately begins outputting data. To display and log readings with a connection to the In-Situ RuggedReader®, proceed as follows:

1. First, install the desktop component of the TDG Logger software from the downloads section of the In-Situ website at www.In-Situ.com or from the In-Situ software/resource CD.

2. On your next ActiveSync® connection, launch the Win-Situ Software Manager to install TDG Logger on your RuggedReader.

3. Attach cable and power, connect to the RuggedReader’s 9-pin serial port.

4. On the RuggedReader, tap Start, tap Programs, tap TDG Logger:

TIP: Microsoft® ActiveSync® is needed in order for the RuggedReader to communicate with a desktop/laptop PC. It is included on the In-Situ software/resource CD and also available over the Internet at www.Microsoft.com/Windownsmobile.
The TDG Logger application will launch,

![TDG Logger application launch](image1)

and in a moment device readings will be displayed. Allow a few minutes for the readings to stabilize.

![Device readings](image2)
TO LOG READINGS ON THE RUGGEDREADER

To log or record readings, you must first specify a site. The Record button is dimmed out (unavailable) until a site is entered.

1. Tap the down arrow beside the site box.
2. Select <New>.
3. Tap to put the cursor in the Site Name box.
4. Tap the keyboard symbol and enter a site name.
5. Tap OK when finished.

TIP: Logged data are organized by the site where the data were logged. The site name is used as the filename for the logged data text file.
6. Tap the Record button to log readings.

7. Output will be logged until you tap OK to exit TDG Logger, or disconnect the probe from the battery box.

Readings will be logged to a .txt file on the RuggedReader (Built-In Storage \ TDGLogger) with the same name as the site. For the example above, use the File Explorer to navigate to My Device \ Built-In Storage \ TDGLogger \ south dam.txt.

The T506 is powered continuously when plugged into the battery box. Disconnect when not in use to conserve power.
4  OPERATION

TAKING A MEASUREMENT

1. Fully submerge the probe in the water to be sampled. The system does not need to be powered on while equilibrating.

   If the water is warmer than the air temperature, expect an immediate positive reading. If the water is colder than ambient, a negative reading will occur.

2. Agitate the probe at least once a minute.

3. During the first 5 minutes, the reading will reach approximately 90% of its final value. Continue to agitate the probe every minute.

   Equilibrium is the condition that exists when the pressure inside the sensing membrane is equal to the pressure outside (in water or air). As equilibrium is approached, the reading over a five-minute period should be stable within 0.0026 Atm. If the pressure increases only slightly between one-minute readings, then you are close enough to equilibrium.

Handle the probe with care. A severe blow can damage the internal pressure transducer.

TIP: If the probe is near the surface, agitate it frequently to dislodge air bubbles from the tubing.
To help in identifying the equilibrium point, we suggest plotting a graph of pressure versus time. From the graph it can be observed that equilibrium is reached after about three minutes. The reading may then climb slowly, but that slight increase can be disregarded, except in high-accuracy situations.

4. To log the measurements on a RuggedReader, see To Log Readings on the RuggedReader in Section 3. The results will be logged to a .txt file on the RuggedReader (Built-In Storage \ TDGLogger) with the same name as the site.

**FACTORS AFFECTING ACCURACY**

- Dirt, oil, or algae buildup on the membrane will slow response time. See Section 5 for cleaning recommendations.

**FACTORS AFFECTING RESPONSE**

- Water temperature affects response time; higher temperatures shorten the response time as the gas has higher thermodynamic energy. Conversely, lower temperatures retard the response time.

- Leaks or restrictions anywhere in the membrane will extend the response time and cause low readings.

**SOME SAMPLING HINTS**

- Depth has no effect on the measurement except for the issue of bubble formation.

- Sample as close to the source as possible.

The T506 is powered continuously when plugged into the battery box. Disconnect when not in use to conserve power.
Repairs or servicing not covered in this manual must be carried out by the manufacturer. Contact In-Situ as described on page 7.

**THE PROBE**

- Store the probe out of direct sunlight and protect it from excessive moisture. **Do not store the probe in a sealed plastic bag.**

- If the probe has been used in brackish, dirty, or otherwise contaminated water, be sure to rinse the probe in clean water after use, and clean the membrane. **Do not let contaminants dry on the probe surface.**

**THE MEMBRANE CARTRIDGE**

The membrane cartridge, if handled carefully and cleaned regularly, can last indefinitely. Membranes with five years’ field usage have been tested and found to have characteristics identical to those of new membranes. The most significant factors that will deteriorate the tubing are direct sunlight, dirt buildup, and biofouling.

In-Situ will refurbish current models of In-Situ and Alpha Designs TDG sensor membrane cartridges sent to us by customers for such service. We do not, however, offer used or refurbished cartridges for sale.
SECTION 5: CARE & MAINTENANCE

CLEANING THE MEMBRANE CARTRIDGE

If the probe is being used in brackish, dirty, or otherwise contaminated water, be sure to clean the membrane cartridge regularly. This can be done without removing the cartridge from the probe.

1. Disconnect power.

2. Carefully remove the slotted guard by turning counterclockwise. Leave the membrane cartridge attached to the probe.

3. Prepare a warm soapy solution in a 500 mL beaker or similar container. Use a mild, non-oily soap.

4. Submerge the membrane cartridge in the warm soapy solution.

5. Using a SOFT toothbrush (a baby’s toothbrush is ideal), gently stroke the membrane filament as shown below. This will remove most attached dirt and debris. Do not pinch the membrane against the support. Use care, as the membrane material is sensitive to nicks and abrasions.

6. Biofouling may be removed by rinsing in a dilute solution of common household bleach (4 parts water to 1 part bleach).

7. Do not soak in any chemical solution for more than one minute.

8. Never use strong acid or alkaline solutions.

6. Rinse thoroughly in clean water.
REMOVING THE MEMBRANE CARTRIDGE

To replace the membrane cartridge, or check for moisture in the tubing, first remove the cartridge from the probe.

1. Disconnect power.
2. Carefully remove the slotted guard by turning counterclockwise.
3. Using your thumb and forefinger, grip the cartridge at the dimples, located at the probe end of the membrane. Gently unscrew the assembly, taking care not to touch the membrane tubing. Place the cartridge in a safe clean area.

While the cartridge is off—

- Inspect the face of the pressure orifice on the probe. If any beads of moisture appear on the surface, remove them with a tissue. Do not put anything into the small hole.
- Inspect the cartridge where it fits onto the probe. It should be clean and free of moisture. Carefully remove any debris or moisture with a tissue. Be sure the miniature bore is not blocked. If the bore is clogged or plugged, the membrane cartridge will need to be replaced.
LEAKY MEMBRANE

If the membrane appears to be leaking, replace the entire cartridge (order replacement part 70-020).

As an emergency measure, the leak may be temporarily repaired: Allow the membrane to dry completely, apply a small dab of silicone glue to the leak, and allow 24 hours for a full cure. Replace the membrane cartridge as soon as possible.

REMOVING WATER CONDENSED IN THE MEMBRANE

If the probe is left in water for long periods, water vapor will eventually effuse through the membrane wall where it can condense and create pockets of water. This will affect the response and the accuracy of your readings. If readings are slow or erratic, check for water trapped in the membrane assembly.

1. Remove the membrane cartridge from the probe as described above and place it on a clean, dry, warm surface—between 35° and 55° C (95° – 131°F)—out of direct sunlight for a day or two.

   Alternatively, the cartridge may be placed in a warm oven for a few hours. Do not exceed 60°C (140°F).

2. Inspect the tubing through a magnifying glass to ensure that all moisture has evaporated.

3. When dry, reattach the cartridge to the probe—take care not to touch the membrane tubing—and replace the guard.
REPLACING THE MEMBRANE CARTRIDGE

1. Remove the old membrane cartridge from the probe as described above.

2. Mount the new membrane cartridge.

3. Tighten the cartridge until it seats.

GENERAL RESPONSE CHECK

The system’s response can be checked at any time without dismantling the probe. Rise and decay curves if plotted will approximate the shape of a natural log function.

1. Fill a small container, such as a drinking glass, with plain seltzer or carbonated water at room temperature.

2. Power on the system, connect to a RuggedReader (or use HyperTerminal, see the Appendix) and wait for the display to stabilize.

3. Submerge the probe until the membrane is fully immersed. The displayed value should rise rapidly. Do not exceed 1.92 Atm or possible membrane damage could occur. Remove probe from solution quickly if this value is approached.

4. Remove the probe from solution and rinse in clean water.

THE PRESSURE SENSOR

The pressure sensing element of the T506 is factory-calibrated. No user calibration is possible or necessary.
BATTERY REPLACEMENT (BATTERY BOX ACCESSORY)

The 9V alkaline battery in the optional battery box can power the probe for about 10 hours. 9V alkaline batteries are readily available from electronic suppliers, or from In-Situ Inc. (Catalog No. 2101-0001).

To replace the battery:

1. Loosen the screws at all four corners of the battery box cover with a screwdriver (either type) and remove the cover.

2. Pull the battery out and unplug the connectors. Attach the new battery to the battery connectors as marked, and press it into place.

3. Close the cover—be careful not to pinch the wires—and tighten the screws.

A fresh 9V battery will operate the unit for approximately 10 hours.
6 TROUBLESHOOTING

If the T506 fails to respond to the procedures in the Operations section, several checks can be made. Repairs or servicing not covered in this manual should only be carried out by the manufacturer.

Erratic readings

- Cable disconnected or damaged. If cable is damaged contact In-Situ as described on page 7.
- Pressure transducer damaged. Contact In-Situ as described on page 7.
- Water in the connectors. Disconnect and allow to dry thoroughly.

No reading in water

- Water may be at equilibrium with air. This actually happens. Check another sample.
- Place probe in warm water. If still no reading, membrane may be restricted. Replace the membrane cartridge (replacement part 70-020).
- Water condensed in membrane. See drying instructions in Section 5.
Instrument takes too long to stabilize

- Dirty or oily membrane. Refer to cleaning instructions in Section 5.
- Water condensed in membrane. See drying instructions in Section 5.
- Leaky membrane. Repair or replace the cartridge. See temporary membrane repair recommendations in Section 5.

Readings increase then decrease even though water has not changed

- Bubbles forming on the membrane surface. Agitate to remove. They can be quite stubborn, especially in shallow waters.

Readings seem to follow the depth of the probe

- Membrane is leaking. Repair or replace the cartridge. See temporary membrane repair recommendations in Section 5.

Readings are slow or erratic

- Water condensed in membrane. See drying instructions in Section 5.

If you are in doubt about the condition of your membrane cartridge, contact In-Situ as described on page 7. Accuracy of ALL your measurements depends on it.
To display and log readings from the T506 using a computer or handheld device that can run an ASCII terminal program such as HyperTerminal, do the following.

- Set the communication options:
  
  Connect using: COM1
  Bits per second: 9600
  Data bits: 8
  Parity: None
  Stop bits: 1
  Flow control: Hardware

- Connect the RS232 serial cable from the battery box/interconnect cable assy (p/n 70-068) to the COM 1 on the computer. Note that a null modem adapter may be needed with some handhelds.

After approximately five seconds the probe will send its initial ASCII string identifying the product. Subsequently the probe will output gas pressure information every four seconds. The first two of these measurements will need to be discarded as the probe is collecting other information it needs to calculate the actual total dissolved gas pressure.
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