

5000TOC Sensor

Instruction Manual

METTLER TOLEDO

A graphic element consisting of a series of parallel diagonal lines forming a triangular shape, pointing towards the bottom right, located behind the Mettler Toledo logo.

IMPORTANT SAFETY INFORMATION

- Please read thoroughly before operating the 5000TOC Sensor product -

- Follow all warnings, cautions, and instructions indicated on and supplied with this product.
- Install equipment as specified in this instruction manual. Follow appropriate local and national codes.
- Use only factory documented components for repair. Tampering or unauthorized substitution of parts and procedures can affect the performance and cause unsafe operation of your process as well as void factory warranties.
- Protective covers must be in place unless qualified personnel are performing maintenance.
- Use of this equipment is in a manner not specified by the manufacturer; the protection provided by it against hazards may be impaired.
- Prior to shipping sensor back to the factory for repair or re-calibration, water MUST be drained from sensor to avoid damage due to freezing.

WARNINGS:

- Installation of cable connections and servicing of this product require access to shock hazard voltage levels.
- Main power must employ a switch or circuit breaker as the disconnecting device for the equipment. The switch or circuit breaker shall be located in close proximity to the equipment and within easy reach of the operator and shall be marked as the disconnect device.
- Electrical installation must be in accordance with the National Electrical Code and/or any other applicable national or local codes.
- Safety and performance require that this instrument be connected and properly grounded through a three-wire power source.
- PROCESS UPSETS: Because process and safety conditions may depend on consistent operation of this instrument, provide appropriate means to maintain operation during sensor cleaning, replacement, or sensor or instrument calibration.
- Ozone gas (O₃) is generated inside the 5000TOC Sensor enclosure during normal operation. The smell of ozone may be apparent when opening the front cover of the enclosure and caution should be taken when opening. Prolonged exposure to ozone gas is hazardous and may cause health problems.

This manual includes safety information with the following designations and formats:

WARNING: POTENTIAL FOR PERSONAL INJURY.

CAUTION: possible instrument damage or malfunction.

NOTE: important operating information

Definition of Equipment Symbols



On the instrument indicates: Caution, risk of electric shock



On the instrument indicates: Caution (refer to accompanying documents)



On the instrument indicates: There is alternating current present.

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1. INTRODUCTION

The 5000TOC Sensor is an addition to the Smart family of sensors available for use with the 770MAX Multiparameter Analyzer/Transmitter. This manual covers the routine operation of the 5000TOC sensor and also includes instructions for using the functions in the 770MAX instrument that are specific to the 5000TOC Sensor.

The 5000TOC Sensor and 770MAX instrument provide continuous, accurate and repeatable total organic carbon measurement of pure and ultrapure water. Operation of this equipment should be in accordance with its intended use only and should adhere to the installation and operational guidelines described in this manual.

Please refer to the 770MAX Multiparameter Analyzer/Transmitter Manual, Part No. 84372, for detailed instructions of instrument functions beyond those specific to the 5000TOC sensor.

NOTE: The 5000TOC Sensor is used with 770MAX instruments operating on software version 4.0 or higher. You may upgrade a 770MAX instrument to operate with the 5000TOC Sensor if the instrument is currently operating on software version 3.0 or higher. Contact Mettler-Toledo Thornton, Inc. Technical Service for details.

The 5000TOC Sensor has more functions than most 770MAX Smart sensors, requiring more extensive interface between instrument and sensor. A maximum of two 5000TOC Sensors can be installed on one 770MAX instrument, in any of the four smart input channels. A single 770MAX patch cable is used to interface each sensor with the instrument. The remaining channels may be used for other Smart Sensors.

2. INSTALLATION

UNPACKING

Carefully unpack the 5000TOC sensor. The box should contain the following items:

- 5000TOC Sensor
- 5000TOC Sensor Instruction Manual
- 5000TOC Start-up Sheet
- Certificate of Calibration
- Installation Kit includes:

One - 6 foot (2m) length of PTFE tubing, 0.125 inch O.D., with compression type tube ferrule attached at one end

Two - 5 foot (1.5m) lengths of Polyurethane tubing, 0.25 inch O.D. with no fittings attached

One - Plastic 30cc Syringe

One - Tool, 5000TOC cover

One - Pressure regulator, 316 SS with integral 40 micron filter

INSTRUMENT DESCRIPTION

Shown below (FIGURE 1) are the case dimensions for the 5000TOC Sensor.

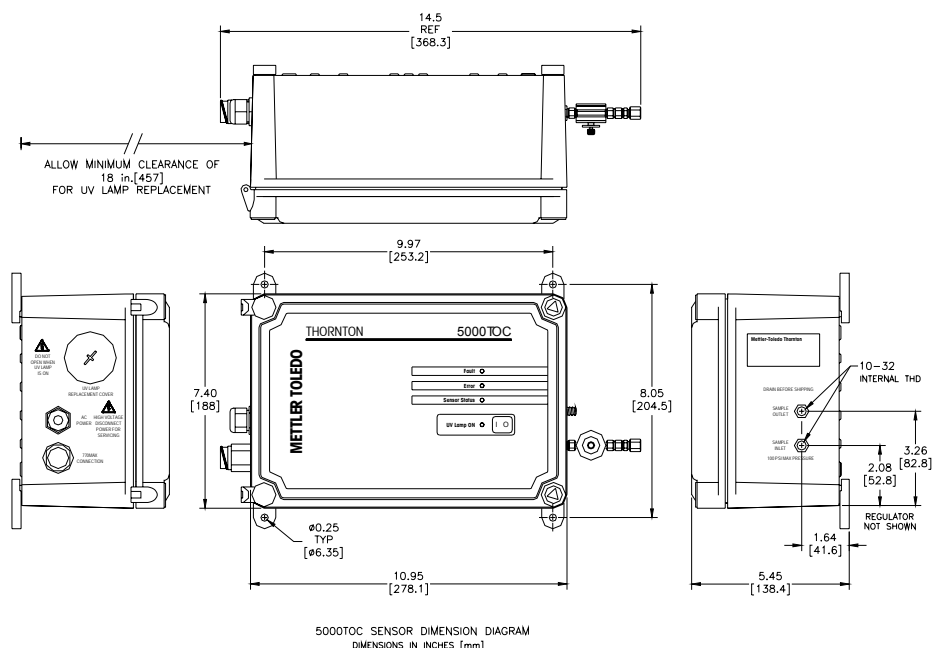


FIGURE 1

INSTRUMENT INSTALLATION

Mount the 5000TOC Sensor as close to the sample point of your system as possible. **Shorter sample tubing length between the sampling point and the 5000TOC Sensor will reduce response time.** As shown in Figure 1, the 5000TOC Sensor is supplied with wall-mounting tabs for wall or panel mount. The 5000TOC sensor can be mounted to a pipe using a pipe-mount accessory (See Section 8: Accessories and Replacement parts.).



Please note when pipe mounting this sensor there is risk of sensor damage due to sudden shock or excessive vibration. Be sure the pipe is securely fastened.

The 5000TOC Sensor can also be placed on a bench-top or table. In this type of installation, the mounting tabs must be removed from the bottom of the sensor enclosure in order for the sensor to stand on its own. The bottom safety drain fitting will need to be removed as well for bench top installation, leaving the small opening in the bottom of the enclosure open.

Sensor internals include components made of fragile materials; therefore precautions should be taken to avoid damage due to improper handling. The 5000TOC Sensor requires routine maintenance; therefore it is beneficial to mount the sensor in an easily accessible location.

SAMPLE TUBING CONNECTIONS

The installation kit provided with the sensor includes sample tubing consisting of two 5-foot (1.5 m) lengths of 0.25 inch O.D. Polyurethane tubing and one 6-foot (2 m) length of PTFE (polytetrafluoroethylene) tubing with a tube ferrule fitting attached to one end.

The following items are necessary to insure the proper installation of the sensor:

- Sample isolation valve (not provided with sensor).
- 0.125 inch compression tube fitting for sample point (common tube fitting adapters are available from Thornton, see Accessories in section 8).

NOTE: The sample point should contain a shut-off valve to isolate the sensor when necessary. Proper installation guidelines should be followed when installing this valve to reduce the possibility of air entrapment or sediment in the sample line.

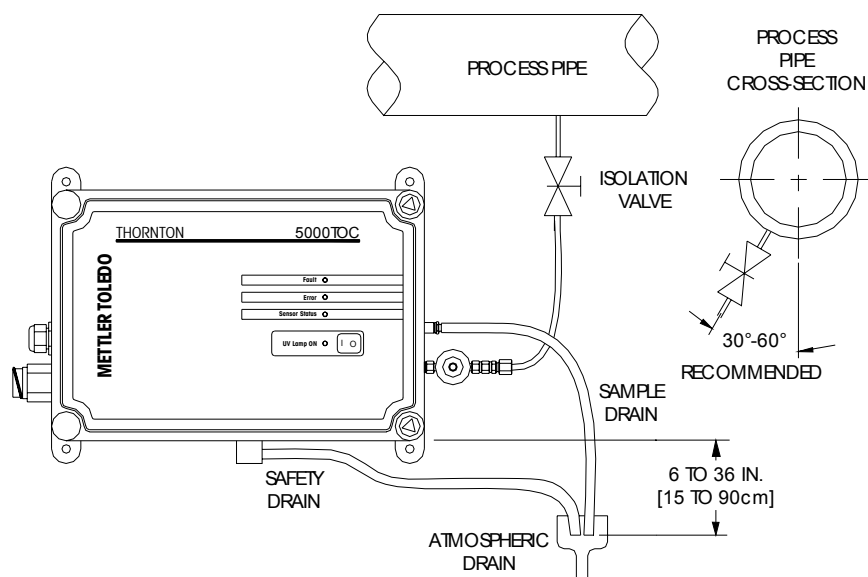


FIGURE 2

- Remove the protective covers from the sample connections on the sensor.
- Attached the open tube end of the PTFE tubing to the sample isolation valve. Cut excess tubing to minimize sample tubing length. Be sure all fittings are properly fastened to avoid leaks and the possibility of air ingress.

Flush the sample inlet tubing to remove any particles that may be in the line or fittings before connecting it to the 5000TOC Sensor, or prior to initial sensor startup.

- Locate the Pressure Regulator with integral 40 micron filter, provided in the sensor installation kit. The male-threaded end of the regulator is screwed into the female-threaded sample inlet fitting. Secure with a wrench to insure the connection is tight, making sure the knob on the regulator is facing outward towards the front of the enclosure so that the adjustment knob is accessible. **Do not over tighten.**
- Connect the ferruled end of the 0.125 inch PTFE tubing to the pressure regulator, by screwing the male-threaded fitting end into the female-threaded connection of the 40 micron filter. The pressure regulator is pre-assembled to the 40 micron filter at the factory; therefore the pressure regulator can only be assembled in the one direction.
- Connect the length of Polyurethane tubing containing the hose barb connector to the Sample Outlet fitting. The fitting is attached to the tube; therefore thread the fitting into the fitting on the sensor.
- Run tube to atmospheric drain located close to the sensor. See figure 2, for dimensional detail of drain location. **Take note of the 6 to 36" drain requirement.**

Important! Polyurethane sample outlet tubing must be fed to a nearby standpipe or drain sump to create an air gap and prevent siphoning. Installation must adhere to the dimensions shown in Figure 2 for proper sensor operation.

- Connect second length of Polyurethane tubing to the safety drain (if provided) located on the bottom of enclosure.
- Run tube to atmospheric drain located close to the sensor. See Figure 2, for dimensional detail of drain location.
- Once all tubing connections are complete and the sample inlet tubing has been flushed to drain, sample water can be introduced to the sensor. Slowly open the isolation valve at the sample point until flow is observed at the sample outlet drain. Adjustment of the inlet pressure regulator may be

required in order to achieve flow. This is accomplished by turning the locking ring counterclockwise and then turning the adjustment knob clockwise to increase flow. At this point, actual flow rate is not critical as this is only a rinse step. Recommended initial rinse time is 4 to 24 hours, however time may be decreased based on sample point conditions. For more details on pressure regulator operation see Section 4. Shut off the sample flow to the sensor and connect AC power to the 5000TOC Sensor.

AC POWER CONNECTION

As shown in the left side view of Figure 1, there is a bulkhead cable gland located on the left-hand side of the sensor enclosure labeled 'AC POWER' to allow for the passage of the AC power cable (not provided with sensor). If the installation demands hard conduit installation for AC power, this fitting may be removed and the hole used to terminate a conduit fitting.

NOTE: Use watertight fitting and hub that comply with the requirements of UL514B. Connect the conduit hub to the conduit before attaching the fitting to the analyzer (UL508-263.16). The opening accepts a 3/8" NPT conduit fitting with nut.

The terminal connections for AC power are located on the printed circuit board mounted to the front cover of the sensor, as shown in Figure 3. Keep AC power separated from all other internal wiring. Use the fasteners provided to secure the power wires. Be sure there is enough excess to avoid putting mechanical stress on the wiring when the front door is fully opened. The diagram below shows the terminal connections for AC power. Be sure the line fuse is properly installed when making electrical connections. A spare fuse kit is available from Thornton. See Section 8 for ordering information.

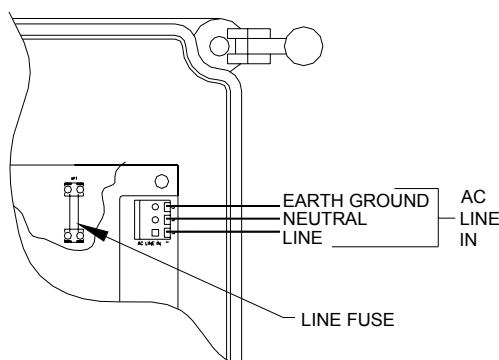


FIGURE 3

SMART SENSOR CONNECTION

Also located on the left-hand side of the sensor enclosure (refer to Figure 1) is the 770MAX smart sensor connector, labeled '770MAX Connection'. The standard 770MAX patch cable attaches directly to this connector. Align the keys of the two connectors and twist the locking nut to secure the patch cable.

Once both electrical connections are secured, the sample shut-off valve can be opened and the sensor flushed with sample water.

Section 3 of this manual defines the TOC functions available when using the 5000TOC Sensor in conjunction with the 770MAX instrument. Read carefully prior to operating the 5000TOC Sensor.

SENSOR DETAILS

The 5000TOC Sensor is designed with four local LED indicators and a UV Lamp control key on the front panel, as shown in Figure 4. The LEDs are designed to provide local indication of sensor status. The operation of the LEDs is synchronized with the 770MAX display status messages that appear in the 6-digit measurement name location.

LED Indicators:

FUNCTION	COLOR	OPERATION
FAULT	RED	Flashes during Fault condition, sensor operation stopped
ERROR	AMBER (Orange)	Illuminates during Error condition, sensor remains operational
SENSOR STATUS	GREEN	Illuminates whenever AC Power is on and 770MAX patch cable is connected to the sensor
UV LAMP ON	GREEN	Illuminates whenever the UV Lamp is on

The UV Lamp control key is designed to provide a local On/Off control for the UV lamp to allow for quick lamp change-out and assist the operator during troubleshooting, if necessary.

NOTE: If the UV Lamp Key is pressed to turn the UV Lamp off, the UV Lamp cannot be turned on from the 770MAX, it can only be turned on by pressing the sensor key again.

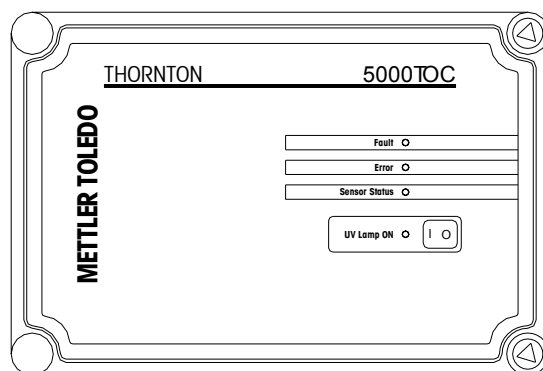


FIGURE 4. 5000TOC Front Panel

The front cover of the sensor is hinged on the left side. Located at the top and bottom right corners of the sensor enclosure are two triangle-shaped door fasteners. The installation kit provided with the sensor includes the special tool needed to loosen these fasteners and open the front door to the enclosure. Periodic access will be required to perform routine service and maintenance. Additional front cover tools are available from Thornton. See Section 8 for ordering information.

3. TOC Functions

The 5000TOC Sensor is part of the 770MAX family of Smart sensors. The 770MAX will automatically identify the 5000TOC Sensor when it is connected to the 770MAX and all cell constants and factory calibration data are automatically read and stored. The 770MAX will also provide TOC specific menus for the channel connected to the 5000TOC Sensor. Section 3.1 shows these menus and provides the data entry options for each menu item.

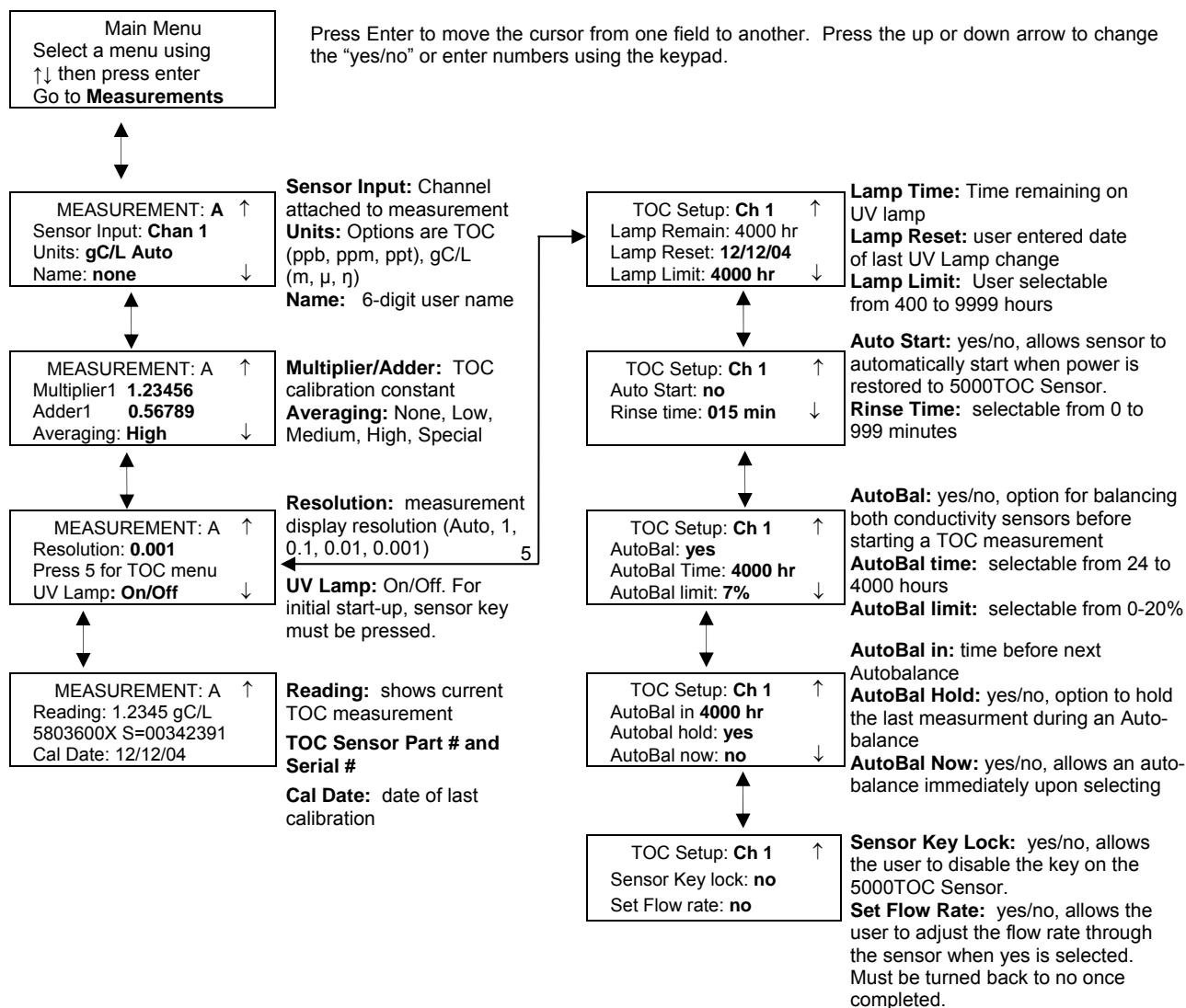
The 5000TOC Sensor is configured with factory default settings to minimize measurement setup time. These default settings allow for sensor operation with minimal keystrokes. The 5000TOC Sensor is more complex than other Smart sensors and may require a higher level of operational setup. Once these parameters are set, the TOC sensor will function automatically, similar to other Smart sensors, and will require user interface only for periodic service and maintenance. Measurements available from the 5000TOC Sensor include TOC, Conductivity/Resistivity (compensated and uncompensated) and Temperature. Refer to the 770MAX manual for instructions of how to configure the display and use these measurements for other control functions available with the 770MAX instrument.

770MAX TOC MENUS

The menu tree shown below appears in the Measurements menu of the 770MAX when the 5000TOC Sensor is connected to one of the four 770MAX Smart channels. The information shown inside the menu blocks reflects the factory default values when a new sensor is connected to the 770MAX. To the right of

the menu blocks is the definition of each menu item and the user options available. Menu items shown in bold are user configurable. It is important to be familiar with the TOC menus prior to operating the 5000TOC sensor.

NOTE: All of the setup parameters described in this section are located within the MEASUREMENTS menu of the 770MAX. Once in the 'Measurements' screen, press page-down twice to arrive at the TOC Setup prompt screen. The menu will prompt you to 'Press 5' to enter the specific TOC Setup menus. The factory default values are as shown.



LAMP TIME/LAMP RESET/LAMP LIMIT

The UV lamp in the 5000TOC Sensor is rated for 4000 hours of normal usage. The 770MAX will display an error message when the lamp operating time has exceeded the lamp limit. The user can reset the Lamp Limit from 400 to 9999 hours. It is the user's responsibility to assure by calibration or other means that the lamp is outputting sufficient UV light for the sensor to make accurate TOC measurements.

To set the Lamp Limit or reset the lamp installation date, enter the Measurement menu for the measurement displaying the TOC value. Press Page Down until "Press 5 for TOC menu" is displayed. Press 5 and then Page Down until the lamp parameters are displayed. The Lamp Remain value is the number of hours remaining before the Lamp Limit has been exceeded. This value cannot be directly changed. When a new lamp is installed, the date should be entered using the keypad into the Lamp Reset value. Press Enter after the new date is entered. The Lamp Remain time will be reset to the Lamp Limit value. The Lamp Limit is changed by directly entering a value for 400 to 9999 hours. When the lamp operating time is exceeded, an Error message will be displayed.

AUTO START

Auto Start is a feature that allows the 5000TOC Sensor to automatically start making TOC measurements when it is connected to a 770MAX or when the 770MAX restarts after a power failure. The factory default setting for the Auto Start function is 'No'. Therefore **during initial start-up**, the 770MAX will identify the sensor as a 5000TOC Sensor, yet will not start a TOC measurement. To start a TOC measurement the user must go to the 'UV Lamp: On/Off' screen and set this mode to 'On' to turn the UV lamp on and start a TOC measurement. The user may also push the UV lamp button at the sensor to start a measurement. Once the 'Auto Start' mode is set to 'Yes', it is no longer necessary to turn the 'UV Lamp' option to 'On' as the 'Auto Start' function will override the Measure TOC function.

To enable Auto Start, enter the measurement menu for the measurement displaying the TOC value. Press Page Down until "Press 5 for TOC menu" is displayed. Press 5 and then press Page Down until the Auto Start function is displayed. Select 'Yes' if you want to enable the Auto Start feature. Select 'No' to disable this feature. In the event that direct human intervention is desired to re-start measurements, this feature should be set to 'No'.

RINSE TIME

The Rinse Time is the time at start up (initial connection to a 770MAX, 770MAX system reset or 770MAX power reset) that the sensor will have sample water flowing through it before making TOC measurements. The Rinse Time can be set from 1 to 999 minutes. To set the Rinse Time, enter the measurement menu for the measurement displaying the TOC value. Press Page Down until "Press 5 for TOC menu" is displayed. Press 5 and then press Page Down until the Rinse Time is displayed. Using the 770MAX keypad, enter the Rinse Time desired and press Enter.

AUTOBALANCE/AUTOBALANCE TIME/ AUTOBALANCE LIMIT

The 5000TOC Sensor is capable of automatically balancing the two conductivity sensors. This step is performed to account for small differences in conductivity measurement between the two conductivity sensors. This step is performed at the factory prior to shipment of a new sensor and is performed during sensor startup. If power to the sensor is interrupted and restored, or if the patch cable is disconnected and then re-connected, an Autobalance will occur if the Autobalance function is enabled. The user also has the ability to set or change settings for the following functions associated with Autobalance:

- Enable (yes) or disable (no) Autobalance feature
- Set a time interval (AutoBal Time) for the Autobalance to occur automatically
- Set the tolerance (AutoBal Limit) for balancing the sensors (limit in %)
- View the time remaining until the next Autobalance (AutoBal in xxxx.x hr)
- Set a hold 'current measurement' so the analog outputs and relays are held in their current state while an Autobalance occurs (AutoBal Hold)
- Perform an immediate Autobalance (AutoBal Now)

To set the Autobalance parameters, enter the measurement menu for the measurement displaying the TOC value. Press Page Down until "Press 5 for TOC menu" is displayed. Press 5 and then press Page Down until the Autobalance features are displayed. There are 2 screens of Autobalance features. In the first screen, you can enable or disable the Autobalance feature (default is yes). You can select the time interval for the Autobalance. It is selectable from 24 to 4000 hours (factory default is 4000 hours). You can set the Autobalance limit. This is the percentage difference allowed between the two conductivity cell readings during an Autobalance cycle when the lamp is off. Under normal operating conditions, there is no need to reset the AutoBal Limit or AutoBal Time.

Press Page Down to access the next screen of Autobalance features. You can directly view the time remaining until the next Autobalance. This time cannot be directly changed. You can select whether to hold the outputs during the Autobalance cycle. You can also elect to do an Autobalance immediately by selecting 'Yes' for the AutoBal Now function.

SENSOR KEY LOCK

The Sensor Key Lock menu is located below the Autobalance menus. You can set the Sensor Key Lock to 'Yes' or 'No'. The default is 'No'. To de-activate the Keypad at the Sensor, change this to 'Yes'. This

function can be used to avoid inadvertently turning the UV lamp off at the sensor under normal operating condition.

SET FLOW RATE

The capability to set the flow rate is located in the final TOC screen. When Set Flow Rate is set to 'Yes', the sensor LED lights act as flow indicators during the flow adjustment process. See Section 4, for details on how and when to perform a flow adjustment. Once the flow is adjusted to the proper level, the user must change the Set Flow Rate: 'Yes' back to 'No' to confirm the flow rate is properly set.

4. OPERATION

There are two basic operational circumstances for the 5000TOC Sensor and 770MAX system. Both scenarios are described below. The first of which is called the 'Initial Start-up' condition and the second is called the 'Normal Operation' condition.

INITIAL START-UP

Initial start-up refers to the condition where a 5000TOC Sensor is installed and setup for the first time. As shown in Section 3, factory default settings for a 5000TOC Sensor are designed to minimize setup time for this sensor and allow the sensor to measure automatically. However, during initial start-up it is desirable to first set the flow rate through the sensor. This is performed to insure the flow is optimized through the sensor and to avoid a potential flow rate alarm condition. Once the sensor is installed and sample water flowing through the sensor, and the 770MAX patch cable is connected, follow these steps to insure the sensor operates at the specified sample flow rate.

SETTING SAMPLE FLOW RATE

The 5000TOC Sensor is designed to operate optimally at a flow rate of 20 mL/min. The flow rate was set during the factory calibration to this value. However, since the flow rate may depend on the sample line plumbing and input pressure, it is advisable to reset the flow rate at installation and to check it periodically. It is also possible to calibrate the flow sensor device, refer to Section 5, Flow Calibration. To set the flow rate, enter the measurement menu for the measurement displaying the TOC value. Press Page Down until "Press 5 for TOC menu" is displayed. Press 5 and then Page Down until the Set Flow Rate menu is displayed. Change the 'No' to 'Yes' to immediately initiate the 'set flow rate' mode at the sensor. It will stay in this mode until the 'Yes' is changed back to 'No'.

In this mode, the sensor LED lights on the front cover act as a bar-graph type indicator as described below. The flow rate is set by adjusting the pressure regulator installed on the sample inlet connection of the 5000TOC Sensor (see Figure 5). There is a small adjustment knob in the center of the regulator and a larger locking ring below it. Turn the locking ring counterclockwise to unlock the adjustment knob. Turning the small adjustment knob clockwise will increase the flow rate while turning it counterclockwise will decrease the flow rate. Initially, start adjustment with the regulator knob turned counterclockwise until there is no flow observed. Caution should be taken not to thread the knob out if the regulator body. Once this is completed, begin turning the adjustment knob clockwise slowly to gradually increase flow.

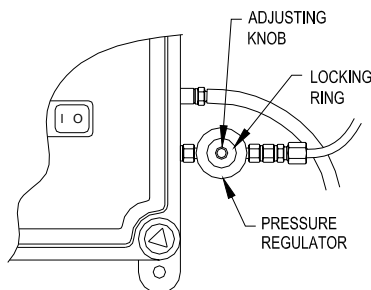


FIGURE 5. Pressure Regulator Location

The flow rate value is indicated by the four LEDs on the front of the 5000TOC Sensor. When the flow rate is set to 20 mL/min ($\pm 5\%$), all four LEDs will be on as shown in the table below. If the flow rate is too

high, only the top LEDs will be on (turn the adjustment knob counterclockwise). If the flow rate is too low, the bottom LEDs will be on (turn the adjustment knob clockwise). If the flow rate is far from 20 mL/min, only the top (Fault) LED or the bottom (UV Lamp) LED will be on. As the flow rate approaches the correct value more LEDs will turn on. Turning on 3 or 4 LEDs is acceptable. Refer to the table below.

LOW LOW	LOW	NEAR SET	SET	NEAR SET	HIGH	HIGH HIGH
○	○	○	●	●	●	●
○	○	●	●	●	●	○
○	●	●	●	●	○	○
●	●	●	●	○	○	○

○ = not illuminated
● = illuminated

When the flow rate is set correctly (3 or 4 LEDs on), turn the locking ring on the pressure regulator clockwise to lock the adjustment knob in place, being careful not to move the adjusting knob. Return the Set Flow Rate option to 'No' in order to leave this mode and this menu. The flow rate setting operation is now complete.

START TOC MEASUREMENT

Now that the flow rate is set, the operator can return from the TOC menus in order to start the TOC measurement process. The factory default for Auto Start is No. It is for this reason that the UV Lamp did not automatically turn on. Return to the menu option to turn the UV Lamp on. Change the factory default from 'No' to 'Yes'. At this point, the 770MAX display will display the following message: 'Press the switch on Sensor # _ to turn UV Lamp on, or press enter to continue'. The number displayed in this message is the channel associated to the 5000TOC Sensor. If more than one TOC sensor is installed, the user can change the number to whichever sensor they wish to control. No more than 2 TOC sensors can be installed on one 770MAX meter.

At this time, the Key on the sensor must be pressed before the UV Lamp will turn on and a TOC measurement will begin. This process is designed for safety, to insure that an operator is not working inside the sensor when someone at the 770MAX instrument is trying to turn on the UV Lamp.

During the setup of the TOC sensor, if the Auto Start function in the TOC setup menus is changed from 'No' to 'Yes', the 770MAX would still have prompted the operator to press the key at the sensor during this initial start-up. However after this startup, the Auto Start function takes priority and the sensor would automatically start.

NORMAL OPERATION

Under normal operating conditions, the 5000TOC Sensor is continuously relaying information to and from the 770MAX. The 770MAX display also acts as a status indicator for the sensor. If the display screen is set to display a measurement from the 5000TOC Sensor, under normal operating conditions the display will show the measurement letter, name and value, same as all other sensor measurements. If the 5000TOC Sensor is in any mode other than measurement mode, such as Rinsing, Auto balance, Error or Fault, then this status is displayed by flashing alternately within the six-character block used for the measurement name.

The 770MAX six-character TOC status indicators are as follows:

UV OFF	Flashes alternately with measurement name when UV lamp is turned off.
RINSE	Flashes alternately with the measurement name when sensor is in Rinse mode.
AUTBAL	Flashes alternately with the measurement name when sensor is in the Autobalance mode.
ERROR	Flashes alternately with measurement name when an Error exists with the TOC sensor.
FAULT	Continuously displayed in place of measurement name when Fault condition exists.

If an ERROR or FAULT condition is displayed on the measurement screen, the user can go to the Messages screen to retrieve more information regarding the cause of the condition. Refer to Section 6.4 of this manual for more information. If the Auto-balance function is set to “yes”, the 5000TOC sensor will perform an auto-balance based on the interval set within the 770MAX TOC sensor setup menus.

5. CALIBRATION

If a complete calibration is needed, the normal order of parameters to calibrate is flow rate, temperature, conductivity, and TOC.

FLOW CALIBRATION

Periodically it may be necessary to calibrate the sample flow rate through the 5000TOC Sensor. Changes that may affect the flow calibration of the sensor include dramatic process condition changes at the sample point, a change to the sensor's physical location or to the sensor sample tubing. All of these can sometimes alter flow characteristics and affect flow measurement.

In the Calibrate/Sensor menu of the 770MAX, the user can calibrate the flow measurement from the 5000TOC Sensor (refer to the 770MAX instruction manual for keystroke instructions and further details). The options for the type of calibration are a one-point or two-point calibration. A two-point calibration will provide the best results. Ideally, the two calibration points should be approximately 15 mL/min and 25 mL/min. Calibrating the flow sensor of the 5000TOC Sensor requires equipment such as a graduated cylinder or beaker and a stopwatch or other timing instrument. Alternatively, using a balance to weigh the volume collected will provide a more accurate measurement and precise calibration.

When ready to perform a calibration, use the sample outlet tubing to capture a specific volume into the beaker or graduated cylinder and note the amount of time taken to reach that volume. Convert the volume and time into units of mL/min. It is important that the user is careful not to drastically change the relative position of the Sample Outlet tubing when capturing flow samples for calibration, as this will cause some variation in calibration.

To perform a flow calibration, select the Calibrate menu in the 770MAX instrument menus (reference the calibration procedure in the 770MAX instrument operation manual, p/n 84372).

- Select Sensor calibration. The menu will allow the user to enter a hold time, which holds the current output to avoid triggering alarm setpoints during the calibration process. If left at '00' there is no hold function in effect.
- Press Page Down and select the measurement letter corresponding to the sensor being calibrated, in this case the letter associated to the TOC sensor.
- On the same screen select either one- or two- point calibration.
- On the same screen select the parameter to calibrate. The options are TOC, gC/L, C1, C2, T1, T2 and Flow. Select Flow.
- Press Page Down. The display shows the current reading for the flow rate. At this point, measure the actual flow rate from the Sample Outlet using a graduated cylinder/beaker and stopwatch.
- Adjust flow accordingly, until the desired flow rate is attained, i.e., ~25 mL/min \pm 5%.
- Enter the actual flow rate.
- Press Page Down to perform the calibration of point 1.
- If doing a 2-point calibration, adjust the flow rate to the second value, i.e., ~15 mL/min \pm 5%.
- Enter the actual flow rate.
- Press Page Down to perform the calibration of point 2.
- The display will show the measured value before and after calibration.
- Enter calibration date. Press page down.
- Save changes to accept calibration.
- Exit menus.

TEMPERATURE CALIBRATION

A one-point calibration is used for the temperature sensors (that are contained within the conductivity sensors). Refer to the 770MAX instrument manual 84372 for instructions to perform a temperature calibration using the 770MAX.

The principal methodology to calibrate the two temperature sensors is to turn off the TOC lamp and flush water through the TOC unit and also flush water into a reference sensor that is in parallel with the TOC system. The water should be near ambient temperature to minimize the ambient cooling of the water as it flows through piping. This helps to insure that the water at the reference sensor and the water at the sensor under test (SUT) are at the same temperature. Maintaining a high flow rate also helps to reduce the ambient cooling/heating effects.

Thornton provides the service and/or the equipment to perform such a test (excluding the plumbing hardware to tee off of the sample line to the TOC sensor). Thornton's 1885 770MAX Calibration Kit includes the necessary equipment. The kit includes a flow chamber and calibrated, traceable 2-electrode conductivity sensor, along with a calibrated, traceable 770MAX instrument. Consult Thornton Technical Service for assistance.

The sequence of steps to perform the calibration of C1 or C2 is identical to the Flow calibration with the following exceptions.

- Select T1 or T2 accordingly.
- Select 1-point calibration.
- Use an appropriate temperature reference as described above.

CONDUCTIVITY CALIBRATION

A one-point calibration is used for 2-electrode resistivity or conductivity sensors such as those used in the 5000TOC Sensor. Refer to the 770MAX instrument manual 84372 for instructions to perform a conductivity calibration using the 770MAX.

The principal methodology to calibrate the two conductivity sensors is to turn off the TOC lamp and flush high purity process water through the TOC unit and also flush water into a reference sensor that is in parallel with the TOC system. The water should be near ambient temperature to minimize the ambient cooling of the water as it flows through piping. This helps to insure that the water at the reference sensor and the water at the sensor under test (SUT) are at the same conductivity. Maintaining a high flow rate also helps to reduce any impact of CO₂ altering the conductivity measurement.

NOTE: It is not desirable to calibrate the sensors inside the 5000TOC Sensor with a conductivity reference standard solution. The conductivity of standard solutions is very high in comparison to the normal operating range of the conductivity sensors within the TOC sensor. Therefore, this type of calibration is not recommended.

Thornton provides the service and/or the equipment to perform such a test (excluding the plumbing hardware to tee off of the sample line to the TOC sensor). Thornton's 1885 770MAX Calibration Kit includes the necessary equipment. The kit includes a flow chamber and calibrated, traceable 2-electrode conductivity sensor, along with a calibrated, traceable 770MAX instrument. Consult Thornton Technical Service for assistance.

The sequence of steps to perform the calibration of C1 or C2 is identical to the Flow calibration with the following exceptions.

- Select C1 or C2 accordingly.
- Select 1-point calibration.
- Use an appropriate reference conductivity standard as described above.

TOC CALIBRATION

A 1-point and a 2-point TOC calibration are available when using the 5000TOC Sensor with the 770MAX instrument. Refer to the 770MAX instrument manual 84372 for key-stroke instructions to perform calibrations using the 770MAX.

For field TOC calibration, a 1–point calibration is recommended at mid-range for the sensor, or a 500 ppb Sucrose solution, prepared using a traceable reference standard. As the 5000TOC Sensor is a flow through device that operates using sample line feed pressure to move the sample through the device, auxiliary equipment is required to introduce the reference solution. Solution volume should be 200 mL minimum. Thornton can provide the service and/or additional equipment needed to perform this calibration. The System Suitability Kit 58091525 provides the necessary equipment capable of introducing a standard solution. Contact Thornton for details regarding calibration standard solutions.

Low-level TOC calibrations (<100 ppb) are not recommended for on-site field calibrations as it is typically not practical to inject low concentrations of organics and achieve acceptable results as this requires sophisticated equipment and very controlled test conditions. However, a second method for verification and calibration with the use of a separate calibrated TOC instrument is an acceptable option. If a separate calibrated, traceable, TOC instrument is available, a side-by-side comparison and verification can be performed and the 5000TOC Sensor can be calibrated against this device using a one-point calibration. This second instrument needs to be plumbed into the same sample line as the sensor and care taken to insure there are no loose fittings or wide variations in sample inlet tubing lengths to each instrument. These factors are likely to cause erroneous readings.

The sequence of steps to perform the calibration of TOC is identical to the Flow calibration with the following exceptions.

- Select TOC or gC/L accordingly.
- Select 1-point or 2-point calibration. 1-point Calibration is recommended for most applications.
- Use an appropriate reference TOC standard as described above.
- When performing a 1-point calibration, the user has the option to adjust the Slope or the Offset in the calibration factors. Select Slope for most 1-point calibrations. Select Offset only for very low TOC applications, typically <5-10 ppb.
- In all calibrations, the new Slope or Offset is automatically determined.
- Like any other calibration, when performing a 2-point calibration, make sure to use two TOC solutions that differ significantly in TOC.

6. SERVICE AND MAINTENANCE

The 5000TOC Sensor is designed to minimize service and maintenance. There are no moving mechanical components, therefore normal operating wear and tear is negligible. This reduces the amount of consumable components as well as the amount of time needed to maintain the sensor. Listed below are instructions on how to perform simple periodic maintenance, which includes UV Lamp change (every 4000 hours of operation), filter replacement (typically every 12-18 months), internal tubing replacement (typically every 3-5 years), and general cleaning. It is recommended to re-calibrate flow during periodic maintenance to insure proper flow through the sensor.

UV LAMP REPLACEMENT

Thornton recommends after every 4000 hours of operation, the UV lamp inside the 5000TOC Sensor is replaced. This is a simple procedure that requires only a few minutes to complete. The following steps explain the proper procedure for the UV lamp change-out. Refer to Figure 6.

NOTE: Use of a UV lamp other than those provided by Thornton specifically for use with the 5000TOC Sensor will affect performance and void the warranty of this product.

Step 1 – At the sensor, turn off UV lamp (UV lamp ON LED will turn off). If the LED does not turn off, check that the Sensor Key Lock is off in the 770MAX. Refer to Section 3 Sensor Key Lock function in this manual.

Step 2 – Once power to the UV lamp is off, open the front cover of the sensor enclosure with the front cover tool.

Step 3 – Remove the side cover labeled 'UV LAMP REPLACEMENT COVER' on the left side of the sensor enclosure. Use a flat-head screwdriver and turn the cover counterclockwise to loosen and unscrew the cover.

Step 4 – Disconnect the power cable to the UV lamp. This connector is located on the backside of the front cover, above the circuit board.

Step 5 – Slide the cable of the UV lamp through the side opening of the enclosure and gently slide the UV lamp out of the oxidation chamber assembly (black cylinder). Be careful not to let the UV lamp hit the quartz glass tube inside the chamber.

Step 6 – Hold new lamp from the ends of the lamp. Do not touch the bulb. Slide the new UV lamp into the side opening of the enclosure and into the oxidation chamber opening until it stops. Do not use excessive force to insert the UV lamp as this may cause damage to the lamp or the internal components of the oxidation chamber.

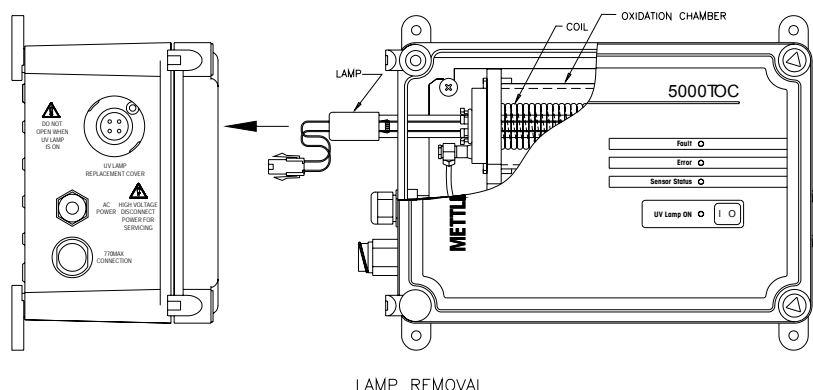
Step 7 - Feed the power cable through the side opening of the enclosure. Re-connect it to the power connector on the front door.

Step 8 – Close front cover of the sensor and secure fasteners with the front cover tool.

Step 9 – Install the UV Lamp replacement cover on the opening on the side of the enclosure.

Step 10 - In the 770MAX menus, select the measurement corresponding to the TOC sensor and page down until prompted to 'push 5 to enter TOC menus'. Press the 5 key.

Step 11 – Press Enter key until the cursor is under the date shown for Lamp Reset: Enter the date when the lamp was replaced and hit the enter key. Back out of menus and SAVE changes prior to exiting the measurement menu. This resets the lamp timer to the Lamp limit value (factory default is 4000 hours).



LAMP REMOVAL

FIGURE 6.

40 MICRON FILTER REPLACEMENT

The 5000TOC Sensor includes two (2) 40 micron sintered 316 SS filter fittings. Sample feed water to the sensor is pure and ultrapure water, therefore the frequency of filter change should be low. Thornton recommends every 12-18 months as a preventative maintenance measure; however the filters may perform acceptably for longer periods of time.

The first filter is located on the sample inlet tubing and was pre-assembled to the tubing provided with the sensor. The filter is a small 316 SS fitting with a female-threaded end (end attached to the sample tubing fitting) and a male-threaded end (the end which is secured into the pressure regulator inlet). Using 5/16" (8mm) sized wrench, this filter can be removed by first removing the tubing from the female-end and then unscrewing the male-end from the pressure regulator inlet. The replacement fitting kit provides a separate instruction sheet to complete this procedure.

The second filter is located inside the sensor enclosure. This filter is located on the outlet side of the second conductivity sensor (the conductivity sensor downstream of the oxidation chamber labeled sensor

2). A similar procedure to the sample inlet filter is required for removal and replacement of this filter. The replacement fitting kit provides a separate instruction sheet to complete this procedure. See Section 8, Accessories for part number.

INTERNAL TUBING REPLACEMENT

Under normal operating conditions, replacement of internal tubing is required only as a preventative maintenance measure, every 3 to 5 years of operation. In varied operating conditions, replacement may be necessary at a different timeframe. An Internal Tubing Replacement Kit includes all pre-cut tubing and ferruled ends where needed, as well as instructions of how to replace each length of tubing. See Section 8, Accessories for part number.

FRONT PANEL CLEANING

Clean the 5000TOC Sensor enclosure and front face-panel with a damp soft cloth (water only, no solvents). Gently wipe the surface and dry with a soft cloth.

TROUBLESHOOTING CHECKLIST

Listed below are some techniques that may assist in troubleshooting this piece of equipment. Refer to Section 6.4 for Fault and Error messages that appear in the 770MAX menus when a Fault or Error LED illuminates to signal the user that an undesirable condition exists with the TOC measurement system.

Problem	Possible Cause
None of the LEDs illuminated	<ul style="list-style-type: none">• Patch cable disconnected• LED/Keypad failure.• Circuit board failure
Only the RED Fault LED is illuminated.	<ul style="list-style-type: none">• Power to sensor disconnected or circuit breaker tripped with patch cable to 770MAX plugged in
No Flow from sensor sample outlet	<ul style="list-style-type: none">• Flow orifice clogged• Pressure regulator not adjusted properly• Sample flow shut off to sensor inlet• Internal component leaking• Sample feed pressure too low
Erratic flow through the sensor	<ul style="list-style-type: none">• Sample outlet tubing not installed per manufacturer's instructions• Pressure regulator failure or not adjusted properly• Sample feed pressure too low

ERRORS & FAULTS

When an Error or Fault condition exists, the 770MAX TOC measurement will display the status indication by flashing alternately with the measurement name (flashing ERROR or FAULT). In the messages menu of the 770MAX, there is an option to display the current message or the message history (last 3 messages) for any of the 16 measurements. The messages associated with the 5000TOC Sensor are listed in the following tables. The first character of the message will be an F for a fault and an E for an error. A fault will cause the sensor to not operate. Faults cause the 770MAX to control relays and analog outputs to the defined failsafe condition, i.e., on fault set minimum or maximum.

Fault Message Table

Source	Message Displayed	Description	Action
Sensor	F-UV Lamp Failure	UV lamp not lit when powered up	Check lamp connections or Replace lamp
Sensor	F-No AC Power	AC Power loss at sensor	Restore power to sensor
770MAX	F-No flow detected	Flow < 10 ml/min = no flow or flow sensor failed	Adjust pressure regulator Check for obstruction in water line
770MAX	F-C1 shorted	C1 failure (sensor or cable)	Replace C1
770MAX	F-C2 shorted	C2 failure (sensor or cable)	Replace C2
770MAX	F-C1 open	C1 failure or no water	Check for flow. Replace C1.
770MAX	F-C2 open	C2 failure or no water	Check for flow. Replace C2.
770MAX	F-T1 open/shorted	T1 failure (sensor or cable)	Replace C1
770MAX	F-T2 open/shorted	T2 failure (sensor or cable)	Replace C2
770MAX	F-Conductivity high	Input conductivity > 100 μ S/cm compensated on C1	User must correct
770MAX	F-Temp high	Temp Over range > 95 deg C at C1	User must correct
770MAX	F-Communication	Communication failure between MAX and sensor	Set by MAX

An error is generated by a condition that may cause a problem with the proper operation of the sensor. Under an error condition, the sensor can still make measurements but the measured value may be in error.

Error Message Table

Source	Message Displayed	Description	Action
Sensor	E-UV lamp over time	Lamp life > user limit	Override possible Change lamp
770MAX	E-Insufficient flow	Flow rate below 15 mL/min	Adjust pressure regulator Check for obstruction in water line Replace filter
770MAX	E-Flow too high	Flow > 25 ml/min	Adjust pressure regulator
Sensor	E-NVRAM Failure	Can't communicate or checksum invalid	Repair sensor. Will work with default settings. Set by sensor
770MAX	E-AutoBal too high	Δ C12 < user limit	Turn lamp off. Flush system Restart
770MAX	E-Conductivity unstable	Δ C1 too noisy	Check for air bubbles
770MAX	E-Conductivity low	Input conductivity < 0.050 μ S/cm compensated on C1	User must correct
770MAX	E-Temp high	Temp Over range > 90 °C at C1	User must correct
770MAX	E-Temp low	Temperature detected <2 °C at C1	User must correct
770MAX	E-TOC over range	TOC > 1 ppm	Mis-application of sensor

7. SPECIFICATIONS

TOC Performance Specifications

Measurement Range	0.05 - 1000 µgC/L (ppbC)
Accuracy	Greater of 2 ppbC or $\pm 5\%$ of measurement
Repeatability	± 0.2 ppbC, TOC < 10 ppbC, $\pm 2.0\%$, TOC > 10 ppbC ± 0.2 ppbC, TOC < 10 ppbC, $\pm 2.0\%$, TOC > 10 ppbC (Instrument-to-Instrument)
Resolution	0.001 ppbC (µgC/L)
Analysis Time	Continuous
Initial response time	< 60 seconds
Limit of Detection	0.025 ppbC
Conductivity Cell	
Constant Accuracy	$\pm 1\%$
Conductivity Cell	
Constant Repeatability	$\pm 0.25\%$
Temperature Sensor	Pt1000 RTD, Class A
Temperature Accuracy	$\pm 0.25\text{ }^{\circ}\text{C}$ @25 °C

Sample Water Requirements

Temperature	5 to 90 °C
Particle Size	<100 micron
Minimum Water Quality*	$\leq 2\text{ }\mu\text{S/cm}$
Flow rate	$\geq 20\text{ mL/min}$
Pressure	15 to 100 psig (1.0 bar to 6.9 bar) at sample inlet connection

General Specifications

Overall Dimensions	11" (280mm) W x 7.4" (188mm) H x 5.25" (133mm) D
Sample Connections	
Inlet	0.125" (3mm) O.D. compression-type (ferrule) tube connection (Fitting, 40 mm filter and 6' (2m) tubing supplied)
Outlet	0.25" (6mm) O.D. Barb connection (5' (1.5m) flexible tubing provided)
Inlet Filter	316SS, inline 40 micron (x2)
Weight	5.0 lb. (2.3 kg)
Enclosure material	Polycarbonate plastic, flame retardant, UV and chemical resistant UL # E75645, Vol.1, Set 2, CSA #LR 49336
Enclosure rating	NEMA 4X Industrial environment
Wetted parts	316SS/Quartz glass/PEEK/Titanium/PTFE/Polyurethane (outlet tubing only)/EPDM
Ambient Temperature/ Humidity rating	5 to 50 °C / 5 to 80% Humidity, non-condensing
UL Electrical Environment	Installation Category II
Power requirements	100 - 130VAC or 200 - 240VAC, 50/60 Hz, 25W Maximum
Wall Mount	Standard, mounting tabs provided
Pipe Mount	Optional, with pipe-mount bracket accessory (for nominal pipe sizes 1" to 4")
Maximum Sensor Distance	300ft (91m)
Local Indicators	Four LED lights for Fault, Error, Sensor Status and UV Lamp ON
Ratings/Approvals	CE Compliant, UL and cUL (CSA Standards) listing pending.

* Sample water quality with a conductivity > 2.0 µS/cm may result in reduced accuracy.

8. ACCESSORIES AND REPLACEMENT PARTS

5000TOC SENSOR ACCESSORIES

- 58 079 010 Printer, 110 VAC for connection to serial part of 770MAX
- 58 079 011 Printer, 220 VAC for connection to serial part of 770MAX
- 58 091 520 Kit, Tool, 5000TOC Sensor (includes 5/16", 3/8", 7/16" and offset screwdriver)
- 58 091 502 Kit, Filter, 40 micron, 316 SS (2 used per sensor)
- 58 091 521 1 1/2" Pipe Mount Kit
- 58 091 522 2" Pipe Mount Kit
- 58 091 523 3" Pipe Mount Kit
- 58 091 524 4" Pipe Mount Kit
- 58 091 525 Kit, System Suitability Pump (Standard solutions sold separately)

5000TOC SENSOR REPLACEMENT PARTS

- 58 091 510 Assembly, Oxidation Chamber (UV Lamp not included)
- 58 091 511 Assembly, Conductivity Sensor (for use as both C1 or C2)
- 58 091 512 Valve, Pressure regulating, 316 Stainless Steel
- 58 091 513 Orifice Plate, 316 Stainless Steel
- 58 091 514 Assembly, Flow sensor with pre-mounted capillary tubing
- 58 019 515 Kit, Internal Tubing (pre-attached ferrules included)
- 58 091 516 Assembly, Sensor PCB, 110 VAC version
- 58 091 517 Assembly, Sensor PCB, 220 VAC version
- 58 019 518 Power Supply, UV Lamp
- 58 091 519 Kit, Fuse, Sensor PCB line voltage
- 87015 Tool, 5000TOC Sensor Cover

5000TOC SENSOR CONSUMABLES

- 58 079 510 Replacement UV Lamp
- 58 091 526 Kit, Traceable system suitability standards (for use with 58 091 525)
Includes four 480mL bottles, (1) Sucrose, (1) p-Benzoquinone and (2) reagent water for one test
- 58 091 527 Kit, Traceable TOC Calibration Solutions

9. RATINGS

CE DECLARATION



Declaration of Conformity

We,
Mettler-Toledo Thornton, Inc.
36 Middlesex Turnpike
Bedford, MA 01730, USA
Declare Under our sole responsibility that the product:

5000TOC Sensor

to which this declaration relates, in conformity with the following European, harmonized and published standards at the date of this declaration:

EMC Emissions: EN 55011 Class A

EMC Emissions and Immunity: EN 61326 Measurement Control and Laboratory equipment EMC requirements.

Safety: EN 61010-1 2001-02, Second edition

UL LISTING (Approval pending)

US UL61010-1 Electrical Equipment for Measurement, Control and Laboratory use

CAN/CSA CSA 22.2 No. 61010-1

10. WARRANTY

Mettler-Toledo Thornton, Inc. warrants products it manufactures against defects in materials and workmanship for 18 months from the date of shipment from Thornton. Some non-Thornton manufactured resale items may have shorter warranties. Thornton honors only the warranty period of the original manufacturer. Consumable items such as pH and ORP sensors and TOC UV lamps are warranted for a period of 6 months from shipment in normal use and service. Catalog descriptions, although accurate, should not be taken as a guarantee or warranty. Mettler-Toledo Thornton's obligation under the warranty shall be to repair at its facility or replace any products, which Thornton finds to be defective. Items returned for warranty must be properly packaged, shipped prepaid and insured, and must be accompanied by a Return Materials number assigned by Thornton Customer Service. Proper return packaging for pH, ORP, and dissolved oxygen sensors includes their original storage boot, chamber or alternative packaging containing a small amount of water to keep the sensor tip from drying out. TOC instruments must be re-packaged according to their instruction manuals.

Note: Substitution, modification or mis-wiring of cables voids all warranties.

THE ABOVE WARRANTY IS THE ONLY WARRANTY MADE BY METTLER TOLEDO THORNTON, INC. AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THORNTON SHALL NOT BE LIABLE FOR ANY LOSS, CLAIM, EXPENSE OR DAMAGE CAUSED BY, CONTRIBUTED TO OR ARISING OUT OF THE ACTS OR OMISSIONS OF THE BUYER OR THIRD PARTIES, WHETHER NEGLIGENT OR OTHERWISE. IN NO EVENT SHALL THORNTON'S LIABILITY FOR ANY CAUSE OF ACTION WHATSOEVER EXCEED THE COST OF THE ITEM GIVING RISE TO THE CLAIM, WHETHER BASED IN CONTRACT, WARRANTY, IDEMNITY, OR TORT (INCLUDING NEGLIGENCE).

RETURNED GOODS:

Contact Mettler-Toledo Thornton Customer Service for a Return Materials Authorization (RMA) number before any item is returned. Items returned for credit or exchange must be in new, salable condition and in original packaging. For items being returned up to 90 days there is a 15% restocking charge; from 91 to one year, 25% restocking charge. No returns on custom and/or special orders.

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