Part No. 84373

770MAX
Multiparameter Analyzer/Transmitter
Service Manual

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

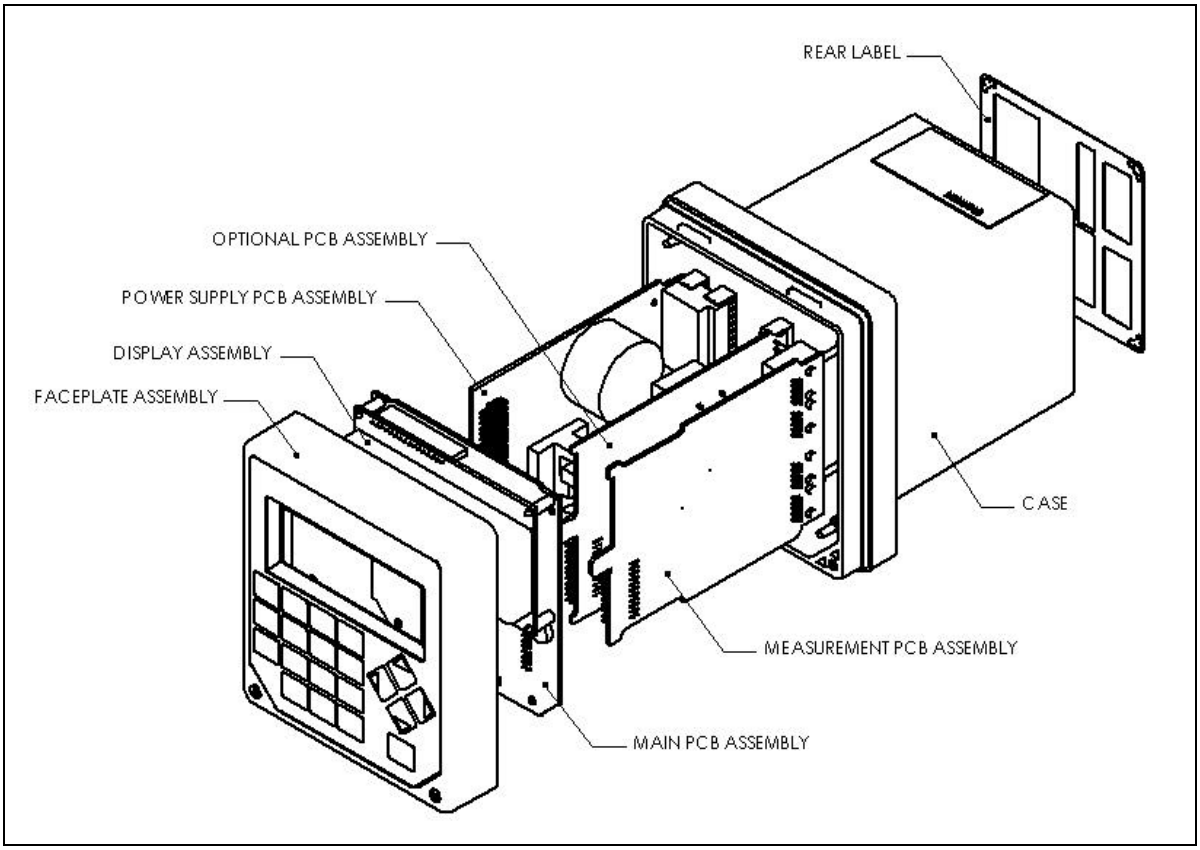
The 770MAX series utilizes 3 or 4 surface-mount printed circuit boards plus a display module which slide into the molded case and are held in place by the front cover secured by two screws.

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 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.

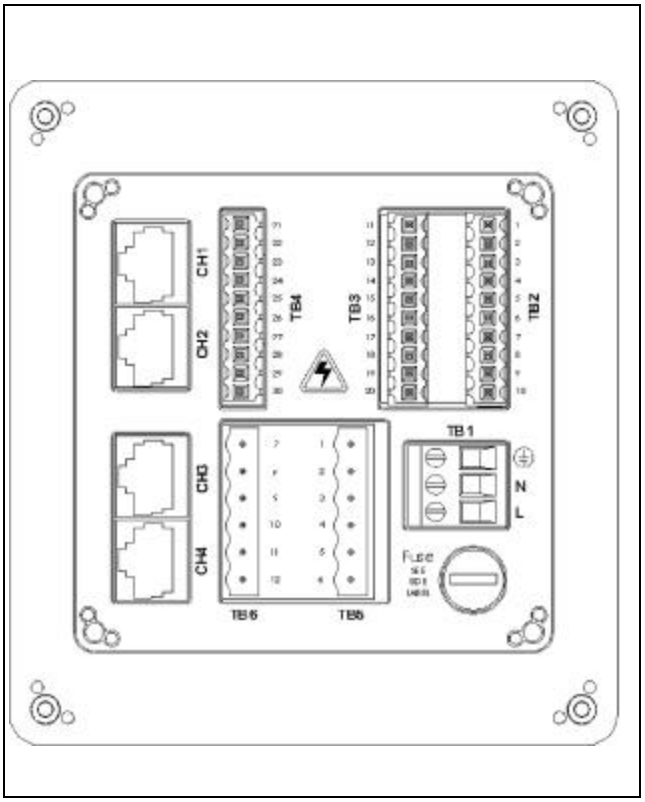


770MAX exploded view

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.

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.

[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.

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 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 3*	100 Ω	0 – 700 Ω
Res 2*	2000 Ω	300 – 14,000 Ω
Res 1*	50,000 Ω	3750 – 175,000 Ω
Res 0*	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 Manual 84372, Chapter 4 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, 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.
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.
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 Manual 84372, Chapter 4 for 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 PROGRAM SOFTWARE UPGRADE

Over the life of the instrument, it may become desirable to upgrade the main operating software of the 770MAX to a newer version. The main operating software revision number can be displayed by stepping through the menus: Other Menus/Software Revs/Main Program.

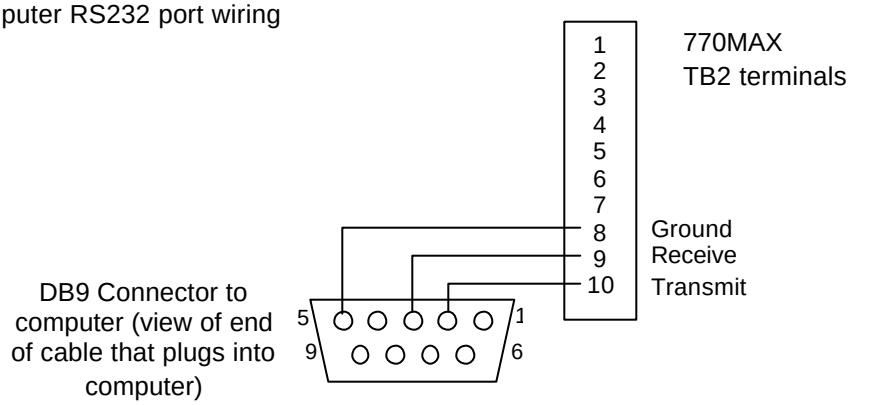
The main program software is changed by downloading the new operating file using Thornton utility program Max95.exe. It runs on computers using Windows95 or later and occupies about 0.7 MB of hard disk space.

NOTE: Not all menus of the Max95 program are functional—use only those needed for the upgrade as described in the procedure below.

A cable is required with connector for the computer's RS232 port. Most computers use a DB9 connector as shown. Tinned leads at the other end connect to the 770MAX screw terminals.

Because the memory chip containing operating software also contains extensive instrument calibration data, it is not practical to upgrade software by replacing the memory chip.

770MAX to computer RS232 port wiring



Procedure

1. Record all the configuration settings and the serial number of the 770MAX unit being upgraded.
2. Confirm that the 770MAX is configured for communications. Press Menus and up arrow to display "RS232 Setup". Set Baud = 38.4K, Par = Even, Data Output = Off, if they are not already set this way.
3. Connect the 770MAX to the computer RS232 port as shown above.
4. From e-mail or floppy disk, copy the program Max95.exe and the new 770MAX software file e.g. 43714_14 into a convenient folder or desktop of the computer.
5. Run Max95.exe by double clicking it in Windows Explorer and ignore any small incidental windows that may open.
6. Click to open 'Communication' menu and 'RS-232 Functions' and select 'Gateway Port Setup'.
7. Select Port—COM 1 (or other port if you are using another).
8. Select Baud Rate—38400.

9. Select Data Bits—8.
10. Select Parity—Even.
11. Uncheck Enable Polling. Leave other settings as found (Flow Control—Xon/Xoff, Stop Bits—1).
12. Click OK and observe 'Connected' in the lower border of the window when communications are functioning.
13. Click on the integrated circuit button (Program Unit, 4th from right) on the tool bar.
14. Select Units to Program—One Unit and enter 0 (zero) in the box. Leave Unit Type at Main.
15. Click 'Read' and locate the new 770MAX software file and click OK. The new software version will be loaded into computer memory.
16. Click 'Program'. Loading to the 770MAX will take several minutes. Allow to run until 100% is displayed.
17. Restore the serial number of the unit using the appropriate command in Chapter 6.
18. Disconnect the RS-232 wiring from the 770MAX.
19. If necessary, reconfigure the unit with the settings recorded in step 1.

MEASUREMENT SOFTWARE UPGRADE

Over the life of the instrument, it may become desirable to upgrade the measurement software of the 770MAX to a newer revision to add additional capabilities. 770MAX measurement software is upgraded by installing a new part 43715 integrated circuit in a socket located on the measurement printed circuit board. The following tools and equipment are needed:

1. Static-free work station.

2. Small flat-blade screwdriver.

3. PLCC diagonal extraction tool (to remove the integrated circuit). Part number 126-453 available from Contact East, Inc., 1-978-682-2000. (If the tool is not available, the integrated circuit can be removed using two very small screwdrivers and prying at the diagonal corners of the chip. Use extra care to prevent damage to the socket.)

CAUTION: This instrument and associated electronic parts are static sensitive. All work must be done at an approved static free work station. Personnel replacing static sensitive devices should be properly grounded to avoid component damage.

Installation Procedure

1. Disconnect power wiring and unplug all input and output connections from the unit, *noting the location of each plug-in connector for use in re-installation.*
2. Loosen the two front cover screws—they are captive and will be retained in the cover.
3. Lift the front cover off the instrument and unplug the keypad ribbon cable from the front circuit board.
4. Carefully slide the entire assembly of circuit boards out of the case onto a static-free surface.
5. Unplug the measurement circuit board (right-most board which has the 4 Smart sensor patch cord sockets) from the front circuit board.
6. Locate the part no. 43715 large integrated circuit in a socket (position U6) of the measurement circuit board. Note that the sloped edge of the integrated circuit faces the patch cord sockets. Using the PLCC diagonal extraction tool or alternative tools noted above, gently remove the integrated circuit from the socket.

CAUTION: Excessive force or twisting could break the socket.

7. Align the new integrated circuit over the socket with the sloped edge facing the patch cord sockets. Press it evenly into place with a thumb or finger.
8. Plug the measurement board back into the front display board.
9. 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.
10. Plug the front cover keypad ribbon cable back onto the display circuit board pins.
11. Replace the cover back onto the instrument and tighten the two cover screws.

12. Reconnect input and output plugs in their original locations and re-wire power to the meter.

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. These options are UL and cUL recognized when installed in instruments manufactured since July 2000. These options are not CE rated.

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. Obliterate the CE mark with a waterproof marker.
11. Reinstall in 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 overrange.
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.

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, 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, 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.

1. SERIAL PORT COMMUNICATIONS

1.1. General

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

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.

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.

All commands must specify an identifier address (same as the network address). A command with an address different from that of the unit will be sent over the network. The identifier address “00” can be used to indicate that the command is designated for the device on the RS232 port (not another unit on the network).
NOTE: References to a network address are for future capability.

All floating point values use Intel standard format.

1.2. Command Format

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

*"**a**"* is the opcode (upper case letter from A to Z).
*"**xx**"* is the network address of the unit (from 00 to FF hexadecimal). This address can be specified as ***"00"*** which indicates the command is for this unit (on the serial port).
"c…c" is the command data.
<cr> is the ASCII carriage-return character.

1.3. 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.

1.4. 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.
0E: data not available.

2. COMMAND SET

2.1. Command Summary

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

All other opcodes will return an error message.

2.2. Data Output Format

If the data output feature is enabled then the measurement data will be transmitted with the following format. Each defined measurement will be transmitted as a separate string,

"Daa=bcd eeeeeeee ffffff ggh"

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:		"d"	Setpoint condition. (" " = no error, ">" = high setpoint exceeded, "<" = low setpoint exceeded).
08:		" "	Always a space.
09-17:		"eeeeeeee"	Measurement data
18:		" "	Always a space.
19-24:		"ffffff"	Units for measurement (example: Mo-cm).
25:		" "	Always a space.
26-27:		"gg"	Exclusive-or checksum of all preceding characters.
28:		“h”	Carriage-Return character.

2.2.1. Data Output Example

```
D07=A1   286.2020 uS/cm  1C
D07=B1    22.8267  °C    03
```

2.3. 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 the network address of a unit (leave blank or set to 00 for this unit).

Response Format:

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

Where ***"xx"*** is the network address of the unit (00).

“yyy’ is the model number

“aaaa….aa” is the unit name (as programmed by the user).

“zzz” is the software revision number.

“bbbbbbbb” is the serial number

Example

Command: ***"A"*** or ***"A00"***

Response: “A00=Thornton #775-LA0 (Lab Unit), Ver=1.00, S/N=000072358”.

2.4. Get Data Command

Description:

This command will return the latest set of measurement data.

Command Format:

"Dxxab"

Where ***"xx"*** is the network address of a unit (can be set to 00 for this unit).

"a" = measurement channel (A..Z) to get. If this character is a "?" then all measurements will be returned.

"b" = optional = ***"F"*** to request measurement data in floating point format, otherwise data is returned in the real format.

Response Format:

"***Dxx=bcd eeeeee ffffff ggf***"

Where ***"xx"*** is the network address of the unit.

"bc….ff" is the data returned with the format described in section 2.2.

Example #1:

Command: ***"D00B"***

Response: ***"D00=A1 513.67 Ko-cm C7"***

Example #2:

Command: ***"D00?"***

Response: ***"D00=A1 513.67 Ko-cm C7"***

"D00=B1 25.45 DegF DA"

"D00=C2 18.18 Mo-cm 32"

"D00=D2 25.45 DegC 91"

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 in 8 responses for the 8 defined measurements in the meter.

2.5. Set Auto Data Output Command

Description:

This command will enable or disable the automatic data output.

Command Format:

"Bxxa"

Where ***"xx"*** is the network address of a unit (can set to 00 for this 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: ***"B00=OK"***

Notes:

If the data output is enabled on a unit over the network, then the data will be sent out the serial port of that unit only (the data will not be sent over the network).

2.6. Reset Command

Description:

This command will perform various types of resets: either a system, measurement, total flow or total grains 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 … P).
4. "G" – resets a total grains measurement. The next character in the command specifies the channel (A ... P)

Command Format:

"Rxx*ab"

Where ***"xx"*** is the network address of a unit (set to 00 for this unit).

"a" is reset type (either S, M, T, or Z).

"b" is the optional information (such as channel number for a total flow reset).

Response Format:

"Rxx=OK".

Where ***"xx"*** is the network address of the unit.

Example:

Perform a system reset.

Command: ***"R00*S"***

Response: ***"R00=OK"***

2.7. Set Parameter Command

Description:

This command will set a parameter value.

Command Format:

"Sxxaabb=ccccccccccd"

Where ***"xx"*** is the network address of a unit (can set to 00 for this unit).

"aa" = code of parameter to be changed (00 to FF), see list below.

"bb" = index number (channel , measurement number, relay number, etc).

"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 network address of the unit.

Example:

Set the value of setpoint #2 to 0.001125.

Command: ***"S002A02= 1.125000m".***

Response: ***"S00=OK".***

2.8. Get Parameter Command

Description:

This command will get a parameter value.

Command Format:

"Gxxaabb?"

Where ***"xx"*** is the network address of a unit (can set to 00 for this unit).

"aa" = code of parameter to be changed (00 to FF), see list below.

"bb" = channel or measurement number (index number).

Response Format:

"Gxxaabb=ccccccccccd ".

Where ***"xx"*** is the network address of the unit.

"aa" = code of parameter to be changed (00 to FF), see list below.

"bb" = index number (channel , measurement number, relay number, etc).

"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.

Command: ***"G002A02?".***

Response: ***"G002A02=1.1125000m".***

2.9. 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
2. #Circuits = 7
3. #Measurements = 16
4. #Analog outputs = 8
5. #Relays = 4
6. #Setpoints = 16
7. #Discrete Outputs = 2
8. #Discrete Inputs = 2

Int. Code	Hex Code	Name	Type	Max Index Number	Description
01	01	SmasterPassword	String	1	Master password
02	02	sUser1Password	String	1	User #1 password
03	03	sUser2Password	String	1	User #2 password
04	04	SCustomerName	String	1	Name of unit
05	05	ISensorType	Integer	#Channels	Sensor type
06	06	ISensorSpecifics	Integer	#Channels	Sensor sub-type (signal)
07	07	IMeasureChan	Integer	#Measurements	Measurement channel
08	08	IMode	Integer	#Measurements	Measurement mode
09	09	IRange	Integer	#Measurements	Measurement range
10	0A	iOtherChan1	Integer	#Measurements	1st other channel needed for measure
11	0B	iOtherChan2	Integer	#Measurements	2nd other channel needed
12	0C	IMeasureErrorCode	Integer	#Measurements	Measurement error codes
13	0D	sName	String	#Measurements	Name of measurement
14	0E	iAvgMode	Integer	#Measurements	Averaging level
15	0F	fCellMultiplier1	Float	#Channels	Sensor Multiplier for main signal
16	10	fCellAdditive1	Float	#Channels	Sensor additive for main signal
17	11	fCellMultiplier2	Float	#Channels	Sensor multiplier for second signal
18	12	fCellAdditive2	Float	#Channels	Sensor additive for second signal
19	13	fTDSFactor	Float	#Measurements	TDS factor
20	14	iCompMode	Integer	#Measurements	Compensation method
21	15	fLinearComp	Float	#Measurements	Linear compensation value
22	16	iTempSource	Integer	#Measurements	Temperature source
23	17	fManualTemp	Float	#Channels	Fixed temperature value
24	18	iResolution	Integer	#Measurements	Resolution for measurement
25	19	lSerialNumber	Long	#Channels	Sensor serial number
26	1A	lSensorCalDate	Long	#Channels	Sensor calibration date/time
27	1B	dTotalFlow	Float	#Channels	Total flow for channel
28	1C	fPipeID	Float	#Channels	Pipe inside diameter
29	1D	iFlowExternReset	Integer	#Channels	External flow reset enabled/disable
30	1E	fMaxGPM	Float	#Channels	Maximum GPM
31	1F	fMaxPSI	Float	#Channels	Maximum PSI
32	20	fTankHeight	Float	#Channels	Tank height in feet
33	21	fTankArea	Float	#Channels	Tank area in square feet
34	22	fIP	Float	#Channels	IP factor for pH
35	23	fSTC	Float	#Channels	STC factor for pH
36	24	fCellMultiplier3	Float	#Channels	2nd sensor multiplier for Inductive
37	25	fCellAdditive3	Float	#Channels	2nd sensor additive for Inductive
38	26	fInstallationK	Float	#Channels	For inductive sensors
39	27	iSpMeasurement	Integer	#Setpoints	Measurement for setpoint
40	28	iSpType	Integer	#Setpoints	Type of setpoint
41	29	iSpRelay	Integer	#Setpoints	Relay or output for setpoint
42	2A	fSpValue	Float	#Setpoints	Setpoint value
43	2B	iSpMult	Integer	#Setpoints	Multiplier factor for setpoint
44	2C	iSpIgnorOver	Integer	#Setpoints	Ignore overrange for setpoint
45	2D	lSPTimer	Long	#Setpoints	Time since last setpoint error
46	2E	iRDelay	Integer	#Relays	Relay delay
47	2F	iRHyster	Integer	#Relays	Relay hysteresis
48	30	iRState	Integer	#Relays	Relay state
49	31	iExternReset	Integer	#Relays	Reset relay externally via input line
50	32	iRType	Integer	#Relays	Type of relay

Int. Code	Hex Code	Name	Type	Max Index Number	Description
51	33	iAoutSignal	Integer	#Analogs	Measurement for analog output
52	34	iAoutType	Integer	#Analogs	Analog output type
53	35	iAoutLowEnd	Integer	#Analogs	Low end either 0 or 4 mA
54	36	iAoutControl	Integer	#Analogs	Output line to control for dual range
55	37	iAoutOnFailure	Integer	#Analogs	Output current on error or failure
56	38	fAoutMin1	Float	#Analogs	
57	39	fAoutMid1	Float	#Analogs	
58	3A	fAoutMax1	Float	#Analogs	
59	3B	fAoutMin2	Float	#Analogs	
60	3C	fAoutMax2	Float	#Analogs	
61	3D	iAMin1Mult	Integer	#Analogs	
62	3E	iAMid1Mult	Integer	#Analogs	
63	3F	iAMax1Mult	Integer	#Analogs	
64	40	iAMin2Mult	Integer	#Analogs	
65	41	iAMax2Mult	Integer	#Analogs	
66	42	iLanguage	Integer	1	Language (0=English).
67	43	iBaud	Integer	1	Baud rate
68	44	iParity	Integer	1	Parity
69	45	iDataOutputOn	Integer	1	Set to 1; Off, set to 0
70	46	iOutputTime	Integer	1	Data output time in seconds
71	47	iNetworkAddress	Integer	1	
72	48	iNetworkType	Integer	1	
73	49	iAutoScrollOn	Integer	1	
74	4A	iDisplayMode	Integer	1	
75	4B	iDisplayStart	Integer	1	
76	4C	IDisplayOrder	Integer	#Measurements	
77	4D	bLockoutEnabled	Integer	1	
78	4E	iUser1LockState	Integer	1	
79	4F	iUser2LockState	Integer	1	
80	50	fMeterCalSlope2	Float	#Circuits * #Channels	
81	51	fMeterCalSlope1	Float	#Circuits * #Channels	
82	52	fMeterCalOffset	Long	#Circuits * #Channels	
83	53	lMeterVerDate	Long	#Circuits * #Channels	
84	54	lMeterVerDate	Long	#Circuits * #Channels	
85	55	dCalMeasureLimit	Float	#Circuits * #Channels	
86	56	dCalMeasureBefore1	Float	#Circuits * #Channels	
87	57	dCalMeasureAfter1	Float	#Circuits * #Channels	
88	58	dCalMeasureBefore2	Float	#Circuits * #Channels	
89	59	dCalMeasureAfter2	Float	#Circuits * #Channels	
90	5A	dCalMeasureBefore3	Float	#Circuits * #Channels	
91	5B	dCalMeasureAfter3	Float	#Circuits * #Channels	
92	5C	dCalValue1	Float	#Circuits * #Channels	
93	5D	dCalValue2	Float	#Circuits * #Channels	
94	5E	dCalVallue3	Float	#Circuits * #Channels	
95	5F	dCalVerifyInput1	Float	#Circuits * #Channels	
96	60	dCalVerifyInput2	Float	#Circuits * #Channels	
97	61	dCalVerifyInput3	Float	#Circuits * #Channels	
98	62	fMeterCalSlope1Prev	Float	#Circuits * #Channels	
99	63	fMeterCalSlope2Prev	Float	#Circuits * #Channels	
100	64	fMeterCalOffsetPrev	Float	#Circuits * #Channels	
101	65	iPowerSave	Integer	1	

Int. Code	Hex Code	Name	Type	Max Index Number	Description
102	66	dTotalppmG	Float	#Channels	
103	67	sUnitSerialNumber	String	1	
104	68	dCell_K_Factor	Float	#Channels*10	K factors for Vortex flow sensors
105	69	dCell_F_Factor	Float	#Channels*10	F factors for Vortex flow sensors
106	6A	lMDateTime	Long	1	Meter date/time in seconds since 1/1/98
107	6B	dCalVerifyMeasured1	Float	#Circuits * #Channels	
108	6C	dCalVerifyMeasured2	Float	#Circuits * #Channels	
109	6D	dCalVerifyMeasured3	Float	#Circuits * #Channels	

Setpoint Types:

0 No Setpoint
1 High
2 Low
3 USP
4 Reset

Analog Output Types:

0 Normal
1 Bilinear
2 Auto range
3 Log

2.10. 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 the network address of a unit (can set to 00 for this unit).

"aa" is the key code as follows:

00 = Key #0.
01 = Key #1
02 = Key #2
03 = Key #3
04 = Key #4
05 = Key #5
06 = Key #6
07 = Key #7
08 = Key #8
09 = Key #9
0A = Menus key.
0B = Help key.
0C= Right Arrow key.
0D = Left Arrow key.
0E = Up Arrow key.
0F = Down Arrow key.
10 = Help key.
11 = Page-Up key.
12 = Page-Down key.
13 = Next 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 the network address of the unit.

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

Example:

Command: ***"K000A"***
Response: ***"K00=This is the main menu. Select a function then press NEXT:64"***

2.11. 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 the network address of a unit (can set to 00 for this unit).
"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 the network address of the unit.

Example:

Display "This is a test" for 10 seconds.
Command: ***"M000AThis is a test"***.
Response: ***"M00=OK".***

2.12. Self-Test Command

Description:

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

Command Format:

"Uxx*".
Where ***"xx"*** is the network address of a unit (can set to 00 for this unit).

Response Format:

"***Uxx=OK***" if all of the tests pass.
"U***xx=FAILED=aa***" if one or more tests fail.
Where ***"xx"*** is the network address of the unit.
"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*"***
Response: ***"U00=FAILED=01,04"***. This response indicates that the ROM test and timer tests failed.

2.13. 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 the network address of a unit (can set to 00 for this unit).

"a…a" = string of any ASCII characters used to test the port (up to 128).

Response Format:

"Exx=a…a=zz"

Where ***"xx"*** is the network address of the unit.

"a…a" = string of characters from the command.

"zz" = "OK" if there is no communication problem.

Example

Command: ***"E00123456789A"***

Response: "E=00123456789A=OK"

2.14. 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 the network address of a unit (can set to 00 for this unit).

"a" is the analog output number (1-4, or 1-8 with optional outputs).

"bbbbbbbb" is the output current in mA.

Response Format:

"***Oxx=OK***".

Where "***xx***" is the network address of the unit.

Example:

Set the output of channel 3 to 12.125mA:

Command: ***"O00=312.125"***

Response: ***"O00=OK"***

2.15. 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 the network address of a unit (can set to 00 for this unit).

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 the network address of the unit.

"aa" = code of parameter (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).

2.16. 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 the network address of a unit (can set to 00 for this unit).

"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 the network address of the unit.

"aa" = output number.

"b" = the state of the output (0=low, 1=high).

Example:

Set output #1 high:
Command: ***"L00011"***
Response: ***"L0001=1"***

2.17. Read Input Line Command

Description:

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

Command Format:

"Ixxaa?".

Where ***"xx"*** is the network address of a unit (can set to 00 for this unit).

"aa" = input line number.

Response Format:

"Ixxaa=b".

Where ***"xx"*** is the network address of the unit.

"aa" = input number.

"b" = the state of the output (0=low, 1=high).

Example:

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

2.18. 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 the network address of a unit (can set to 00 for this unit).

"aa" = 01 for the date, 02 for the time.

"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: ***"T00=OK"***

Example #2:

Read the data and time:
Command: ***"T0000=?"***
Response: ***"T00=07/02/97, 13:45:20"***

2.19. 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 the network address of a unit (can set to 00 for this unit).

Response Format:

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

Example:

Command: ***"Q3A".***
Response:
T3A=08/31/98, 10:54:59
Q3A =Exceptions: 0.
Q3A =Divide by 0: 0.
Q3A =Messages sent: 45781.
Q3A =Messages received: 43259.
Q3A =Comm errors: 1.
Q3A =Comm timeouts: 2517.
Q3A =LSC Bus Busy: 2.
Q3A =Buffer overflows: 0.
Q3A =Wrong sender: 0.
Q3A =Error responses: 0.
Q3A =LSC Collisions: 0.
Q3A =LSC Tx Timouts: 0.
Q3A =LSC Resets: 0.
Q3A =EEPROM Errors: 0.
Q3A =Sensor Nvram Errors: 0.

2.20. Get Messages Command

Description:

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

Command Format:

"Fxxa".

Where ***"xx"*** is the network address of a unit (can set to 00 for this unit).

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

Response Format:

"Fxx=yyyyyyyyy".

Example:

Command: "***F3AA".***

Response: "***F3AA=Measure PCB failed***."

"***F3AA=Temp out of range***."

"***F3AA=Res sensor open***."

2.21. 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 the network address of a unit (can set to 00 for this unit).

Response Format:

"***aaaaaaa…."***

2.22. Get Setup Information Command

Description:

This command will return a block of data containing all of the setup data for a specific function such as measurements, setpoints, relays, etc.

Command Format:

"Vxxyyzz*".

Where ***"xx"*** is the network address of a unit (can set to 00 for this unit), "yy" is the type of data to return ("01"=measurement, "02"=setpoint, "03"=relays, "04" = analog output), "zz" = the measurement number (or setpoint number, etc).

All data in the response is either hexadecimal, floating point, or ascii string.

Response Format:

For measurement: "Vxx01zz=aabbccdd ….zz***"***

"aa" = channel.
"bb" = sensor type.
"cc" = sensor sub type.
"dd" = measurement type.
"ee" = range.
"ff" = averaging.
"gf" = resolution.
"hhhhhhh" = name.
"ii" = other channel #1.
"jj" = other channel #2.
"kkkkkkkk" = multiplier #1.

“lllllll” = additive #1.
“mmmmmmmm” = multiplier #2.
“nnnnnnnn” = additive #2.
“oo” = temperature source.
“pppppppp” = temperature value.
“qq” = compensation method.
“rrrrrrrr” = compensation value.
“ssssssss” = maximum value #1.
“tttttttt” = maximum value #2.
“uuuuuuuu” – maximum value #3.
“vvvvvvvv” = sensor part number.
“wwwwwwww” = sensor serial number.
“xxxxxxxx” = sensor cal data.
“yy” = smart sensor status.
“zz” = xor checksum of all preceding characters

For setpoints: “Vxx02zz=aabbccddddddddeeffffffffzz”
“aa” = setpoint measurement
“bb”=setpoint type.
“cc” = setpoint relay
“dddddddd” = setpoint value.
“ee” = ignore setpoint if error
“ffffffff” = time since last activation
“zz” = xor checksum of all preceding characters

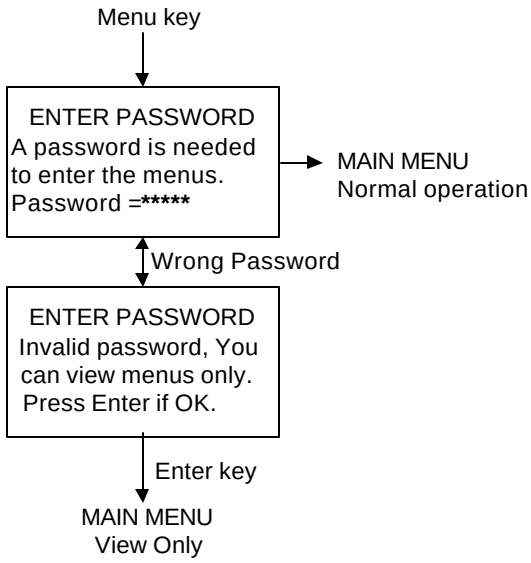
For relays: “Vxx03zz=aabbccddeezz”
“aa” = relay delay
“bb” = relay hysteresis.
“cc” = relay state.
“dd” = external reset enabled.
“ee” = relay type.
“zz” = xor checksum of all preceding characters

For Analog Outputs:
“Vxx04zz=aabbccddeeffffffffgggggggghhhhhhhhiiiiiiiijjjjjjjjkkkkkkkkkllmmmmmmmmz”
“aa” = measurement.
“bb” = analog output type.
“cc” = control
“dd” = output level on failure.
“ee” = low end ouput (0 or 4mA)
“ffffffff” = minimum value #1
“gggggggg” = mid value #1
“hhhhhhhh” = max value #1
“iiiiiiii” = min value #2
“jjjjjjjj” = max value #2
“kkkkkkkk” not used.
“ll” = number of decades.
“mmmmmmmm” = calibration date.
“zz” = xor checksum of all preceding characters

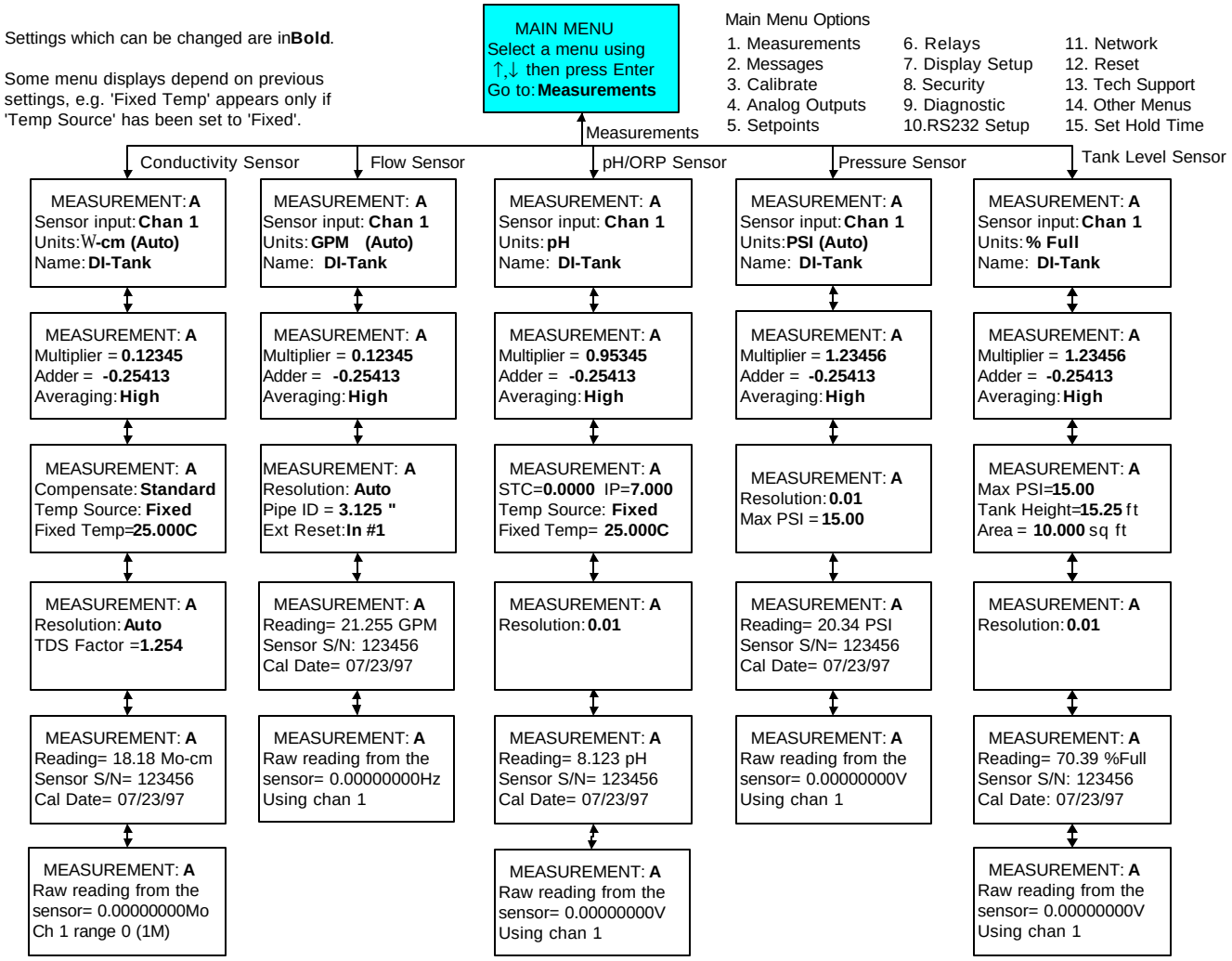
CHAPTER 7: MENU TREES

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.

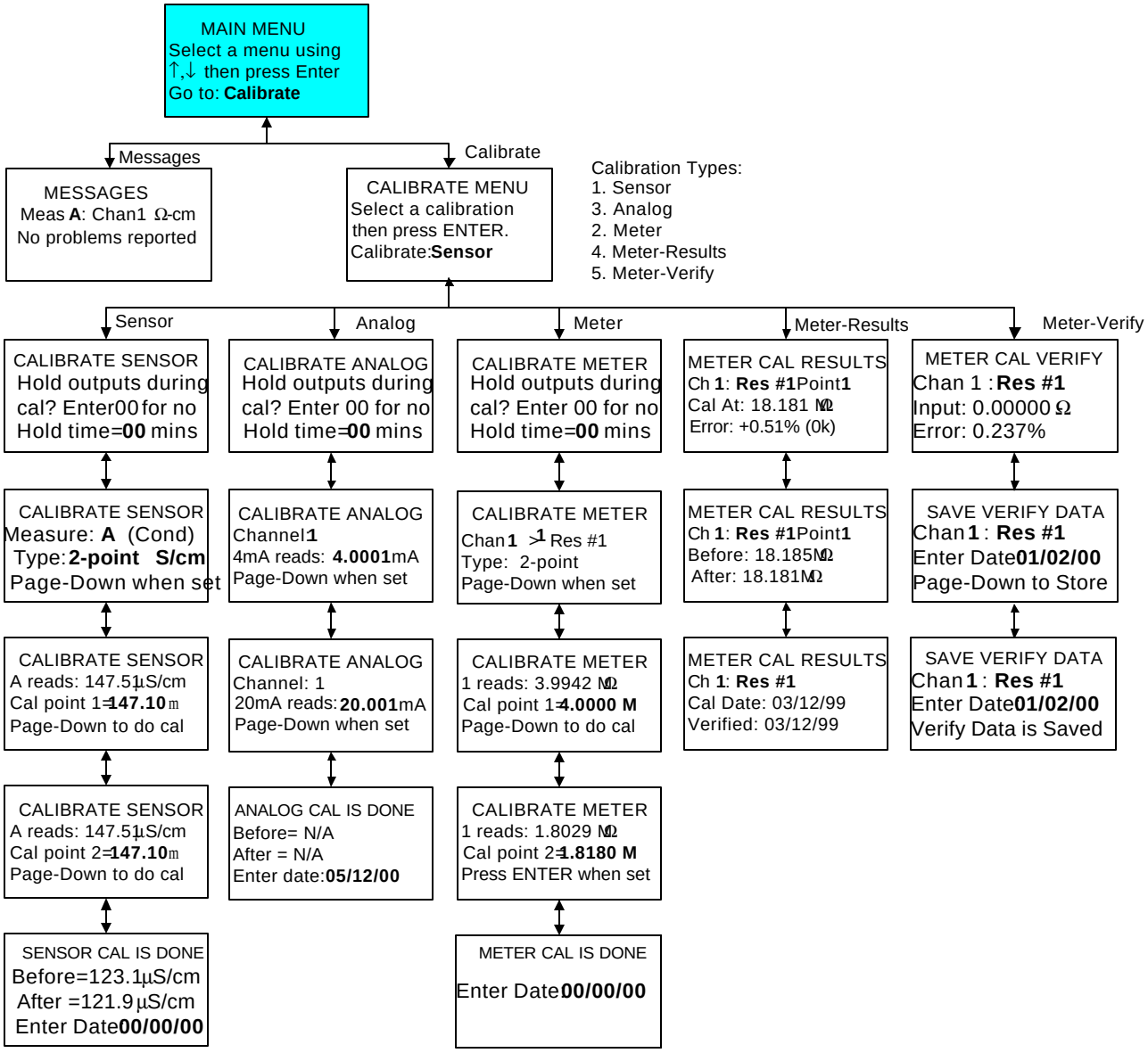
The screens below will appear after pressing **Menu** only if security has been enabled. Otherwise pressing **Menu** accesses the Main Menu directly, as shown on the following pages.



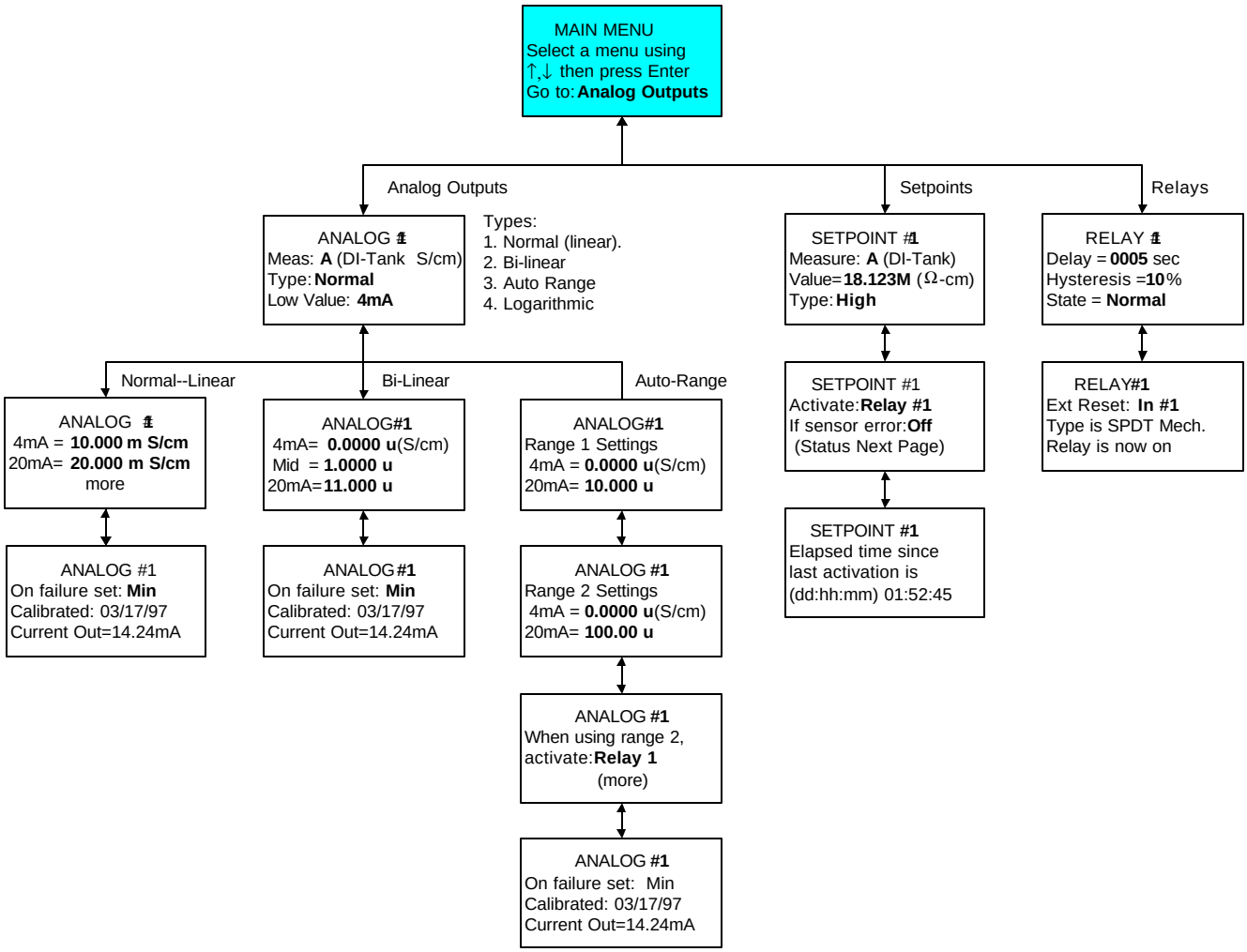
MEASUREMENTS MENUS



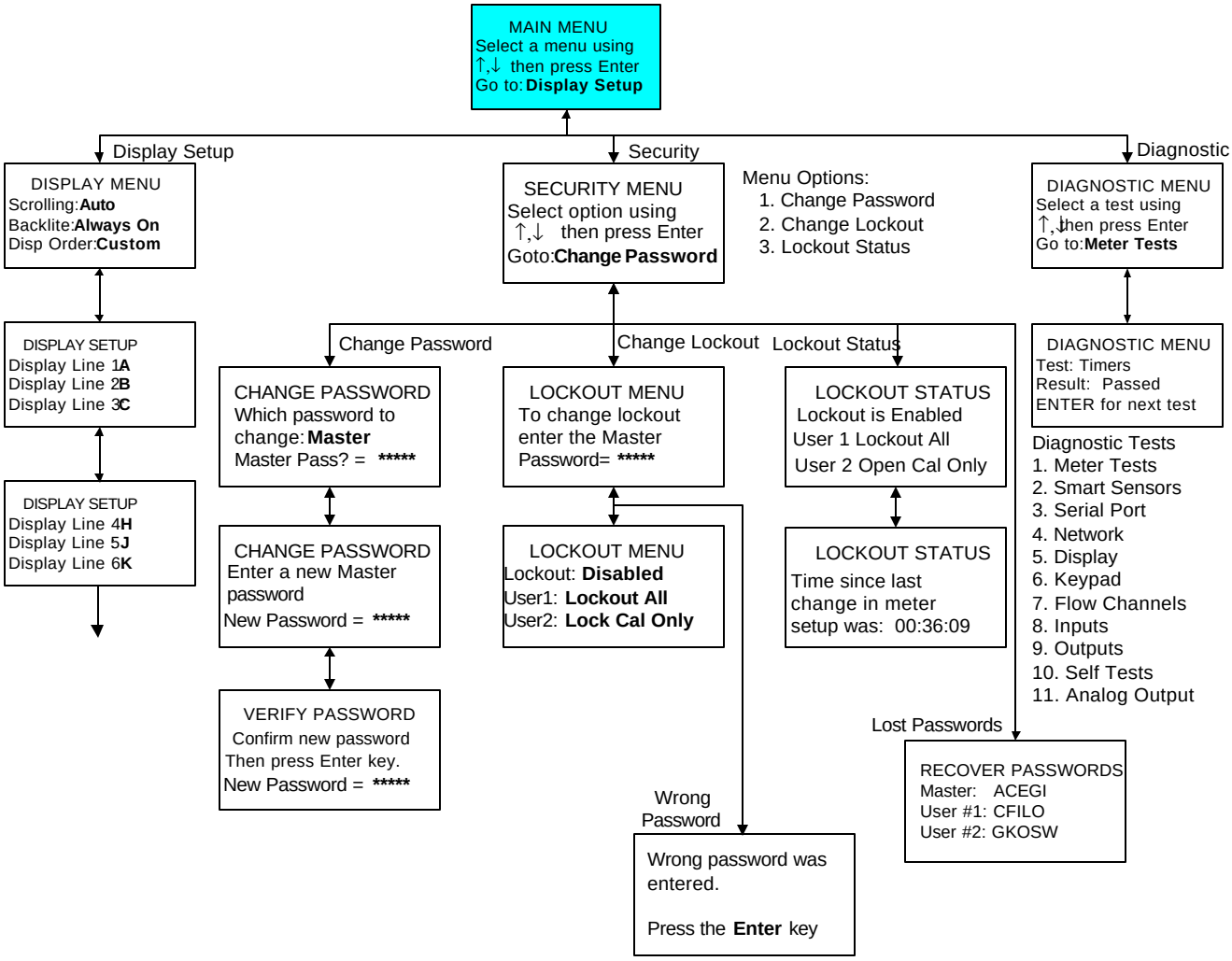
MESSAGES AND CALIBRATION MENUS



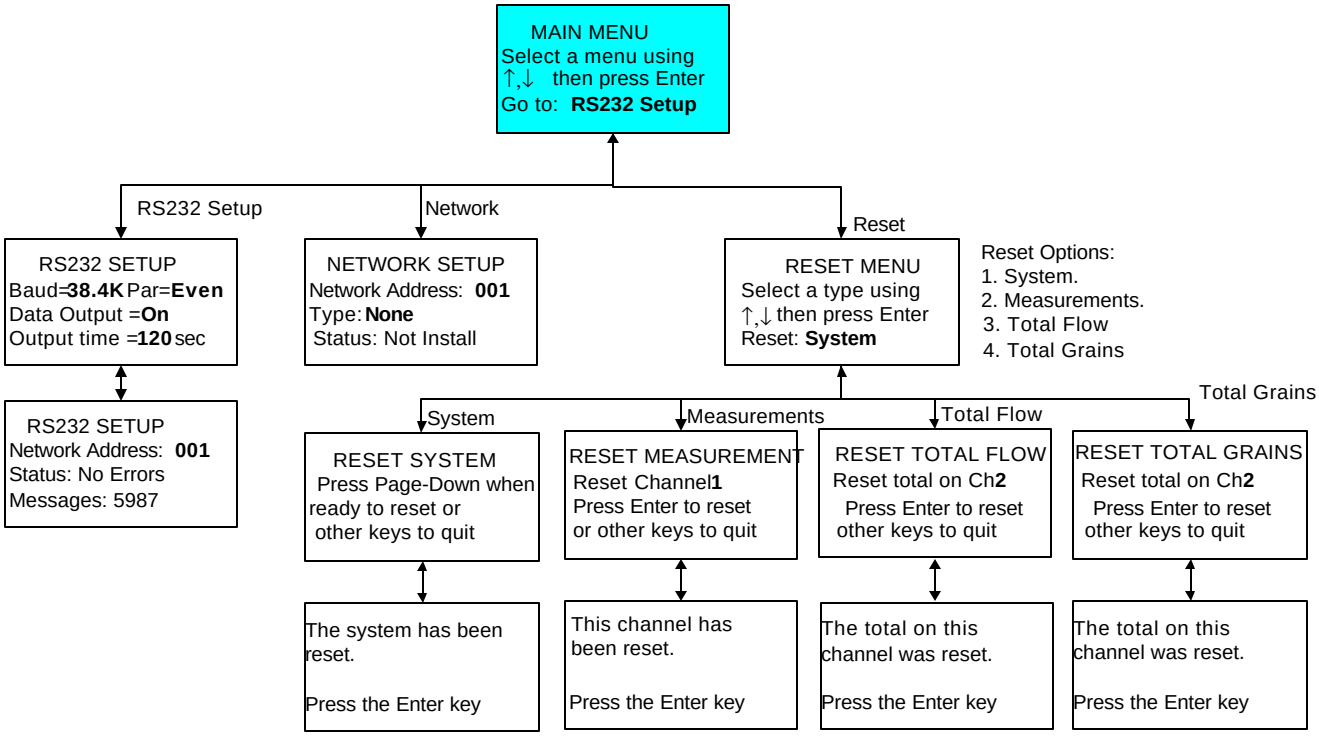
ANALOG OUTPUTS, SETPOINTS AND RELAYS MENUS



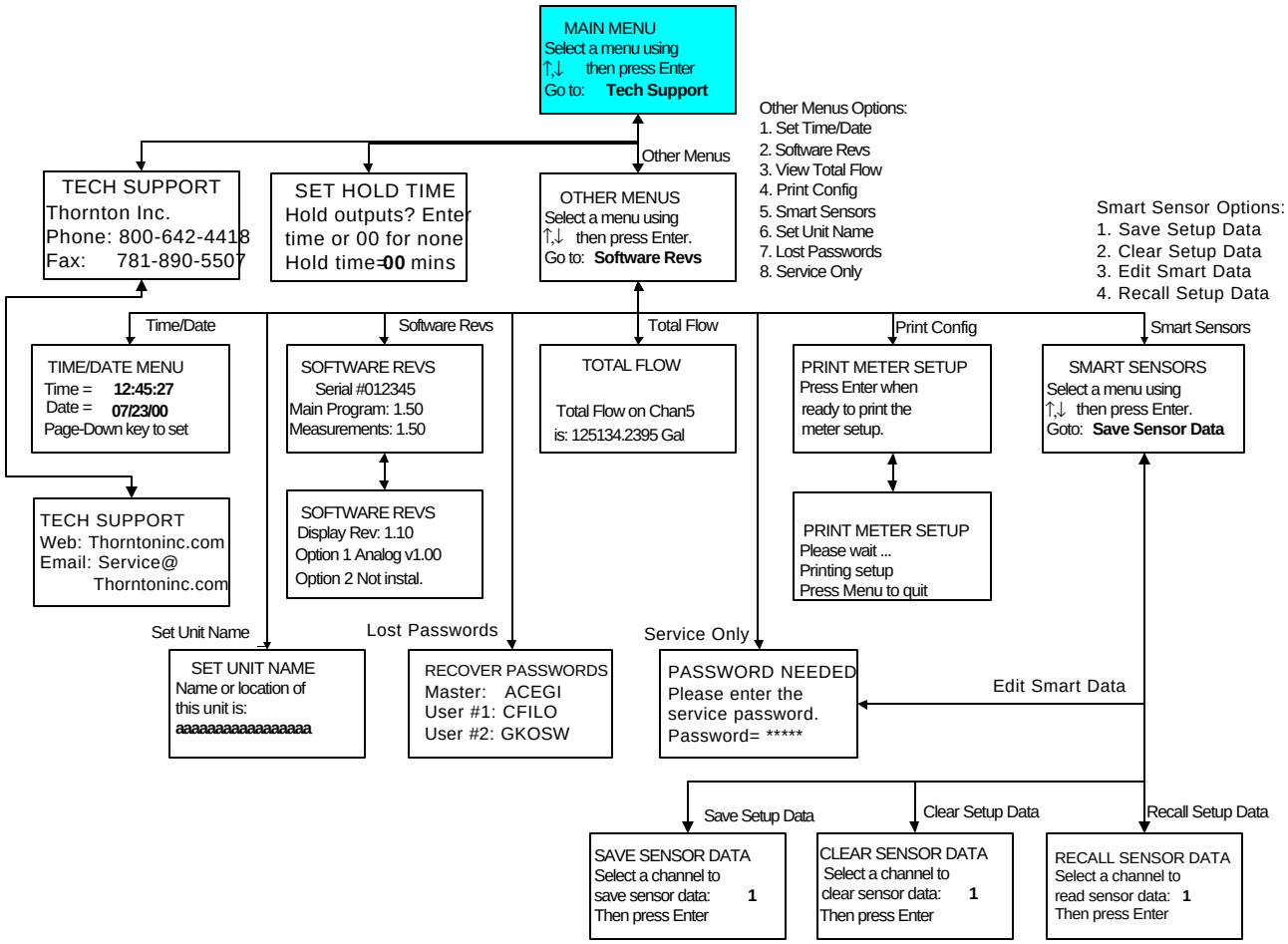
DISPLAY SETUP, SECURITY AND DIAGNOSTICS MENUS



RS232, NETWORK AND RESET MENUS



TECH SUPPORT, SET HOLD TIME AND OTHER MENUS



CHAPTER 8: 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
24 VDC Power Supply for 1 or 2 pulse input flow sensors (powered by 85-265 VAC)	1000-66
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 pH/ORP BNC preamp – for pH/ORP electrode with BNC connector (no temp. comp.)	1000-78
Smart pH/ORP K9 preamp – for pH/ORP electrode with K9 connector (no temp. comp.)	1000-84
Smart conductivity adapter cable – allows decade box input for calibration	1000-82
Smart frequency adapter cable – allows frequency input for pulse flowmeters	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, 0.5 A slo blo, 5 x 20 mm (Littlefuse 239.500 or equivalent)	35092*
Panel mounting screws (6-32 x 7/16", 4 required)	21800
Front panel assembly, molded cover with gasket, screws, retaining washers and keypad	07331
Screws for front panel (2 required, included in front panel assembly above)	21674
Retaining washers for front panel (2 required, included in front panel assembly above)	21675
Vacuum fluorescent display module (order connector and mounting standoffs separately)	47048
Connector for vacuum florescent display module above	25300
Liquid crystal display module (order mounting standoffs separately)	47047
Display standoffs (4 required for either display above)	21673
Relay option kit (to convert model 775-_ _0 to 775-_ _1) not CE rated	1000-91
Analog output & relay option kit (to convert 775-_ _0 to 775-_ _2) not for 230 VAC power, not CE rated	1000-92

*Recommended Spare parts

WARRANTY

Thornton Inc. warrants products it manufactures against defects in materials or workmanship for one year from start-up or 18 months from the date of shipment from Thornton, whichever is sooner. Warranties do not apply to limited life components such as batteries. Some non-Thornton manufactured resale items may have shorter warranties than one year. Thornton honors only the warranty period of the original manufacturer. Catalog descriptions, although accurate, should not be taken as a guarantee or warranty. Thornton's obligation under the warranty shall be to repair at its facility or replace any products which Thornton finds to be defective. Items returned for warranty must be properly packaged, shipped prepaid and insured, and must be accompanied by the Return Authorization Number described below.

Returned Goods: Please contact us for a Return Authorization Number before any item is returned. Items returned for credit or exchange must be in salable condition. Items returned after 30 days from date of invoice, will be subject to a 10% rehandling charge.

Note: Substitution or modification of cables voids all warranties.

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