THORNTON

Leading Pure Water Analytics

Part No. 84372

770MAX Multiparameter Analyzer/Transmitter

Instruction Manual

METTLER TOLEDO

IMPORTANT SAFETY INFORMATION

- 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.
- Protective covers must be in place unless qualified personnel are performing maintenance.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by it against hazards may be impaired.

WARNINGS:

- Installation of cable connections and servicing of this product require access to shock hazard voltage levels.
- Main power and relay contacts wired to separate power source must be disconnected before servicing.
- Main power must employ a switch or circuit breaker as the disconnecting device for the equipment.
- 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.
- RELAY CONTROL ACTION: the770MAX instrument relays will always de-energize on loss of power, equivalent to normal state, regardless of relay state setting for powered operation. Configure any control system using these relays with fail-safe logic accordingly.
- 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.

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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CHAPTER 1: INTRODUCTION

This manual covers routine operation of the 770MAX. For service, communications, unusual applications, etc. see Service Manual, Part No. 84373.

The 770MAX is a Multiparameter Analyzer/Transmitter for high accuracy measurement and control. It accepts inputs from up to four Smart Sensors plus two additional pulse flow sensors.

Smart Sensor parameters include:

- Resistivity with temperature
- 2- or 4-electrode conductivity with temperature
- pH with temperature
- ORP
- Dissolved oxygen
- Flow
- Temperature
- Pressure
- Level

In addition, derived measurements are available, including:

- total dissolved solids
- % concentration of HCl, H_2SO_4, NaOH
- % rejection, totalized flow
- % recovery
- ratio
- difference
- total flow
- flow velocity
- grains
- ppm-gallons

Smart Sensors are rapidly installed using patch cords up to 300 feet (91 m) long with connectors at both ends. Some sensors are restricted to shorter distances.

Smart Sensors used with the previous generation 770PC instrument are not compatible with 770MAX due to signal processing and connector differences. Where it is desired to update existing sensors for use with 770MAX, consult Thornton Service.

The 770MAX can display up to 16 measurements, each with custom six-character names and engineering units. These measurements are displayed four to a screen and can be manually or automatically scrolled.

Standard outputs include 4 isolated analog (0/4-20 mA) signals, RS232 and two TTL discrete output ports. Optional outputs include 4 additional analog signals and 4 SPDT relays. All options are contained within the single 1/4 DIN enclosure.

The 770MAX is supplied with mounting hardware for sealed front panel mounting. Pipe and wall mounting kits as well as sealed rear cover can be ordered separately.

NOTE: Multiparameter capability allows several sensors to be used in the same process line with a single instrument. However, when 4-electrode conductivity, and pH or ORP sensors are to be used in the same process, or if the process uses electrical current (such as electrodeionization, electroplating, etc.), consult Thornton for application considerations.

CHAPTER 2: INSTALLING THE 770MAX

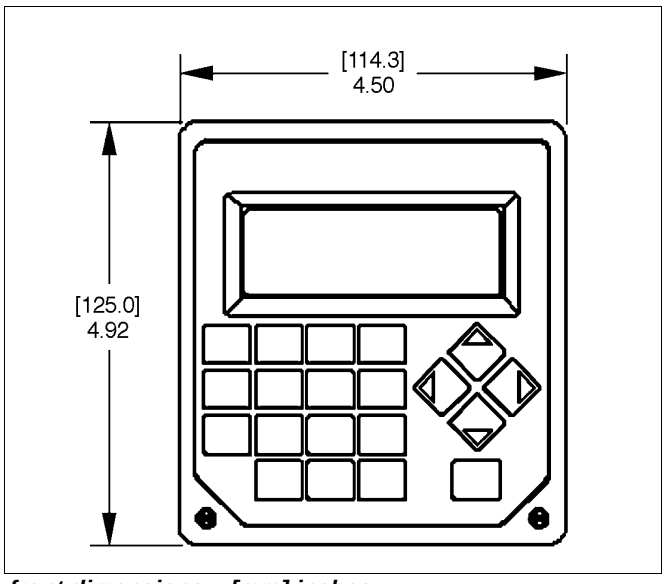
UNPACKING

Carefully unpack the 770MAX, the carton should contain:

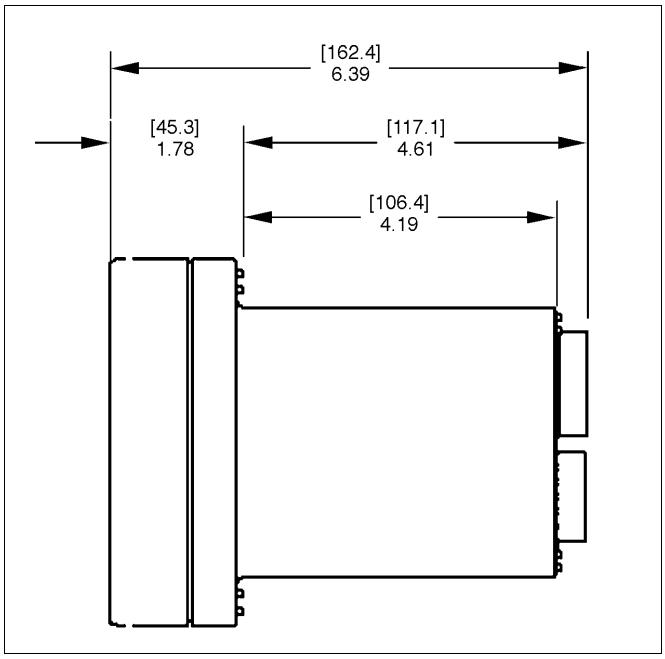
- 770MAX instrument
- 770MAX Instruction Manual
- mounting screws, 4
- panel mounting gasket

INSTRUMENT DESCRIPTION

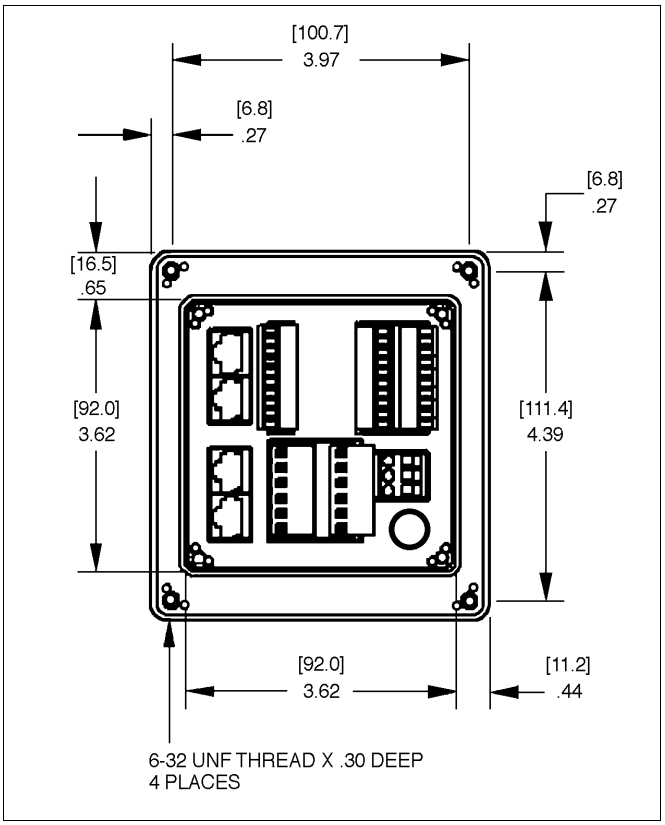
Shown below are the 770MAX case dimensions:



front dimensions – [mm] inches



side dimensions – [mm] inches

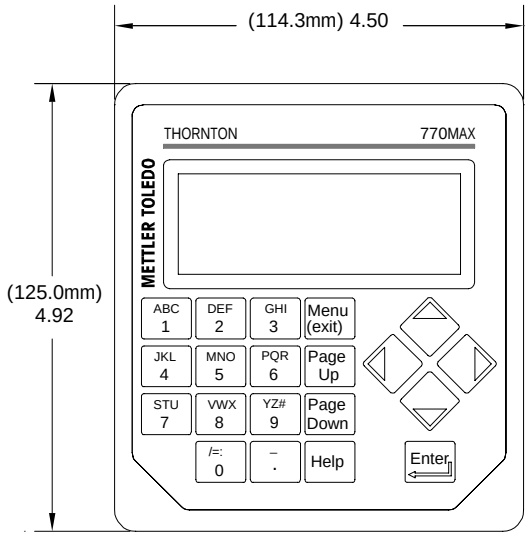


rear dimensions – [mm] inches

Front Panel

Display:
The display has four lines of 20 characters each; either backlit LCD or optional vacuum fluorescent display. Custom six-character names may be given to each measurement in place of Chan 1, Chan 2, etc.

Keypad:
The keypad consists of 9 function keys and 11 alphanumeric entry keys. See **Chapter 3: Getting Started** for detailed descriptions of each key.



770MAX FRONT PANEL/MEMBRANE

front panel

Rear Panel

All electrical, relay, input, output, and communication connections are made via the rear panel of the 770MAX. The options available are dependent on the 770MAX model purchased. See **CONNECTIONS** later in this section.

INSTRUMENT INSTALLATION

The 770MAX can be mounted in a panel, on a pipe or wall. A rear cover is available if required (see **Chapter 8: Accessories and Spare Parts**).

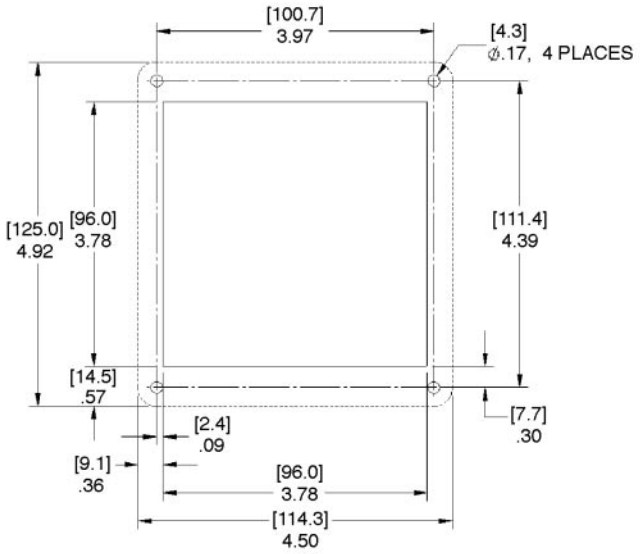
CAUTION: The maximum ambient temperature allowed depends on the model and power supply voltage. Model 775-_A2 should not be used with 240 VAC power. See specifications and provide ventilation if necessary.

Panel Mount

The 770MAX is supplied with four mounting screws and a gasket to provide a seal at the panel cutout.

To mount the 770MAX in an instrument panel:

1. Use the illustration below to mark panel cutouts.



panel cutout – [mm] inches

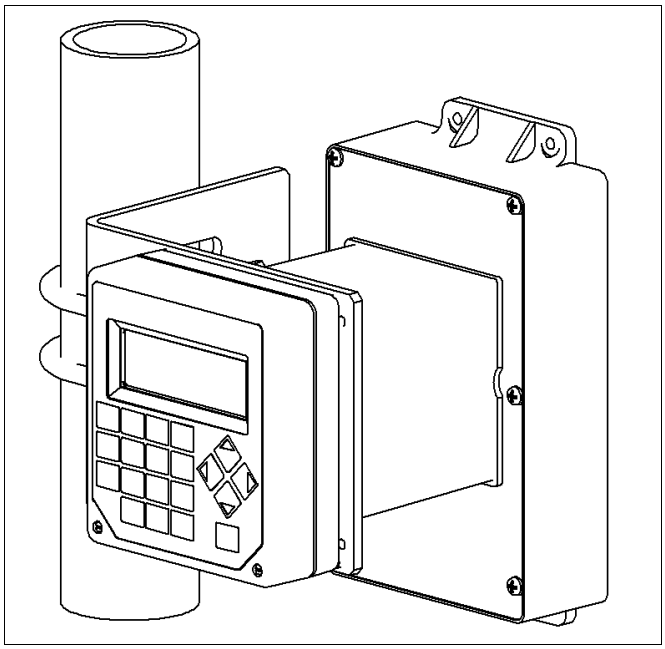
   If multiple instruments will be mounted on the same panel, allow enough space for the flanges to overlap the panel between instruments (dotted outline).

2. Make the panel cutout and drill the mounting screw holes; all cutouts should be clean and free of burrs.
3. Remove the backing paper and slide the adhesive gasket onto the rear of the instrument flange. Align it evenly and press into place. The two small pins near each screw hole are intended to control compression of the gasket for optimum sealing.
4. Slide the 770MAX into the panel and secure with (4) 6-32 mounting screws (supplied) from the back.

NOTE: If the rear cover is required, install the 770MAX in the panel before attaching the cover.

Pipe Mount

To mount the 770MAX on a 2" pipe, use the accessory pipe mounting bracket, Part No. 15540, ordered separately.



pipe mount

Wall Mount and Rear Cover

Accessory Kit 1000-69, ordered separately, provides sealing of the rear of the 770MAX. It includes provision for wall mounting. See assembly instructions supplied with that kit.

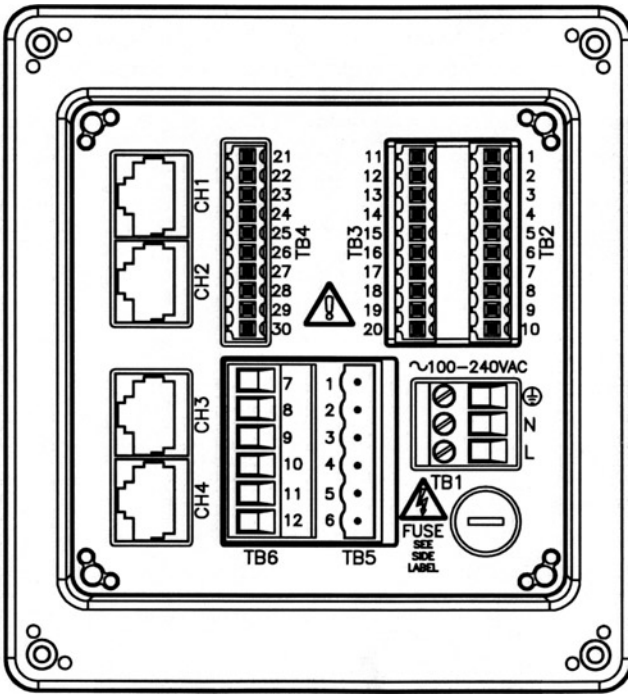
CONNECTIONS

All connections are made via the rear panel. Standard outputs on TB2 and TB3 on all models include 4 analog outputs, RS232, 2 discrete outputs plus 2 discrete inputs. Additional terminal blocks depend on the 770MAX model purchased:

Model 775-_ _0 – standard outputs.

Model 775-_ _1 – standard outputs and 4 relays on TB5 & TB6.

Model 775-_ _2 – standard outputs, 4 additional analog outputs on TB4 and 4 relays on TB5 & TB6.



rear panel terminal boards

WARNING: MAKE SURE POWER TO ALL WIRES IS TURNED OFF BEFORE PROCEEDING WITH THE INSTALLATION. HIGH VOLTAGE MAY BE PRESENT ON THE INPUT POWER WIRES AND RELAY WIRES.

Acceptable wire sizes for 770MAX terminals are from 22 AWG (0.326 mm^2) to 14 AWG (2.08 mm^2) for all connections except relays. For TB5 and TB6 relay terminals use 26 AWG (0.126 mm^2) to 14 AWG (2.08 mm^2). If more than one wire must be connected to a terminal, wire size must be further limited.

Input Power

The 770MAX has a universal power supply for operation in the range of 100-240 VAC, 47-63 Hz.

Terminal block TB1 provides the connections for the input line power. See above section for wire sizes. To connect, strip 0.5 in. (13 mm) of insulation from each conductor. Turn the terminal screws fully counterclockwise, then insert the appropriate wire into its terminal and securely tighten adjacent screw.

CAUTION: a full 0.5 in. (13 mm) of bare conductor must be exposed for reliable power connection to these deep terminals. This is much more than is required for other terminals.

For AC power, make connections as follows:

Board	Terminal	Connection	Color
TB1	⏚	Earth ground	Green
	N	AC power, neutral	White
	L	AC power, hot	Black

WARNING: MISWIRING THE POWER MAY CAUSE A HAZARD, DAMAGE THE INSTRUMENT AND WILL VOID ALL WARRANTIES.

Smart Sensor Connections

Use the four modular jacks labeled CH 1 through CH 4 on the rear panel for connecting Smart Sensors compatible with the 770MAX. Patch cords are available up to 300 feet (91 m) in length, however, pressure and level sensors are limited to 150 feet (46 m) and four-electrode conductivity sensors are limited to 50 feet (15.2 m). See **Chapter 8: Accessories**. If pulling patch cords through conduit, protect the modular connector latch from breakage by covering with tape, as needed.

To connect Smart Sensors:

1. Connect large connector of patch cord to sensor.
2. Plug other end into the desired channel jack.

NOTE: To avoid confusion when patch cords are unplugged, label each cord near the instrument with channel number and sensor identification.

CAUTION: Do not cut or shorten patch cords. They use very fine gage shielded conductors not suitable for screw terminals or splicing.

Do not extend patch cords using computer network cables since they provide only 8 of the 10 conductors needed by 770MAX and will damage the modular jacks.

A break in a continuous patch cord run such as near an instrument cabinet exit can be provided using a 5 ft (1.5 m) or 15 ft (4.5 m) extension cord and connector. See **Chapter 8: Accessories**.

See the appropriate sensor instruction manual for detailed information regarding installation and use.

Smart Sensors used with the previous generation 770PC instrument are not compatible with 770MAX due to signal processing and connector differences. Where it is desired to update existing sensors for use with 770MAX, consult Thornton.

CAUTION: Route all sensor and output signal wiring away from power and switching circuit wiring to minimize noise pickup and interference.

Pulse Flow Sensor Connections

In addition to Smart Sensors, two pulse flow sensors may be connected at terminals 6 and 7 on TB2. See **Appendix B: Pulse Flow Input Setup**, for details.

Other Connections

Each connection terminal and terminal block are labeled by number. The following tables identify each connection. Terminal block and output connection availability are model dependent.

Board	Terminal	Connection
TB2 (All models)	1	Shield
	2	Common
	3	+5V
	4	Discrete in 2
	5	Discrete out 2
	6	Channel 6 flow
	7	Channel 5 flow
	8	Digital ground
	9	RS232 receive
	10	RS232 transmit
TB3 (All models)	11	Shield
	12	Common
	13	Discrete in 1
	14	Discrete out 1
	15	Analog output 4 +
	16	Analog output 3 +
	17	Analog output -
	18	Analog output -
	19	Analog output 2 +
	20	Analog output 1 +
TB4 (Model 775-_ _2 only)	21	Shield
	22	Not Used
	23	Not Used
	24	Analog output 5 +
	25	Analog output 6 +
	26	Analog output -
	27	Analog output -
	28	Analog output 7 +
	29	Analog output 8 +
	30	Shield

Board	Terminal	Connection
TB5 (Models 775-_ _1 & 775-_ _2 only)	1	Relay 3, normally open
	2	Relay 3, common
	3	Relay 3, normally closed
	4	Relay 4, normally open
	5	Relay 4, common
	6	Relay 4, normally closed
TB6 (Models 775-_ _1 & 775-_ _2 only)	7	Relay 1, normally open
	8	Relay 1, common
	9	Relay 1, normally closed
	10	Relay 2, normally open
	11	Relay 2, common
	12	Relay 2, normally closed

Relays

Comply with relay current and voltage limitations. When relays will be switching inductive loads, connect an RC snubber component across the relay terminals to protect the contacts and prevent process upset. (Suggested component is QuenchArc 104M06QC100.)

Discrete Inputs and Outputs

Discrete inputs (TB2-4 and TB3-13) allow external dry isolated contacts to pull their +5V logic level to common (TB2-2 and TB3-12) to provide discrete control action within the 770MAX. This control may be configured to reset total flow, reset total grains or restore a relay to non-alarm condition for an acknowledge function.

Discrete outputs (TB2-5 and TB3-14) provide a TTL/CMOS level signal with respect to common (TB2-2 and TB3-12) that may be used by external control circuits. Discrete outputs can be assigned to setpoints in the 770MAX setup similar to relays.

CAUTION: Route wiring to discrete inputs and outputs away from power or switching circuits and provide shielding to an earth ground at the far end of the cable.

Analog Outputs

Connections for analog outputs are on TB3 (and TB4, if specified). Note that connections use common terminal (18) for analog outputs 1 and 2 and common terminal (17) for analog outputs 3 and 4; with similar wiring for analog outputs 5-8 if used. Analog outputs are self-powered and have a maximum load capacity of 500 ohms.

CAUTION: Do not connect analog outputs to circuits supplying power. They are already powered.

INITIAL START UP

When power is first supplied to the 770MAX, a message similar to the following will be displayed:

```
* * * * * * * * * * * * * * * * * * * *
        Thornton Inc.
            vX.XX
* * * * * * * * * * * * * * * * * * * *
```

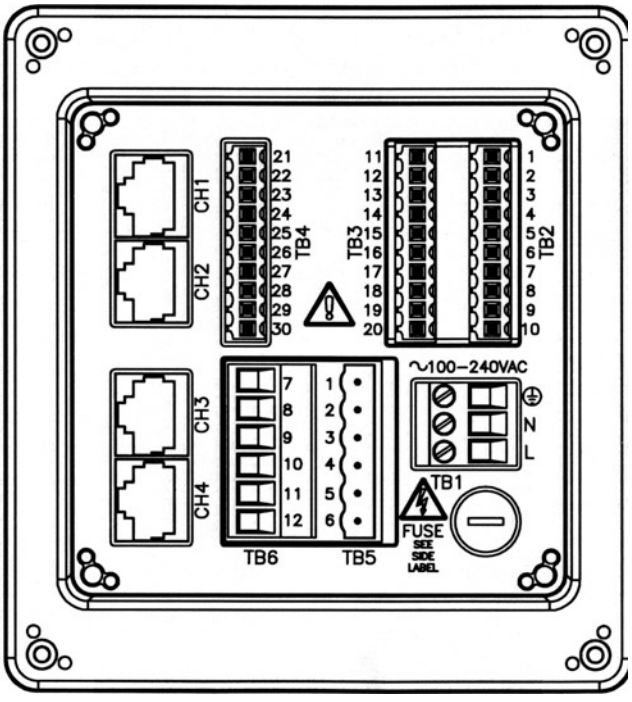
The second line indicates the instrument main software version.

After initialization, the display will go to measurement mode.

Display Contrast Adjustment

(775-LXX LCD display models only)

Depending on ambient lighting and temperature conditions, some adjustment of the LCD display contrast may be needed. Allow the instrument to warm up to operating conditions before making an adjustment. Loosen the two captive front panel screws and lift the front panel off. Using a fine screwdriver, adjust the small potentiometer on the left side below the display to obtain the desired contrast. Replace the front panel.



rear panel terminal boards

CHAPTER 3: GETTING STARTED

Please read this chapter for an overview of the 770MAX. It will help you understand the operating system and how to use the display and keypad for data entry.

The following chapters provide detailed information on using the 770MAX:

Chapter 4: Using Menus – understanding the menu system, options, and configuration for your applications.

Chapter 5: Making Measurements – understanding the different types of measurements available, cell constants, temperature compensation, and calibration.

For help diagnosing and resolving measurement problems, see **Chapter 7: Troubleshooting**.

OPERATING MODES

The 770MAX has two operating modes:

- **Measure** – used to present measurement data; the instrument will usually be in this mode.
- **Menu** – used to set up the system for your specific applications and access all other operational features.

Measure Mode

The 770MAX can calculate and display up to 16 different measurements simultaneously. In display mode, these measurements are displayed in groups of four and are easily scrolled, manually or automatically.

Channels vs. Measurements

The 770MAX has six numbered input *channels* to which sensors can be connected. Four can be used with Smart Sensors. The remaining two can be used for pulse flow sensors only. Channels are numbered 1 through 6 and are identified by the type of sensor connected.

The input from any channel can be used to calculate and display a variety of *measurements* depending on the type of sensor. Measurements are assigned letters A up to P.

Note that there are only six input channels but 16 measurements available. Each sensor can be used for multiple measurements.

Measurement Types

The measurement types available depend on the type of sensor connected. After the sensor has been connected, a unit of measurement can be defined.

The 770MAX accommodates the following sensor types:

- Resistivity (Conductivity) with temperature
- Temperature
- Pressure
- pH with temperature
- Flow
- Tank Level
- Voltage (ORP, dissolved oxygen and miscellaneous others)

Menu Mode

Menu mode allows you to set up the 770MAX specifically for your applications.

The Main Menu consists of many sub-menus in a loop, which can be scrolled for easy access. These sub-menus allow you to:

- Define measurement parameters.
- Define and set outputs, setpoints and relays.
- Calibrate sensors and the meter.
- Display error messages.
- Diagnose problems.
- Access security and maintenance functions.

Each menu may consist of one or more screens, or pages, where you define the desired settings.

The remainder of this chapter describes how to use the keypad and display to define settings and enter information in menu mode.

The next chapter, **Chapter 4: Using Menus**, details the content of each menu.

USING THE DISPLAY AND KEYPAD

The 770MAX operating system is very straightforward, but understanding a few rules will make it easier to navigate.

Display

The four-line display provides read-out of measurement data as well as all menu screens and data entry fields.

Most display information and prompts are self-explanatory, for further assistance press **Help** and page down to read the message. Press **Help** again to return to the original screen.

If an up or down arrow is shown on the right side of the display, then more screens of information are available.

A flashing value in the display mode indicates a setpoint for that measurement has been exceeded. A high alarm condition is indicated by > after the value. A low alarm

condition is indicated by <. A flashing arrow → in the lower right corner indicates that a measurement not currently being displayed has exceeded a setpoint.

A flashing dot between the measurement letter and the channel number indicates a defective Smart Sensor is connected to that channel (Smart communication has been lost). Example display:

```
A Chan1    1.234 µS/cm
B Chan1    25.23 °C
C Chan2    35.71 GPM
D Chan3    8.96  pH →
```

Keypad

The keypad consists of 9 function keys and 11 alphanumeric entry keys.

Menus (exit)

Press **Menus** to access the menu mode. Press again to exit the menu mode.

Page Up/Page Down

Press **Page Down** to move to the next screen of information (if any). Press **Page Up** to move to the previous screen of information (if any). Additional screens are indicated by an up or down arrow on the right side of display.

When finished with a data entry screen, press **Page Down** to go to the next one.

Help

Press **Help** to view more information or instructions regarding the current screen or data entry field.

Press **Page Up** or **Down** as necessary to view the entire message. Press **Help** again to return to the original screen.

Enter

Press **Enter** to select a menu option, to select an option from a list, to complete an alphanumeric entry, or move to the next data entry field.

Arrows

The four arrow keys function as follows:

- **Up** – press to view the next item in a list of options.
- **Down** – press to view the previous item in a list of options.
- **Left** – press to move the cursor left in a line of text or numbers (may also move cursor to the previous field).
- **Right** – press to move the cursor right in a line of text or numbers (may also move cursor to the next field).

Alphanumeric keys

The alphanumeric keys are multi-functional. For example, the "1" key can be used to type the letters "A, B, C" in either upper or lower case, as well as the numeral "1."

Repetitive presses of the same key produce the different entries. Using the "1" key as an example:

- first press = A
- second press = B
- third press = C
- fourth press = a
- fifth press = b
- sixth press = c
- seventh press = 1

then the sequence repeats.

Notes:

The "0" key will yield the following characters: / = : ( ) 0

The "-" key will yield the following characters:. - + ^ _ ! $

If another letter from the *same* key is desired, the right arrow must be used to move the cursor to the next position in the data entry field.

When a *different* key is pressed, the cursor automatically moves to the next position.

If a lower case letter is selected, the next key pressed will begin the sequence with the lower case.

The up and down arrow keys can be used to scroll through the entire alphabet.

If the 770MAX is expecting a numeric entry, the first press will yield the number on the key.

NOTE: When many measurements (display lines) are used, response of the display to pressing keys may be slower.

Data Entry

In menu mode, each line of the display presents an option followed by a data entry field.

If a colon (:) follows the field name, use the up/down arrow keys to scroll through a list of options.

If an equal sign (=) follows the field name, use the alphanumeric keys to enter the required information. (See **Alphanumeric Keys** above.) In most cases, numbers are entered as a four digit number followed by a units multiplier. The units multipliers are:

- n (nano) = multiply value by 0.000,000,001 (10^{-9})
- µ (micro) = multiply value by 0.000,001 (10^{-6})
- m (milli) = multiply value by 0.001 (10^{-3})
- _ (units) = multiply value by 1
- K (kilo) = multiply value by 1,000 (10^{3})
- M (mega) = multiply value by 1,000,000 (10^{6})

When the desired option is selected or the alphanumeric entry complete, press **Enter** to move the cursor to the next field. (When the last field on a screen has been completed, pressing **Enter** will return the cursor to the top of the screen.)

If the menu consists of more than one screen of fields, press **Page Down** to continue.

CHAPTER 4: USING MENUS

INTRODUCTION

After installation is complete, use the menu system to set up the 770MAX for your applications.

First, set up the Measurement Menu for each measurement. Then go through the rest of the menus to set any outputs, setpoints, relays and other functions as necessary. Menu selections are automatically saved as you make them, although on exiting menus you can restore previous settings.

If desired, photocopy the Measurement Parameters Record form provided in **Appendix A** to record the menu options selected.

After all menu options have been set, return to display mode to view measurement readings.

MAIN MENU

The Main Menu is used for all instrument functions except the actual display of measurements. The following sub-menus are available from the Main Menu:

- **Measurements** – define measurement parameters (sensor, units, custom name, temperature compensation, calibration constants, etc.).
- **Messages** – display any messages or problems encountered for each measurement channel.
- **Calibrate** – perform sensor, meter, or analog output calibration.
- **Analog Outputs** – assign outputs to measurements, as well as scaling analog outputs.
- **Setpoints** – define values, type (high, low, USP, and total flow reset) and assigned relay or digital output.
- **Relays** – define relay control action.
- **Display Setup** – customize display.
- **Security** – enable password protection.
- **Diagnostic** – access a series of diagnostic testing routines.
- **RS232 Setup** – format the digital data output parameters.
- **Network** – set up information for connection to network.
- **Reset** – return settings to default values or reset total flow.
- **Tech Support** – telephone and facsimile numbers for assistance.
- **Set Hold Time** – freeze the current relay and analog outputs.
- **Other Menus** – access to less commonly used menus.

  Set Date/Time – enter date and time.

  Software Revs – display revision of installed software.

  View Total Flow – display total flow measurements with high resolution.

  Print Config – print current setup information.

  Smart Sensors – save, clear, or edit smart sensor data in sensor's memory.

  Set Unit Name – enter descriptive name for this instrument.

  Lost Passwords – retrieve lost passwords.

  Service Only – for use by Thornton Service personnel only.

Access

To access the Main Menu, press **Menus**. If security is active, a prompt for a password will appear.

Press the up or down arrow key to step through the sub-menus. Press **Enter** to select a menu.

NOTE: Access to menu functions can be password protected for security. If you are locked out, you can still review settings but not change them. Press any alphanumeric key as the (wrong) password and press **Enter** to review menu settings.

Exit

After completing all data entry for one menu option:

- Press **Page Up** until you return to the Main Menu to select another menu option; or
- Press **Menus** twice to save settings, exit the menu system and return to display mode.
- If no keys are pressed for 5 minutes, the Measure mode will resume automatically and settings will be saved.

To exit menus and *discard* any changes made:

- Press **Menus** once and then press **1** to exit the menu system, revert to the prior menu settings, and return to display mode.

MEASUREMENTS MENU

The Measurements Menu is used to set up the parameters for each measurement.

Install all sensors before using this menu; Smart Sensor data will be read by the 770MAX and automatically entered into the system as appropriate.

For detailed information regarding specific measurements, see **Chapter 5: Making Measurements**.

Measurement

Sixteen different measurements may be defined in system memory. Each measurement you define will be identified by a letter (A through P) which will become a line on the display in the normal measuring mode.

When a Smart Sensor is first connected, the 770MAX automatically assigns to it the next one or two available measurements, depending on the type of sensor. Measurements may all be reassigned as required for the application, including additional measurements of secondary parameters such as temperature, total flow, readout in different units, etc.

After entering the Measurements Menu, use the up/down arrow keys to select the desired letter, then press **Enter** to continue with the measurement setup. Complete all setup for one measurement before starting another.

To set up the next measurement, press **Page Up** until you return to the initial measurement screen and then select another letter to define the new measurement.

Sensor Input

Use the up/down arrow keys to select the input channel (1 through 6) where the desired sensor is connected, then press **Enter**.

If a Smart Sensor is connected to that channel, the sensor type and calibration data will be read by 770MAX. Then you may continue with selecting units, measurement name, etc. Remember that Channels 5 and 6 can be used for pulse flow sensors only.

Units

The available units of measure are determined by the type of sensor defined for the channel. Following are the available units for each type:

Resistivity (Conductivity)
- resistivity in ohm-cm
- conductivity in S/cm or S/m
- °C or °F
- total dissolved solids
- %HCl
- %NaOH
- $\%H_2SO_4$

Temperature
- °C
- °F

Pressure
- PSI
- kPascal
- mmHg
- bars
- kg/cm
- inches
- feet

Flow
- GPM
- gallons
- m3/hr
- Hz
- m3
- liter
- liter/min
- feet/second
- grains
- ppm-Gallons

Tank Level
- gallons
- m3
- liter
- PSI
- inches
- feet
- % full

pH
- pH
- volts
- °C
- °F

Voltage (ORP)
- volts
- amps

Dissolved oxygen
- g/L
- ppb
- ppm
- %sat
- mmHg
- bar

Also, the following comparative units can be defined in conjunction with input from a second sensor:

- ratio
- difference
- % rejection
- % recovery

If ratio or difference is selected, press the up arrow to return to the **Sensor Input** field and select the two channels for comparison. Then continue with the remainder of the Measurements Menu.

Some units require secondary selections. The most common is the units multiplier. For example, if Resistivity is selected, an appropriate units multiplier must also be selected (i.e., M = mega = 1,000,000. K = kilo = 1,000. m = milli = 0.001. u = micro = 0.000001, or none).

Name

Each measurement can be given a custom name for easier identification (up to six alphanumeric or symbol characters). If a name is not entered, the measurement will be identified by the measurement letter and sensor channel. When a name is first entered, it is automatically duplicated to all other measurements using the same sensor channel. These may be overwritten as desired.

Note: See **Chapter 3: Getting Started** for instructions in using the alphanumeric keys.

Multiplier

This calibration constant (also known as cell constant, slope or span) is pre-programmed into all Smart Sensors and automatically read by the 770MAX. If a Smart Sensor is connected to this channel, no change should be made; just press **Enter** to continue to the next field.

If the Multiplier stored in the Smart Sensor has been changed from the factory setting, a caret '^' will be displayed after the Multiplier and Adder.

If a pulse input flow sensor is connected, enter the appropriate multiplier factor and then press **Enter**. See Appendix B of this manual or the sensor manual for its calibration factor in pulses per gallon. See **Chapter 6: Calibrating and Verifying** for calibration instructions.

Note: This multiplier value is a calibration constant unique to the sensor. It is <u>not</u> the same as a units multiplier, which

indicates the factor of ten by which the displayed readings must be multiplied (e.g., 2 K = 2000).

Adder

This calibration constant (zero or offset) is also pre-programmed into all Smart Sensors, and automatically read by the 770MAX. If a Smart Sensor is connected to this channel, no entry is required; just press **Enter** to continue to the next field.

If the Adder stored in the Smart Sensor has been changed from the factory setting, a caret '^' will be displayed after Adder and Multiplier.

Averaging

Averaging, or filtering, stabilizes measurement readings in applications with rapidly changing parameters or noisy signals. The following options are available: none, low, medium, high, or special.

The higher the averaging, the longer the response time to changes in the measurement.

For most measurements, special averaging is recommended. Special averaging uses high averaging for small changes, but will respond quickly if a large change is detected.

Compensation

Resistivity, conductivity, and pH measurements are normally temperature compensated to display equivalent values at 25 °C.

The following types of temperature compensation routines are available: standard, cation, glycol 1, glycol 50, alcohol, linear 2.00%, Light 84, or none. For more information regarding temperature compensation see **Chapter 5: Making Measurements**.

The source of the temperature measurement may be from the sensor's built-in temperature sensor or some other source. This information can be entered in a later field.

STC (high purity pH only)

The solution temperature coefficient (STC) allows selection of temperature compensation for the ionization of pure water. This is in addition to the conventional (Nernst) temperature compensation, which is always active.

STC is useful for pure water samples with a conductivity of less than 30 µS/cm where the changing ionization of water is significant. It references the pH to 25°C. In all other applications, leave the STC value at zero. See **Chapter 5: Making Measurements**.

IP (special pH sensors only)

The isopotential point (IP) should be left at 7.0 pH for conventional pH electrodes.

Temp Source

The following options are available for the source of the temperature used for temperature compensation: this channel, fixed, or other channels.

This channel (**This Ch**) uses the sensor's built-in temperature sensor.

Fixed uses the same value (usually 25°C) for all calculations.

If the temperature sensor is located on another channel, use the up arrow to scroll through the channels and select the desired one.

Pressure Source

For barometric pressure compensation of dissolved oxygen calibration only, the following options are available: This Channel, Fixed, other channels.

Resolution

Resolution is the number of digits that will be displayed to the right of the decimal point.

The available options are: auto, 1, .1, .01, and .001.

Max PSI (pressure & level only)

Enter the full scale pressure value for this sensor.

Pipe ID (flow only)

Flow velocity measurements in ft/sec require the inside diameter of the pipe (in which the sensor is installed) for calculations. Enter the precise inside diameter in inches.

External Flow Reset (flow only)

If it is desired to reset the flow totalizer from external contacts, select Discrete Input #1 or #2. Connect the external contacts to the appropriate discrete input terminals identified in **Chapter 2: Installing the 770MAX.**

NOTE: The contacts must be isolated and voltage-free.

TDS Factor (conductivity/resistivity only)

Total Dissolved Solids (TDS) is another useful way to measure and display conductivity/resistivity data. The default setting of 1.0 for the TDS Factor provides conversion to sodium chloride at approximately 0.5 ppm per uS/cm. For more information on TDS, refer to **Chapter 5: Making Measurements**.

Tank Height (level only)

Enter the full scale tank height in feet for a level measurement. Level measurement is linear, for straight-sided tanks only.

Area (level only)

Enter the cross-sectional area of the tank in square feet to allow a level measurement to compute volume units.

Status

The status fields are for display only, to verify measurement and sensor information.

Reading

Displays the latest reading for this measurement, it will be updated every few seconds.

Sensor S/N

Displays the sensor's serial number as stored in the Smart Connector (Smart Sensors only).

Cal Date

Displays the sensor's most recent calibration date.

MESSAGES

Select a measurement letter to display any diagnostic system messages for that measurement. These can be helpful in troubleshooting.

CALIBRATE MENU

The Calibrate Menu is used to calibrate the sensors, the analog outputs or the meter. For detailed calibration instructions, see **Chapter 6: Calibrating and Verifying**.

The 770MAX meter components are factory calibrated within specifications. It is not normally necessary to re-calibrate.

Best sensor performance is normally obtained by using the factory-documented cell constants already stored in Smart Sensor memory. However, pH sensors require periodic re-calibration; see your sensor instruction manual for recommendations.

To perform calibration of any component, accurate and precise standards are required.

ANALOG OUTPUTS

The Analog Outputs Menu is used to assign analog outputs to measurements and define any necessary options.

Four or eight analog outputs are provided, depending on the model purchased. Each output can be programmed to operate as a normal (i.e., linear), bi-linear, auto-range, or logarithmic output. Outputs can be programmed to activate a relay or digital output (auto-range only), and to send either a minimum or maximum value if a sensor failure is detected.

See **Chapter 2: Installing the 770MAX** for connection information.

Analog

Use the up/down arrow keys to select the desired output (1 through 4 or 8), then press **Enter** to continue with setup for that output. Complete all setup for one output before starting another.

To set up the next output, press **Page Up** until you return to the initial analog output screen and then select another analog output number.

Measurement

Use the up/down arrow keys to select the letter of the measurement that will use this analog output, then press **Enter**.

Scaling Type

The following types of output scaling are available: normal, bi-linear, auto-range, and logarithmic.

Normal scaling provides a linear 4 mA (or 0 mA) to 20 mA output. Low and high measurement values can be entered to correspond to those outputs.

Bi-linear scaling provides two scaling ranges for a single linear strip chart: usually a wide measurement range at the high end of the scale, and a narrower range with high resolution at the low end.

In addition to entering low and high values, a mid-range scaling value must be defined. For example, a user in the power industry may want to monitor condensate. Measurements are normally in the range of 0-1 µS/cm but during a condenser leak, a range of up to 10 µS/cm is desirable. Settings for the low, mid and high values might be 0, 1 and 11 µS/cm, to give convenient plotting on a 10-division strip chart.

Auto-Range scaling provides two ranges of output and allows a control (relay or discrete output) to be activated. It is designed to work with a PLC or two points of a multipoint strip chart recorder to meet the same needs as bi-linear scaling above.

Two separate settings are used, one for the high limit of the high range and one for the high limit of the low range, for the single 0/4-20 mA signal. The low value is always zero.

Auto-range scaling also allows activation of a relay while on the high range for a logic signal or for actual switching of the signal through double throw contacts. At the cross-over point, a ~2% hysteresis prevents jumping back and forth between ranges.

For the power industry example above, with rising conductivity, the 0/4-20 mA signal would go from 0-100% for 0-1 µS/cm, jump to 10% and activate the relay when just above 1 µS/cm, then go 10-100% for 1-10 µS/cm. Thus both 0-1 and 0-10 µS/cm ranges may be recorded on the same chart using a single signal.

Logarithmic scaling provides an output for use with logarithmic chart paper. A high value and the number of decades must be entered. The low value is defined by the

other two settings. For example, a high value of 1000 µS/cm with 3 decades would give a range of 1–10–100–1000 µS/cm.

Low Value (signal level)

Select 4 mA or 0 mA as the low value of the output signal.

0/4 mA (scaling limit)

Enter the measurement value that will correspond to 4 mA (or 0 mA).

IMPORTANT: Be sure to select the appropriate units multiplier (M = mega = 1,000,000. K = kilo = 1,000. m = milli = 0.001. u = micro = 0.000001, or none) e.g., M for megohm-cm or u for µS/cm.

Whenever the measurement is less than or equal to this number, the output signal will be set to its minimum value.

If the output scaling type is auto-range, the low value is always zero.

Note: Output signals can be "inverted" by setting the minimum value higher than the maximum. For example, to obtain an inverted 1-7 pH signal for control of caustic feed, set the 0/4 mA limit to 7 and the 20 mA limit to 1.

Mid (Bi-linear scaling only)

Enter the measurement value that will correspond to the middle of the range (10 or 12 mA). Then select the appropriate units multiplier (M = mega = 1,000,000. K = kilo = 1,000. m = milli = 0.001. u = micro = 0.000001, or none).

20 mA (scaling limit)

Enter the measurement value that will correspond to 20 mA. Then select the appropriate units multiplier.

Whenever the measurement is greater than or equal to this number, the output signal will be set to its maximum value.

Num of Decades (logarithmic scaling only)

Select the number of decades for the scale, from 1 to 6 (e.g., 1 to 100 is two decades).

When using range 2, activate: (auto-range only)

Use the up/down arrow keys to select the relay or discrete output to activate when the high limit of the low range has been exceeded, then press **Enter**.

On failure set

If the sensor or measurement fails, the system can failsafe to either the minimum (min) or maximum (max) signal level.

Calibrated

Displays the output's most recent calibration date.

Current Out

Displays the actual current (mA) being output.

SETPOINTS

The Setpoints Menu is used to define measurement limits or alarm conditions. You can set high and low values, USP limits for conductivity, or a reset for total flow measurements.

When the measurement value is higher than a high setpoint or lower than a low setpoint, an alarm condition exists. Setpoint alarm conditions are indicated by a flashing measurement reading when in display mode. Also, a relay or digital output can be activated when a setpoint is exceeded.

The USP setpoint is a high limit used for pharmaceutical water monitoring with non-temperature compensated conductivity measurements. USP (United States Pharmacopoeia <645>) requires that non-temperature compensated conductivity of pharmaceutical waters must be below limits based on temperature. A table of these limits is stored in the 770MAX memory. The 770MAX USP setpoint automatically changes with the water temperature. A percent safety margin below the USP limit can also be set. For example, the USP table limit at 15°C is 1.0 µS/cm. If the setpoint value is set at 40% then the setpoint will activate whenever the conductivity goes above 0.6 µS/cm at 15°C.

Temperature (°C)	Conductivity limit (µS/cm)	Temperature (°C)	Conductivity limit (µS/cm)
0	0.6	55	2.1
5	0.8	60	2.2
10	0.9	65	2.4
15	1.0	70	2.5
20	1.1	75	2.7
25	1.3	80	2.7
30	1.4	85	2.7
35	1.5	90	2.7
40	1.7	95	2.9
45	1.8	100	3.1
50	1.9		

USP <645> Stage 1 Conductivity Limits as a Function of Temperature

NOTE: Setpoints are defined for a specific measurement. Measurement parameters must be defined before the setpoint can be assigned.

Setpoint #

Use the up/down arrow keys to select a setpoint (1 through 16), then press **Enter** to continue with setup for that setpoint. Complete all setup for one setpoint before starting another.

To set up the next setpoint, press **Page Up** until you return to the initial setpoint screen and then select another setpoint number.

Measure

Use the up/down arrow keys to select the measurement to which this setpoint will apply, then press **Enter**.

Value

Enter the desired setpoint value.

IMPORTANT: Be sure to select the appropriate units multiplier (M = mega = 1,000,000. K = kilo = 1,000. m = milli = 0.001. u = micro = 0.000001, or none) e.g., M for megohm-cm or u for µS/cm.

Note: USP values are defined as a percentage below the USP table conductivity limit as noted above. The multiplier field will change to % when USP is selected as type in the next line of the screen.

Type

Select high, low, USP (conductivity only), or reset (flow or deionization capacity only). Select Off to disable the setpoint. USP and reset type setpoints always alarm on a high condition.

Activate

When the setpoint is exceeded, the 770MAX can activate a relay or discrete output line. Relays are only available on models with that option.

Discrete outputs are normally at +5V and go to 0 V when the setpoint is exceeded. There are no delay, hysteresis or inverted state settings available for discrete outputs as there are for relays.

If sensor error

If the sensor fails, the 770MAX can allow the setpoint to be active or disable the setpoint.

Select Off to disable the setpoint when there is a sensor failure.

Status

Displays the elapsed time (hours:minutes:seconds) since this setpoint was activated.

RELAYS

Relays can be programmed to activate when a setpoint is exceeded (see **SETPOINTS** above). Delay times and hysteresis values can be entered to "fine tune" the use of relays.

The relays available depend on the 770MAX model purchased. See **Chapter 2: Installing the 770MAX** for connection information.

If relays are not available on your instrument, an error message will be displayed when this menu is accessed.

Relay

Use the up/down arrow keys to select the desired relay (1 through 4), then press **Enter** to continue with setup for that relay. Complete all setup for one relay before starting another.

To set up the next relay, press **Page Up** until you return to this screen and then select another relay number.

Delay

A time delay requires the setpoint to be exceeded continuously for a specified length of time before activating the relay. Enter the delay time in seconds.

If the condition disappears before the delay period is over, the relay will not be activated.

Hysteresis

A hysteresis value requires the measurement to return within the setpoint value by a specified percentage before the relay is deactivated.

For a high setpoint, the measurement must decrease more than the indicated percentage below the setpoint value before the relay is deactivated. With a low setpoint, the measurement must rise at least this percentage above the setpoint value before the relay is deactivated. For example, a high setpoint is set at 100 and the measurement is currently above this value so the setpoint is exceeded and the relay is activated. If the hysteresis value is 10%, then the measurement must fall below 90 before the relay is deactivated.

Enter a percentage value.

State

Relay contacts are in normal state until the associated setpoint is exceeded, then the relay is activated and the contacts change.

Select Inverted to reverse the normal operation (i.e., contacts are in abnormal state until the setpoint is exceeded).

Ext Clear

To allow use of an external “acknowledge” pushbutton to deactivate a 770MAX relay powering an alarm circuit, discrete inputs may be used. An external input line (from the pushbutton) connected to Discrete in #1 or #2 can be used to clear (deactivate) the relay if it has been activated. The available options are: disabled, Discrete In #1, or Discrete In #2.

Select disabled if the input line is not used for this purpose.

Type …

Displays the type of relay installed.

Relay is …

Displays the current status of the relay.

DISCRETE OUTPUTS

Discrete outputs are normally at 0 V and go to +5 V when a setpoint is exceeded.

DISPLAY SETUP

The Display Setup Menu is used to define how measurements are displayed.

Scrolling

In display mode, measurements are displayed four per screen. To define how additional screens of measurements are viewed, the following options are available: manual, auto, and locked.

Manual allows you to scroll through the measurements by pressing the up/down arrow or page up/down keys.

Auto changes the measurements displayed approximately every five seconds.

Locked prevents users from changing the display with the arrow and page keys.

Measurements

Measurements can be displayed in alphabetical order (by measurement letter) or in a user defined order. Select Custom to choose the order of display.

Display Setup (custom measurements only)

Display line X

For each line of the display, select the desired measurement letter, and then press **Enter**.

SECURITY

The Security Menu is used to prevent unauthorized changing of parameters. Users can be locked out of all menu functions, locked out of calibration only, or locked out of all menus except calibration. Without the correct numeric password, the user will only be able to view the menus.

A master password is required to change any passwords, lockout options, or to enable/disable the security program. Two user passwords can be defined.

The initial master and user passwords are set to a default of 00000.

Go to …

Use the up/down arrow keys to select the desired security option, then press **Enter**. The available options are: Change Lockout, Change Password, and Lockout Status.

To select another option after completing any of these options, press **Page Up** to return to this screen and select.

Change Lockout

Enter the master password to change any of the security lockout options.

Lockout

If lockout is enabled, users must enter their password to gain access to the menus. If disabled, no passwords will be required.

User 1

Select the desired lockout for User 1. The available lockout options are: Lockout All, Lock Cal Only, and Open Cal Only.

User 2

Select the desired lockout for User 2.

Change Password

Use to change any of the passwords.

Which password to change

Select the desired user or master password.

Master Pass

Enter the master password to proceed.

New password

Enter a new 5 character password and press **Enter**. You will then be prompted to re-enter the password to confirm it.

Lockout Status

The status fields are for display only.

Lockout is

Displays whether security lockout is disabled or enabled.

User 1

Displays current lockout option for User 1.

User 2

Displays current lockout option for User 2.

Time since last access in menus

Displays the elapsed time since the menus were last accessed by any user.

DIAGNOSTICS

The Diagnostic Menu is used to run a series of diagnostic testing routines to verify the operation of system components, including: meter, sensors, analog output, serial port, network, display, keypad, flow channels, inputs and outputs.

Use the up/down arrow keys to select a component to test, then press **Enter**. The indicated test will be performed and the results displayed. Press **Enter** to perform the next test.

To test another component, press **Page Up** to return to the Diagnostic Menu and select the next component.

NOTE: Some diagnostic tests may interrupt normal operation (such as analog outputs).

For detailed information regarding diagnostic tests, see **Chapter 7: Troubleshooting**.

RS232 SETUP

The RS232 Menu is used to format the data output communication parameters (baud, parity, etc.).

For detailed digital communications information, see the 770MAX Service Manual, Part No. 84373.

NETWORK

The Network Menu will be used to set up a network connection address and type when this function becomes available.

RESET

The Reset Menu is used to clear user programming and return most settings to their default values; for the entire system, for single measurements, or total flow readings by channel.

Use the up/down arrow keys to select the desired option to reset, then press **Enter**. The available options are: System, Measurements, and Totalizers.

System

A system reset will:

- Clear and disable all relays, setpoints, and analog outputs.
- Clear all measurements.
- Set the serial port to 38.4K baud and even parity. The data output is turned off.
- Turn off display scrolling and set the display order to automatic.
- Read Smart sensors and set up measurement channels (as if you plugged in a new sensor).

It will not change the unit number.

Press **Page Down** to reset the system.

Measurements

A measurement reset will reset a channel to its default modes and clear all setpoints, relays and analog outputs that apply to that channel.

Select the channel to reset, then press **Enter**.

Totalizers

A totalizer reset will clear the total flow or deionization capacity reading for a channel and set it to zero.

Select the channel to reset, then press **Enter**.

This may also be done by remote contacts.

TECH SUPPORT

Displays the telephone, e-mail and facsimile numbers for Thornton Technical Support.

SET HOLD TIME

Use a hold time to freeze the relay and analog outputs so that alarms are not triggered during calibration or other service procedures. Normal relay and analog output operation resumes when the set period has elapsed or when the hold time is reset to zero.

Enter a hold time in minutes (1 to 99), then press **Enter**.

OTHER MENUS

The Other Menu is used to access less commonly used features, including:

- Set Date/Time
- Software Revisions
- View Total Flow
- Print Configuration
- Smart Sensors
- Set Unit Name
- Lost Passwords
- Service Only

Set Date/Time

Use to enter the correct date and time. Note that the internal clock does not run when power is off. It is only a convenience for setting the dates of calibration.

Time

Enter time in hours, minutes and seconds (hh:mm:ss).

Date

Enter date in month, day and year format (mm/dd/yy).

Software Revs

Displays the engineering revision numbers of the currently installed system circuit boards (main, measurement, display option).

View Total Flow

Displays any total flow measurements by channel.

Use the up/down arrow keys to select the channel to display, then press **Enter**.

Print Configuration

A computer or printer can be used to record all setup information. If a device is connected to the RS232 output, press **Enter** to print.

See **770MAX Service Manual 84373** for connection information.

Smart Sensors

The Smart Sensors Menu is used to save, clear, or edit data stored in the Smart Sensors' memory.

Use the up/down arrow keys to select the desired option, then press **Enter**.

Save Data

Select the channel to which the desired Smart Sensor is connected then press **Enter** to save.

Clear Data

This function restores factory sensor calibration data, replacing any user calibration. Select the channel to which the desired Smart Sensor is connected then press **Enter** to clear.

Edit Data

This option is for use by Thornton Service Personnel only and requires a service password.

Set Unit Name

This feature is especially useful when more than one unit is used. Enter the name or location of this unit (up to 20 characters).

The unit name is displayed whenever exiting menus and appears in configuration printout, calibrator certificate, etc.

Lost Passwords

To recover lost passwords, record the codes displayed on screen and then call Customer Service for assistance.

Service Only

These are service password protected functions for use by Thornton Service Personnel only.

CHAPTER 5: MAKING MEASUREMENTS

INTRODUCTION

After all menu options have been set, measurement readings are viewed in the display mode. If measurements have not been set up using the menus, default values will be used to calculate and display readings. Available measurement types and units are given in **Chapter 4: Using Menus**.

See the appropriate sensor manual for complete sensor installation and use instructions.

NOTE: Smart Sensors used with the previous generation 770PC instrument are not compatible with 770MAX due to signal processing and connector differences. Where it is desired to update existing sensors for use with 770MAX, consult Thornton.

Displaying Measurements

To return to display mode from menu mode, press **Menus** twice to exit the menu system and return to display. If the 770MAX is left in menu mode, it will automatically default to display mode after 5 minutes of inactivity.

770MAX can calculate and display up to 16 different measurements, in groups of four. Scroll through measurements one at a time by using the up/down arrow keys or in groups of four by using the page up/down keys. Alternatively, the display can be configured to automatically scroll through the measurements in any convenient order. See **DISPLAY SETUP** in **Chapter 4: Using Menus** for available options.

Flashing measurements indicate a setpoint has been exceeded. A flashing arrow → in the lower right corner indicates that a setpoint has been exceeded for a measurement that is not currently displayed.

A flashing dot after the measurement letter indicates a defective Smart Sensor is connected to that channel (Smart communication has been lost).

Averaging (filtering) of measurements may be momentarily suspended. Press **Enter** in the normal display mode. An asterisk will appear briefly in the lower right corner and all measurements will be updated once with no averaging. Averaging resumes with subsequent updates.

Sensor Constants

Each sensor is defined by a set of calibration constants, also known as sensor constants. The two constants, multiplier and adder, are used to derive an accurate measurement from the sensor's output signal. The multiplier is also known as slope or span. The adder is also known as the offset or zero point.

When using Smart Sensors, these constants are stored in the Smart Sensor's memory and automatically read by the 770MAX. If using a pulse input flow sensor, consult the sensor instruction manual for guidance in entering these values.

These constants are re-calculated during calibration. See **Chapter 6: Calibrating and Verifying** for calibration instructions.

NOTE: The calibration constant "multiplier" is a value unique to an individual sensor. It is <u>not</u> the same as a units multiplier, which indicates the factor of ten by which the displayed readings must be multiplied (e.g., 2 K = 2000).

Temperature Compensation

Resistivity, conductivity and pH readings can be compensated for changes in temperature. For example, the resistivity of pure water at 25°C is 18.18 Megohm-cm. However, at 30°C its resistivity is 14.08 Megohm-cm. Temperature compensation will adjust the reading to a constant temperature (usually 25°C), and the value of pure water will always be 18.18 Megohm-cm.

The source of the temperature measurement may be from the sensor's built-in temperature sensor, a sensor connected to another channel, or a manually entered fixed value.

Generally, best results are achieved by using the built-in temperature sensor because it is immersed in the same environment.

Temperature compensation details are provided in the appropriate measurement sections later in this chapter.

RESISTIVITY/CONDUCTIVITY

The measured resistivity (or conductivity) of a solution can be displayed in terms of:

- resistivity in ohm-cm
- conductivity in S/cm or S/m
- total dissolved solids (TDS)
- %HCl
- %NaOH
- $\%H_2SO_4$
- % rejection

Resistivity is expressed in ohm-centimeters (Ω-cm) which is the reciprocal of conductivity.

Conductivity is expressed in siemens per centimeter (S/cm) or siemens per meter (S/m). Be careful to select the desired units as they can be confused easily.

These measurements can be displayed with a unit multiplier in front of the units (i.e., M = mega = 1,000,000. K = kilo = 1,000. m = milli = 0.001. u = micro = 0.000001, or none).

Total Dissolved Solids (TDS) may be inferred and displayed based on conductivity/resistivity data. TDS is the concentration of sodium chloride (or other conductive substance) corresponding to the measured conductivity. Salinity is the same as TDS, specifically for sodium chloride. Both are given in units of parts per billion (ppb), parts per million (ppm) or parts per thousand (ppk, as abbreviated on 770MAX).

The default setting of 1.0 for the TDS Factor provides conversion based on the conductivity of sodium chloride at 0.462 ppm per µS/cm, with non-linear corrections at very low and very high conductivities. The TDS factor may be changed to provide conversion for other substances. It is a multiplier on the sodium chloride conversion. Values for other materials are given in the table below (normalized to NaCl). These values adjust the TDS value for the actual conductivity of the materials in the table. Different values are needed for measurements involving ion exchange calculations—see below.

Material	TDS factor
KCl	1.0786
$CaCl_2$	0.8839
$CaCO_3$	0.8407
NaOH	0.3480

Total Dissolved Solids for ion exchange calculations are based on the conductivity and weight of the materials present expressed as their ion exchange equivalent as calcium carbonate. Because this conversion varies with each application, it should be determined on an individual basis. For a defined composition of neutral minerals with conductivity the same as sodium chloride, a TDS factor of 0.856 will give readout as ppm NaCl expressed as $CaCO_3$. For conditions of strong base exchange, a TDS factor of 0.435 will give readout as ppm NaOH expressed as $CaCO_3$. These are also the types of conversions used for Di-Cap™ deionization capacity monitoring described later in the flow section.

% HCl, % NaOH, % H_2SO_4 settings allow the respective concentrations to be inferred from conductivity and read out directly as percent by weight. This function must be used in applications having only the chemical and pure water present. Conductivity is only a quantitative measurement and cannot tell if there are other conductive materials present.

Temperature Compensation

The following types of temperature compensation routines are available for resistivity/conductivity measurements: standard, standard 75, cation, glycol 1, glycol 50, alcohol, linear 2.00%, Light 84, or none.

Standard compensation includes compensation for non-linear high purity effects as well as conventional neutral salt impurities and conforms to ASTM standards D1125 and D5391.

Standard 75 compensation is the Standard compensation routine referenced to 75°C. This compensation may be preferred when measuring Ultrapure Water at an elevated temperature. [Note: Resistivity of Ultrapure water compensated to 75°C is 2.4818 Mohm-cm]

Cation compensation is used in power industry applications for specific conductivity using ammonia or ETA (ethanolamine) water treatment and cation conductivity measurements with acidic samples. It takes into account the effects of temperature on the dissociation of pure water in the presence of these bases and acids.

Glycol 1 compensation matches the temperature characteristics of 100% ethylene glycol. Compensated measurements may go well above 18 Mohm-cm.

Glycol 50 compensation matches the temperature characteristics of 50% ethylene glycol in water. Compensated measurements using this solution may go above 18 Mohm-cm.

Alcohol compensation provides for the temperature characteristics of a 75% solution of isopropyl alcohol in pure water. Compensated measurements using this solution may go above 18 Mohm-cm.

Linear compensation adjusts the reading by a factor expressed as a "% per °C" (deviation from 25°C). Use only if sample stream has a well-characterized linear temperature coefficient. The factory default setting is 2.00%/°C.

Light 84 compensation matches the high purity water research results of Dr. T.S. Light published in 1984. Use only if your institution has standardized on that work.

DISSOLVED OXYGEN

The measurement of dissolved oxygen concentration can be displayed in units of:

gO2 grams per liter, g/L

ppmO2 parts per million = mg/L

ppbO2 parts per billion = µg/L

%sat percent saturation

Sensors for dissolved oxygen come pre-calibrated for zero offset. The user should perform a simple calibration using air as the reference prior to use. Automatic corrections for temperature and barometric pressure are provided. The barometric pressure may be displayed as another measurement in units of mmHg or bar. For diagnostic purposes, the senor output in voltage or current (depending on sensor type) may also be displayed.

pH

The measured pH of a solution can be displayed in terms of pH units or volts.

Due to aging in the process, pH sensors require re-calibration after a period of time. The stability of the sensor depends on the nature of the sample solution, pressure, temperature, etc. For this reason, calibration intervals should

be based on experience with the particular application. See **Chapter 6: Calibrating and Verifying** for calibration instructions.

Temperature Compensation

Conventional Nernst temperature compensation is always in effect to correct for the varying output of all pH electrodes with temperature. If no temperature sensor is available, or temperature compensation is not desired, select a fixed temperature as the temperature source.

Isopotential Point

Most sensors have a zero potential, or isopotential point (IP), of pH 7.0. Special purpose electrodes with a zero potential at values other than 7.0 will have this identified in their instruction manuals. A different IP setting will allow proper temperature compensation of these special electrodes.

Solution Temperature Coefficient

For high purity pH measurements, the solution temperature coefficient (STC) compensates for the ionization of pure water. This is in addition to the conventional (Nernst) temperature compensation, which is always active.

STC is useful for pure water samples with a conductivity of less than 30 µS/cm where the changing ionization of water is significant. It references the pH to 25°C.

In all other applications, leave the STC value at zero.

For ammonia, phosphate and/or amine-treated power plant samples, the STC should be set to 0.033 pH/°C.

For pure makeup water or boiling water reactor samples, the STC should be 0.016 pH/°C.

The appropriate values for other pure water compositions may be determined by developing temperature vs. pH data for the particular sample with STC set at zero. The negative slope of this data becomes the STC value.

TEMPERATURE

The measured temperature of a solution can be displayed in terms of:

- °C
- °F

A temperature sensor is usually incorporated into a pH or conductivity/resistivity sensor. This temperature sensor can be used for temperature compensation and/or temperature readout.

To display temperature values as well as using them for compensation, set up one measurement for the primary parameter (e.g., resistivity or pH) and another for the temperature readout.

PRESSURE

The measured pressure of a solution can be displayed in terms of:

- PSI
- kPascal
- mmHg
- bars
- kg/cm^2
- inches
- feet

The maximum pressure reading for the sensor is pre-programmed into all Smart Sensors and automatically read by the 770MAX.

For tank level measurements, see **TANK LEVEL**. For difference and ratio measurements see **DERIVED MEASUREMENTS**.

FLOW

The measured flow of a solution can be displayed in terms of:

- gallons
- m^3
- liter
- Hz
- GPM
- m^3/hr
- liter/min
- feet/second
- % recovery
- ratio
- difference
- ppm-Gallons
- grains

Smart Sensors for flow can be installed on channels 1 through 4. Pulse type, non-Smart Sensors for flow can be installed only on channels 5 and 6 and require entry of their calibration factors in pulses per gallon as the measurement Multiplier.

Flow measurements require the inside diameter of the pipe for flow velocity calculations. In some applications, calibration of flow sensors is required for specific piping installations. See **Chapter 6: Calibrating and Verifying** for calibration instructions.

Totalized Flow is expressed in volume (gallons, m^3 or liters). After a measurement with total flow units has been defined, 770MAX will keep a running total of the volume flowing past the sensor. There are three ways to clear the total flow value and reset it to zero:

1. Use the Reset Menu (see **Chapter 4: Using Menus**).
2. If external reset is enabled (see **Measurement Menu** in **Chapter 4: Using Menus**), then total flow will be

cleared when the discrete input line is momentarily pulsed low. (See **Chapter 2: Installing** for terminal connections).

3. Configure a total flow or deionization capacity setpoint as a reset type, with its value at the desired point for reset.

Flow Rate is expressed in volume per unit time.

Flow Velocity is expressed in feet per second.

Percent Recovery can be calculated as the flow ratio of pure water output to feedwater input through a Reverse Osmosis membrane. For set up, see **DERIVED MEASUREMENTS** later in this chapter.

Deionization capacity in ppm-gallons can be inferred by measuring the flow rate and mineral concentration entering a deionization bed; with results displayed in units of ppm-gallons. For set up, see **DERIVED MEASUREMENTS** later in this chapter.

Flow measurement in terms of Hertz can be used as a diagnostic tool to verify operation of pulse-type flow sensors.

ORP

This measurement type is used to measure oxidation reduction (redox) potentials or any other sensor output in volts. No special settings or calibration are normally required.

TANK LEVEL (VOLUME)

The level of solution inside a tank is measured with a tank level sensor mounted on the tank. Measurements can be displayed in units of:

- gallons
- m^3
- liter
- PSI
- inches
- feet
- % full

To calculate volume, the cross-sectional area (sq. ft) must be entered. To calculate %Full, the tank height (ft) must be entered.

The maximum pressure reading for the sensor also must be known. The Max PSI value is pre-programmed into Smart Sensors and is automatically read by the 770MAX.

DERIVED MEASUREMENTS

The following additional measurements can be derived from the results of two or more direct measurements:

- sum
- difference
- ratio
- % rejection
- % recovery
- deionization capacity — total ppm-gallons or grains
- watts or volt-amps

To set up any of the derived measurements, first set up the primary measurements which will be used to calculate the derived measurement. Define the primary measurements as if they were stand-alone readings. Then the derived measurement can be defined.

Difference

Measurement by difference allows one measurement to be subtracted from another. For example, to display the difference between the incoming flow rate and outgoing flow rate of a process stream:

1. Set up the measurement for the incoming flow sensor.
2. Set up the measurement for the outgoing flow sensor.

   IMPORTANT: Use the same units for both measurements!

3. Set up a third measurement to display the difference between the two.
   a. Select a new measurement letter.
   b. Press **Enter** to bypass the **Sensor Input** field (if “none” is displayed, press the up arrow to select any input channel, then press **Enter**).
   c. Select units of **diff**.
   d. Press the left arrow key three times to return to the beginning of the **Sensor Input** field. Select the letter for the initial measurement and then for the measurement to be subtracted.
   e. Complete the remaining menu options as desired.
4. Press **Menus** twice to return to display mode. All three measurements will be displayed: incoming flow, outgoing flow, and the difference.

Ratio

Measurement by ratio allows one measurement to be divided by another (e.g., measurement A / measurement B = displayed reading).

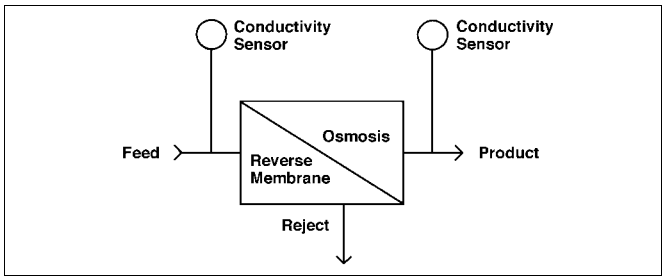
Set up measurements as for **Difference** (see above), except select units of ratio.

% Rejection

% Rejection is measured in conductivity to determine the ratio of impurities removed from product water to the total impurities in the incoming feed water. The formula for obtaining percent rejection is:

[1 – (Product/Feed)] x 100 = % Rejection

The figure below shows a diagram of an RO installation with sensors installed for percent rejection.



% rejection diagram

To set up the % rejection measurement:

1. Set up the measurement for the conductivity sensor installed in the feed line.
2. Set up the measurement for the conductivity sensor installed in the product line.

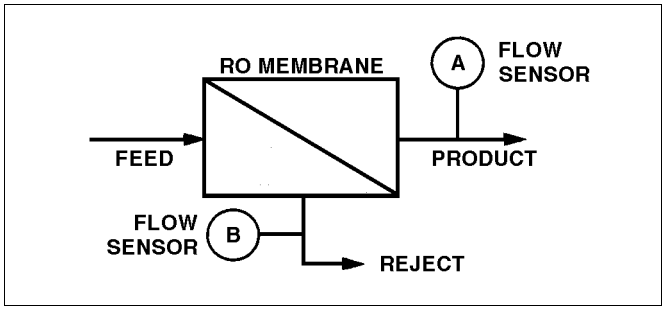
   IMPORTANT: Use the same units and temperature compensation type for both measurements!
3. Set up a third measurement to display the % rejection.
   a. Select a new measurement letter.
   b. Select the sensor input channel to which the feed line conductivity sensor is connected.
   c. Select units of **% Rej**.
   d. Select the sensor input channel to which the product line conductivity sensor is connected.
   e. Complete the remaining menu options as desired.
4. Press **Menus** twice to return to display mode. All three measurements will be displayed: feed line conductivity, product line conductivity, and % rejection.

% Recovery

Percent Recovery is the flow ratio of pure water output to feedwater input through a membrane process. Flow sensors are installed in the product and reject sides of the membrane. The formula for obtaining Percent Recovery is:

[Product / (Product + Reject)] x 100 = % Recovery

The figure below shows a diagram of an installation with sensors installed for percent recovery.



% recovery diagram

To set up the % recovery measurement:

1. Set up the measurement for the flow sensor installed in the product side.
2. Set up the measurement for the flow sensor installed in the reject side.

   IMPORTANT: Use the same units for both measurements!
3. Set up a third measurement to display the % recovery.
   a. Select a new measurement letter.
   b. Select the sensor input channel to which the product side flow sensor is connected.
   c. Select units of **% Rec**.
   d. Select the sensor input channel to which the reject side flow sensor is connected.
   e. Complete the remaining menu options as desired.
4. Press **Menus** twice to return to display mode. All three measurements will be displayed: product flow, reject flow, and % recovery.

Deionization Capacity (DI-Cap™) Total ppm-gallons or grains

The 770MAX can monitor the flow rate and mineral concentration entering a deionization bed and infer the extent of resin capacity consumption. By multiplying ppm total dissolved solids (TDS) based on conductivity, times flow rate in gallons, and integrating the result over time, total ppm-gallons or grains of minerals that have entered the bed can be monitored.

The 770MAX can accomplish this automatically by setting measurement units to ppm-gallons or grains. From this and knowledge of the total capacity of the bed, the "% of run" and/or anticipated time for next regeneration can be determined. This measurement requires installation of a flow sensor and a conductivity sensor.

To set up a deionization capacity measurement:

1. Set up the measurement for the flow sensor.
2. Set up the measurement for the conductivity sensor.
3. Set up a third measurement for deionization capacity.
   a. Select a new measurement letter.
   b. Select the sensor input channel to which the flow sensor is connected.
   c. Select units of ppm-gallons (ppmG) or grains (gr).
   d. Select the sensor input channel to which the conductivity sensor is connected for the "on Ch_" setting.
   e. Complete the remaining menu options including TDS Factor. See **RESISTIVITY/CONDUCTIVITY TDS** section earlier in this chapter.

In the measure mode all three measurements will be displayed: flow, conductivity, and deionization capacity.

Note: For comparison of units, 1 grain = 17.12 ppm-gallons.

Watts or Volt-Amps (VA)

When the 770MAX uses two or more of the Smart Signal Adapters (part no. 1000-xx), it is possible to calculate Power units in Volt-Amperes (VA) or Watts (W).

This simple multiplication routine is only available if at least two channels are connected to Smart Signal Adapters. One channel must have Volts, and the other Amperes (Amps), selected as their unit of measure.

When configuring the third measurement, where VA or W units is selected, one of the two channels connected to the Smart Signal Adapters must be selected as the sensor input. When doing so, the display will show the next channel connected to a Smart Signal Adapter. This will show up on the third line of the display, to the right of the Units (Watt or VA). The 770MAX allows the option of accepting the channel or selecting “None”. If “None” is selected the 770MAX will not perform the multiplication routine and display 0.000 for this measurement.

CHAPTER 6: CALIBRATING AND VERIFYING

The Calibrate Menu is used to calibrate the sensors, analog outputs, or the meter measuring circuits.

The 770MAX meter measuring and analog output circuits are factory calibrated within specifications; therefore, it is not normally necessary to re-calibrate them. Best sensor performance is normally obtained by using the factory-documented calibration constants programmed into Smart Sensors. However, pH sensors will require periodic re-calibration; see the pH sensor instruction manual for recommendations. Level sensors may require calibration after installation to accommodate the sensor location.

As a safeguard, a "hold time" may be entered to freeze the current relay states and analog outputs so that alarms are not triggered during calibration procedures.

CAUTION: "Hold time" will freeze <u>all</u> relays and analog outputs on <u>all</u> measurements, not just the measurement being calibrated.

ACCESS

To access the Calibrate Menu:

1. Press **Menus**.
2. Press the up arrow key until the Calibrate Menu is displayed, then press **Enter**.

See the appropriate section below for calibration procedures.

After completing the desired calibration, press **Menus** twice to exit the menu system and return to display mode.

SENSOR CALIBRATION

The 770MAX uses two calibration constants to calculate measured values from the sensor's linear output signal. These constants, referred to as the adder and multiplier, are pre-programmed into all Smart Sensors and are automatically read by the 770MAX. They can be viewed in the Measurements Menu.

The adder (also known as zero or offset) is an indicator of how far the sensor is offset from the nominal zero point. The multiplier (also known as cell constant, slope or span) is an indication of the sensitivity of the sensor.

Sensors can be calibrated at either one or two points. A one-point calibration will calculate either a new adder or multiplier factor depending on the type of sensor (see chart below). A two-point calibration will recalculate both the multiplier and adder factors.

sensor type	factor calculated by one-point calibration
resistivity/conductivity	multiplier
pH or ORP	adder
flow	multiplier
temperature	adder
pressure, tank level	adder

Sensor calibration requires accurate standards in the range of expected measurements. For a one-point calibration only a single standard is needed. For a two-point calibration, two standards of known value are required.

The new calibration data is held in the 770MAX memory for use by any measurement using the sensor. The data is also saved in the Smart Sensor's memory. The sensor can then be disconnected or moved to another channel or 770MAX without requiring re-calibration. If necessary, the user calibration data can be cleared, restoring factory calibration data, using the Smart Sensors Menu under the Other Menus (see **Chapter 4: Using Menus**).

The basic calibration procedure and sequence of screen messages are the same for all sensor types. Following is an overview of each sensor type, followed by the 770MAX sensor calibration procedure. pH is the only routinely calibrated measurement and is emphasized here.

NOTE: The accuracy of a calibration is limited by the accuracy and traceability of the standards and their vulnerability to contamination. Also, it is important to ensure that the meter is properly calibrated before performing a sensor calibration.

Calibration Overviews for Each Parameter

pH

Due to aging in the process, pH sensors require periodic re-calibration. The stability of the sensor depends on the nature of the sample solution, pressure and temperature variations, etc. For this reason, calibration intervals should be based on experience with the particular application. For new applications it is advisable to re-calibrate frequently. If no significant variation is found, the calibration interval may be increased.

For example, begin with a daily calibration, then extend to weekly, then to monthly as experience and process accuracy dictate. Such a sequence is also appropriate for new sensors, because they will show some initial drift as they acclimate to the process.

Two methods are used for pH sensor calibration: buffer and grab sample.

Buffer calibration requires removal of the sensor from the process, rinsing it with deionized water and immersing it in standard buffer solutions. It is usually done as a two-point calibration and gives the most direct traceablilty to the

standard(s). Use fresh, traceable standard buffer solutions and rinse the sensor well between solutions.

Grab sample calibration is an indirect method that allows the sensor to remain in the process; it is limited to a one-point calibration. A sample is removed and measured by a portable pH system that has been previously calibrated in standard buffer solutions. This value is used to calculate a difference to be applied during a one-point calibration procedure. (See **pH Grab Sample Calibration** below.)

For greatest accuracy, a two-point buffer calibration is generally recommended. In some situations, it is most convenient to do a grab sample calibration on a routine basis with a more accurate two-point buffer calibration performed at less frequent intervals.

For a one-point calibration, the buffer value chosen should be near the expected sample pH. For a two-point calibration, buffer values should bracket the anticipated measurement range, if possible. The difference between the two should be 2 pH units or more.

Automatic buffer recognition allows the 770MAX to recognize pH buffer values during calibration. When the sensor is put in a buffer solution, the meter automatically displays the closest buffer value, corrected for temperature. pH vs. temperature tables for 4.00, 6.86, 7.00, 9.00, 9.18, 10.00 pH @25C buffer solutions are stored in memory. Since some values are very close to each other, it may be necessary to manually correct the automatic value provided.

Temp (°C)	pH of buffer solutions					
0	4.00	6.984	7.13	9.26	9.464	10.34
5	4.00	6.951	7.10	9.21	9.395	10.26
10	4.00	6.923	7.07	9.15	9.332	10.19
15	4.00	6.900	7.05	9.10	9.276	10.12
20	4.00	6.881	7.02	9.05	9.225	10.06
25	4.01	6.865	7.00	9.00	9.180	10.00
30	4.01	6.853	6.99	8.96	9.139	9.94
35	4.02	6.844	6.98	8.92	9.102	9.90
40	4.03	6.838	6.97	8.89	9.068	9.85
45	4.05	6.834	6.97	8.86	9.038	9.81
50	4.06	6.833	6.97	8.83	9.011	9.78
55	4.07	6.834	6.97	8.80	8.985	9.75
60	4.09	6.836	6.98	8.78	8.962	9.70
70	4.13	6.845	6.98	8.76	8.921	9.67

NOTE: In most applications, an adder offset of more than ±2.5 pH units or a multiplier of less than 0.8 is an indication that the sensor should be replaced soon. See **pH Sensor Diagnostics**, in **Chapter 7: Maintenance & Troubleshooting**.

ORP (Voltage)

For ORP measurement, no sensor calibration is recommended, although one-point calibration is possible. It is recommended that the instrument read in absolute millivolts established by factory meter calibration. Standard ORP solutions are available for checking operation of sensors, however, their tolerance under process conditions is generally too wide to allow reliable calibration.

Resistivity/Conductivity

Only a one-point calibration is used for 2-electrode resistivity or conductivity sensors. With 4-electrode sensors, two-point calibrations are performed.

Select a fresh standard with a value close to the expected sample resistivity/conductivity, but not less than 100 µS/cm. (The uncertainty due to atmospheric carbon dioxide contamination of the standard would be greater than the non-linearity of the measurement between 100 µS/cm and pure water.) Remember to enter the appropriate unit multiplier: µ, m, k, or M. For polymer body sensors, allow at least 15 minutes equilibration time for the temperature measurement and compensation to fully stabilize.

Temperature

A one- or two-point calibration can be performed for temperature sensors, though calibration is rarely required. For temperature measurement in polymer body conductivity sensors, allow at least 15 minutes equilibration time for the measurement to fully stabilize.

Flow

In some instances, a one-point calibration of flow sensors is needed to accommodate non-ideal piping arrangements. A second point of calibration can be performed at zero flow.

If an accurate flowmeter is not available for comparison, determine a standard flow rate by measuring the amount of time for a known tank level change and computing the volume change per unit time.

Pressure

Although calibration is seldom required, a simple 1-point zero calibration is easily performed. If a second point of calibration is needed, use an accurate traceable pressure instrument as the standard.

Tank Level

A two-point calibration after installation is generally recommended to accommodate the unique sensor location. Calibrate at zero and some measurable high level. Level measurements are linear, for straight-sided tanks only.

Dissolved Oxygen

Only a one-point air calibration is normally performed, at startup and periodically thereafter. Automatic correction for temperature and barometric pressure is provided. Although not normally required, a one-point calibration of the barometric pressure measurement may be performed if pressure is set up as a measurement. A one-point zero dissolved oxygen calibration is available but not normally recommended since zero DO is very hard to achieve and sensor electrical zero is very close to theoretical.

Calibration Procedure

This procedure is generic for all parameters. Refer above to specifics about the type of sensor to be calibrated. The accuracy of any calibration is limited by the accuracy of the standards and technique.

To perform a sensor calibration:

1. Access the Calibration Menu.
2. Select sensor calibration.
3. Enter the hold time in minutes. If holding the outputs is not necessary, leave at zero. Press **Page Down**.
4. Select the measurement letter corresponding to the sensor to be calibrated.
5. Select either one- or two-point calibration.
6. Place the sensor in the first calibration solution or establish conditions for the first calibration point.

   Press **Page Down**. The current reading will be displayed.
7. Enter the value of the first calibration standard/point (including units multiplier, if necessary) as Cal point 1.

   NOTE: For pH, the 770MAX automatically recognizes the nearest buffer value corrected for temperature. Press **Enter** if the value is correct, or change it if incorrect. For dissolved oxygen, the 770MAX automatically computes the oxygen concentration for air-saturated water, corrected for barometric pressure and temperature.
8. Wait for a stable reading, then press **Page Down** to begin calibration. (The displayed value is before calibration and will be slow to update.)

9a. If performing a one-point calibration go to Step 12.

9b. If performing a two-point calibration, place the sensor in the second calibration solution or establish conditions for the second calibration point. The current reading will be displayed. Press **Page Down**. The current reading will be displayed.

10. Enter the value of the second calibration standard/point (including units multiplier, if necessary).
11. Press **Page Down** to begin calibration.
12. After calibration is complete, the measurement values before and after calibration are displayed.
13. Enter the date as month/day/year (mm/dd/yy), then press **Page Down** to save.
14. Select **Yes** to save the calibration data in the Smart Sensor memory.

    NOTE: Steps 13 and 14 must be completed, answering "yes" to save calibration data permanently; otherwise the calibration data will be lost on power down or on disconnecting the patch cord.
15. If the hold function was used, reset it to zero to resume normal operation of analog outputs and relays.

After calibration, the 770MAX will return to the display mode and the new calibration constants will be used for all measurements using that sensor.

pH Grab Sample or Comparison Calibration Procedure

This method should only be used when the pH is stable. To perform a grab sample calibration:

NOTE: For pure water samples (<20 µS/cm conductivity), the "grab sample" should be a flowing side stream not exposed to air before the measurement to minimize contamination.

1. Take a grab sample from the process stream.
2. Record the pH displayed on the 770MAX at the time the grab sample is taken.
3. Measure the grab sample pH as soon as possible.
4. Subtract the recorded 770MAX pH from the grab sample pH. Record the difference, retaining the sign (positive or negative).
5. Access the 770MAX Calibration Menu.
6. Select sensor calibration.
7. Select the measurement letter corresponding to the sensor to be calibrated.
8. Select one-point calibration.
9. Press **Page Down**. The current reading will be displayed.
10. Add the difference value calculated in step 4 to the currently displayed pH and immediately enter the result as the calibration standard value.
11. After calibration is complete, the measurement values before and after calibration are displayed. These values are for display only.
12. Enter the date as month/day/year (mm/dd/yy), then press **Page Down** to save.
13. Select Yes to save the calibration data in the Smart Sensor memory; otherwise, select No.

ANALOG OUTPUT CALIBRATION

This section is not for startup scaling of analog outputs; for that see **Chapter 4: Using Menus**. This section fine-tunes the 4 and 20 mA signal levels.

The analog output signals have been factory calibrated to specifications. They may be re-calibrated in a two step process where 0/4 mA and 20 mA levels are adjusted. A precision milliammeter must be connected in series with the output to perform the calibration.

To perform an analog output calibration:

1. Connect the milliammeter to the analog output being calibrated.

2. Access the Calibration Menu.
3. Select analog output calibration.
4. Select the analog output channel to be calibrated.
6. Adjust the “4 mA adjust” percentage display to obtain the desired reading on the milliammeter (or other output reading device). A higher percentage display produces a lower output signal. When done, press **Page Down.**
7. Adjust the “20 mA adjust” percentage display to obtain the desired reading on the milliammeter and press **Page Down**.
8. Enter the calibration date as month/day/year (mm/dd/yy),and press **Page Down** to store it.
9. To perform another calibration, press **Page Up** to return to the initial calibration screen. To go to display mode, press **Menus** twice.

METER CALIBRATION

The 770MAX is factory calibrated within specifications. It is not normally necessary to perform meter re-calibration unless required to meet Q.A. protocols or extreme conditions cause out of specification operation.

Meter measuring circuits are calibrated by input channel and circuit type. Each channel contains resistance, temperature, voltage and frequency measurement circuits. The resistance circuits can be calibrated over four ranges: 500K, 20K, 2K and 200 ohms.

In addition to calibration, the most recent calibration can be verified to ensure best performance.

To calibrate or verify the meter measuring circuits, precision electronics are required. It is strongly recommended to use the Automatic Smart Calibrator Kit, Part No. 1875. For details regarding meter calibration see the Calibrator Kit instruction manual.

If it is desired to use local standards lab equipment, provide a decade box, voltage source and frequency source with traceable accuracy exceeding meter specifications. Obtain the appropriate adapter cable(s) listed in **Chapter 8: Accessories and Spare Parts** and refer to Service Manual, Part No. 84373, for procedures

CHAPTER 7: MAINTENANCE & TROUBLESHOOTING

MAINTENANCE

Front Panel Cleaning

Clean the front panel with a damp soft cloth (water only, no solvents). Gently wipe the surface and dry with a soft cloth.

For Technical Support and repair information contact:
Metter-Toledo Thornton, Inc.
36 Middlesex Turnpike
Bedford, MA 01730
Phone: 781-301-8600 or 800-510-PURE
Fax: 781-271-0214
E-mail: service@thorntoninc.com
Also see Service Manual 84373 for more details.

TROUBLESHOOTING CHECKLIST

If the equipment is used in a manner not specified by Mettler-Toledo Thornton Inc., the protection provided by the equipment may be impaired.

Review the table below for possible causes of common problems:

Problem	**Possible Cause**
Display is blank.	No power to 770MAX. Blown fuse. LCD display contrast set incorrectly. Hardware failure.
Incorrect measurement readings.	Sensor improperly installed. Incorrect units multiplier entered. Temperature compensation incorrectly set or disabled. Sensor or meter needs calibration. Sensor or patch cord defective or exceeds recommended maximum length. Hardware failure.
Measurement readings not stable.	Sensors or cables installed too close to equipment that generates high level of electrical noise. Recommended cable length exceeded. Averaging set too low. Sensor or patch cord defective.
Displayed measurement reading is flashing.	Setpoint is in alarm condition (setpoint exceeded).
Flashing "→" in lower right corner of display.	A measurement not currently displayed is in setpoint alarm condition.
Desired measurement letter is not displayed as a possible selection when scrolling through options for analog outputs, setpoints, etc.	Measurement has not been defined, define measurements first.
When replacing a non-Smart Sensor, cannot clear old sensor information and enter new sensor type.	Go to Measurement Menu: • Select desired measurement letter • Select channel "none" • Select units of "none" • Go back to channel and select desired channel • Select sensor type and units
Cannot change menu settings.	User locked out for security reasons.
Data not sent out to serial port.	Serial port miswired. Baud rate and/or parity set incorrectly.

pH SENSOR DIAGNOSTICS

The adder and multiplier constants, viewed in the Measurements Menu, can provide valuable preventive maintenance information about pH sensors. However, the values must not be changed in this menu or the sensor will have to be recalibrated.

The **adder** factor (zero, asymmetry or standardize offset) is an indication of how far the sensor has drifted from the nominal zero starting point, in pH units. It is recalculated after every calibration. Drift in this value is usually due to aging or contamination of the reference electrode portion of the sensor.

An offset of more than ±2.5 pH units or a more rapid change in this value is an indication that the sensor should be replaced soon.

Because 770MAX display is auto-ranging, when the adder factor is very small, it may be displayed in milli-pH units with an “m” prefix following the numeric value. In this case the value is very near the nominal zero offset.

The **multiplier** (slope or span) is an indication of the sensitivity of the sensor to changes in pH. It has a nominal value near 1 and is recalculated after every 2-point calibration. Reduction in this value is usually due to aging, coating or hot caustic attack of the glass measuring membrane of the sensor.

A sensor with a multiplier value less than 0.80 should be replaced soon.

DIAGNOSTIC MENU

The Diagnostic Menu is used to run a series of automated diagnostic testing routines to verify the operation of system components, including: meter, sensors, analog output, serial port, network, display, keypad, flow channels, inputs and outputs.

To access the Diagnostic Menu:

1. Press **Menus**.
2. Press the up arrow key until the Diagnostic Menu is displayed, then press **Enter**.
3. Use the up/down arrow keys to select a component to test, then press **Enter**. The indicated test will be performed and the results displayed.
4. To test another component, press **Page Up** to return to the Diagnostic Menu and select the next component.
5. After completing the desired diagnostics, press **Menus** twice to exit the menu system and return to display mode.

CAUTION: Some diagnostic tests may interrupt normal operation of analog outputs and relays and could upset related processes. Activate the HOLD function before using these diagnostics.

See the appropriate section below for information regarding the specific diagnostic tests.

Meter Tests

Use to test the timers, ROM checksum, and RAM. Tests are performed sequentially, press **Enter** to perform next test.

Smart Sensors

Select a channel to view the raw sensor data (actual voltage, ohms, etc.).

Serial Port

On back of meter, use a jumper wire to connect TB2 terminals 9 and 10 then press **Enter** to begin test.

Network

Not currently available.

Display

An automated sequence will test the display of all characters (alpha, numeric and symbol). Press **Enter** to stop the test.

Keypad

Press any key to test its response, the correct name of the key should be displayed. Press **Menus** twice to exit this test.

Flow Channels

Diagnostic not currently available.

Inputs

The level of the discrete input lines (high or low) will be displayed and updated.

Outputs

Set the discrete outputs low or high for testing. Press **1** to set low or **2** to set high.

Self Tests

An automated series of tests will check the operation of the following components:

- Smart sensors
- Analog outputs
- Discrete outputs
- Discrete Inputs
- Network
- Display circuit board
- Measurement circuit board
- Options circuit board
- Other components (ROM, RAM, etc.)

The display shows how many times the tests have run, the elapsed time and the number of errors found. Press **Menus** to stop the test sequence.

Analog Output

Select an output to test, then enter a current value (milliamps) to send out the analog output then press **Page Down** to set. Repeat test with a second current value to verify range response.

CHAPTER 8: ACCESSORIES AND SPARE PARTS

ACCESSORIES

Description **Part Number**

Patch cords have connectors at both ends for 770MAX and Smart Sensors (not used with pulse input flow sensors). Pressure and level sensors are limited to 150 ft (45.6 m) maximum and 4-electrode conductivity sensors are limited to 50 ft (15.2 m) maximum length.

- 1 ft. (0.3 m) cord 1001-79
- 5 ft. (1.5 m) cord 1005-79
- 10 ft. (3 m) cord 1010-79
- 15 ft. (4.5 m) cord 1015-79
- 25 ft. (7.6 m) cord 1025-79
- 50 ft. (15.2 m) cord 1050-79
- 100 ft. (30.5 m) cord 1100-79
- 150 ft. (45.6 m) cord 1115-79
- 200 ft. (61 m) cord 1120-79
- 300 ft. (91 m) cord 1130-79

Rear cover for wall mounting and sealing 1000-69

Cable Grip Kit – for sealing 1/2” conduit hole entrances for 2 patch cords to rear cover or other enclosure, with large grommets to pass modular connector of patch cord 1000-80

Pipe mounting bracket, for 2" pipe 15540

Patch cord extension 5 ft (1.5 m) 1005-87

Patch cord extension 15 ft (4.5 m) 1015-87

Connector for patch cord extension 25320

12 VDC Power Supply for 1 or 2 pulse input flow sensors (powered by 85-265 VAC) 1000-65

Pulse input flow sensor kit , required for some pulse flow sensors 1000-67

Automatic Smart Calibrator Kit 1875

Smart pH/ORP BNC preamp – for pH/ORP electrode with BNC connector (no temp. comp.) 1000-78

Smart ORP AS9 preamp, 1 m – for ORP electrode with K9 connector 1000-84

Smart ORP AS9 preamp, 3 m – for ORP electrode with K9 connector 1000-02

Smart pH VP preamp, 1 m cable – for pH electrode with VP connector 1000-96

Smart pH VP preamp, 3 m cable – for pH electrode with VP connector 1000-97

Smart pH VP preamp, 5 m cable – for pH electrode with VP connector 1000-98

Smart conductivity adapter cable – allows decade box input for calibration 1000-82

Smart frequency adapter cable – allows frequency input for pulse flowmeters 1000-83

770MAX Service Manual 84373

SPARE/REPLACEMENT PARTS

Description	Part Number
10-Terminal plug-in connector, 2 for models 775-_ _0 & 775-_ _1; 3 for model 775-_ _2	25302*
6-Terminal plug-in connector, 2 for models 775-_ _1 and 775-_ _2	25301*
Fuse, 0.5 A slow blow, 5 x 20 mm (Littlefuse 218.500 or equivalent)	35092*
Panel mounting screws (6-32 x 7/16”, 4 required)	21800
Front panel assembly, molded cover with gasket, screws, retaining washers and keypad	07331
Screws for front panel (2 required, included in front panel assembly above)	21674
Retaining washers for front panel (2 required, included in front panel assembly above)	21675
Vacuum fluorescent display module (order connector and mounting standoffs separately)	47048
Connector for vacuum florescent display module above	25300
Liquid crystal display module (order mounting standoffs separately)	47047
Display standoffs (4 required for either display above)	21673
Relay option kit (to convert model 775-_ _0 to 775-_ _1), not CE rated	1000-91
Analog output & relay option kit (to convert 775-_ _0 to 775-_ _2) not CE rated	1000-92

*Recommended Spare parts

APPENDIX A: SETUP PARAMETERS

MEASUREMENT PARAMETERS RECORD

Photocopy this form for each measurement programmed into the 770MAX.

Unit Name: _____

Date: _____

Sensors Installed:

Chan 1: _____ S/N= _____ Cal Date= _____

Chan 2: _____ S/N= _____ Cal Date= _____

Chan 3: _____ S/N= _____ Cal Date= _____

Chan 4: _____ S/N= _____ Cal Date= _____

Chan 5: _____ S/N= _____ Cal Date= _____

Chan 6: _____ S/N= _____ Cal Date= _____

Measurement (A–P): _____

Sensor Input Channel: _____

Sensor Type: _____

Units: _____

Name: _____

Multiplier: _____

Adder: _____

Averaging: _____

Temperature Compensation: _____

STC (pH only): _____

IP (pH only): _____

Temperature Source: _____

Resolution: _____

Max PSI (pressure only): _____

Pipe ID (flow only): _____

TDS Factor (conductivity /resistivity & DI Capacity only): _____

Tank Height (tank level only): _____

Area (tank level only): _____

Analog Output (1–4 or 8): _____

Output Type: _____

On Failure Set Output: _____

Setpoint (1–16): _____

Setpoint Value: _____

Setpoint Type: _____

Setpoint Activates: _____

If Sensor Error: _____

Relay (1–4): _____

Time Delay: _____

Hysteresis Value: _____

Relay State: _____

External Clear?: _____

APPENDIX B: PULSE FLOW INPUT SETUP

The 770MAX has flow inputs for 4 Smart sensors and 2 pulse input sensors. Smart sensors connect to channels 1-4 using a patch cord and have their precalibrated values stored in NVRAM which are automatically communicated to the 770MAX when connected. Power for Smart sensors is provided through the patch cord and connector and no further setup is required.

Covered in Appendix B is the installation of flow sensors to the pulse flow inputs, Channels 5 and 6. Flow constants must be manually entered into the 770MAX Measurements menu. Pulse flow inputs require signals that go below 0.9V and above 3.2V but that do not exceed 5V.

WIRING

Pulse input flow sensors connect directly to 770MAX channel 5 and 6 input screw terminals with no patch cord. Many pulse input sensors require an isolated external power supply and some require additional components, as shown in the following figures. One external power supply can power two pulse input flow sensors. Part 1000-65 provides 12 VDC, 0.42 A from 100 to 240 VAC.

Some pulse input sensors also require a resistor and/or diode as shown. They are available in separately ordered flow input kit 1000-67 which should be mounted nearby. The 1000-67 kit has a 2.2KΩ, 0.5W resistor and 1N4148 or 1N914 diode mounted on a 3-position screw-mounted terminal strip. See the end of this chapter for power supply and kit dimensions.

WARNING: POWER SUPPLY 1000-65, IF USED, HAS OPEN POWER TERMINALS AND MUST BE MOUNTED INSIDE AN ENCLOSURE TO PROTECT PERSONNEL FROM SHOCK HAZARD.

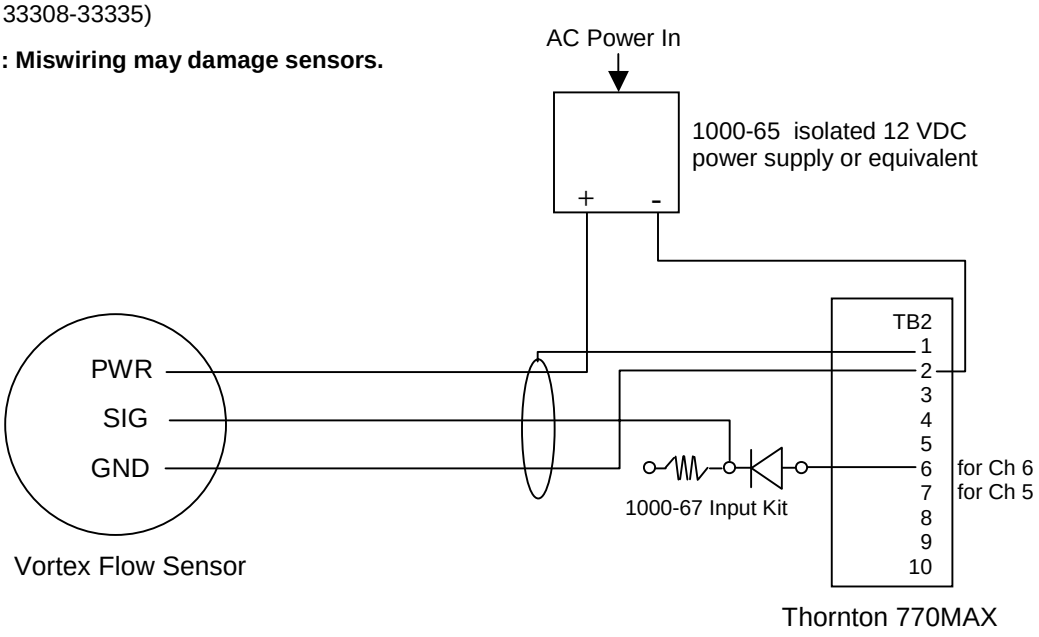
The following diagrams provide the wiring connections for pulse input flow sensors. When two pulse input sensors are used, they may use the same shield (1), common (2) and power (3) terminals at the 770MAX, but use separate input terminals—terminal (7) for Channel 5 or terminal (6) for Channel 6.

NOTE: Locations with excessive electrical noise may produce erratic flow response. In that case, connect the shield to a reliable earth ground near the sensor or at a junction box instead of terminal 1 in the 770MAX.

Vortex Flow Sensors (Asahi/America)

(Thornton 33308-33335)

CAUTION: Miswiring may damage sensors.

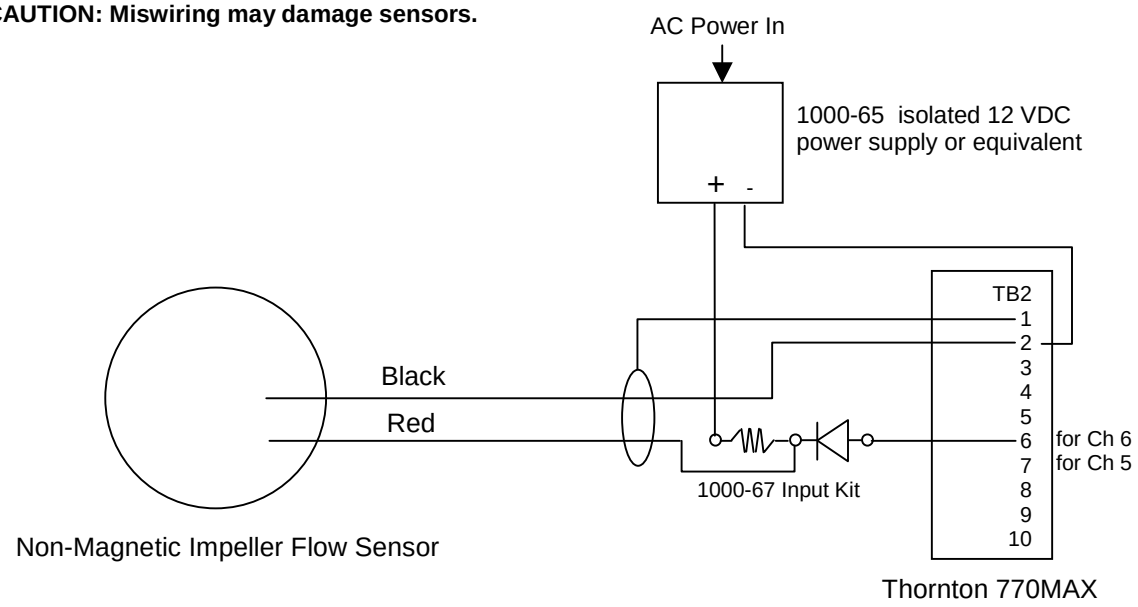


Extension cable: 3-conductor with shield, 20 AWG (Belden 9364 or equivalent), 1000 ft (305 m) maximum.

Non-Magnetic Impeller Flow Sensors (Data Industrial 200-Series)

(Thornton 33142-33145, 33159-33162, 33173, 33273)

CAUTION: Miswiring may damage sensors.

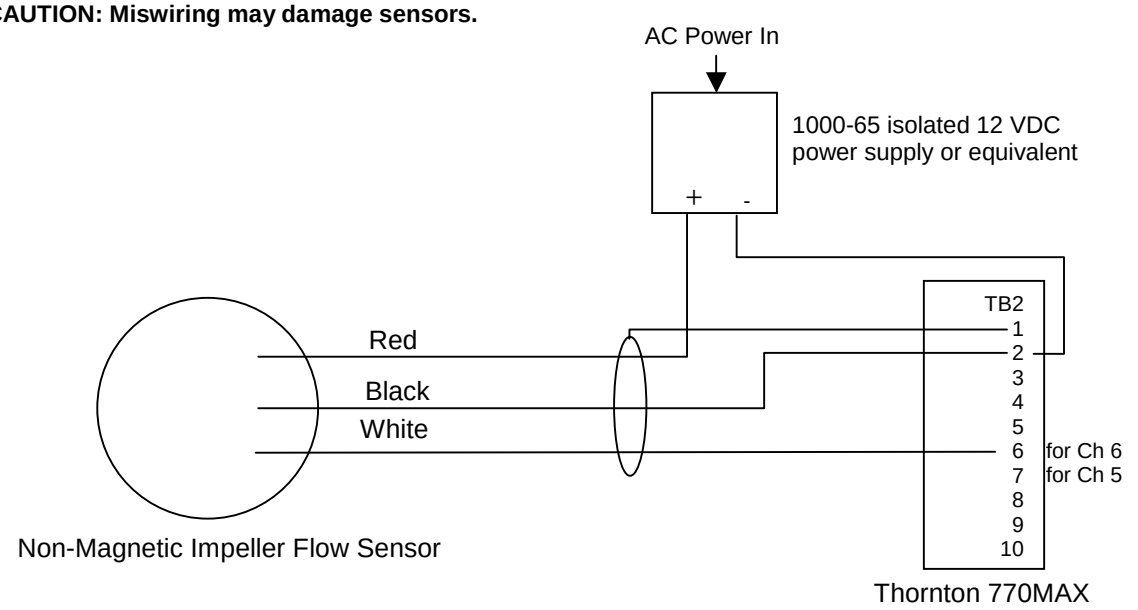


Extension cable: 2-conductor with shield, 22 AWG (Belden 8451 or equivalent), 2000 ft (610 m) maximum.

Non-Magnetic Impeller Flow Sensors (Data Industrial 4000-Series)

(Thornton 33171-33172, 33174-33177, 33349-33350)

CAUTION: Miswiring may damage sensors.

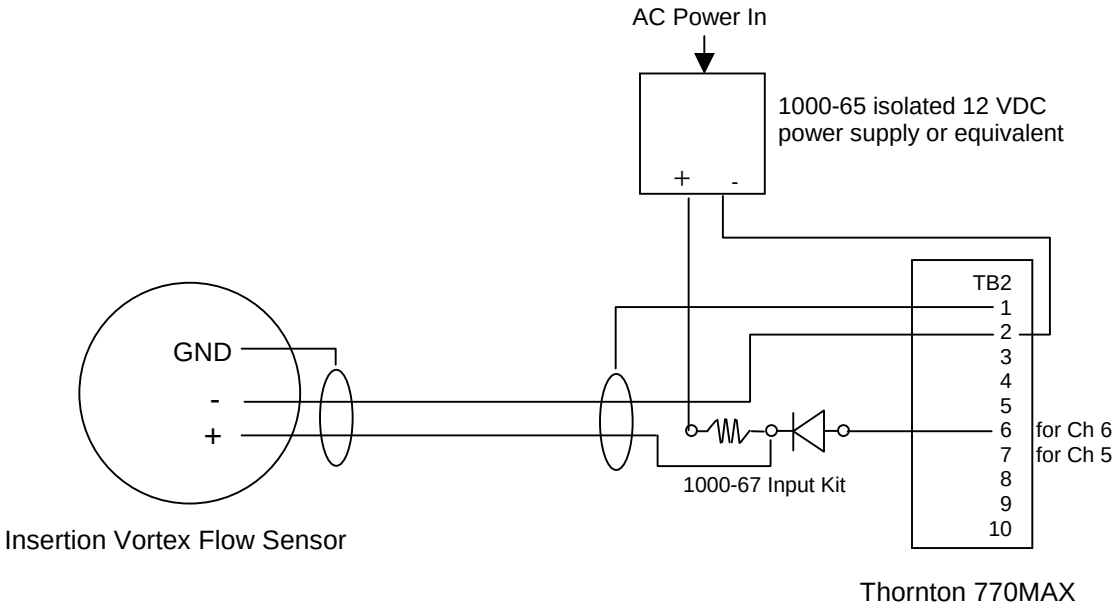


Extension cable: 3-conductor with shield, 20 AWG (Belden 9364 or equivalent), 2000 ft (610 m) maximum.

Insertion Vortex Flow Sensors (Fluidyne 2300-A Pulse Output Type)

(Thornton 33358-33375)

CAUTION: Miswiring may damage sensors.

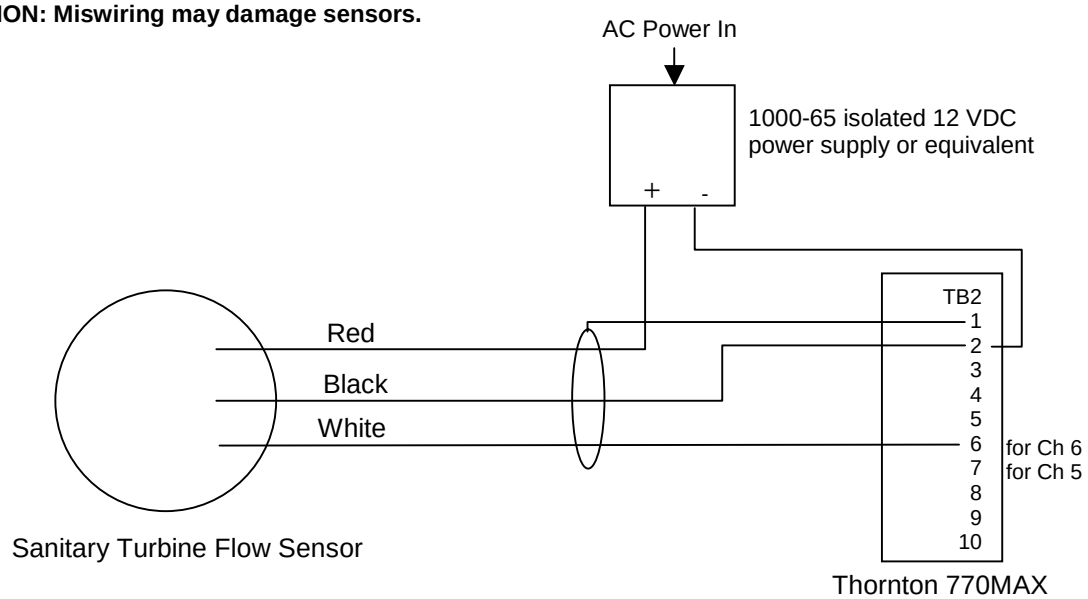


Extension cable: 2-conductor with shield, 22 AWG (Belden 8451 or equivalent), 2000 ft (610 m) maximum.

Sanitary Turbine Flow Sensors (Hoffer HO-Series)

(Thornton 33336-33348, 33376-33377)

CAUTION: Miswiring may damage sensors.

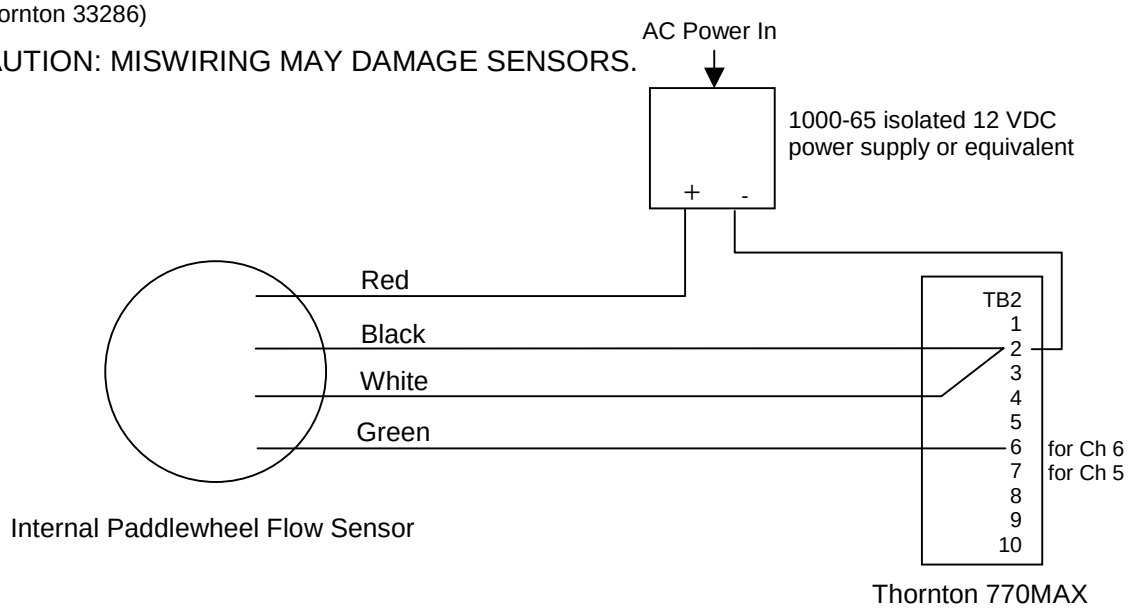


Extension cable: 3-conductor with shield, 20 AWG (Belden 9364 or equivalent), 3000 ft (915 m) maximum.

Internal paddlewheel Flow Sensors (Proteus PS600 series)

(Thornton 33286)

CAUTION: MISWIRING MAY DAMAGE SENSORS.



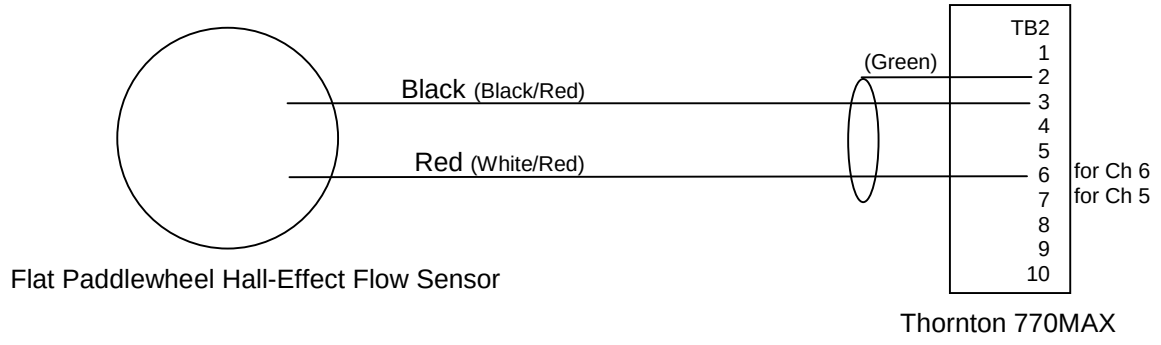
Extension cable: 3-conductor with shield, 20 AWG (Belden 9364 or equivalent)

Flat Paddlewheel Hall-Effect Flow Sensors (Signet 2507, 2536, 2540-Series)

(Thornton 33282, 33285, 33287, 33298-33305) first colors listed

and Flow Technology Sensors with PS-910-QD-0 Hall-Effect Pickup (colors in parentheses)

CAUTION: Miswiring may damage sensors.



Extension cable: 2-conductor with shield, 22 AWG (Belden 8451 or equivalent), 1000 ft (305 m) maximum.

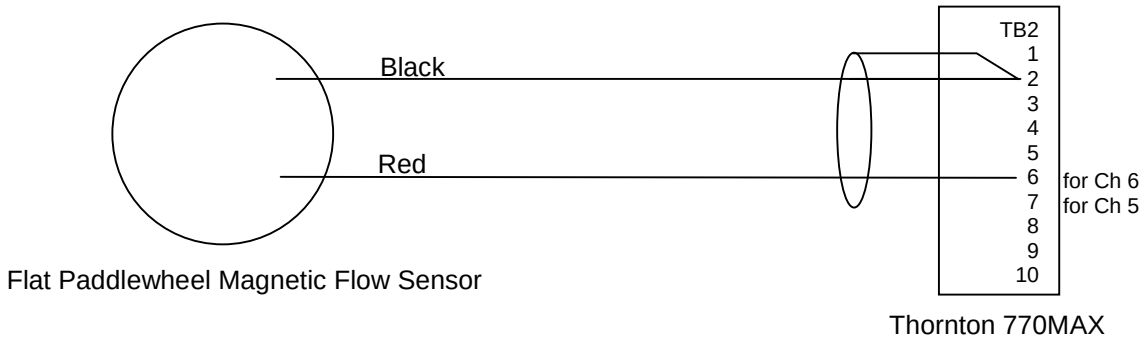
Flat Paddlewheel Magnetic Flow Sensors (Signet 515-Series)

(Thornton 33189, 33190, 33193, 33195, 33196, 33199, 33229)

NOTE: Signet 515-Series sensors are functional only in the highest 75% of flow range.

NOTE: Signet 525-Series sensors are not compatible with 770MAX pulse input.

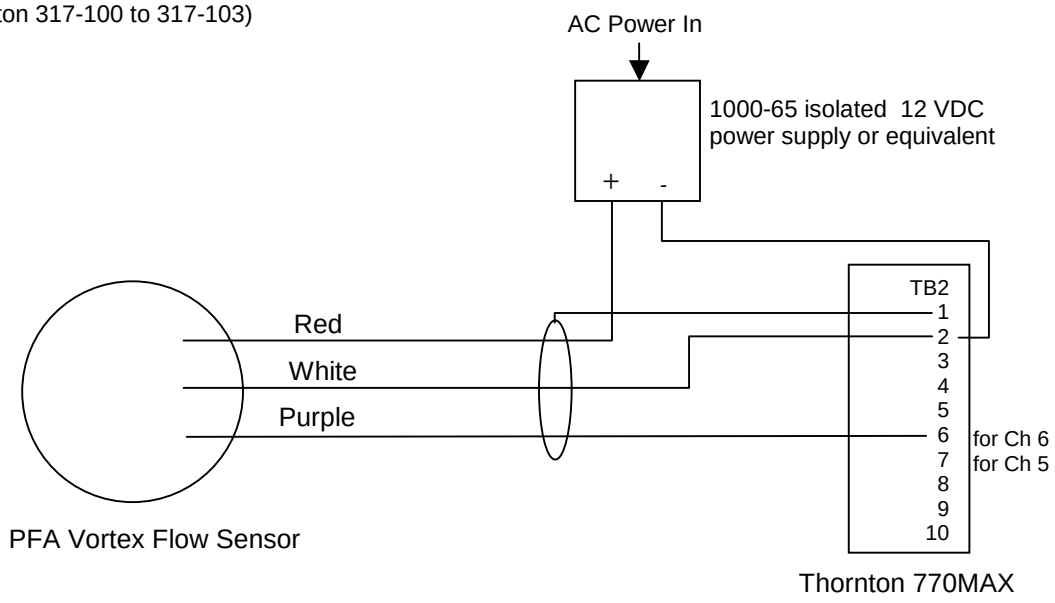
Caution: MISWIRING MAY DAMAGE SENSORS.



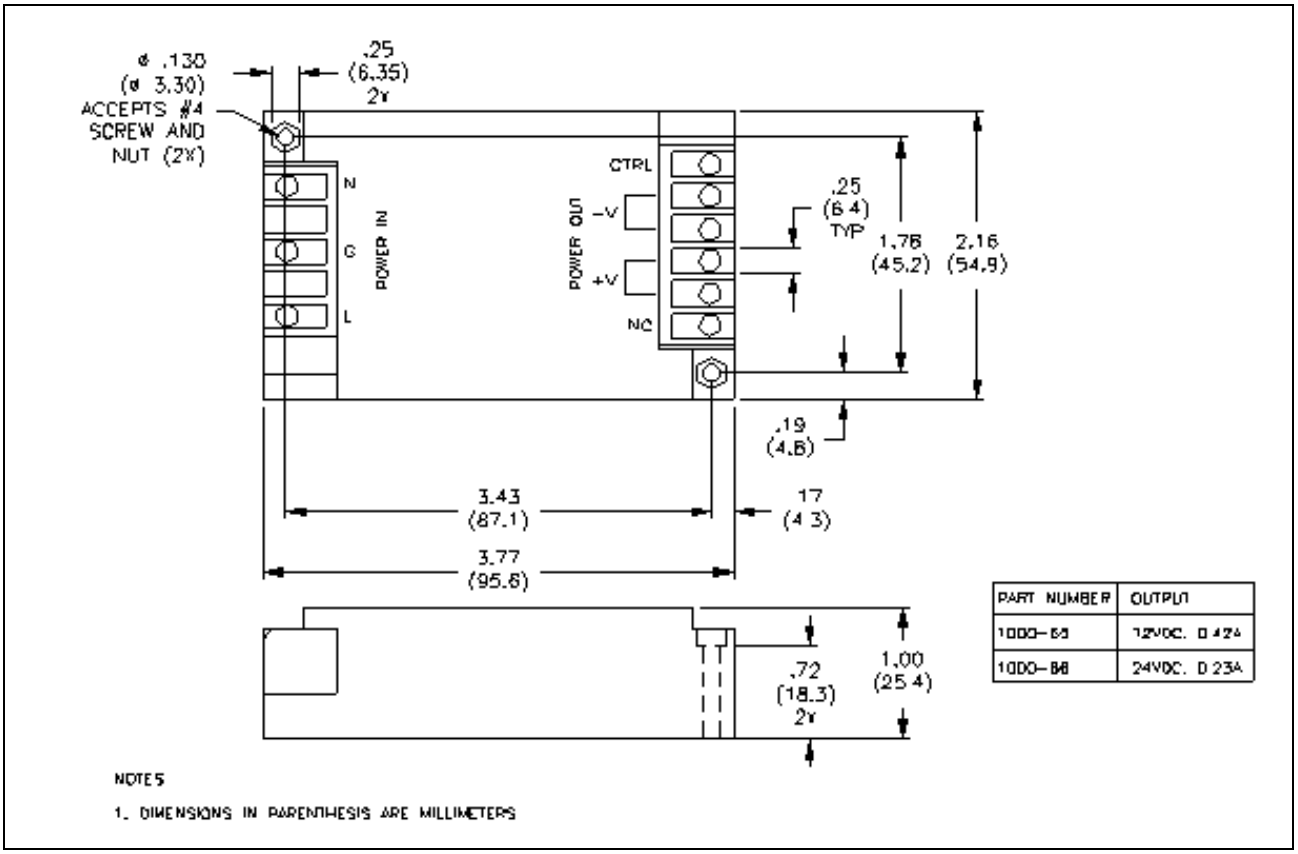
Extension cable: 2-conductor with shield, 22 AWG (Belden 8451 or equivalent), 1000 ft (305 m) maximum.

PFA Vortex Flow Sensors (Thornton 317-Series)

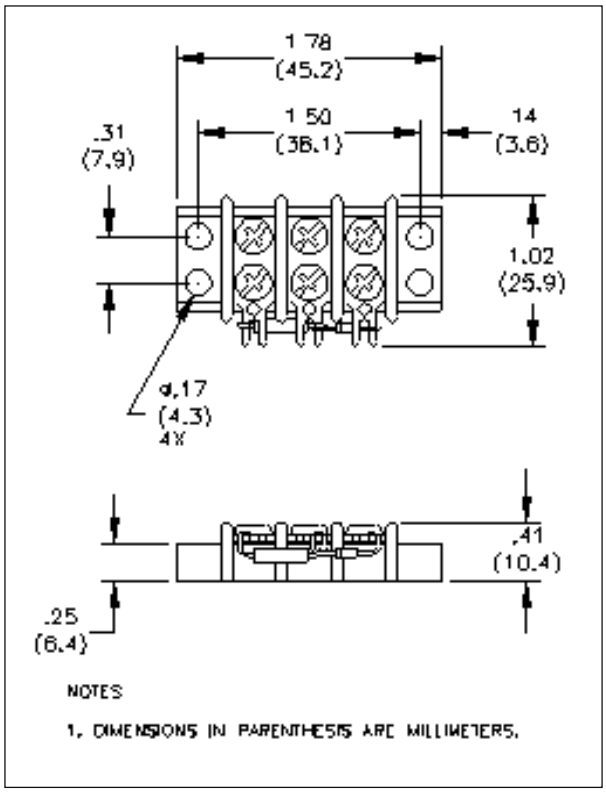
(Thornton 317-100 to 317-103)



Extension cable: 3-conductor with shield, 20 AWG (Belden 9364 or equivalent).



1000-65 power supply dimensions



CALIBRATION CONSTANTS FOR PULSE INPUT FLOW SENSORS

Forward-Swept Non-Magnetic Impeller (Data Industrial) Sensor Flow Constants

Enter these Multiplier and Adder constants into the 770MAX Measurements menu for channel 5 and/or 6.

Thornton Part No.	Data Ind. Part No.	Pipe Size	Fitting	Pipe Material	Multiplier Constant (Pulses/gal)	Adder Constant (GPM)
33349	410200	1/2"	flow-thru/pipe	PVC	422.2	0.1204
33350	411200	3/4"	flow-thru/pipe	PVC	182.54	0.0710
33176	400200	1/2"	flow-thru/pipe	PVC	145.28	0.1444
33177	401200	3/4"	flow-thru/pipe	PVC	104.62	0.1513
33175	402200	1"	flow-thru/pipe	PVC	97.82	0.1120
33142	220P-1.5	1-1/2"	Socket tee	PVC	35.31	-0.3160
33143	220P-2	2"	Socket tee	PVC	22.018	1.0682
33144	220P-3	3"	Socket tee	PVC	7.221	1.8861
33145	220P-4	4"	Socket tee	PVC	3.909	3.8068
33172	400500	1/2"	Socket Union	PVDF	100.22	0.0005
33174	401500	3/4"	Socket Union	PVDF	97.879	0.1633
33171	402500	1"	Socket Union	PVDF	95.755	0.0197
33162	228PF-1.5	1-1/2"	Weld tee	PVDF	28.807	0.6738
33159	228PF-2	2"	Weld tee	PVDF	15.244	0.7203
33160	228PF-3	3"	Weld tee	PVDF	10.836	3.2868
33161	228PF-4	4"	Socket tee	PVDF	5.8224	7.4608
33173	228PF-6	6"	Weld tee	PVDF	3.2538	4.5861

For Data Industrial sensor models not listed above, consult the flow sensor installation manual, available at www.dataindustrial.com. Convert the 'K' factor for the sensor in units of GPM/Hz to a Multiplier in units of pulses/gallon by dividing 60 by the K value. Enter the result as the Multiplier in the 770MAX Measurements menu. For example, if the K factor is 2, the Multiplier would be 60/2 = 30.

Convert the flow sensor 'Offset' in units of Hz from the sensor installation manual into an Adder in units of GPM by multiplying the Offset by the original K factor. Enter the result as the Adder in the 770MAX Measurements menu. For example, if the Offset is 0.3 and the K factor is 2, the Adder would be 0.3 x 2 = 0.6.

Flat Paddlewheel Sensor Flow Constants

Values below are for the Multiplier in pulses per gallon. The Adder is left at zero for all Signet sensors. Data for additional sensors is in the sensor installation manual available at www.gfsignet.com.

Pipe Size	Magnetic P515-Series	Hall-Effect 2536-Series
Sch 80 Tees PVC & CPVC		
1/2"	480.19	991.71
3/4"	257.72	545.14
1"	174.67	352.43
1-1/4”	83.39	177.18
1-1/2"	58.58	117.85
2"	32.48	66.739
2-1/2”	21.833	42.994
3"	13.541	26.652
4"	7.626	15.006
Sch 80 PVC Saddles for Sch 80 PVC Pipe		
2"	32.480	66.739
2-1/2”	21.833	42.994
3"	13.541	26.652
4"	7.626	15.006
6"	4.162	8.325
8"	2.370	5.016
Sch 80 PVC Saddles for Sch 40 PVC Pipe		
2"	27.350	54.700
2-1/2”	18.874	37.159
3"	12.638	23.697
4"	6.728	13.456
6"	3.730	7.459
8"	2.153	4.529

SPECIFICATIONS

Functional

Sensor inputs:	4 Smart Sensor channels, 2 pulse flow channels	
Cond./Resist. Ranges:	0.01 Constant 2-E Cell:	0.001 µS/cm to 2000 µS/cm
		0.5 kΩ-cm to 1000 MΩ-cm
	0.1 Constant 2-E Cell:	0.01 µS/cm to 3000 µS/cm
		0.33 kΩ-cm to 100 MΩ-cm
	10 Constant 2-E Cell:	10 µS/cm to 200,000 µS/cm
	50 Constant 2-E Cell:	10 µS/cm to 1.0 S/cm
	4-E Cell:	10 µS/cm to 800,000 µS/cm
	TDS: covers equivalent conductivity ranges	
	Concentrations: HCl: 0-15%, NaOH: 0-13%, H_2SO_4: 0-20%, by weight	
pH & ORP Ranges:	-1 to 15 pH, -1500 to +1500 mV	
Temperature Range:	-40° to 200°C, -40 to 392°F with Pt1000 RTD or Pt100 RTD	
Flow Range:	Sensor range in GPM, LPM, m^3/hr, Hz; 0.5 to 4000 Hz	
Pressure:	Sensor range in psi, bars, kPa, mmHg, kg/cm^2, inches, feet	
Tank Level (Volume):	Sensor range in gallons, m^3, liters, % full, psi, inches, feet	
Derived Measurements:	total flow, % rejection, % recovery, sum, difference, ratio, ppm-gallons, total grains	
Temperature Compensation:	Automatic, referenced to 25°C for Resistivity, Conductivity, Percent Rejection and TDS. Field selectable for standard high purity (Thornton/Light), cation/ammonia/ETA (power industry), isopropyl alcohol, glycol, or Light 84 (special microelectronics applications).	
	pH temperature compensation for Nernst electrode output effects plus adjustable solution temperature compensation for high purity water ionization effects, referenced to 25°C.	
Discrete Inputs:	Two standard, buffered TTL/CMOS level or dry (potential-free) contacts for resetting flow totalizers or total grains measurement.	

Outputs

Setpoints/Alarms:	16, set individually as high, low or USP limit on any measurement. Any relay can be programmed to operate from multiple setpoints.
Relays:	Optional, 4 SPDT relays, rated 5 amp max. resistive load up to 30 VDC or 250 VAC, potential free.
Discrete Outputs:	Two standard, buffered TTL/CMOS level.
Analog Output Signals:	Four standard, four additional--optional, powered 0/4-20 mA outputs, 500 ohm load maximum, isolated from input and from ground; accuracy ±0.05 mA, typical. Outputs are assignable to any measurement with free scaling in linear, bi-linear, logarithmic or dual range format.
Serial Output:	RS232 standard, maximum distance 50 feet, field selectable up to 38.4 k baud.

Performance

Resistance accuracy:	±0.3% of reading, 1000 ohms to 6 Mohms; ± 0.5% of reading 6 Mohms to 10 Mohms; ±1% of reading or ±0.5 ohm, whichever is greater, 10 to 1000 ohms. (Divide range limits by cell constant to obtain resistivity limits in Mohm-cm.)
Temp. accuracy:	±0.2°C with Pt1000 RTD
Voltage accuracy	±0.02 pH, ±3 mV
Frequency:	±0.1 % or 0.001 Hz, whichever is greater
Repeatability:	±0.02% of reading, 1000 to 10 Mohms; ±0.8% of reading, 10 to 1000 ohms for cond./resist, ±0.05°C, ±0.02pH, ±0.3mV
Ratings/Approvals:	775-LA0 and 775-VA0 models are CE compliant. See ratings declaration page. All models are UL and cUL (CSA standards) Recognized.

Environmental

General:	If the equipment is used in a manner not specified by Thornton Inc., the protection provided by the equipment may be impaired.
	For indoor use only; Pollution Degree 2

Storage Temperature: -20° to 80°C (-4° to 176°F)

Operating Temperature:

Model	115 VAC Power	230 VAC Power
775-_A0	-10 to 50°C (14 to 122°F)	-10 to 50°C (14 to 122°F)
775-_A1	-10 to 50°C (14 to 122°F)	-10 to 40°C (14 to 104°F)
775-_A2	-10 to 40°C (14 to 104°F)	-10 to 40°C (14 to 104°F)

UL Humidity Test: 0 to 80% RH up to 88°F (31°C), decreasing linearly to 50% at 104°F (40°C)

Altitude: up to 6500 ft. (2000 m)

UL Electrical Environment: Evaluated to IEC664 Installation (Overvoltage) Category II, Local Level.

Enclosure

Display/keypad: 20 character x 4 line backlit LCD or vacuum fluorescent; 20 tactile feedback keys

Material: ABS-PC alloy, UV and chemical resistant

Rating: front panel seal, and rear with accessory back cover, rating pending

Panel Cutout: 3.78” x 3.78” (96 x 96 mm) 1/4 DIN

Wall Mount: With accessory rear cover, 8.84 x 4.82 (225 x123 mm) overall.

Pipe Mount: With accessory bracket, for a 2" pipe.

Weight: 2 lbs. (0.9 kg)

Sensor Patch Cord Length: 300 ft (91 m) maximum; for pressure and level sensors, 150 ft (45.6 m) maximum; reduced accuracy for mid-range conductivity with patch cords longer than 200 ft (61 m); reduced accuracy with 4-E conductivity sensors only, at high conductivity with patch cords longer than 50 ft (15 m).

Power: 100-240VAC 25 Watts maximum, 47-63 Hz. On power loss all stored values are retained in non-volatile memory without batteries. Clock does not run when power is off.

770MAX MODEL NUMBERING

Example: model **775-L-A-0** has a liquid crystal display, AC power and 4 analog outputs

775 - _ **-** _ **-** _

| | | Output option

| | **0** – 4 analog outputs

| | **1** – 4 analog outputs, 4 relays

| | **2** – 8 analog outputs, 4 relays (not for 240 V operation)

| |

| | Power option

| **A** – 100-240 VAC

|

| Display option

L – backlit liquid crystal display

V – vacuum florescent display

RATINGS

CE

Declaration of Conformity

We,

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

770MAX Multiparameter Analyzer/Transmitter, Models 775-LA0 and 775-VA0

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

EMC Emissions:	EN 55022	Class A ITE emissions, requirements.
EMC Emissions and Immunity:	EN 61326	Measurement Control and Laboratory equipment EMC requirements.
Safety:	EN 61010-1	"Safety requirements for electrical equipment for measurement, control and laboratory use" incorporating Amendments Nos. 1 & 2.

These conclusions are based on test reports from Curtis-Straus, Littleton, MA USA.
Anthony Bevilacqua, Mettler-Toledo Thornton, Inc.

UL Recognition

Mettler-Toledo Thornton, Inc., 36 Middlesex Turnpike, Bedford, MA 01730, USA has obtained Underwriters Laboratories' Recognition for 770MAX Multiparameter Analyzer/Transmitters. They bear the cULus recognition mark, signifying that the products have been evaluated to the applicable ANSI/UL and CSA Standards for use in the U.S. and Canada.

US UL	3111-1 Electrical Measuring and Test Equipment
CAN/CSA	C22.2, No. 1010.1

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.

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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