THORNTON
Leading Pure Water Analytics

Part No. 84373

770MAX
Multiparameter
Analyzer/Transmitter

Service Manual

METTLER TOLEDO

IMPORTANT SAFETY INFORMATION

This instrument is compliant with safety standards as outlined in the European Community low voltage directive EN61010-1 and with CSA Std C22.2, No. 0-M1982 General Requirements – Canadian Electrical Code, Part II, 0.4-M1982 Bonding and Grounding of Electrical Equipment and 142-M1987 Process Control Equipment. Certification is pending.

Please read and observe the following:

INSTALLATION: This instrument must be installed by trained instrumentation personnel in accordance with relevant local codes and instructions in this manual. Observe all instrument specifications and ratings.

SHOCK HAZARD: Make sure power to all wires is turned off before proceeding with installation or service of this instrument. High voltage may be present on the input power and relay wires.

RELAY CONTROL ACTION: 770MAX optional 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 safety conditions may depend on consistent operation of this instrument, take appropriate action to maintain conditions during sensor cleaning, replacement or sensor or instrument calibration. A timed “Hold” function may be selected which holds analog output signals and relays with their existing conditions for a set maintenance time interval.

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.

On the instrument indicates: Caution, risk of electric shock

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

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CHAPTER 1: INTRODUCTION

See Instruction Manual 84372 supplied with the instrument for standard operating information for the 770MAX. This service manual covers instrument calibration, upgrades, RS232 communications and other information for troubleshooting and training.

The 770MAX is provided with a **Help** key which provides supplementary information about the area of the menus being displayed. It can be especially helpful in initial configuration.

INSTRUMENT OVERVIEW

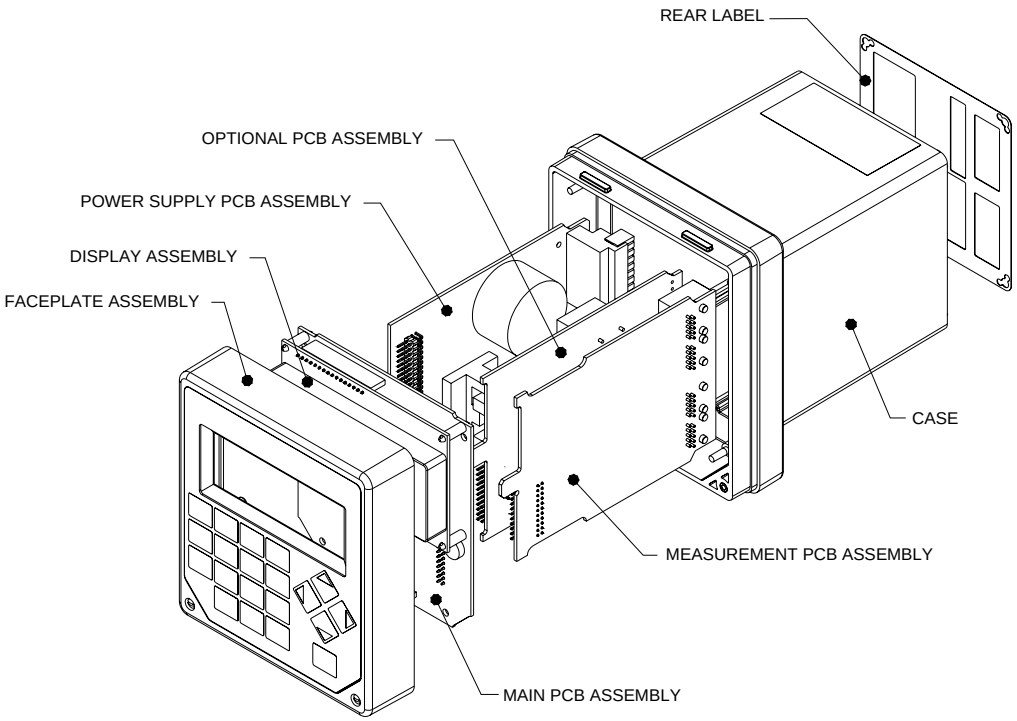
The 770MAX series utilizes 3 or 4 surface-mount printed circuit boards plus a display module which slide into the molded case and are held in place by the front cover secured by two screws.

The **main circuit board** is located in the front of the instrument. It contains the display module, main processor, operating firmware and flash memory which retains all setup configuration data plus calibration data for (standard) analog outputs 1-4.

The **power supply circuit board** is located on the left side of the instrument. It contains the universal 100-240 VAC or 24 VDC power supply plus terminal connections for the 4 standard analog outputs, RS232 communications, discrete inputs and outputs and pulse flow input circuits.

The **measurement circuit board** is on the right side of the instrument and contains the measuring and communication interface circuits for smart sensors plus the NVRAM with measuring circuit calibration data.

The **options circuit board**, if used, is in the center and contains 4 relays, and may contain 4 additional analog output circuits and their calibration data, depending on the option specified. The label on the rear of the case depends on which, if any, options board is installed. An options board may be installed in the field using the appropriate kit of parts.

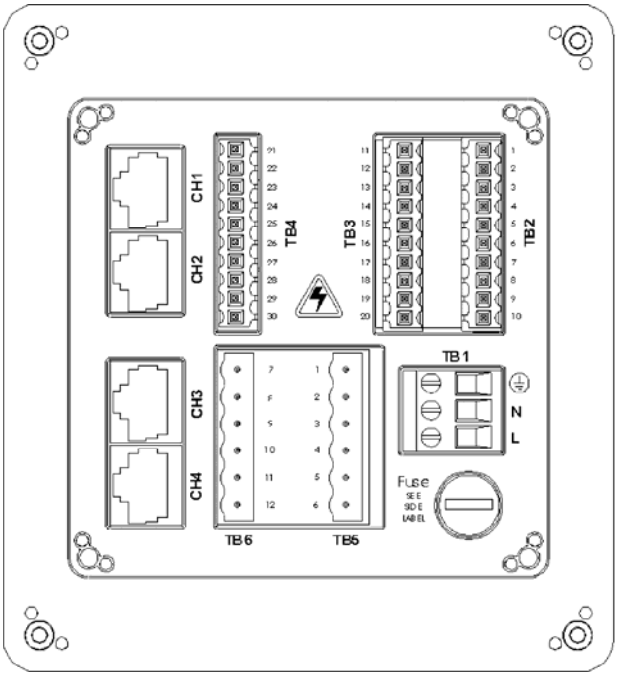


770MAX exploded view

WIRING

For full installation wiring instructions, refer to manual 84372. Information here is for reference only.

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



Rear panel terminal boards

AC Power Wiring

Board	Terminal	Connection
TB1	⏚	Earth ground
	N	AC power, neutral
	L	AC power, hot

CAUTION: Power wire insulation must be stripped back 0.5 in. (13 mm) for reliable connection.

DC Power Wiring

Board	Terminal	Connection
TB1	⏚	Earth ground
	+	DC power, positive
	-	DC power, negative

CAUTION: Power wire insulation must be stripped back 0.5 in. (13 mm) for reliable connection.

SENSOR WIRING

Smart sensor patch cords plug into jacks CH1 through CH4. To avoid confusion when unplugged, label the channel at the end of each patch cord.

Extending or making a break in patch cords must be done only using extension cables 1005-87 (5 ft, 1.5 m) or 1015-87 (15 ft, 3 m) and union connector 25320.

CAUTION: Do not cut or shorten patch cords. They use very fine gage shielded cable 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.

Pulse input flow sensor wiring is shown in Appendix B of Instruction Manual 84372.

Other Connections

Refer to rear panel figure for location.

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 +

Board	Terminal	Connection
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

CHAPTER 2: METER CALIBRATION

The 770MAX has been factory calibrated to meet its specifications. It is not normally necessary to re-calibrate unless extreme conditions cause out-of-spec operation shown by verification. Periodic verification or calibration may also be necessary to conform with QC requirements.

The 770MAX may be calibrated using high precision resistance decade boxes, voltage source and frequency generator with the following procedures. This is intended only for installations that have a policy of traceability to their own internal standards. Standards equipment accuracies must exceed the 770MAX specifications as required by the applicable QC policy.

NOTE: This is an extensive process requiring 72 calibration points to fully cover all measurement ranges of all parameters on all channels. It is strongly recommended, where possible, to use the Thornton 1875 Automatic Smart Calibrator Kit which is supplied with a traceable certificate of accuracy. It also enables printing out calibration certificates for instruments it has calibrated. It is supplied with its own instruction manual.

It is necessary to verify and/or calibrate only those measuring circuits actually being used in the installation. The following Adapters are needed to interface with standards equipment:

1000-82 resistance adapter for conductivity, resistivity, temperature.

1000-79 voltage adapter for pH, ORP, pressure, level.

1000-83 frequency adapter for flow.

Before attempting calibration, perform a verification to determine if calibration is, in fact, necessary. Verify at least one value for each internal range. Recommended values are given in the table at the end of the verification procedure.

VERIFICATION PROCEDURE

1. If the 770MAX outputs are connected for alarm or control, set a hold time per steps 3-6 of the calibration procedure in the next section. Press Menus twice to exit.
2. Connect the appropriate adapter to the patch cord of the channel to be verified.
3. Connect the adapter leads to the test equipment. (The resistance adapter has four leads—two for resistance and two for temperature.)
4. On the 770MAX front panel, press Menus.
5. Press the up arrow key until “Go to: Calibrate” is displayed. Press Enter.
6. Press the down arrow key to display “Go to: Meter-Verify”.
7. Press Enter. The channel, parameter and range identification are displayed.
8. Select the channel and measurement type to be verified using Enter and up arrow. (Measurement types are Res_[i], Temp, Volts and Freq.)
9. Enter the verification value from Table A at “Input:__ “, including any unit multiplier, e.g. K, M, etc.
10. Set the test equipment for exactly the same verification value from Table A.
11. Allow the error value to fully stabilize and then confirm that the resulting Error (in percent of reading, except for voltage) is acceptable.
12. NOTE: Calibration is unnecessary if the error is smaller than the limit of error of the standard or of the 770MAX specification.
13. Press Enter to reach the parameter/range field, e.g. Res #_.
14. Press up arrow to go to the next range and repeat steps 8-12 for the 3 remaining resistance verification points.
15. Repeat steps 8-13 for the other channels to be verified.
16. For the temperature range, repeat steps 2-14 but with the decade box connected to the temperature leads of the conductivity adapter.
17. For the voltage range, repeat steps 2-15 with a precision voltage source connected to Smart voltage adapter 1000-79.
18. For the frequency range, repeat steps 2-15 with a precision frequency generator producing a

[i] The meter will display Res #1, Res #2, Res #3, or Res #4. This is to accommodate a future feature. All of these selections are equivalent: the meter will auto-range to the correct measuring circuit regardless of the number indicated.

0-3 V square wave connected to Smart frequency adapter 1000-83.

19. For frequency verification of channels 5 and 6, connect the frequency generator directly to TB2 terminals 7 (+) and 6 (+) respectively and to common, TB2 terminal 2 (-). Repeat step 18, omitting the adapter.
20. Press Menus twice to exit.

Recommended Verification Points

Parameter & Range	Verification Point	Range of Measurement
Res 4*	100 Ω	0 – 700 Ω
Res 3*	2000 Ω	300 – 14,000 Ω
Res 2*	50,000 Ω	3750 – 175,000 Ω
Res 1*	1 MΩ	150,000 – 10 MΩ
Temp	1100 Ω	900 – 1500 Ω
Volts	0.5 V	-1.5 to +1.5 V
Freq	500 Hz	0.5 – 4000 Hz

*The 770MAX automatically selects the appropriate measuring range for the resistance it detects.

CALIBRATION PROCEDURE

1. Connect the appropriate adapter to the patch cord of the channel to be calibrated.
2. Connect its leads to the test equipment. (The resistance adapter has four leads—two for resistance and two for temperature.)
3. On the 770MAX front panel, press Menus.
4. Press the up arrow key until “Go to Calibrate” is displayed, then press Enter.
5. Press the up arrow key to display “Go to: Meter” and press Enter.
6. In “Hold time= 00 mins”, if meter outputs are connected for alarm or control, enter a value greater than the time in minutes needed to complete calibration. Analog and relay outputs will be held at their current status for that period of time to prevent upset while off-line.
7. Press Enter. The channel, parameter and range identification are displayed.
8. Select the channel and range to be calibrated using Enter and up arrow. Select the calibration Type (number of points). It is recommended to do 3-point calibrations for resistance and 2-point calibrations for all other measurements, including temperature.
9. Press Page Down to display the CALIBRATE METER screen with the reading and the recommended calibration value.
10. Set the test equipment for the exact calibration value.[ii]
11. Press Page Down and wait for the calibration to be performed.
12. Repeat steps 10 and 11 for additional calibration points.
13. On completion, “METER CAL IS DONE” will be displayed. Correct the date if necessary and page up twice to the main calibration screen.
14. Set the channel, parameter, range and type for the next calibration and page down.
15. Repeat steps 8-14 for the remaining ranges.
16. Repeat steps 1 and 8-15 for the other channels to be calibrated.
17. For the temperature range, repeat steps 1-2 and 8-16 but with the decade box connected to the temperature leads of the conductivity adapter.
18. For the voltage range, repeat steps 1-2 and 8-16 with a precision voltage source connected to Smart voltage adapter 1000-79.
19. For the frequency range, repeat steps 1-2 and 8-16 with a precision frequency generator producing a 0-3 V square wave connected to Smart frequency adapter 1000-83.
20. For frequency calibration of channels 5 and 6, connect the frequency generator directly to TB2 terminals 7 (+) and 6 (+) respectively and to common, TB2 terminal 2 (-). Repeat step 19, omitting the adapter.
21. Press Menus twice to exit.

[ii] Units manufactured prior to March 00, may give an erroneous default resistance on one range of 2Ω which should be changed in the display and in the decade box setting to 200Ω.

Calibration Values

	Point 1	Point 2	Point 3
Res #1	4.000MΩ	160.0KΩ	1.8MΩ
Res #2	160.0KΩ	7000Ω	25.0KΩ
Res #3	7000Ω	500.0Ω	2000Ω
Res #4	500.0Ω	10.0Ω	200.0Ω
Temp	1000Ω	1400Ω	-
Voltage	1.000V	-1.000V	-
Freq.	100.0 Hz	1000.0 Hz	-

CHAPTER 3: ANALOG OUTPUT CALIBRATION

ANALOG OUTPUT CALIBRATION

This section describes *calibration* of the 0/4-20 mA output signals. For startup information to *scale* the range that the signal represents in engineering units, see main Instruction Manual 84372, Chapter 4. Analog output signals are factory calibrated within specifications but may be re-calibrated if necessary.

The 770MAX analog output calibration is performed by measuring the output signal when it is set to its minimum (4 mA) and maximum (20 mA) limits and entering the exact mA value into the instrument's display. The 770MAX automatically computes any deviation from 4 and 20 mA and adjusts itself accordingly. Verification of outputs is accomplished through a diagnostic menu.

It is desirable to calibrate and verify when the system receiving instrumentation is connected in the circuit to present the approximate operating load to the circuit. Maximum load is 500 ohms.

Calibration Procedure

1. Disable or place in manual any control system using the analog output signals since they will be interrupted during calibration.
2. Connect a high precision milli-ammeter in series with the analog output signal to be calibrated. (See Chapter 1 for terminal connections.)
3. Press Menus and Up arrow to display "Goto: Calibrate", and press Enter.
4. Press Up arrow to display, "Goto: Analog", and press Enter twice, *(press Enter once for meters with software version 2.5 or greater),* passing through the Hold Time screen.
5. Select the output signal # to be calibrated and press Enter.
6. Read the exact output current on the milli-ammeter and enter that precise value into the "4 mA reads= 4.0000" screen and press Page Down. *(NOTE: For meters with software version 2.5 or greater, at the "4mA adjust=" screen, use arrow keys and re-adjust % value displayed until milli-ammeter reads 4.000mA and press Page Down.)*
7. Read the exact output current on the milli-ammeter and enter that precise value into the "20 mA reads= 20.000" screen of the 770MAX and press Page Down. *(NOTE: For meters with software version 2.5 or greater, at the "20mA adjust=" screen, use arrow keys and re-adjust % value displayed until milli-ammeter reads 20.000mA and press Page Down.)*
8. Enter the date and press Page Down to save it.
9. Press page up twice and repeat steps 2 and 5-8 for the additional outputs.
10. Press Menus twice to exit and resume normal measurement. The 770MAX automatically computes any deviation from 4 and 20 mA and adjusts itself accordingly.
11. Reactivate any system suspended in step 1.

ANALOG OUTPUT VERIFICATION

Analog outputs may be verified using the 770MAX diagnostic menu and a milli-ammeter. The menu allows setting the analog outputs to specific mA values.

Verification Procedure

1. Disable or place in manual any control system using the analog output signals since they will be interrupted during verification.
2. Connect a high precision milli-ammeter in series with the analog output signal to be verified. (See Chapter 1 or terminal connections.)
3. Press Menus and Down arrow to display, "Goto: Diagnostic" and press Enter.
4. Use Up/down arrows if needed to display, "Goto: Analog Output" and press Enter.
5. Using up/down arrows select the Analog Output # to be verified and press Enter.
6. Using Up/down arrows set Output @ 4.00mA or another level to be verified.
7. Press Page Down.
8. Measure the actual output on the milli-ammeter, record the value and compare it with 770MAX output specifications.

9. Repeat steps 6 through 8 for 8, 12, 16 and 20mA.
10. Press Menus twice to exit
12. Reactivate any system suspended in step 1.

CHAPTER 4: UPGRADES

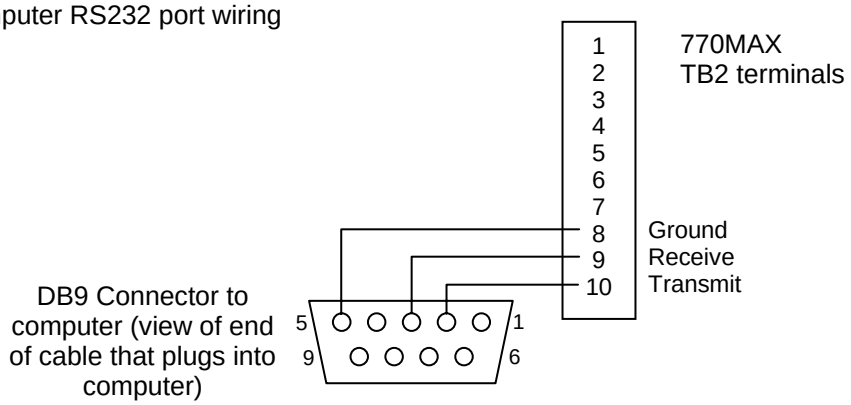
There is software for various functions located in the 770MAX. The need for field upgrade is likely to occur only with the Main Program and Measurement software.

Optional relays and additional analog outputs can be added in the field using the appropriate kits described later in this chapter.

MAIN AND MEASUREMENT SOFTWARE UPGRADE

For software upgrades, refer to upgrade kits: 91006 Upgrade Tools (one kit per site) and 91007 Upgrade Components (one kit per instrument) and their instructions 84551. For reference, the connections to the 770MAX RS232 port are given below. If the computer has a 25-pin connector, on that connector, pin 7 connects to Ground, pin 3 connects to Receive, and pin 2 connects to Transmit. Software upgrade kits may only be used in an instrument with main software revision 3.0 or higher.

770MAX to computer RS232 port wiring



OUTPUT UPGRADES

Relays and additional analog outputs may be added with circuit boards to an existing 775-_A0 Instrument (which has no option board already installed). Kit 1000-91 adds 4 SPDT relays to convert an instrument to model 775-_A1. Kit 1000-92 adds 4 SPDT relays and 4 additional analog outputs, to convert an instrument to model 775-_A2. **CAUTION: Adding these outputs restricts operating conditions:**

Kit 1000-91 lowers the maximum ambient temperature rating to 104°F (40°C) when operating on 230 VAC power.

Kit 1000-92 lowers the maximum ambient temperature rating to 104°F (40°C) on 115 VAC power and cannot be used above 130 VAC. This kit may only be installed in an instrument with main software revision 1.5 or higher.

Output Kit Installation Procedure

1. Disconnect power wiring and unplug all input and output connections from the unit, *labeling the location of each plug-in connector for use in re-installation.*
2. Peel off the rear face terminal identification label and replace it with the label supplied in the kit which will have additional cutout(s).
3. Loosen the two front cover screws—they are captive and will be retained in the cover.
4. Lift the front cover off the instrument and unplug the keypad ribbon cable from the front circuit board.
5. Carefully slide the entire assembly of circuit boards out of the case onto a static-free surface.

6. As shown in the exploded view in **Chapter 1: Introduction**, align the new output option circuit board with the large dual connector at the bottom back, between the power supply and measurement boards. Carefully plug it into the back of the main circuit board.
7. Carefully align the entire circuit board assembly so each circuit board keys into its respective slot in the case and slide it in. Some flexing may be necessary to assure complete installation. The terminal blocks must fit into the cutouts to be flush with the back of the case.
8. Plug the front cover keypad ribbon cable back onto the display circuit board pins.
9. Replace the cover back onto the instrument and tighten the two cover screws.
10. Mark the instrument identification label with the appropriate model number: replace the final “0” in 775-_A0 with a “1” if using 1000-91 or with a “2” if using 1000-92.
11. Reinstall the existing wiring plugs to respective receptacles and add connections to the new outputs as required.

CHAPTER 5: TROUBLESHOOTING

ON-LINE ERROR MESSAGES

The following messages can appear in the “Go to: Messages” menu to indicate error conditions or problems with reading sensors. This menu area should always be checked first when an operating problem is encountered.

1. "Measure PCB failed" – hardware failure.
2. "No sensor on chan"
3. "Invalid sensor type"
4. "Sensor checksum err"
5. "Sensor const bad" – the sensor multiplier or adder factor may be wrong.
6. "Invalid pipe ID"
7. "Invalid tank height"
8. "Invalid channel" – the selected channel is wrong for the desired measurement (i.e. %Rejection, ratio, etc.).
9. "Res sensor open" – patch cord or sensor cable may be bad.
10. "Res sensor shorted" – patch cord or sensor cable may be bad.
11. "Compensate error" – wrong compensation method selected or conductivity may be too high for this compensation method.
12. "Temp out of range"
13. "Unable to measure R" – unable to measure resistance of sensor (air bubble, dry cell, etc.).
14. "Invalid max PSI"
15. "Invalid tank area"
16. "Unknown measurement"
17. "Too big to display" – the measurement is too large to be displayed.
18. "Total flow over" – total flow has reached the upper limit.
19. "Temperature high"
20. "Voltage over range" – the voltage from the sensor (pH, pressure) is too high (bad sensor).
21. "Invalid max GPM"
22. "Check TDS factor"
23. "Range may be wrong" – measurement may have a wrong range (i.e. set for S/cm instead of uS/cm).
24. "Invalid setpoint #"
25. "Reference volts bad" – for pressure sensors this is a bad sensor.
26. "Flow rate is 0" – the flow rate is zero gpm so the calculated measurement is zero or over range.
27. "Bad meter calibrate" – a meter calibration factor is bad, should recalibrate.
28. "A/D over range" – the A/D convert reported an error, may be a defective measurement board.
29. "Unknown error #xxxx"

“LSC is Locked” could appear in the startup screen and indicates that internal local serial channel communication has halted. This could be caused by loose internal connections. Re-seat all circuit board and ribbon cable connectors and re-power the instrument. If the message persists, factory service will be required.

NOTE: When a 500TOC Sensor is connected to a 770MAX instrument, the ‘Messages’ menu area will appear different. There will be three options shown on the message display; 1-Current Messages, 2-Messages History, and 3-Clear History. There may be Error and Fault messages specific to the 5000TOC Sensor within these menu options. Refer to the 5000TOC operations manual, 84445 for detailed information regarding Error and Fault messages specific to the 5000TOC Sensor and the use of these menus.

SENSOR TROUBLESHOOTING

Temp. Compensated Measurements

Temperature compensated measurements such as conductivity/resistivity and pH require the temperature signal from the sensor to be within range or the compensated measurement will display asterisks. If the temperature signal has failed or is not available, operation can be continued by changing the temperature source (under the Measurements menu) to a fixed value or to use the temperature signal from another channel that is also correct for this measurement. In some cases, using temperature from another channel

may be desirable anyway, to obtain a faster responding or more accurate temperature signal.

"Raw" Sensor Signals

Direct reading of the sensor output is available from the "Measurements" menu. It gives "raw" readings in base units, e.g. Hz for flowrate. It is not adjusted with calibration factors, temperature compensation, etc. and is helpful in finding the cause of erroneous readings.

To view the "raw" reading, press **Menus** and select the desired measurement. Page down to the last normal screen (indicated by disappearance of the down arrow in the lower right corner), then page down one more to see "Raw reading from the sensor= XXXXX XX" plus identification of channel (and internal range for resistivity).

OFF-LINE DIAGNOSTICS

The Diagnostic Menu is used to run a series of off-line 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.

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

To access the Diagnostic Menu:

1. Press **Menus**.
2. Press the up arrow key until the Diagnostic Menu is displayed, and then press **Enter**.
3. Use the up/down arrow keys to select a 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.

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.).

Analog Output

Select an output to test, and 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.

Serial Port

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

Network

Diagnostic 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 input lines (high or low) will be displayed and updated every second.

Outputs

Set the 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 circuits (ROM, RAM, etc.)

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

CHAPTER 6: RS232 COMMUNICATIONS

Connections for the RS232 serial port are shown in Chapter 4.

GENERAL

The Serial Port Communications command set provides the user with complete control and configuration of a meter.

1. All messages sent to and from the meter will consist of the printable set of ASCII characters. Each message will be terminated with a carriage-return (<CR>) character.
2. All messages sent to the 770MAX will receive a response. The response will consist of the requested data, an "OK" message, or an error message.
3. All commands must specify an identifier address (same as the network address). The identifier address “00” will be read by any meter as its address. Therefore there are two addresses that the meter will respond to: address “00” and the address set as the Network Address.

COMMAND FORMAT

The format of all commands is: ***"axxc…c<CR>".***
Where:

"a" is the opcode (upper case letter from A to Z).
"xx" This address is ***"00"*** for the serial port interface.
"c…c" is the command data. Format may include “=” for setting parameters or special function characters
<CR> is the ASCII carriage-return character.

RESPONSE FORMAT

The format of all responses is: ***"axx=c…c<CR>".***
Where:

"a" is the opcode (upper case letter from A to Z).
"xx" is the network address of the unit (from 01 to FF hexadecimal).
"c…c" is the response data.
<CR> is the ASCII carriage-return character.

The response data will be one of the following types:

1. **Command Accepted**: if the command is accepted then the response data section will consist of the message "OK".
2. **Command Data**: if the command requests data then that information will be returned. The format of the data depends upon the command type.
3. **Command Rejected**: if the command is rejected then an error message will be returned with the format: ***"ERROR #yy"*** where ***"yy"*** is an error code.

ERROR CODES

The following error codes will be used when a command is rejected (the format is "***ERROR #xx***"):

01: invalid opcode.
02: parameter error.
03: checksum error.
04: parity error.
05: unit is not available.
06: command failed.
07: timeout error.
0C: overflow error
0D: invalid board type
0E: data not available

COMMAND SET

Command Summary

	Command	Function	Opcode
	Opcode order		
1.	Attention	Returns the software revision level and serial number.	A
2.	Set Auto Data Output	Enables or disables the data output	B
3.	Copy Calibration	Copies calibration data from one channel to all others	C
4.	Get Data	Returns the latest set of measurement data	D
5.	Echo Command	Echoes the characters in the command (for testing the port)	E
6.	Get Messages	Returns all messages for a measurement	F
7.	Get Parameter	Gets a parameter value	G
8.	Print Meter Setup	Sends the meter setup out serial port (readable format).	H
9.	Read Input Line	Reads the state of an input line	I
10.	TOC Control	Performs various control functions on a TOC sensor	J
11.	Key Press	Simulates a key press, returns the menus displayed	K
12.	Get/Set Output Line	Gets or sets the state of an output line	L
13.	Display Message	Displays a message	M
14.	Set Analog Output	Sets the analog output current to a level (for testing)	O
15.	Print Error Status	Returns a summary of all error counters	Q
16.	Reset	Performs various types of resets	R
17.	Set Parameter	Sets a parameter value	S
18.	Get/Set Date/Time	Gets or sets the date or time	T
19.	Self Test	Performs all of the self tests	U
20.	Return All Setup	Returns all setup information	Z

	Command	Function	Opcode
	Command Order		
1.	Attention	Returns the software revision level and serial number.	A
2.	Copy Calibration	Copies calibration data from one channel to all others	C
3.	Display Message	Displays a message	M
4.	Echo Command	Echoes the characters in the command (for testing the port)	E
5.	Get Data	Returns the latest set of measurement data	D
6.	Get Messages	Returns all messages for a measurement	F
7.	Get Parameter	Gets a parameter value	G
8.	Get/Set Date/Time	Gets or sets the date or time	T
9.	Get/Set Output Line	Gets or sets the state of an output line	L
10.	Key Press	Simulates a key press, returns the menus displayed	K
11.	Print Error Status	Returns a summary of all error counters	Q
12.	Print Meter Setup	Sends the meter setup out serial port (readable format).	H
13.	Read Input Line	Reads the state of an input line	I
14.	Reset	Performs various types of resets	R
15.	Return All Setup	Returns all setup information	Z
16.	Self Test	Performs all of the self tests	U
17.	Set Analog Output	Sets the analog output current to a level (for testing)	O
18.	Set Auto Data Output	Enables or disables the data output	B
19.	Set Parameter	Sets a parameter value	S
20.	TOC Control	Performs various control functions on a TOC sensor	J

All other opcodes will return an error message.

Command Size

Command		Opcode	Min/Max # of Bytes in Command	Min/Max # of Bytes in Response
1.	Attention	A	2/4	43/73
2.	Set Auto Data Output	B	5	7
3.	Copy Calibration	C	7	7
4.	Get Data	D	5/6	40/644
5.	Echo Command	E	4/132	9/136
6.	Get Messages	F	5	28/100
7.	Get Parameter	G	9	10/29
8.	Print Meter Setup	H	5	3000
9.	Read Input Line	I	7	8
10.	TOC Control	J	8	7/300
11.	Key Press	K	6	89
12.	Get/Set Output Line	L	7	7/8
13.	Display Message	M	6/86	7
14.	Set Analog Output	O	14	7
15.	Print Error Status	Q	4	500
16.	Reset	R	6/7	7
17.	Set Parameter	S	10/29	7
18.	Get/Set Date/Time	T	8/15	7/24
19.	Self Test	U	5	7/14
20.	Return All Setup	Z	5	25200

DATA OUTPUT FORMAT

If the data output feature is enabled then a date time stamp and the date for each active measurement will be sent. Each defined measurement will be transmitted as a separate string. Only values for the active measurements (A-P) will be sent. Each set of data will be preceded by a date/time stamp of the following format:

T01=09/13/22, 08:37:04

The data format will be:

"Daa=bcs eeeeeeeee ffffff gg R= rrrrrrr h"

Position	Field	Data
01:	"D"	This character always "D".
02-03:	"aa"	Unit address (00 to FF).
04:	"="	Always a "=" character.
05:	"b"	Measurement designator (A .. Z).
06:	“c”	Channel of measurement (1 – 6).
07:	"s"	Setpoint condition. (" " = no error, ">" = high setpoint exceeded, "<" = low setpoint exceeded).
08:	" "	Always a space.
09-18:	"eeeeeeeee"	Measurement data
19:	" "	Always a space.

20-24:	"fffff"	Units for measurement (example: Mo-cm).
25:	" "	Always a space.
26-27:	"gg"	Exclusive-or checksum of all preceding characters.
28:	" "	Always a space
29-30:	"R="	Always the characters R=
31:	" "	Always a space
32-38:	"rrrrrrr"	The value of the measurement range resistor
39:	" "	Always a space
40:	"h"	Carriage-Return character

Data Output Example

```
T01=09/13/22,  08:37:04
D01=A1     3.4685 Mo-cm  1B R= 1000000
D01=B1    21.4632  oC    09 R= 1000000
D01=K1     0.2930 uS/cm  13 R= 1000000
D01=L1     0.1100   PPM  56 R= 1000000
```

ATTENTION COMMAND

Description:

This command will return the software revision level, meter configuration, and serial number. It is also used to determine if the meter is on line and able to communicate.

Command Format:

"Axx"

Where ***"xx"*** is 00 or the HEX value of the network address for the unit.
The command "**AT**" or "**A**" will also work.

Response Format:

"Axx=Thornton #775-yyy (aaaaa….aaa), Ver=zzzz, S/N=bbbb…bb"

Where *"xx"* is the HEX value of the network address for the unit.
"yyy' is the model number
"zzz" is the software revision number.
"aaaa….aa" is the unit name (as programmed by the user – 20 characters maximum).
"bbbbb….bbb" is the serial number (15 characters maximum)

Example

Command: ***"A00"*** or ***"Axx"***
Response: **"A01=Thornton #775-VA2 (DI Service Unit #123), Ver=2.50, S/N=123456."**

Number of Bytes in Command

The minimum number of bytes in this command is 1 plus a <CR>.
The maximum number of bytes in this command is 3 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 42 plus a <CR>.
The maximum number of bytes in this response is 72 plus a <CR>.

GET DATA COMMAND

Description:

This command will return the latest set of measurement data.

Command Format:

"Dxxbyz"

Where ***"xx"*** is 00 or the HEX value of the network address for the unit
"b" = measurement channel (A..P) to get. If this character is a "?" then all measurements will be returned.
"y" = optional
y = ***"F"*** to request measurement data in Thornton floating point format

y = ***"E"*** to request measurement data in IEEE floating point format
If y is blank, then data is returned in the real format

"z" required for the ?E option
If **z = 1** then measurements A-H will be sent.
If **z = 2** then measurements I-P will be sent.

Response Format:

"***Dxx=bcs eeeeeeeee ffffff ww R= rrrrrrr h***"
Where ***"xx"*** is the network address of the unit.
"bc….h" is the data returned with the format described in section 2.2 of the MAX Service Manual.

Response Format for "F" option:

"Dxx=ccddeeffggmmnnooppww"

Response Format for "E" option:

"Dxx=bmmnnooppddww"

Response Format for "?E1" option:

"Dxx=AmmnnooppddBmmnnooppddCmmnnooppddDmmnnooppddEmmnnooppaddmmnnooppddGmmnnooppddAmmnnooppddww

Response Format for "?E2" option:

"Dxx=ImmnnooppddJmmnnooppddKmmnnooppddLmmnnooppddMmmnnooppddNmmnnooppddOmmnnooppddPmmnnooppddww

Eight measurements will be returned for the Dxx?Ez command. If z = 1 then measurements A-H will be returned. If z = 2 then measurements I-P will be returned. If a measurement is not active in the meter then the value ***mmnnoopp*** returned will be FFFFFFFF and the units (**dd**) will be 0.

Where:

"b" is the measurement designator A through P.

"cc" = measurement number

A	00
B	01
C	02
D	03
E	04
F	05
G	06
H	07
I	08
J	09
K	0A
L	0B
M	0C
N	0D
O	0E
P	0F

"dd" = measurement type (in HEX)

dd	Measurement Type	dd	Measurement Type
00	none	22	feet
01	Raw resistance reading from cell	23	% full (tank level)
02	Raw RTD reading from cell in ohms	24	ratio (X/Y)
03	Raw voltage reading from cell in volts	25	difference (X-Y)
04	Raw voltage from 2nd signal of cell	26	ppm grains (diCap)
05	Raw frequency reading from cell in Hz	27	grains (diCap)
06	UNUSED	28	Siemens/m
07	UNUSED	29	m^3 (tank level)
08	ohms (resistivity)	2A	liters (tank level)
09	Siemens/cm (conductivity)	2B	gallons (tank level)
0A	TDS	2C	sum (X+Y)
0B	degrees C	2D	current
0C	degrees F	2E	equivalents (diCap)
0D	% HCl	2F	liters/second
0E	% NaOH	30	O_2 in grams per liter
0F	$\%H_2SO_4$	31	O_2 in ppm
10	% rejection	32	O_2 in ppb
11	pH	33	O_2 saturation
12	volts	34	Volt-Amps
13	gpm (flow)	35	Watts
14	gallons (flow)	36	pH c
15	m^3/hour (flow)	37	pbCO2
16	Hertz (flow)	38	ppbCl
17	m^3 (flow)	39	pbSO4
18	liters (flow)	3A	pmCO2
19	liters/minute (flow)	3B	ppmCl
1A	feet/second (flow)	3C	pmSO4
1B	% recovery	3D	ppm (TOC)
1C	psi	3E	gC/L (TOC)
1D	KPascals	3F	ohm-cm (TOC)
1E	mmHg	40	S/cm (TOC)
1F	bars	41	degrees C (TOC)
20	Kg/cm (pressure)	42	degrees F (TOC)
21	inches	43	ml/mn (TOC)

"ee" = multiplier:
- 00 = none
- 01 = nano
- 02 = micro
- 03 = milli
- 04 = units
- 05 = kilo
- 06 = mega
- 07 = auto

"ff" = status byte:
- 00=ok.
- 01=low setpoint
- 02=high setpoint
- 03=USP setpoint error
- 04=over range
- 05=under range

"gg" = not used
"ww" = exclusive OR checksum of all the preceding bytes.

"mmnnoopp" = IEEE floating point data (4 bytes, * ASCII characters). **NOTE** – the floating point number is sent in reverse byte order, i.e. the floating point number is ppoonnmm in IEEE format. Bit seven of the first byte (pp) is the sign bit for the number (=1 for a negative number). The next 8 bits are the exponent (power of 2). The exponent is offset by 127 (i.e. if the exponent is 126 then the exponent is –1, if the exponent is 127 then the exponent is 0, etc.). If the exponent is 00 and the mantissa is 0 then the number is 0. If the exponent is FF then the whole floating point value is not a number (this typically occurs from an overflow such as a divide by 0).

Example #1:

Command: ***"D00B***
Response: ***" D01=A1 1940.8164 o-cm 6D R= 100 "***

Example #2:

Command: ***"D00?"*** (all measurements active)
Response: ***"T01=09/13/22, 11:03:49***

```
D01=A1   1907.6299  o-cm    61 R  =  100
D01=B1   25.5012    oC      08 R  =  100
D01=C1   527.2318   uS/cm   1B R  =  100
D01=D1   77.9289    oF      00 R  =  100
D01=E1   258.2900   PPM     5B R  =  100
D01=F1   0.0000     %HCl    73 R  =  100
D01=G1   0.0000     %NaOH   1D R  =  100
D01=H1   0.0082     H2SO4   47 R  =  100
D01=I1   52.7232    mS/m    51 R  =  100
D01=J1   1907.6299  o-cm    6A R  =  100
D01=K1   527.2318   uS/cm   13 R  =  100
D01=L1   258.2900   PPM     52 R  =  100
D01=M1   25.5012    oC      07 R  =  100
D01=N1   77.9289    oF      0A R  =  100
D01=O1   1907.6299  o-cm    6F R  =  100
D01=P1   52.7232    mS/m    48 R  =  100 "
```

Notes: If the all of the data is requested by specifying the channel as "?" then a number of responses will be sent out with the format described above. Each response or line will be terminated with a CR character. For example, sending the command "D00?" may result is 8 responses for the 8 defined measurements in the meter.

Number of Bytes in Command

The minimum number of bytes in this command is 4 plus a <CR>.
The maximum number of bytes in this command is 6 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 39 plus a <CR>.
The maximum number of bytes in this response is 644.

SET AUTO DATA OUTPUT COMMAND

Description:

This command will enable or disable the automatic data output.

Command Format:

"Bxxa"
Where ***"xx"*** is 00 or the HEX value of the network address for the unit
"a" = ***" 1"*** to enable the data output, ***"0"*** to disable the data output.

Response Format:

"***Bxx=OK***"
Where ***"xx"*** is the network address of the unit.

Example

To enable the data output of this unit:

Command: ***"B001"***
Response: ***"B66=OK"***

Number of Bytes in Command

The minimum number of bytes in this command is 4 plus a <CR>.
The maximum number of bytes in this command is 4 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.
The maximum number of bytes in this response is 6 plus a <CR>.

Notes:

The data output varies according to the number of parameters set for display A-P. (see also the Get Data Command, D01?)

RESET COMMAND

Description:

This command will perform various types of resets: either a system, measurement, total flow, or testing reset. The reset parameter character can be:

1. "***S***" - performs a system reset.
2. "***M***" - performs a measurement reset. Averaging buffers are cleared. RTDs are re-measured.
3. "***T***" - performs a total flow reset. The next character in the command specifies the channel (A … N).
4. "**G**" – resets a total grains measurement. The next character in the command specifies the channel (A … N).

Command Format:

"Rxx*ab"
Where ***"xx"*** is 00 or the HEX value of the network address for the unit.
"a" is reset type (either S, M, T, or G).
"b" is the optional information (such as channel letter for a total flow reset).

Response Format:

"Rxx=OK".
Where ***"xx"*** is the HEX value of the network address for the unit.

Example 1:

Perform a system reset.
Command: ***"R00*S"***
Response: ***"R01=OK"***

Example 2:

Perform a total flow reset on measurement C on unit #1E.
Command: ***"R1E*TC"***
Response: ***"R1E=OK"***

Number of Bytes in Command

The minimum number of bytes in this command is 5 plus a <CR>.
The maximum number of bytes in this command is 6 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.
The maximum number of bytes in this response is 6 plus a <CR>.

Notes:

The response to “Rxx*S” may not allow user to read the response, since this operation will restore the system to its original baud rate and parity defaults, which may not match those selected in the communicating program.

SET PARAMETER COMMAND

Description:

This command will set a parameter value.

Command Format:

"Sxxaabb=ccccccccccd<CR>"

Where ***"xx"*** is 00 or the HEX value of the network address for the unit
"aa" = code of parameter to be changed (00 to FF), see list below.
"bb" = index number for the parameter in hexadecimal notation. See table below.
"ccccccccccc" = value (up to 10 digits including a decimal point).
"d" = optional multiplier ("u" = micro, "m" = milli, "K" = kilo, or "M" = mega).

Response Format:

"Sxx=OK".

Where ***"xx"*** is the HEX value of the network address for the unit.

Example:

Set the value of setpoint #3 to 0.001125 on a MAX with network address 5.
Command: ***"S002A02= 1.125000m".***
Response: ***"S05=OK".***

Number of Bytes in Command

See table below

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.
The maximum number of bytes in this response is 6 plus a <CR>.

Notes:

1. Setting sensor type and sub-type (Codes 05 and 06) does not change the meter display. The display only changes after entering the measurement menu.
2. The **“ccccccccccc”** can be a sub code for the change to be performed on the specific parameter. The sub codes are included in the **Description** column of the table below.

GET PARAMETER COMMAND

Description:

This command will get a parameter value.

Command Format:

"Gxxaabb"

Where ***"xx"*** is 00 or the HEX value of the network address for the unit.
"aa" = code of parameter to get (00 to FF), see list below.
"bb" = channel or measurement number (index number, see below).

Response Format:

"Gxxaabb=ccccccccccd "

Where ***"xx"*** is the HEX value of the network address for the unit.
"aa" = code of parameter to get (00 to FF), see list below.
"bb" = input channel (1…6).
"ccccccccccc" = value (up to 10 digits including a decimal point).
"d" = optional multiplier ("u" = micro, "m" = milli, "K" = kilo, or "M" = mega).

Example:

Get the value of setpoint #2.
Command: ***"G002A01"***
Response: ***"G012A02=1.125000m"***

Number of Bytes in Command

The minimum number of bytes in this command is 8 plus a <CR>.
The maximum number of bytes in this command is 8 plus a <CR>.

Number of bytes in Response

See table below

VARIABLES FOR GET AND SET PARAMETER COMMAND

For the index number, the maximum value depends upon the parameter type and may be:

1. #Channels = 6 (00-05)
2. #Circuits = 7 (00-06)
3. #Measurements = 16 (00-0F)
4. #Analogs = 8 (00-07)
5. #Relays = 4 (00-03)
6. #Setpoints =16 (00-0F)

Note:

1. That the number of bytes sent or received in the table below includes the carriage return.
2. In some cases you can send data values that are outside of the proper range and these will set the parameter to an undetermined value that may cause operation problems. It is up to the programmer to assure that valid values are sent.

	Name	Type	Maximum Index Number	Minimum Number of Bytes	Maximum Number of Bytes	Description
01	SmasterPassword	String	1	Cmd. = 9 Res. = 7	Cmd.= 14 Res. = 14	Master password. The index number **"bb"** of the command has to be "00". The password can be up to 5 characters long.
02	sUser1Password	String	1	Cmd. = 9 Res. =7	Cmd.= 14 Res. = 14	User #1 password
03	sUser2Password	String	1	Cmd. = 9 Res. = 7	Cmd.= 14 Res. = 14	User #2 password
04	SCustomerName	String	1	Cmd.= 9 Res. = 7	Cmd.= 29 Res. = 29	Name of unit. Up to 20 characters long.
05	ISensorType	Integer	#Channels	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Sensor type **(0=NO SENSOR, 1=CONDUCTIVITY, 2=TEMPERATURE, 3=PRESSURE, 4=PH, 5= FLOW, 6=LEVEL, 7=VOLTAGE, 8=FREQUENCY, 9=CHEMICAL, 10= CALIBRATION, 11=INDUCTIVE,12=ADAPTER, 13=DISSOLVED OXYGEN), 14=TOC**
06	ISensorSpecifics	Integer	#Channels	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Sensor sub-type (signal) 0 = no sensor or sub-type For Conductivity or pH: 01=1000 ohm RTD, 02=500 ohm RTD, 03=Thermistor, 04=Not RTD, 05=100 ohm RTD. For Flow Sensors: 01=Signet, 02=Data Industrial, 03=Hoffer, 04=Asahi, 05=Tokico, 06=Fluidyne, 07=Proteus. Additional, or with 0x20 for a 4-20mA sensor. For Pressure or Tank Level: 0x20= 4-20mA output 0x40= 0–1 volt output 0x08 = bridge with 5/11 ratio on supply. 0x10= bridge with internal power supply compensation. For Voltage Sensors: 01= +/- 1.0 volt output 02 = +/- 0.1 volt output 03= 4-20mA output 04= 0-5volt output
07	IMeasureChan	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Measurement channel 0=CHANNEL1, 1=CHANNEL2, 2=CHANNEL3, 3=CHANNEL4, 4=CHANNEL5, 5=CHANNEL6, 6=Not Displayed, 7=Sensor, 8=Ch2, 9=Ch3 A-F = Chan1 10 and greater = Sensor

	Name	Type	Maximum Index Number	Minimum Number of Bytes	Maximum Number of Bytes	Description
08	IMode	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 11 Res. = 11	Measurement mode 0= off (no display) 1= ohms (adapter) 2= ohms RTD (adapter) 3= Volts (adapter) 4= Volts(2) pressure 5= Hz (adapter) 6= xx (adapter) 7= xx (adapter) 8= ohm-cm 9= S/cm 10= TDS 11= °C 12= °F 13= %HCl 14= %NaOH 15= %H_2SO_4 16= % rejection 17= pH 18= V (pH) 19= GPM 20= Gallons total flow 21= m^3/hr flow 22= Hz flow or frequency 23= m^3 total flow 24= Liters total flow 25= L/min 26= Ft/sec 27= % recovery 28= PSI 29= KPa 30= mmHg 31= bars 32= Kg/cm 33= inches H_2O 34= feet H_2O 35= % Full 36= ratio 37= difference 38= ppm grains 39= grains 40= S/m 41= m^3 tank level 42= Liters tank level 43= Gallons tank level 44= sum 45= Amps 46= equiv 47= L/s 48= gO2 49= ppmO2 50= ppbO2 51= %sat 52= VA 53= Watt 54= pH c 55= pbCO2 56= ppbCl 57= pbSO4 58= pmCO2 59= ppmCl 60= pmSO4 61= ppm (TOC)

						62= gC/L (TOC) 63= ohm-cm (TOC) 64= S/cm (TOC) 65= °C (TOC) 66= °F (TOC) 67= ml/mn (TOC)
09	IRange	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Measurement range (0=No range, 1=Nano, 2=micro, 3=milli, 4=units, 5=kilo, 6=mega, 7=auto).
0A	iOtherChan1	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	1st other channel needed for measure
0B	iOtherChan2	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	2nd other channel needed

	Name	Type	Maximum Index Number	Minimum Number of Bytes	Maximum Number of Bytes	Description
0C	lMeasureErrorCode (Get only)	Integer	#Measurements	Cmd.= 9 Res. = 11	Cmd.= 9 Res. = 11	Measurement error codes 0= No measure error 1=Measure PCB failed 2=No sensor on chan 3=Invalid sensor type 4=Sensor checksum err 5=Sensor const bad 6=Invalid pipe ID 7=Invalid tank height 8=Invalid channel 9=Res sensor open 10=Res sensor shorted 11=Compensate error 12=Temp out of range 13=Unable to measure R 14=Invalid max PSI 15=Invalid tank area 16=Unknown measurement 17=Too big to display 18=Total flow over 19=Temperature high 20=Voltage over range 21=Invalid max GPM 22=Check TDS factor 23=Range may be wrong 24=Invalid setpoint # 25=Reference volts bad 26=Flow rate is 0 27=Bad meter calibrate 28=A/D over range 29=Bad install factor 30=Gain Error 31=Meas S/W too old
0D	sName	String	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 15 Res. = 15	Name of measurement
0E	iAvgMode	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Averaging level 0= NONE, 1=LOW, 2=MEDIUM, 3=HIGH, 4=SPECIAL.
0F	fCellMultiplier1	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Sensor Multiplier for main signal
10	fCellAdditive1	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Sensor additive for main signal
11	fCellMultiplier2	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Sensor multiplier for second signal
12	fCellAdditive2	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Sensor additive for second signal
13	fTDSFactor	Float	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	TDS factor
14	iCompMode	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Compensation method 0= NO COMP, 1=STANDARD, 2=CATION 3=GLYCOL 100, 4=GLYCOL 50, 5=ALCOHOL, 6=LINEAR, 7=LIGHT84
15	fLinearComp	Float	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Linear compensation value in Percent
16	iTempSource	Integer	#Channels	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Temperature source 0=this channel, 1=fixed, 2=channel 1, 3=channel 2, 4=channel 3, 5=channel 4.
17	fManualTemp	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 18 Res. = 18	Fixed temperature value in DegC

	Name	Type	Maximum Index Number	Minimum Number of Bytes	Maximum Number of Bytes	Description
18	iResolution	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Resolution for measurement 0=auto, 1="1.", 2="0.1", 3="0.01", 4="0.001"
19	lSerialNumber (Get only)	Long	#Channels	Cmd.= 9 Res. = 10	Cmd.= 9 Res. = 19	Sensor serial number
1A	lSensorCalDate (Get only)	Long	#Channels	Cmd.= 9 Res. = 17	Cmd.= 9 Res. = 17	Sensor calibration date/time
1B	dTotalFlow	Float	#Channels	Cmd.= 9 Res. = 17	Cmd.= 20 Res. = 26	Total flow for channel. Response size varies with reading of the meter.
1C	fPipeID	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Pipe inside diameter in inches
1D	iFlowExternReset	Integer	#Channels	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	External flow reset enabled/disable 0=disable, 1=enable.
1E	fMaxGPM	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 16 Res. = 25	Maximum GPM
1F	fMaxPSI	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 16 Res. = 25	Maximum PSI
20	fTankHeight	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 16 Res. = 25	Tank height in feet
21	fTankArea	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 16 Res. = 25	Tank area in square feet
22	fIP	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 16 Res. = 25	IP factor for pH
23	fSTC	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 16 Res. = 25	STC factor for pH
24	fCellMultiplier3	Float	#Channels			2nd sensor multiplier for Inductive
25	fCellAdditive3	Float	#Channels			2nd sensor additive for Inductive
26	fInstallationK	Float	#Channels			Installation factor for Inductive sensors
27	iSpMeasurement	Integer	#Setpoints	Cmd.= 9 Res. = 7	Cmd.= 11 Res. = 11	Measurement for setpoint (0-15) -1 = not set
28	iSpType	Integer	#Setpoints	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Type of setpoint 0=NO SETPOINT, 1=HIGH, 2=LOW, 3=USP, 4=RESET
29	iSpRelay	Integer	#Setpoints	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Relay or output for setpoint (0=NONE, 1=relay #1, 2=relay #2, etc.)
2A	fSpValue	Float	#Setpoints	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 24	Setpoint value
2B	iSpMult	Integer	#Setpoints	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Multiplier factor for setpoint (0=none, 1=Nano, 2=micro, 3=milli, 4=units, 5=kilo, 6=mega)
2C	iSpIgnorOver	Integer	#Setpoints	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Ignore over range for setpoint 0=OFF, 1=ON
2D	lSPTimer (Get only)	Long	#Setpoints	Cmd.= 9 Res. = 18	Cmd.= 9 Res. = 18	Time since last setpoint error in seconds.
2E	iRDelay	Integer	#Relays	Cmd.= 9 Res. = 7	Cmd.= 13 Res. = 13	Relay delay in seconds
2F	iRHyster	Integer	#Relays	Cmd.= 9 Res. = 7	Cmd.= 12 Res. = 12	Relay hysteresis in Percent (range 0-255)
30	iRState	Integer	#Relays	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Relay state (0=normal, 1=inverted)
31	iExternReset	Integer	#Relays	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Reset relay externally via input line (0=input #1, 1=input #2).
32	iRType	Integer	#Relays			Type of relay (0=mechanical, 1=reed). Not used at this time.
33	iAoutSignal	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 11 Res. = 11	Measurement for analog output (0 - 15)
34	iAoutType	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Analog output type 0=Normal, 1=Bilinear, 2=Auto range, 3=log

	Name	Type	Maximum Index Number	Minimum Number of Bytes	Maximum Number of Bytes	Description
35	iAoutLowEnd	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Low end either 1=0 mA or 0=4 mA
36	iAoutControl	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Output to control for Auto-range 0 = none, 1 = relay1, 2 = relay2, 3 = relay3, 4 = relay4, 5 = Dout1, 6 = Dout2
37	iAoutOnFailure	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Output current on error or failure. 0 = Min., 1 = Max.
38	fAoutMin1	Float	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 21 Res. = 27	Measurement value for bottom of range 1
39	fAoutMid1	Float	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 21 Res. = 27	Measurement value for mid range 1 setting
3A	fAoutMax1	Float	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 21 Res. = 27	Measurement value for the top of range 1
3B	fAoutMin2	Float	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 21 Res. = 27	Measurement value for bottom of range 2
3C	fAoutMax2	Float	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 21 Res. = 27	Measurement value for the top of range 2
3D	iAMin1Mult	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Range factor for above value (0=No range, 1=Nano, 2=micro, 3=milli, 4=units, 5=kilo, 6=mega, 7=auto)
3E	iAMid1Mult	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Range factor for above value (0=No range, 1=Nano, 2=micro, 3=milli, 4=units, 5=kilo, 6=mega, 7=auto)
3F	iAMax1Mult	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Range factor for above value (0=No range, 1=Nano, 2=micro, 3=milli, 4=units, 5=kilo, 6=mega, 7=auto)
40	iAMin2Mult	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Range factor for above value (0=No range, 1=Nano, 2=micro, 3=milli, 4=units, 5=kilo, 6=mega, 7=auto)
41	iAMax2Mult	Integer	#Analogs	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Range factor for above value (0=No range, 1=Nano, 2=micro, 3=milli, 4=units, 5=kilo, 6=mega, 7=auto)
42	iLanguage	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Language (0=English). **Not used**
43	iBaud	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	0 = 1200, 1 = 2400, 2= 4800, 3 = 9600, 4 = 19.2K, 5 = 38.4K
44	iParity	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	0 = none, 1 = even, 2 = odd
45	iDataOutputOn	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Set to 1 to have measure data sent out the RS-232 port. 0 = off
46	iOutputTime	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 12 Res. = 12	Data output time in seconds (0-255)
47	iNetworkAddress	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 12 Res. = 12	Network address (1 to 127)
48	iNetworkType	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	0 = none, 1 = Thornton TNET, 2 = Fieldbus **Not used**
49	iAutoScrollOn	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	1 = on, 0 = off
4A	iDisplayMode	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	0 = auto, 1 = custom

	Name	Type	Maximum Index Number	Minimum Number of Bytes	Maximum Number of Bytes	Description
4B	iDisplayStart	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 11 Res. =11	Scrolls the display according to the number entered by user (i.e.: 1 will scroll one line down from A in the first line, 2 will scroll 2 lines down from A in the first line, etc.)
4C	IDisplayOrder	Integer	#Measurements	Cmd.= 9 Res. = 7	Cmd.= 11 Res. = 11	If Display mode = custom then assigns a measurement character (A –P = 1-16) for the display line (#measurement value).
4D	bLockoutEnabled	Integer	1	Cmd.= 9 Res. = 7	Cmd. = 10 Res. = 10	0 = Disable ; 1 = Enable
4E	iUser1LockState	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	0 = Disable ; 1 = Enable
4F	iUser2LockState	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	0 = Disable ; 1 = Enable
65	iPowerSave	Integer	1=00	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	0 = off, 1 = on
66	dTotalppmG	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	DiCap-Total TDS*Gallons
68	dCell_K_Factor	Float	#Channels*10	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Cell's K factors (for asahi flow sensor)
69	dCell_F_Factor	Float	#Channels*10	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Cell's F factors (for asahi flow sensor)
6A	lMDateTime	Long	1	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Current time and date: # of seconds since 1/1/1998
6B	dCalVerifyM1	Float	#Channels, #Circuit	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Meter verification measurement #1 (from Smart Calibrator)
6C	dCalVerifyM2	Float	#Channels, #Circuit	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Meter verification measurement #2 (from Smart Calibrator)
6D	dCalVerifyM3	Float	#Channels, #Circuit	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Meter verification measurement #3 (from Smart Calibrator)
6E	d4mACalValue	Float	#Analog outputs	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	4 mA Analog calibration data
6F	d20mACalValue	Float	#Analog outputs	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	20 mA Analog calibration data
70	lAoutCalDate	Long	#Analog outputs	Cmd.= 9 Res. = 7	Cmd.= 15 Res. = 15	Analog output calibration date
71	dDisOxyHighGain	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	High gain factor for dissolved oxygen
72	dDisOxyLowGain	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Low gain factor for dissolved oxygen
73	lMeasureErrorCode2	Long	MAX_MEASUREMENTS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Extension of error code bits: 0= No extended measurement error 1 = O2 sig over range 2 = O2 sig under range 3 = Sensor subID bad 4 = Calc pH error
74	iAoutDecades	Integer	#ANALOGS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Number of decades for analog logarithmic output
77	dAtmPressure	Float	#Channels	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Atmosphere pressure
78	cTocCurrentOperation	Character	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Current TOC activity: 0 = TOC is idle 1 = TOC is measuring 2 = TOC is balancing 3 = TOC is rinsing 4 = TOC is setting flow rate
79	lLampLifeLimitHours	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Lamp life limit
7A	cMeasureUnusedChannels_ZeroIsNo	Character	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Set to zero to make meter skip unused channel (for faster measurements)

7C	fPsocVersionNumber	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Sensor software version number
7D	lLampLifeTimer	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Sensor UV lamp timer
7E	lLampResetDate	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Sensor UV lamp reset date
7F	cAutoStartOn	Charac ter	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	TOC auto start on
80	iSRinseCycleinMinutes	Integer	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	TOC rinse cycle minute
81	cAutoCalibrateOn	Charac ter	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Auto Calibrate On
82	iTimeBetweenAutoBalanceI nHours	Integer	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Time between AutoBalance In Hours
83	iBalanceLimitinPercent	Integer	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Balance limit in percent
84	cTocMeasureOn	Charac ter	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Toc measure on
85	cAutoCalHold	Charac ter	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	TOC AutoCal hold
86	cKeypadLock	Charac ter	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	TOC sensor key lock
87	cSetFlowRate	Charac ter	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	TOC sensor set flow mode
88	cTocOverRideLimit	Charac ter	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	TOC over Ride Limit
89	fTocCondLimit	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	TOC conductivity limit
93	dToc_Cond_Mult	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc Cond multiplier
94	dToc_Cond_Add	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc Cond adder
95	dToc_Temp_Mult	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc temp multiplier
96	dToc_Temp_Add	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc temp adder
9B	lSensorCalDate_C_Fact	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc Sensor Cal date C factory
9C	lSensorCalDate_C_User	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc Sensor Cal date C user
9F	lSensorCalDate_User	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc Sensor Cal date C user
A0	dTocFlowMultiplier	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc sensor Flow multiplier
A1	dTocFlowAdditive	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc sensor Flow adder
A2	lTocCalDate_Flow	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc sensor Flow cal date factory
A3	lTocCalDate_Flow_User	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc sensor Flow cal date user
A4	dToc_Cond_Mult_User	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc cond multiplier user
A5	dToc_Cond_Add_User	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc cond adder user
A6	dToc_Temp_Mult_User	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc Temp multiplier user
A7	dToc_Temp_Add_User	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc Temp adder user
AC	dTocFlowMultiplier_User	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc flow multiplier user
AD	dTocFlowAdditive_User	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc flow adder user
AE	dCellMultiplier_User	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc cell multiplier user
AF	dCellAdditive_User	Float	#SMART	Cmd.= 9	Cmd.= 17	Toc cell adder user

			CHANNELS	Res. = 7	Res. = 17	
B0	dFlow_AD_Cal_Offset	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc flow AD cal offset
B1	dFlow_AD_Cal_Mult	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc flow AD cal mult
B2	lTocSensorErrorCode	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc sensor error code: 1 = E-Lamp off 5 = E-Lamp switched off 6 = E-Lamp life exceeded 7 = E-TOC reports error 9 = E-NVRAM Failure 11 = E-AutoBal too high 12 = E-Flow too low 14 = E-Cond Over Limit 15 = E-Flow too high 17 = E-Conductivity unstable 25 = E-Conductivity low 26 = E-Temp high 28 = E-Temp low 29 = E-TOC over range 31 = E-Can't start rinse
B3	lTocSensorFaultCode	Long	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Toc sensor fault code: 2 = F-No AC Power 4 = F-Measure SW too old 3 = F-Communication Err 8 = F-TOC reports fault 16 = F-UV Lamp Failure 18 = F-Cond shorted 20 = F-Cond open/shorted 22 = F-Temp open/shorted 24 = F-Conductivity high 27 = F-Temp high 32 = F-No flow detected
B4	iUsingUsersCal	Integer	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Using user calibration
B5	dBalanceInSeimens	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Balance in siemens
B6	dBalanceInPercent	Float	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 17 Res. = 17	Balance in percent
B7	cTOCSensorStatus_c0	Character	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Toc sensor status 0
B8	cTOCSensorStatus_c1	Character	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Toc sensor status 0
B9	bSmartSensorInstalled	Integer	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Flag for smart sensor installed
BA	sSensorPartNumber	String	#SMART CHANNELS	Cmd.= 9 Res. = 7	Cmd.= 14 Res. = 14	Sensor part number
BB	iMainRevLevel	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Main software version
BC	iMeasureRevLevel	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Measurement software version
BD	iDisplayRevLevel	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Display software version
BE	iAnalogOptionsRevLevel	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	Option board software version
BF	iLanOptionsRevLevel	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	LAN options board software version
C0	iMeasureBuildNumber	Integer	1	Cmd.= 9 Res. = 7	Cmd.= 10 Res. = 10	For debugging

KEYPRESS COMMAND

Description:

This command is used to simulate a key press from the front panel. The response is a string of characters which is the message displayed as a result of the key press. Also, the cursor position is returned.

Command Format:

"Kxxaa"

Where ***"xx"*** is 00 or the HEX value of the network address for the unit.

"aa" is the key code as follows:

10 = Key #0(/=;)
01 = Key #1(ABC)
05 = Key #2(DEF)
04 = Key #3(GHI)
06 = Key #4(JKL)
0A = Key #5(MNO)
09 = Key #6(PQR)
0B = Key #7(STU)
0F = Key #8(VWX)
0E = Key #9(YZ#)
03 = Menu (exit)
13 = Help key.
07 = Right Arrow key.
11 = Left Arrow key.
08 = Up Arrow key.
0C = Down Arrow key.
0D = Page-Up key.
12 = Page-Down key.
02 = Enter Key
14 = Decimal/minus Key
FF = special code to make the unit exit the menu mode.
All other codes are not used.

Response Format:

If the key code is valid then the display message will be returned as:
"***Kxx=a…a:bb".***
Where ***"xx"*** is 00.

"a…a" is the message displayed as a result of the key press.
"bb" is the cursor position.

Example:

Command: ***"K0003"*** Response: ***"K=01 MAIN MENU Select a menu using , then press EnterGoto: Measurements :42"***

Number of Bytes in Command

The minimum number of bytes in this command is 5 plus a <CR>.
The maximum number of bytes in this command is 5 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 88 plus a <CR>.
The maximum number of bytes in this response is 88 plus a <CR>.

DISPLAY MESSAGE COMMAND

Description:

This command is used to display a message for a specified time period in seconds. The display time is from 0 to 256 seconds (specified as a hexadecimal number). If the unit is in the menu mode then the menus will be terminated before the message is displayed.

Command Format:

"Mxxaab...ba".

Where ***"xx"*** is 00.

"aa" is the display time in seconds (from 00 to FF).

"b..b" is the message to be displayed (up to 80 characters).

Response Format:

"Mxx=OK".

Where ***"xx"*** is 00.

Example:

Display "This is a test" for 10 seconds.

Command: ***"M000AThis is a test"*** Response: ***"M00=OK".***

Number of Bytes in Command

The minimum number of bytes in this command is 5 plus a <CR>.

The maximum number of bytes in this command is 85 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.

The maximum number of bytes in this response is 6 plus a <CR>.

SELF-TEST COMMAND

Description:

This command is used to perform the self-test/diagnostic test.

Command Format:

"Uxx*".

Where ***"xx"*** is 00.

Response Format:

"***Uxx=OK***" if all of the tests pass.

"U***xx=FAILED=aa***" if one or more tests fail.

Where ***"xx"*** 00.

"aa" = code of test that failed.

If more than one test fails then multiple codes will be included in this response, each separated by a comma. The codes are:

01 = ROM test fails.
02 = RAM test fails.
03 = NVRAM test fails.
04 = Timer test fails.
05 = A/D test fails.
06 = Serial port test fails.
07 = Network Test fails.
08 = Display test fails.
09 = Keypad test fails.
0A = Analog output test fails.

Example:

Command: ***"U00*"*** or

Response: ***"U00=FAILED=01,04"***. This response indicates that the ROM test and timer 1.tests failed.

Number of Bytes in Command

The minimum number of bytes in this command is 4 plus a <CR>.
The maximum number of bytes in this command is 4 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.
The maximum number of bytes in this response is 13 plus a <CR>.

ECHO COMMAND

Description:

This command is used to test the serial port. The characters in the command are sent back in the response.

Command Format:

"Exxa…a"
Where ***"xx"*** is 00.
"a…a" = string of any ASCII characters used to test the port (up to 128).

Response Format:

"Exx=a…a=zz"
Where ***"xx"*** is 00.
"a…a" = string of characters from the command.
"zz" = "OK" if there is no communication problem.

Example

Command: ***"E00123456789A"***
Response: ***"E00=123456789A=OK"***

Number of Bytes in Command

The minimum number of bytes in this command is 3 plus a <CR>.
The maximum number of bytes in this command is 131 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 8 plus a <CR>.
The maximum number of bytes in this response is 135 plus a <CR>.

SET ANALOG OUTPUT COMMAND

Description:

This command is used to set the analog output current to a value. It is intended for testing purposes only. When this command is received the analog outputs will be held at the set value until another command is received or a key is pressed.

Command Format:

"Oxxa=bbbbbbbb"
Where ***"xx"*** is 00.
"a" is the output channel number (1 - 8).
"bbbbbbbb" is the output current in mA.

Response Format:

"***Oxx=OK***".
Where "***xx***" is the network address.

Example:

Set the output of channel 3 to 12.125mA:
Command: ***"O003=12.125"***
Response: ***"O01=OK"***

Number of Bytes in Command

The minimum number of bytes in this command is 13 plus a <CR>.
The maximum number of bytes in this command is 13 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.
The maximum number of bytes in this response is 6 plus a <CR>.

RETURN ALL SETUP COMMAND

Description:

This command will cause the entire meter setup to be returned. Each setup parameter is sent with the same format as the "Get Parameter" command. This command is equivalent to sending the "Get Parameter" command for every parameter.

Command Format:

"Zxx*"
Where ***"xx"*** is 00.

Response Format:

The response will be multiple lines of data. Each line will be terminated with a CR character and will have the following format (same as the Get Parameter Command response):
Gxxaabb=ccccccccccd".
Where ***"xx"*** is 00.

"aa" = code of parameter to be changed (00 to FF).
"bb" = channel or measurement number.
"ccccccccccc" = value (up to 10 digits including a decimal point).
"d" = optional multiplier ("u" = micro, "m" = milli, "K" = kilo, or "M" = mega).

Number of Bytes in Command

The minimum number of bytes in this command is 4 plus a <CR>.
The maximum number of bytes in this command is 4 plus a <CR>..

Number of bytes in Response

The number of bytes in the response is approximately 25200 (twenty-five thousand two hundred).

GET/SET OUTPUT LINE COMMAND

Description:

This command is used to set an output line to either a low or high level. It is also used to read the state of the line without changing it.

Command Format:

"Lxxaab".
Where ***"xx"*** is 00.

"aa" = output number.
"b" = state (0=low, 1=high). If ***"b"*** is set to a "?" character then the state will be returned (not changed).

Response Format:

"Lxxaa=b".
Where ***"xx"*** is meter address.

"aa" = output number. (00=output 1; 01=output 2)
"b" = the state of the output (0=low, 1=high).

Example #1:

Set output #1 high:
Command: ***"L01001"***
Response: ***"L01=OK"***

Example #2:

Read the state of output #2:
Command: ***"L0101?"***
Response: ***"L0101=0"***

Number of Bytes in Command

The minimum number of bytes in this command is 6 plus a <CR>.
The maximum number of bytes in this command is 6 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.
The maximum number of bytes in this response is 7 plus a <CR>.

READ INPUT LINE COMMAND

Description:

This command is used to read the state of an input line.

Command Format:

"Ixxaa?".
Where ***"xx"*** is 00.
"aa" = input line number (01 for line 1 and 02 for line 2)

Response Format:

"Ixxaa=b".
Where ***"xx"*** is 00.
"aa" = input number.
"b" = the state of the output (0=low, 1=high).

Example:

Read input #1 high:
Command: ***"I0001?"***
Response: ***"I0001=1"***

Number of Bytes in Command

The minimum number of bytes in this command is 6 plus a <CR>.
The maximum number of bytes in this command is 6 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 7 plus a <CR>.
The maximum number of bytes in this response is 7 plus a <CR>.

GET/SET DATE/TIME COMMAND

Description:

This command is used to set or get the date and time.

Command Format:

"Txxaa=bbbbbbbb".
Where ***"xx"*** is 00.
"aa" = 01 for the date, 02 for the time if setting the parameter
"aa" = any characters for getting the date and time (both are received on one command)
"bbbbbbbb" = the time (hh:mm:ss) or date (mm/dd/yy). If ***"b"*** is set to a "?" character then the date and time will be returned.

Response Format:

"Txx=OK" if setting the date or time
or
"Txx=mm/dd/yy, hh:mm:ss".
Where ***"xx"*** is the network address of the unit.

Example #1:

Set the time:
Command: ***"T0002=13:45:00"***.
Response: ***"T01=OK"***

Example #2:

Read the data and time:
Command: ***"T0000=?"***
Response: ***"T01=07/02/97, 13:45:20"***

Number of Bytes in Command

The minimum number of bytes in this command is 7 plus a <CR>.
The maximum number of bytes in this command is 14 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.
The maximum number of bytes in this response is 23 plus a <CR>.

PRINT ERROR STATUS COMMAND

Description:

This command is used to get a summary of all of the error counters

Command Format:

"Qxx".
Where ***"xx"*** is 00.

Response Format:

"***aaaaaaa….”***
Each error counter is returned as a string such as "***Qxx =Messages sent: 45781***".

Example:

Command: ***"Q00".***
Response:

T01 = 09/19/02, 15:17:47
Q01 = Exceptions: 0.
Q01 = Divide by 0: 0.
Q01 = Host Messages sent: 1836.
Q01 = Host Messages received: 78.
Q01 = LSC Messages sent: 14010.
Q01 = LSC Messages received: 13999.
Q01 = Comm errors: 3.
Q01 = Comm timeouts: 6.
Q01 = LSC Bus Busy: 1.
Q01 = Buffer overflows: 0.
Q01 = Wrong sender: 0.
Q01 = Error responses: 0.
Q01 = LSC Collisions: 2.
Q01 = LSC Tx Timouts: 0.
Q01 = LSC Resets: 0.
Q01 = EEPROM Errors: 0.
Q01 = Sensor Nvram Errors: 0.
Q01 = Measure glitches suppressed: 26.

Number of Bytes in Command

The minimum number of bytes in this command is 3 plus a <CR>.
The maximum number of bytes in this command is 3 plus a <CR>.

Number of bytes in Response

The number of bytes in this response is approximately 500.

COPY CALIBRATION COMMAND

Description:

This command is used to copy the meter calibration from one channel to all other channels.

Command Format:

"Cxx*$a".

Where ***"xx"*** is 00.

"a" = the channel that holds the calibration data to be copied to all others.

Response Format:

***"Txx=OK"*.**

Example:

Command: ***"C00*$2".***

Response: "***C00=OK***".

Number of Bytes in Command

The minimum number of bytes in this command is 6 plus a <CR>.

The maximum number of bytes in this command is 6 plus a <CR>.

Number of bytes in Response

The minimum number of bytes in this response is 6 plus a <CR>.

The maximum number of bytes in this response is 6 plus a <CR>.

GET MESSAGES COMMAND

Description:

This command will return all of the messages for a measurement.

Command Format:

"Fxxa".

Where ***"xx"*** is 00.

"a" = the measurement designator ("A" – "Z").

Response Format:

***"Fxx=yyyyyyyyy"*.**

Examples:

Command: "***F00A".***

Response: ***"F01A = *No sensor on chan.***

F01A = *Temp out of range.

F01A = *Res sensor open."

Command: "***F00A".***

Response: ***"F01A = No problems reported."***

Number of Bytes in Command

The minimum number of bytes in this command is 4 plus a <CR>.

The maximum number of bytes in this command is 4 plus a <CR>.

Number of bytes in Response

The response size varies with the message produced by the meter (approximately 28 to 100 characters).

PRINT SETUP COMMAND

Description:

This command will instruct the meter to print the entire meter setup (same as the one from the menus).

Command Format:

"Hxx*"

Where ***"xx"*** is 00

Response Format:

"***aaaaaaa….”***

Number of Bytes in Command

The minimum number of bytes in this command is 4 plus a <CR>.
The maximum number of bytes in this command is 4 plus a <CR>.

Number of bytes in Response

The response will be a display of the entire meter setup. The length varies with the setup chosen by the user. The number of bytes is approximately 3000.

Notes:

The meter will restart after this command.

TOC CONTROL COMMAND

Description:

This command will instruct the meter on TOC operations.

Command Format:

"Jxxaa=bcde..."

Where "xx" is the network address of a unit (can set to 00 for this unit).
"aa" = opcode
"bcde ..." = data

"Jxx01=ab" set TOC data output. a=channel, b=0 for output off, b=1 for output on
"Jxx02=ab" set UV lamp on or off. a=channel, b==0 for off, b=1 for on
"Jxx03=ab" set toc mode. a=channel, "b" = 1 for autobalance, b=2 for measuring
"Jxx04=ab" set Flow command. b=1, sensor in setting flow mode. b=2, sensor in measurement mode.
"Jxx05=ab" save TOC parameters to NVRAM" command, a=channel,

b=1, Save TOC Setup
b=2, Save Lamp parameters
b=3, Save Balance parameters
b=4, Save Users Cal parameters
b=5, Save Fact Cal parameters
b=6, Save Faults and Errors

"Jxx06=a" reset TOC sensor command. a=channel,
"Jxx07=a" clear TOC History command. a=channel,

Response Format:

“Jxx=OK”
"Jxx=c...c" Where "c...c" is the response

Number of Bytes in Command

The minimum number of bytes in this command is 8 plus a <CR>.
The maximum number of bytes in this command is 8 plus a <CR>.

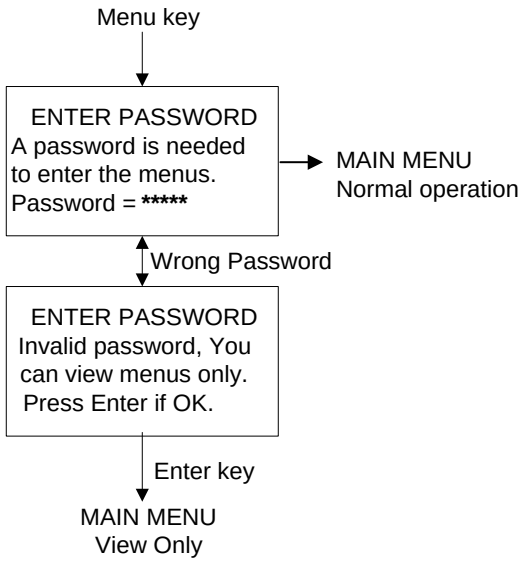
Number of bytes in Response

The minimum number of bytes in this response is 6 plus 7 <CR>.
The maximum number of bytes in this response is 6 plus 300 <CR>.

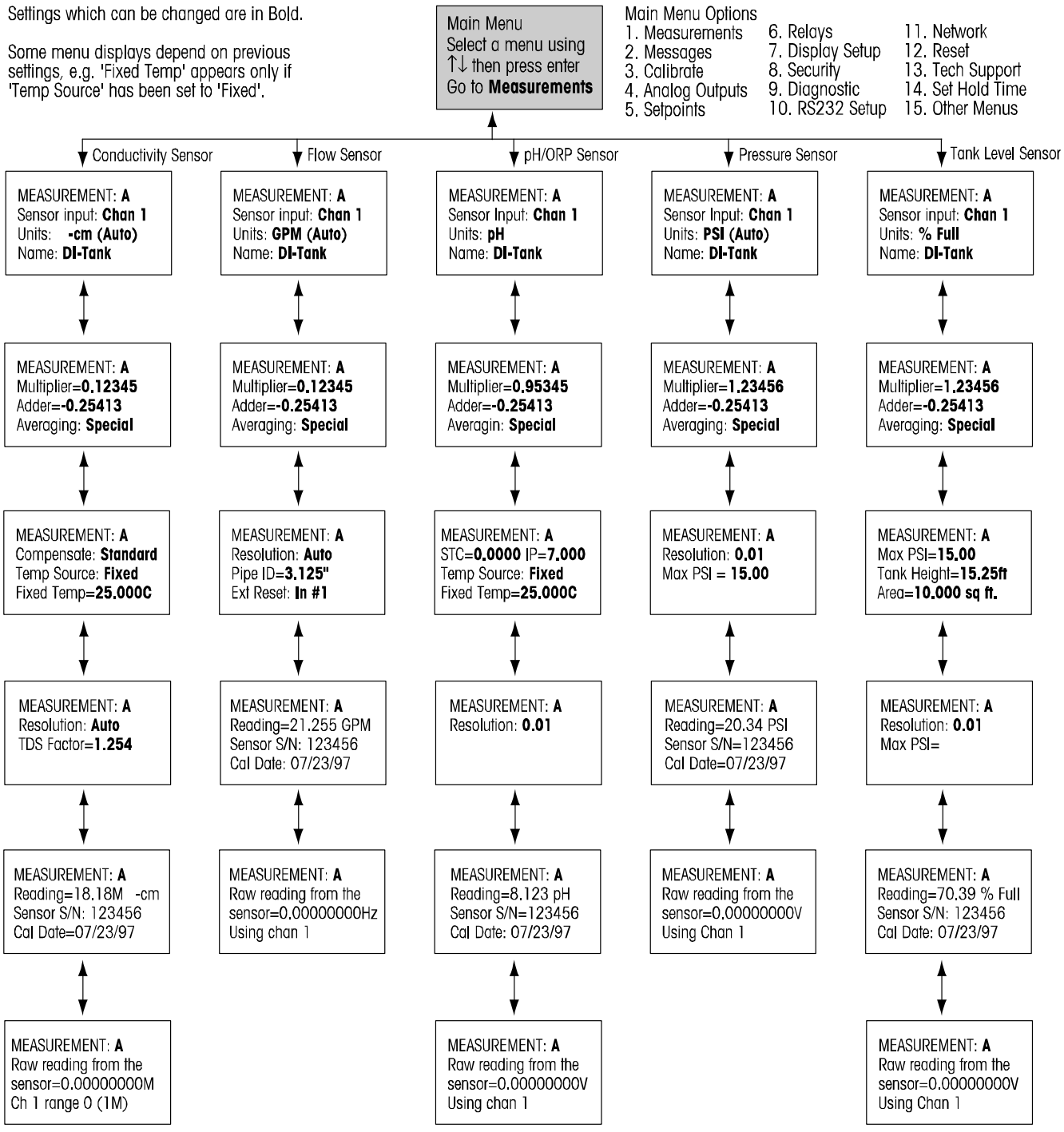
CHAPTER 7: MENU TREES

The following menu trees illustrate the general sequence of settings available in the 770MAX. However, some low level menu items are dependent on the type of sensor connected and on previous menu selections. For example, only a flow measurement with totalized flow units selected will show the menu field for setting External Reset. Also, the model of 770MAX will determine how many analog outputs and relays are present for configuration.

The screens below will appear after pressing **Menu** only if security has been enabled. Otherwise pressing **Menu** accesses the Main Menu directly, as shown on the following pages.

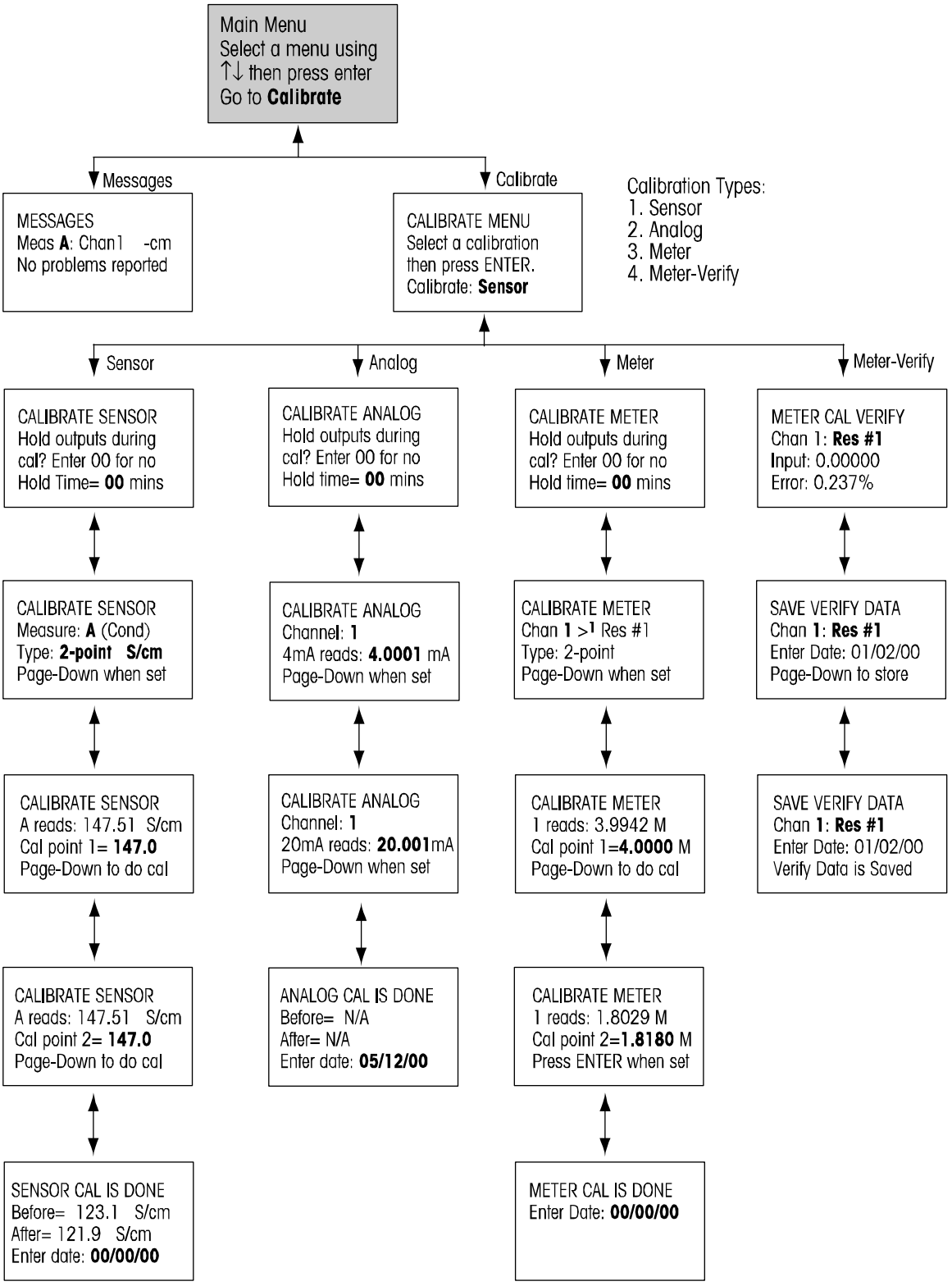


MEASUREMENTS MENUS

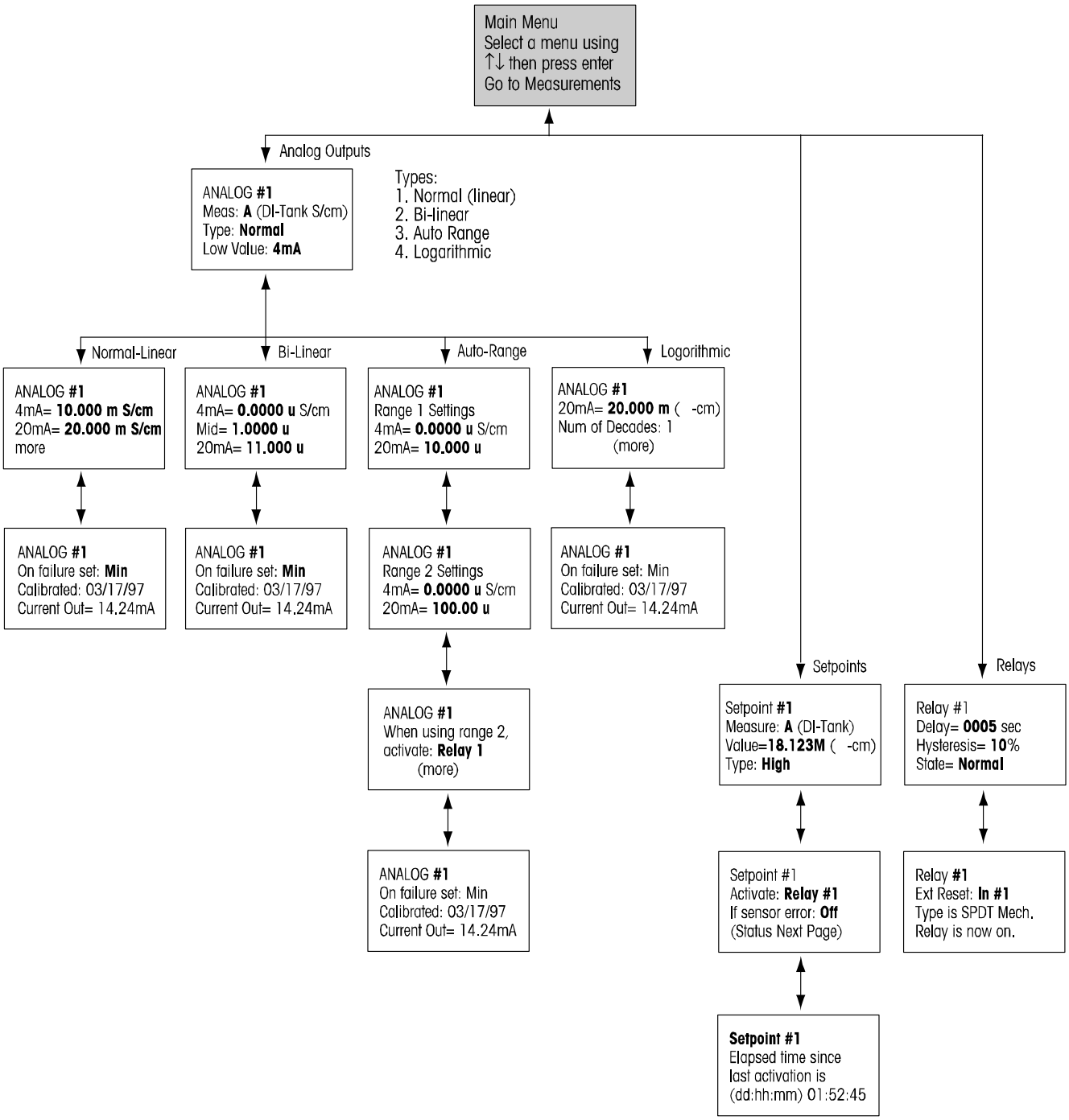


For 5000TOC Sensor menus, see manual 84445.

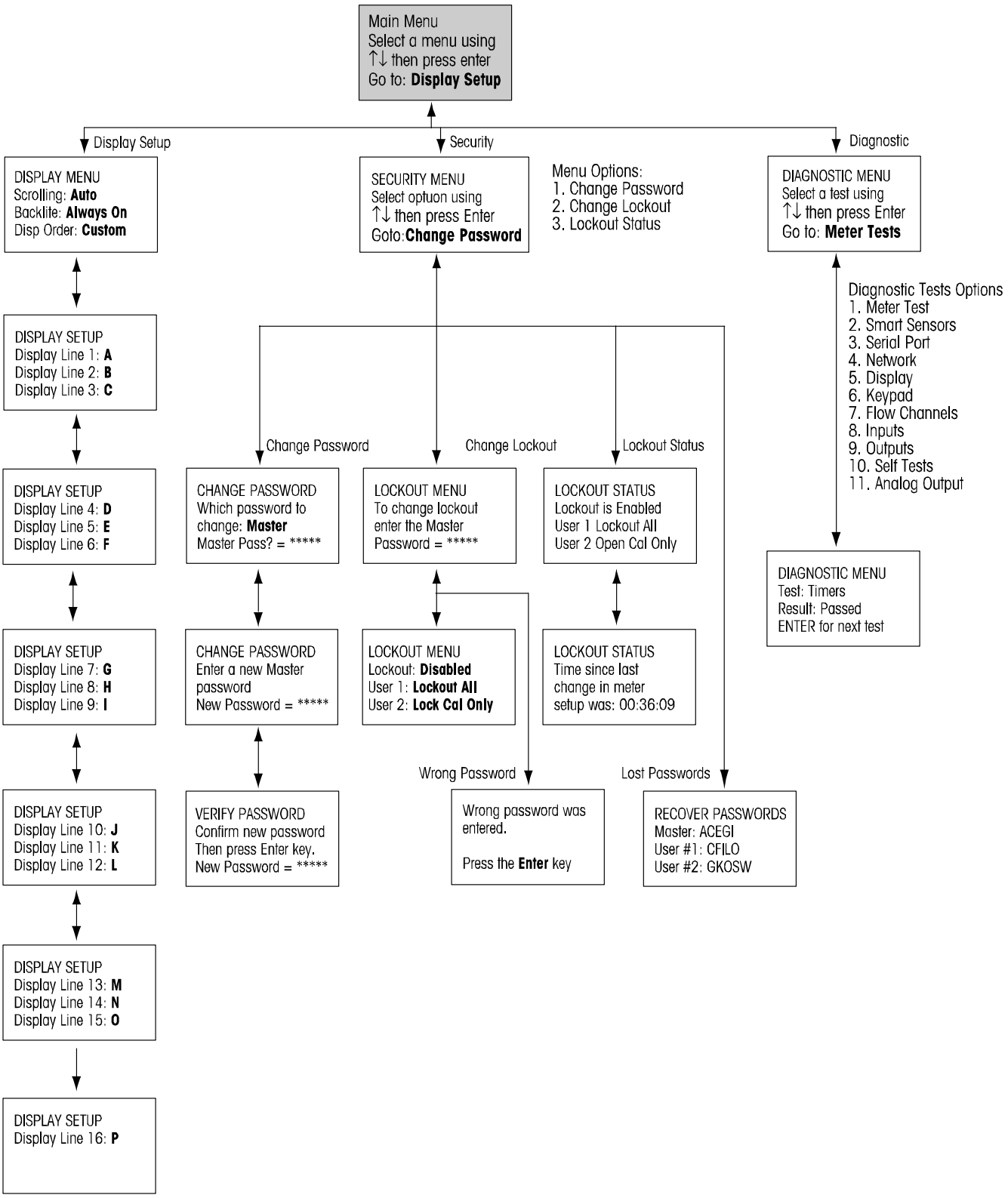
MESSAGES AND CALIBRATION MENUS



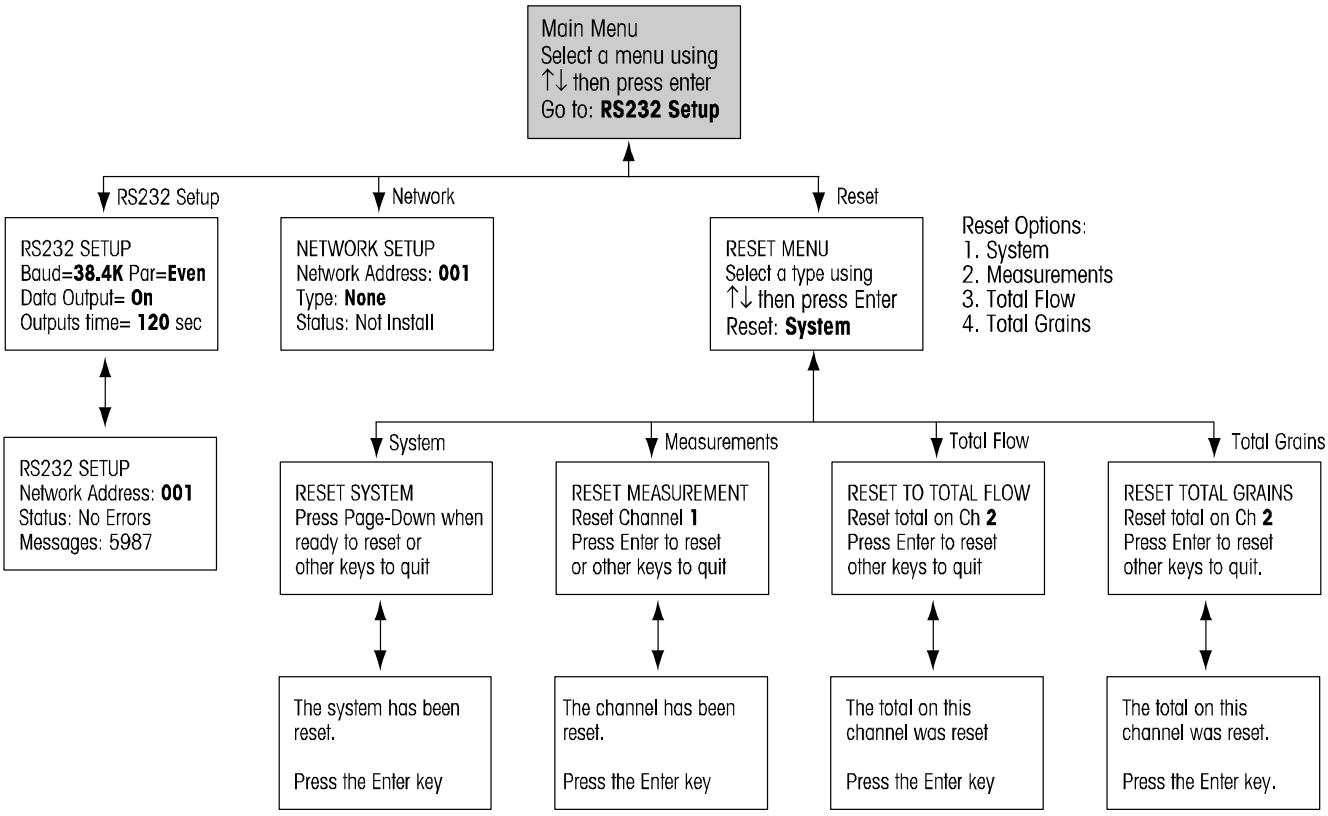
ANALOG OUTPUTS, SETPOINTS AND RELAYS MENUS



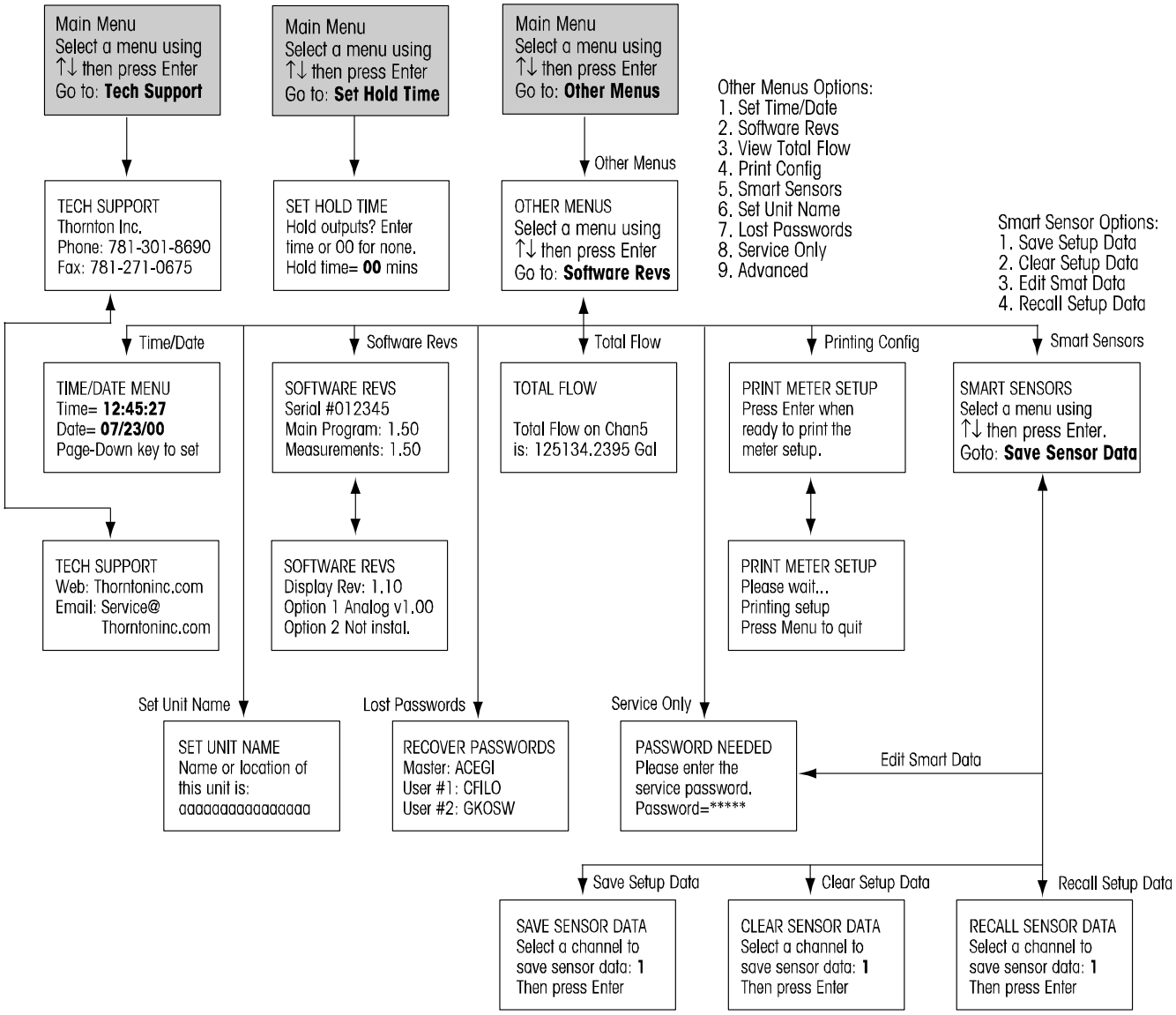
DISPLAY SETUP, SECURITY AND DIAGNOSTICS MENUS



RS232, NETWORK AND RESET MENUS



TECH SUPPORT, SET HOLD TIME AND OTHER MENUS



CHAPTER 8: PRINTER INSTALLATION INSTRUCTIONS

INSTALLATION INSTRUCTIONS FOR USE WITH THE THORNTON 770MAX SERIES INSTRUMENTS

1. Connect the AC adapter to the printer and load paper.
2. Connect the communications cable from the printer to the 770MAX series meter. The cable has a 9-pin (DB-9) male connector on one end and three tinned leads at the other end. The male 9-pin connector is attached to the connector located at the rear of the printer. Use Table 1 and the operating manual for the meter to determine how to wire the leads to the meter. Connect the leads to the pluggable connector that comes with each meter.
3. If the printer power is turned ON, turn the power switch OFF.
4. While pressing the ONLINE button, turn the power switch ON. Release the ONLINE button after the list of the current settings starts printing.
5. The printer will print the following prompt:
   Continue? :Push 'ONLINE SW'
   Write? :Push 'Paper feed SW'
6. Compare the DIP SW settings to the values in Tables 2-4 in this Installation manual.
7. If any of the DIP SW settings need to be changed, push the ON LINE button. Do not change any of the critical settings noted as ** in Tables 2-4. Go to Step 9.
8. If none of the DIP settings in Tables 2-4 need to be changed, push the FEED button. Go to Step 16.
9. The printer will print **Dip SW-1**, then prompt for the input of new settings starting with **1** and continuing through **8** of software Dip SW-1. To select OFF, press the FEED button. To select ON, press the ONLINE button. The resulting setting is then printed out to signify confirmation of the new setting. The ONLINE or FEED lamp lights also light when pressed to confirm button operation.
   The Dip SW Set mode can not be canceled once it is initiated. Input either "ON" or "OFF" for every setting in order from switch number 1 through 8.
10. After switch number 8 on DIP SW-1 is set, the printer once again prompts with
    Continue? :Push 'ONLINE SW'
    Write? :Push 'Paper feed SW'
11. If any of the DIP SW settings on SW-2 or SW-3 need to be changed, push the ON LINE button. Do not change any of the critical settings noted as * in Tables 2-4. Go to Step 13.
12. If the DIP SW-2 and SW-3 settings do not need to be changed, push the FEED button. Go to Step 16.
13. Repeat according to Step 9. As the settings are printed, press FEED to select OFF and press ONLINE to select ON.
14. After switch number 8 on DIP SW-2 is set, the printer once again prompts with
    Continue? :Push 'ONLINE SW'
    Write? :Push 'Paper feed SW'
15. Repeat this process for SW-3.
16. After all settings are selected, the ONLINE and FEED lamps blink alternately and the new settings are written to the memory. When the printer finishes writing everything to memory, "**Dip SW setting complete!"** is printed and the printer returns to ONLINE mode.

    Never turn the printer off while the new settings are being written to the memory. Always wait until "Dip SW setting complete!!" is printed. Then turn the power off.

The function settings in the tables shown with ** after them are required for proper operation of the connected instrument. To change other printer parameter software DIP switches see the DPU-414 manual.

Table 1 (Serial Port Connection)

770MAX	DPU-414 (Serial input connector Pin)	Wire Color
RxD	2 (TxD)	
TxD	3 (RxD)	
GND	5 (GND)	

Table 2 (Software DIP SW-1)

Switch	Function	Setting	Function
1	Input Method	**OFF**	Serial **
2	Printing Speed	**ON**	High
3	Auto loading	**ON**	On
4	CR function	**ON**	Carriage return and line feed **
5	DIP SW setting command	**ON**	Enable **
6	Print Density	**OFF**	100%
7	Print Density	**ON**	100%
8	Print Density	**ON**	100%

Table 3 (Software DIP SW-2)

Switch	Function	Setting	Function
1	Print Mode	**OFF**	Condensed Printing (80 Columns) **
2	User-Defined Characters back-up	**ON**	On
3	Character type	**ON**	Ordinary Characters
4	Zero Font	**ON**	0
5	International Character Set	**ON**	American
6	International Character Set	**ON**	American
7	International Character Set	**ON**	American
8	International Character Set	**OFF**	American

Table 4 (Software DIP SW-3)

Switch	Function	Setting	Function
1	Data Bit length	**ON**	8 Bit **
2	Parity permission	**ON**	None **
3	Parity condition	**ON**	Odd
4	Flow control	**ON**	H/W BUSY **
5	Baud Rate	**OFF**	19200 bps
6	Baud Rate	**ON**	19200 bps
7	Baud Rate	**ON**	19200 bps
8	Baud Rate	**OFF**	19200 bps

The default serial port settings on the 770MAX meters are 19.2kb and no parity. Other settings may be selected in the serial port of the meter is configured differently.

CHAPTER 9: 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 NEMA 4X, IP65 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

Ferrite Suppressor Module (2 required on power line for CE compliance) 95010

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

120VAC calibrator power supply, used when not connected to 770MAX, for downloading to PC 36151

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

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

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SPARE/REPLACEMENT PARTS

Description	Part Number
10 Terminal pluggable connector, 2 for models 775-_ _0 & 775-_ _1; 3 for model 775-_ _2	25302*
6 Terminal pluggable connector, 2 for models 775-_ _1 and 775-_ _2	25301*
Fuse, AC power models, 0.5 A slo blo, 5 x 20 mm (Littlefuse 218.500 or equivalent)	35092*
Fuse, DC power models, 2.5 A fast acting, 5 x 20 mm (Littlefuse 21702.5 or equivalent)	35077*
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 kit	07355
Liquid crystal display kit	07356
Relay option kit (to convert model 775-_ _0 to 775-_ _1)	1000-91
Analog output & relay option kit (to convert 775-_ _0 to 775-_ _2)	1000-92

*Recommended Spare parts

WARRANTY

This Warranty is given expressly and in lieu of all other warranties, express or implied. The Buyer agrees that there is no warranty of merchantability and that there are no other warranties, express or implied, which extend beyond the description on the face of this agreement.

Mettler-Toledo Thornton, Inc. (hereinafter referred to as The Company) warrants to the original Buyer each electrode, component, or instrument manufactured and/or sold by The Company to be free from defects in material and workmanship in normal use and service for a period of one (1) year from shipment, unless expressly stated otherwise by the product packaging or expressly agreed to in advance by the Company. The obligation of The Company under this warranty is limited to repair or replacement of the defective product at The Company's discretion. All warranty claims shall be returned to The Company pursuant to The Company's Returned Goods Authorization program. Shipping costs (including return shipping) are the responsibility of The Buyer. The Company assumes no responsibility for any direct or indirect costs associated with removal of defective products, or re-installation of replacement products. The Company shall not be responsible for damage to any electrode, component, or instrument resulting from misuse, negligence, accident or resulting from repairs, alterations, or installations made by any person or firm not duly authorized by The Company. No agent is authorized to assume for The Company any liability except as above set forth. The Company warrants that services will be performed in a workmanlike manner in conformity with standard industry practice. Should any nonconformity be detected within 30 days after the work is completed and prompt notification is made by Buyer in writing to the Company, Company will supply the necessary service, direction, or consultation to correct the nonconformity.

Returned Goods Policy: A Returned Material Authorization (RMA) number must accompany all returned goods. This authorization is obtained by calling our Technical Service (800) 510-7873 or (781) 301-8600. All transportation costs on authorized returns must be prepaid. Authorized replacement parts sent prior to receipt and evaluation of merchandise being returned will be invoiced in full. Credit will be issued only after the returned part is received and evaluated by factory personnel. The Company is not responsible for products returned without proper authorization.

Factory Restocking Charge: Items returned to The Company more than 30 days after shipment will be subject to a 25 % restocking charge, plus any additional charges for refurbishment to salable condition. The Company will not accept returns more than 90 days after shipment, unless returned under warranty or for non-warranty repair.

Special Products: Cancellation or return of special products will not be accepted.

Disclaimer of Damages:
In no event shall The Company be liable for any type of special consequential, incidental or penal damages, whether such damages arise out of or are a result of breach of contract, warranty, tort (including negligence), strict liability or otherwise. Such damages shall include, but not be limited to loss of profits or revenues, loss of use of the equipment or associated equipment, cost of substitute equipment, facilities, down time costs, increased construction costs or claims of The Buyer's customers or contractors for such damages. The Buyer agrees that in the event of a transfer, assignment, or lease of the equipment sold hereunder The Buyer shall secure for The Company the protection afforded to it in this paragraph.

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