MultiSense Level Controllers and Sensors

Liquid and Foam Version

(systems with controller part nos MLCC-----)

Installation and Operation Manual

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Version 3.3

CONTENTS

SPECIFICATIONS

CONTROLLERS

Power Supply:	AC Versions: 100-250 Vac, 0.5A DC Versions: 24Vdc, 0.5 A
Outputs:	Relay 1 – Liquid Level Control (Volt-free change over contacts) Relay 2 – Foam Level Control (Volt-free change over contacts) Relay 3 – Alarm Output (Volt-free change over contacts) Rating - 240 V a.c. / 30 V d.c. 3 A max. 4-20 mA for liquid level 4-20 mA for Foam level
Indicators:	Relay 2 Active Led – Foam - Green Relay 1 Active Led – Liquid - Yellow Relay 3 Active Led – Alarm - Red
Human Interface (HI):	2 line x 16 character display 6 button membrane keypad Menu system for configuration
Enclosure:	IP65, wall mounting Polystyrene with polycarbonate window 230 wide x 240 height x 260 depth mm Colour Grey (Ral 7035) Connections: screw terminals
Channels:	3-24, typically 8, 16 or 24

SENSORS

Head:	Stainless steel, 80x66x50mm
Connector:	21way (8,16 channels) or 26way (24 channels) LAPP EPIC series R
Diameter:	12 / 24
Length:	250 – 6000 mm
Construction:	316L Stainless Steel, Peek 450G
Seals:	silicon, EPDM, Viton or Perlast
Sections:	3-24, typically 8, 16 or 24
Sensor Cable:	Proprietary multicore cable assembly, 1- 10m long

1 Introduction

The Multisense level control system uses an entirely new type of liquid level sensor. An array of small sensors operate together to give a very accurate form of level measurement. The array typically consists of 8 level sensor electrodes and one termination electrode at each end. The number of sensors can be much larger if the application demands it. Each electrode, or section as they are called, is 30 mm or more in length. The sections work together to measure an array of data, which is used to sense the level of liquid very precisely and can also be used to measure other data such as foam level in multiphase systems.

A Multisense controller energises the sensor and processes the data. The controller includes measurement modules that can drive a series of sensors. Each measurement module drives up to 8 sensors and operates with the other parts of the system. The number of measurement modules is limited mainly by the physical size of the controller to house the modules. The controller calculates the volume of liquid from the height and the internal diameter of the vessel.

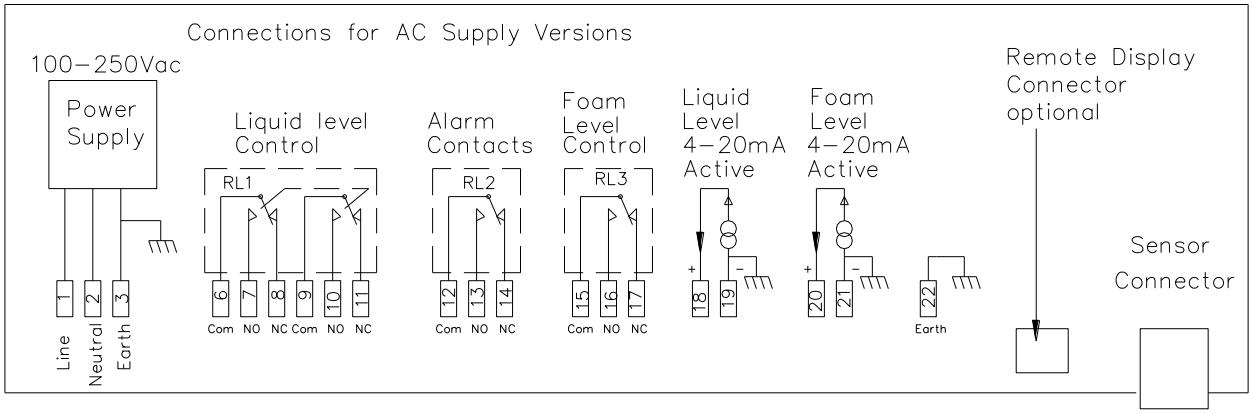
This version of MultiSense is designed to measure and control aqueous liquid and foam level. It is designated by the "CC" characters in the controller part number. (For controllers with part numbers beginning MLCF… please refer to the MultiSense Foam only manual instead.) It should be installed through the space above the process liquid where foam will build up and extend into the liquid. In normal circumstances the sensor should be in contact with the process liquid. If the liquid phase falls below sensor it will not be able to measure foam. (There are other versions of MultiSense, which can measure just the foam, in which case the sensor must be installed above the liquid.)

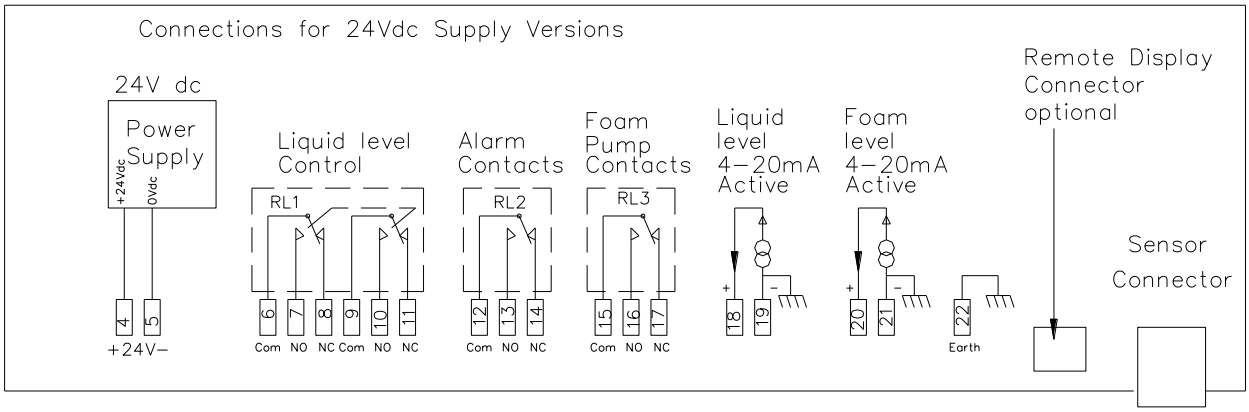
The benefits of the system are:

- High resolution (<1mm height)
- Unaffected by temperature and conductivity changes.
- Hygienic and sterilisable
- Solid state – no moving parts
- Measures liquid height and volume
- Measures foam build up on changing liquid levels
- High Immunity to the effects of surface fouling

2 Quick Start Guide

The sensor and controller must be installed correctly as explained in section 5 of this manual. The controller should be connected to the sensor by means of the sensor cable supplied. Note the cable has one end marked “sensor” and the other marked “controller”. The controller terminals are shown in the diagram below (details can be found in section 5).





The system will require setting-up and commissioning before use. There are two parts to the set-up as follows:

1) Sectioning – captures data characterising the environment of the sensor to enable it to work at its most accurate.
2) Scaling – stores data relating to the absolute volume of liquid to enable the readout to be in accurate volume units. If the controller is to measure liquid height then this process can be ignored.

There are other features which may need setting up depending on the application such as 4-20 ma range, set-points and alarms.

However to get the system operating quickly the most important aspect are the section factors which are derived by the sectioning process. The default section factors, which are set during manufacture, may not be suitable to measure accurately. When power is applied all the Leds flash on and off and the system carries out a self-test procedure. If this is successful the display will show the default measured parameters as shown in section 3.3. If a message is displayed such as Init. Stage 3.. which stays on the screen then there is a problem. See section 3.1

See section 4 on how to carry out a full set-up.

3 Operation

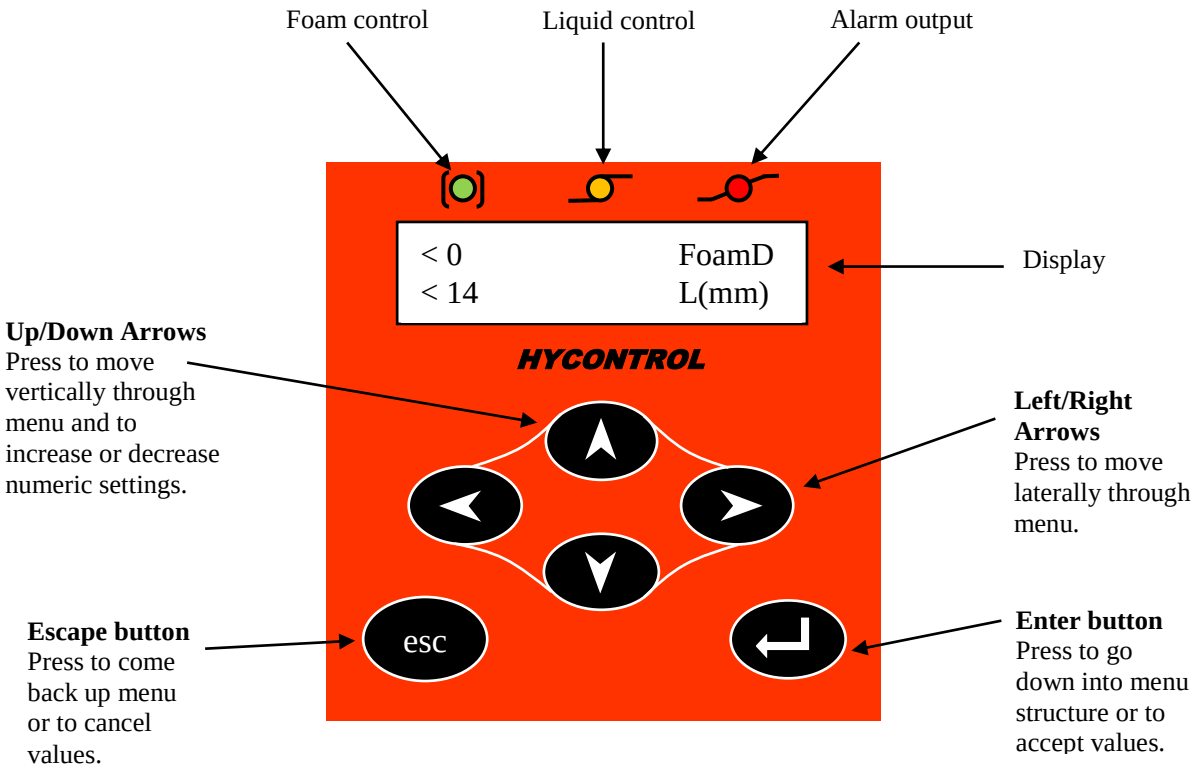
3.1 Powering up

Switch on the power to the controller and after a few seconds the front panel indicators will flash simultaneously as the self-test starts. The controller will then go through 3 initial tests to determine if it is working correctly. The success or otherwise of these tests will be shown on the display and will look something like this initially.

```
Init. stage1...
Synchro spi ...
```

After three stages of tests have run successfully the display will show the control screen similar to that shown in section 3.2 below. The display will then show measurements derived from the sensor and enable the user to check the operation. If the unit does not show the screen below or there seem to be errors then please refer to the troubleshooting section at the end of the manual.

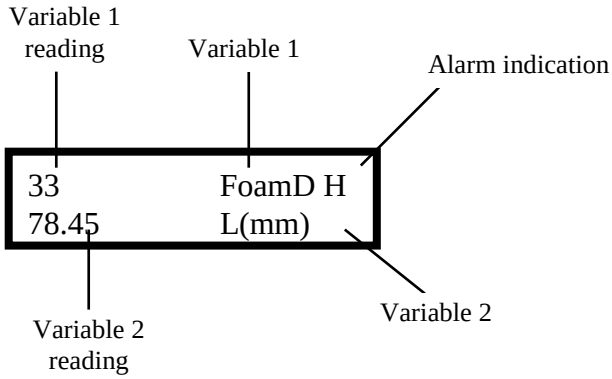
3.2 Understanding the Control Interface (HI)



3.3 Understanding the Control Screen and Indicators

After power up the display will show the control screen. The control screen is the main operating screen and shows two continually updating readings. The user can set which two readings are displayed.

A typical control screen view is shown below with the variable reading on the left and the variable name on the right.



The variables displayed are selected in the Display Menu (see section 3.5) with variable 1 corresponding to the first line of the display and variable 2 the second line. The resolution of the variable readings (the number of decimal places that are displayed for a numerical measurement) can also be changed in the Display Menu with Display Resolution 1 referring to variable 1 and Display Resolution 2 referring to variable 2.

Any two of the following variables can be displayed on the control screen as variable 1 and variable 2.

Variable Options	Typical display reading	Description
Liquid (l)	0.560 L(l)	The volume of liquid in litres
Liquid (mm)	80 L(mm)	The height of liquid from the bottom of the sensor in millimetres
Foam depth(mm)	23 FoamD	The depth of foam in millimetres
Foam height(mm)	80 FoamH	The height of foam from the bottom of sensor in millimetres
Conductivity-K	28.45 K(mS)	The conductivity of the liquid in milliSeimens (mS)
LPump status	off man. LPump	The status of the liquid pump (off/on and auto/manual)
LPump setpoint	0.5/0.9 LSp	The low and high set points for the liquid pump respectively

The < character on the left of the screen, as shown in section 3.2 means that the variable is at the bottom of the range. The > character on the left of the screen means that the variable is at the maximum of the range which is set.

The alarm indication position will be blank if no alarm has been triggered but will show L, H or F for low liquid, high liquid and high foam levels respectively. If two alarms are triggered, both letters will be displayed.

The front panel Led indicators have the following functions:

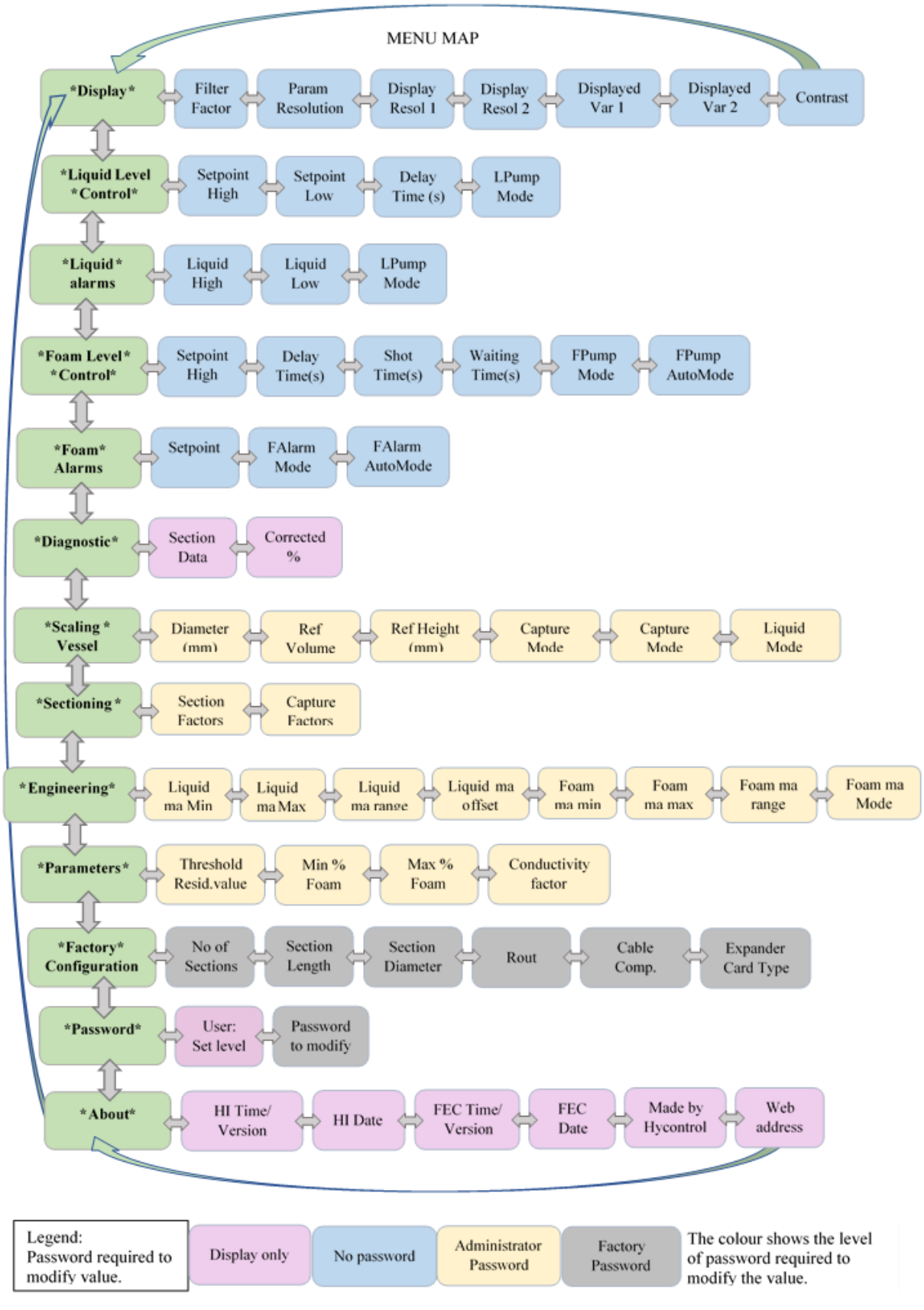
Left – Green On when the foam control contacts operate i.e. during shot time.

Centre – Yellow On when liquid control contacts operate.

Right – Red On when an alarm is triggered.

3.4 The Menu System

The Menu system can be accessed by pressing enter from the control screen. The menu system is comprised of 13 menu levels with which parameters can be set. The Menu map is shown below:



3.4.1 Menu Navigation

A menu branch is easily recognisable by the presence of **"* *"** on the display.

1. Use the up and down buttons to scroll through the menus
2. Press enter to select a menu
    a. Use the left and right arrows to view the different options available within a menu level.
    b. Press enter to modify an option. A ' ?' will appear if change is allowed.
    c. Press to go back or up in the menu list.
3. Press esc to return to the control screen.

3.4.2 Modifying Options and Parameters

Make sure you have the access right to modify the option (see section 3.4.3).

1. Press enter to modify an option: a question mark will appear on the right of the screen.
    a. Press up or down to modify the value. Holding an arrow down makes the value move faster.
    b. Press esc to cancel the change.
    c. Press enter to confirm the change.

2. Press esc to return to the previous level.

3.4.3 Passwords

There are three levels of permission controlled by the passwords:

a) **Default:- no password required**, only parameters shown in blue boxes in the menu map can be modified.

b) **Admin (9987)**;- set-up parameters shown in yellow boxes in the menu map can be changed.

c**) Factory (9968)**:- everything can be changed including the configuration data shown in grey boxes.

After a return to the control screen the permission will be reset to default. This is to prevent someone from accidentally modifying the set-up of the system. Also the permission will also revert automatically to default after several minutes.

3.4.4 To Change the Permission to Admin

To change the permission to *Admin*, go to the password menu and scroll right to the *"Pwd to modify"* option. Press enter and then use the down arrow key to set **9987**. Then press the enter key. The display will respond by showing "accepted". You can make sure you have successfully logged in by checking that the value of the option "*user*" is *admin*. Once this is done any of the set-up parameters can be modified. It is very important to change the set-up parameters with care. Some parameters are captured by the system automatically and may be difficult to recover if lost.

3.4.5 To Reset the Permission Level

To reset the permission to default (in other word log in as default user), set the option *"Pwd to modify"* to **9999**. You can make sure you have successfully logged out by checking that the value of the option "*user*" is *default*. Alternatively an easier way is to simply return to the control screen, at which point the permission level is reset to default and the password to 9999. However the permission level will return to default automatically after several minutes and also returns to default on returning the main display screen.

3.4.6 To Change the Permission to Factory

The factory password is normally only used to set-up the system to suit the sensor during the manufacture. The configuration data, shown in grey boxes on the menu map, can only be changed if the factory password is set. The sensor dimensions would normally only need to be changed if the sensor was replaced by one of a different size. The controller uses the factory set-up information to process the data from the sensor and it is essential that the settings are correct. So the factory settings should not be changed without a very good reason. There are just a few instances when it might be necessary to change the factory set-up parameters. One example is when a different sensor is to be used.

It is a good idea to check the factory settings against the sensor specification during commissioning.

3.5 Menu Functions

Each menu branch and its functions is detailed in the follow sections. The passwords required to make a change to the selection is shown. If the password is not set the value can only be displayed.

3.5.1 * Display *

This menu controls what variables are displayed on the control screen and how the display appears. It is also used to set the resolution for the parameters in all menus.

Menu Item	Password Required	Selection Range	Description
Filter Factor	None	1 - 20	Set the Filter from 1 to 20 to prevent turbulence being interpreted as liquid level change. 1 gives a fast response, 20 gives a slow response. A typical value is 3.
Param. Resolution	None	1 - 0.001	The resolution used when setting any parameters such as setpoint low, vessel diameter and so on.
Display Resol 1	None	1 - 0.001	The number of decimal places displayed for *display variable 1*. This does not change the accuracy of the measurements and the displayed resolution can be higher than the accuracy level.
Display Resol 2	None	1 - 0.001	The number of decimal places displayed for *display variable 2.*
Displayed Var 1	None	Liquid Volume L Liquid Height mm Foam Height mm Foam Depth mm LPump SP Conductivity mS	The variable that is displayed on the top line of the control screen
Displayed Var 2	None	Liquid Volume L Liquid Height mm Foam Height mm Foam Depth mm LPump SP Conductivity mS	The variable that is displayed on the bottom line of the control screen
Contrast	None	0 - 5	The viewing angle of the display can be adjusted between 0 and 90 degrees with 0 at eye level and 5 at 90 degrees

3.5.2 * Level Control Liquid *

This menu is used to set the parameters that control the liquid level. The liquid level control can be switched off to give a measurement only. The factory default is off.

Menu Item	Password Required	Selection Range	Description
Setpoint High	None	Numeric mm or L	High set-point above which the level control contacts reset
Setpoint Low	None	Numeric mm or L	Low set-point below which the level control contacts operate
Delay Time (s)	None	0 – 60 secs	Time for output to operate. Delay acts to prevent fast on/off cycling.
LPump Mode	None	Off On Auto Direct Auto Inverse	Off = Always off. On= always on, Auto Direct = control of level to set-point when pump fills vessel Auto Inverse = control of level to set point when pump drains vessel

3.5.3 * Liquid Alarms *

Menu for liquid level alarm settings. The level at which alarms are invoked can be set or switched off. The factory default is off.

Menu Item	Password Required	Selection Range	Description
Liquid High	None	Numeric mm or L	The alarm will be on if the measured level is above this threshold.
Liquid Low	None	Numeric Mm or L	The alarm will be on if the measured level is below this threshold.
LAlarm Mode	None	Auto / off	Auto = alarm enabled, Off = alarm disabled

3.5.4 * Level Control Foam *

This menu is used to set the parameters that control the foam level. The foam level control can be switched off to give a measurement only. The factory default is off.

Menu Item	Password Required	Selection Range	Description
Setpoint	None	Numeric (mm)	The height or depth of foam which controls the alarm level
Delay Time	None	0 – 60 secs	Initial delay before contacts operate, to discriminate against splashing
Shot Time	None	0 – 60 secs	Time for contacts to remain closed (e.g. on time of pump)
Waiting Time	None	0 – 60 secs	Time between shots (e.g. off time of pump)
FPump Mode	None	Auto / on / off	Auto = control of level by set-point, on = always on, off = always off.
FPump AutoMode	None	Height / Depth	Height = absolute height, Depth = depth of foam above liquid

3.5.5 * Foam Alarms*

Menu for foam level alarm settings. The level at which alarms are invoked can be set or switched off. The factory default is off.

Menu Item	Password Required	Selection Range	Description
Setpoint	None	Numeric (mm)	The height or depth of foam above which the alarm is activated
FAlarm Mode	None	Auto / off	Auto = enable foam alarm, off= disable alarm
FAlarm AutoMode	None	Height / Depth	Height = alarm set-point by height of foam from end of probe Depth = alarm set-point by depth of foam above liquid surface

3.5.6 * Diagnostic *

Tools for checking raw data which may be useful during set-up and troubleshooting.

Menu Item	Password Required	Selection Options	Display Range	Description
Section Data	Display only	Section 1- N	10 – 10,000,000	Raw data as measured by the individual sections in the sensor assembly. Display is shown as uA x 10 normalised to a standard sensor energisation voltage of 1.0 V.
Corrected data	Display only	Section 2- N	0-100%	Measured % submersion of section in liquid, e.g. 100% when below liquid surface, 50% when surface is ½ way up section. For sections which are clearly under the liquid surface a display outside the range 95-105% indicates a problem with the section factors.
Vosc Data	Display only	None	n/a	Factory use only
Self Test	None	Start/Stop	Pass/fail	This requires special test equipment – factory use only.

3.5.7 * Scaling Vessel *

Calibration parameters that must be set during commissioning if measurement in volume is required.

Menu Item	Password Required	Selection Options	Description
Diameter	Admin	1.0 – 5000mm	Effective internal diameter of the vessel, in mm, used to calculate the volume in L from height in mm.
Ref. Volume	Admin	0.1 - 20000 L	Known volume in vessel used as calibration reference, preferably = working volume. This is entered by user when calibrating.
Ref. Height	Admin	1-top of probe mm	Height of liquid in vessel when filled to reference volume, as captured automatically by the system during calibration. Can be set manually if Capture mode = manual
Capture Mode	Admin	Auto / Manual	Auto = reference height measured automatically by system Manual = user can input ref height & section factors using keypad.
Liquid Mode	Admin	Volume/Height	Parameter of setpoint for liquid level control Volume= litres, height =mm. Sets alarm, set-points and engineering parameter units.

3.5.8 * Sectioning*

Capture and display calibration factors that must be set for the measurement to work correctly. This must be used during commissioning. The section factors are set to 1000 during the factory set up. These must be set by the capture function for the instrument to measure the liquid/foam interface correctly. If all the factors are at 1000 then the instrument has not been commissioned properly.

Menu Item	Password Required	Selection Options	Display Range	Description
Section Factors	Admin	Section 2 - N	100 - 2000	Displays the current section factors. Use left and right arrows to scroll through factors. Default values = 1000 before sectioning, typical captured values =800-1200
Capture Factors	Admin	Enter to start capture	100 - 2000	Automatically captures the section factors for a particular liquid and vessel. (if capture mode=Auto) Can be set manually if capture mode in Scaling menu = Manual, (See 3.5.7 above) If password is not set the capture factors option is not visible.

3.5.9 * Engineering *

Sets 4-20 mA output ranges for liquid and foam analogue outputs.

Menu Item	Password Required	Selection Options	Description
Liquid mA min	Admin	Numeric mm or L	Bottom of 4-20mA liquid range - liquid level at 4 mA (or 0mA)
Liquid mA max	Admin	Numeric mm or L	Top of 4-20mA liquid range - liquid level at 20mA.
Liquid mA range	Admin	0 / 4 ma	Sets liquid mA range as 0-20 or 4-20
Offset Liquid mA	Admin	mA	Adjust 4mA(or 0mA) value if required.
Foam mA min (mm)	Admin	Numeric mm	Bottom of 4-20mA foam range - foam level at 4 mA (or 0mA)
Foam mA max (mm)	Admin	Numeric mm	Top of 4-20mA foam range – foam level at 20mA.
Foam mA range	Admin	0 / 4 ma	Sets Foam mA range as 0-20 or 4-20
Foam mA Mode	Admin	Height / Depth	Sets foam mA output to correspond to height or Depth of foam.

3.5.10 * Parameters *

Parameters to set sensitivities of foam and conductivity measurements.

Menu Item	Password Required	Selection Options	Description
Threshold Risid. value	Admin	Numeric	Noise level of section data. Default = 100. Below this threshold data is ignored. To measure pure water this value may need to be reduced down to around 40 to increase the effective range
Min % Foam	Admin	0-1 %	Threshold as % of liquid in foam to register as foam. Data below this not seen as foam. Default = 0.1% which means the foam is measured once it contains at least 0.1% of liquid. To increase the sensitivity to foam
Max % Foam	Admin	0 – 10%	Maximum % liquid content of foam at top of section. Used to estimate partially submerged sections by correcting for the foam profile.
Conductivity Factor	Admin	0.1-10	Calibration factor to allow the conductivity measurement to be calibrated if required. This only has an effect on the conductivity displayed on the screen.

3.5.11 * Factory Configuration *

Fundamental sensor parameters, to match the sensor to the controller. These should not be modified unless the sensor is changed for another with different dimensions.

Menu Item	Password Required	Selection Options	Description
No of Sections	Factory	2 - 24	The number of active sections in the sensor
Section Length	Factory	Section 1-N, 20-255 mm	The length of each section in the sensor (mm)
Section diam (mm)	Factory	12-22	The diameter of the sensor, 12/20/22 mm
R.out	Factory	0-5.00	Default = 1.00
Cable Comp	Factory	0-5.00	Default = 2.0
Expander type	Factory	Version 2 Version 4.2	Default = V4.2

3.5.12 * Password *

Allows change of the permission level by entering a password.

Menu Item	Password Required	Display Range	Description
User	Display only	Default/Admin/Factory	Indicates which permission level is set by password.
Pwd to Modify	Admin / Factor	0-9999	Enables the user to modify parameters by entering the admin or factory password.

3.5.13 * About *

Displays the current version levels used in the controller

Menu Item	Password Required	Description
HI S/W version	none	Version of software installed in Human Interface.
HI Date	none	HI Compilation date
FEC S/W version	none	Version of software installed in controller card.
FEC Date	none	FEC Compilation date
Company Identity	none	Hycontrol Ltd
Web Address	none	www.hycontrol.com

4 Installation

4.1 Introduction

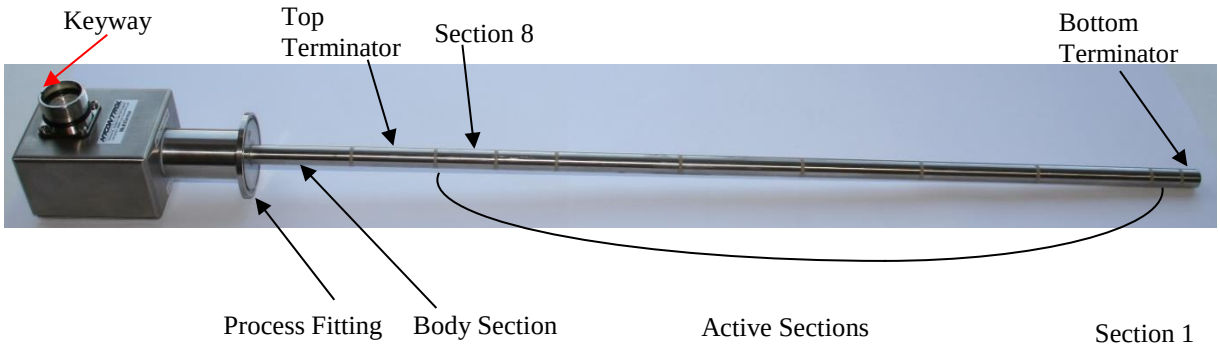
The system must be installed correctly for it to function properly. Please refer to the sections below and the schematic drawing in section 4.4 for the correct installation procedure.

4.2 Sensor Installation

The sensor should be installed in the vessel in a secure position so that it cannot move during use. Any vertical movement will result in errors in the volume measurement. The sensor usually has a fitting to secure into the vessel and which also connects the body of the sensor to the vessel to connect it to earth. The orientation of the sensor must be vertical or very close to vertical to ensure the best accuracy.

It is essential that no active sections including the terminators come into contact with any metal parts or the sensor will suffer a short circuit and not work.

The sensor cable can be fitted to the sensor head. Either end of the cable can be used. There is a key on the plug that should be aligned with a keyway on the socket. The connector should be secured by tightening the locking ring. This only required to be hand tight – do not use a tool for this.

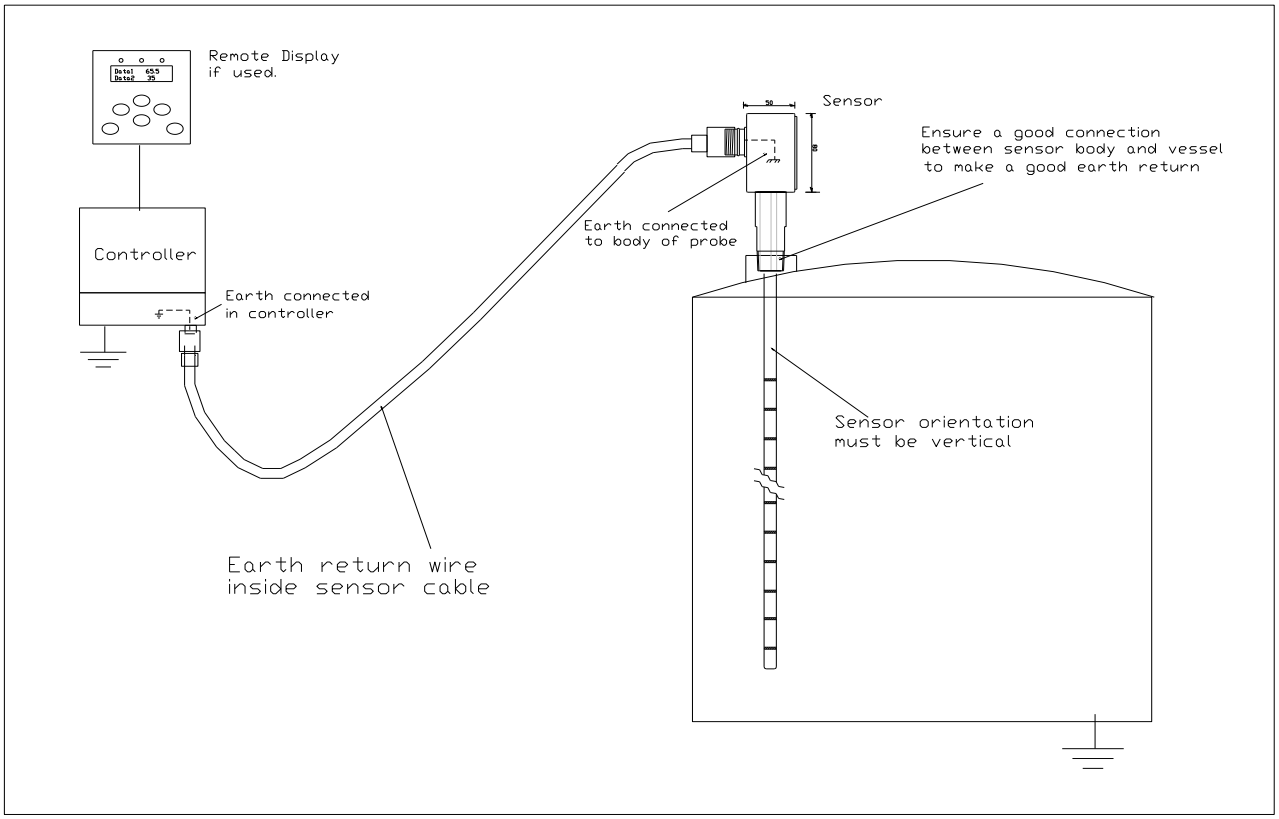


The sensor topography is shown in the photograph above. The process fitting fixes the sensor to the process tank. It also connects the earth in the sensor to the tank structure which will normally be connected to earth. The body section is connected to the process fitting and so is also connected to earth. However none of the other parts of the sensor may connect to any part of the tank. The number of active sections can vary up to 24. The sensor above has 8 sections which is the most common configuration.

The sensor cable should be connected carefully to the sensor head by aligning the connector. There is a key on the plug that should be aligned with a keyway on the socket. The connector should be secured by tightening the retaining ring. This only required to be hand tight – do not use a tool for this, but it must be fully screwed in to ensure all the pins connect properly. Note that the sensor cable is marked for the sensor at one end and the controller at the other. Although the connectors are identical the wiring is not.

An earth return path is required from the vessel to the controller. This is incorporated into the sensor cable so a separate earth cable is not required as a signal return. However it is essential that the sensor fitting or body makes a good contact with the vessel. This normally happens through the process fitting but if any plastic parts are used it may be necessary to bond the sensor body above the fitting to the vessel. (contact supplier for advice)

Note the diagram below which illustrates the earth return requirements.



4.3 Controller Installation

The controller can be supplied as an integrated unit with the display interface in the front panel of the controller or as a separate unit that can be mounted remotely in a control panel.

The controller itself is mounted using brackets fitted to the rear. The brackets have two parts, one that can be screwed to a wall or back panel and the other that attaches to the controller. The controller then slides onto the wall brackets and is attached with small screws that are inserted sideways into the brackets, between the wall and the controller. This is shown in the picture below:

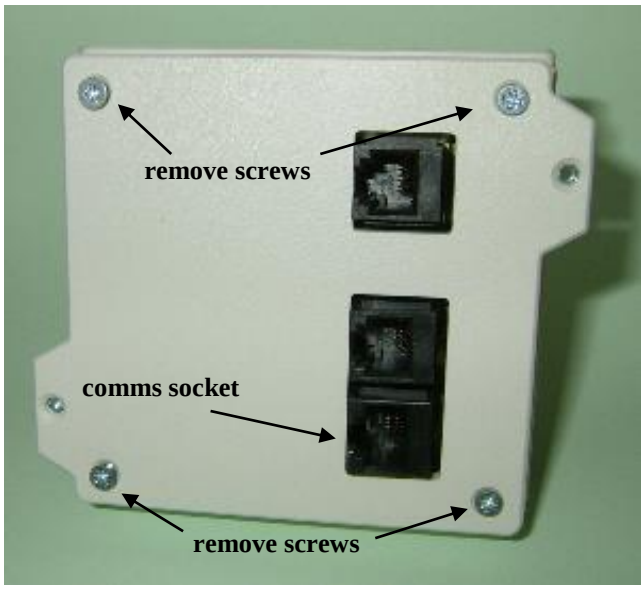
MLC1000/W/8 Controller
With integrated display interface

Mount on wall brackets
supplied.

Secure controller to brackets
by tightening screws.

4.4 Remote Display Installation

When the display interface is used remotely from the controller, it needs to be installed separately. The unit is designed to fit a 92 x 92 mm panel cut out. It can be fitted by unscrewing the back cover placing the unit into the cut out and reattaching the back on the inside of the panel. The unit is then secured on the panel by inserting screws on the two tabs and tightening them against the panel. Do not over-tighten. A comms cable then needs to be connected between the comms socket shown and the controller.



4.5 Cabling to Controller

The cabling has three parts:

- Sensor cables
- Power
- Interfacing

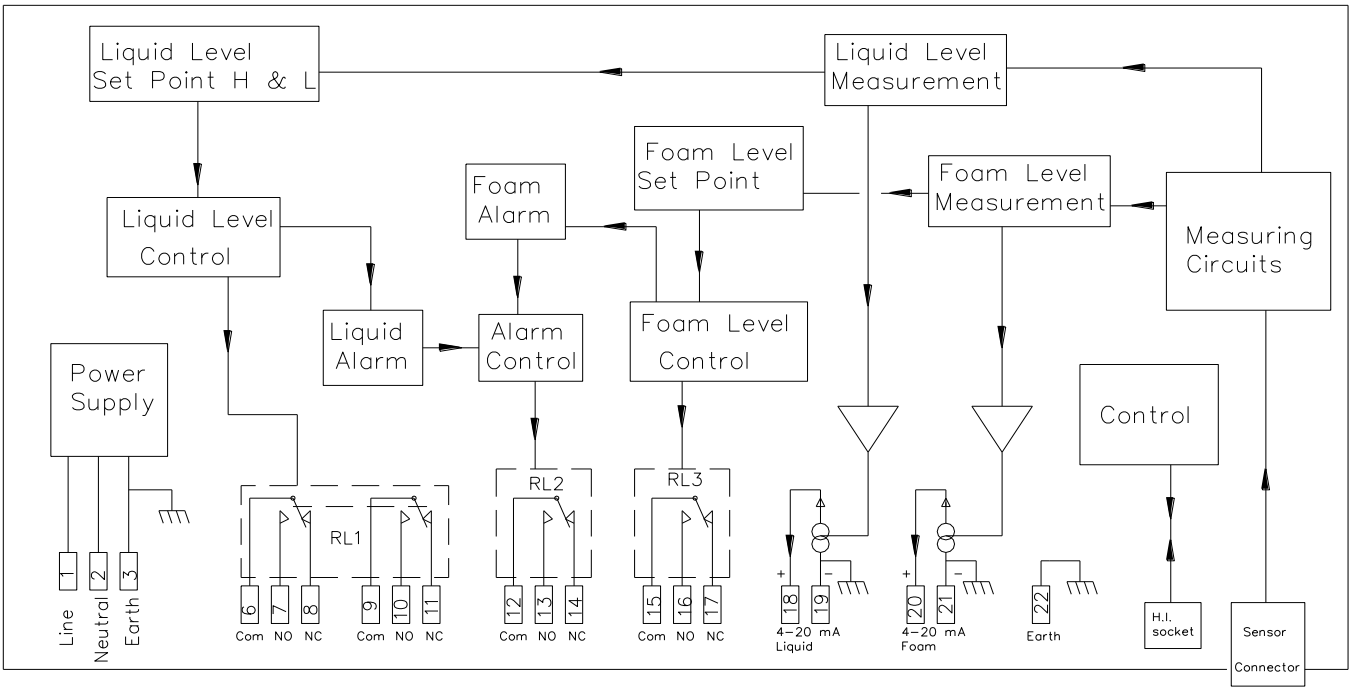
It is essential that a suitable type of cable is used in all cases.

The connections are all accessible inside the terminal housing, at the bottom of the controller. The terminals should be slackened with a small screwdriver to enable the wires to be fitted easily. The terminals are shown in the picture below, for an AC version, but the DC version is identical except for the supply terminals.

AC supply versions – Terminals

Terminal No	Function	Terminal No	Function
1	Line Supply 100 -240Vac	12	Alarm common contact
2	Neutral	13	Alarm normally open contact
3	Earth	14	Alarm normally closed contact
4	Not used	15	Foam Control common contact
5	Not used	16	Foam Control normally open contact
6	Liquid Control A common contact	17	Foam Control normally closed contact
7	Liquid Control A normally open contact	18	Liquid level 4-20 mA output +
8	Liquid Control A normally closed contact	19	Liquid level 4-20 mA output -
9	Liquid Control B common	20	Foam level 4-20 mA output +
10	Liquid Control B normally open contact	21	Foam level 4-20 mA output -
11	Liquid Control B normally closed contact	22	0V return – for earth to vessel.

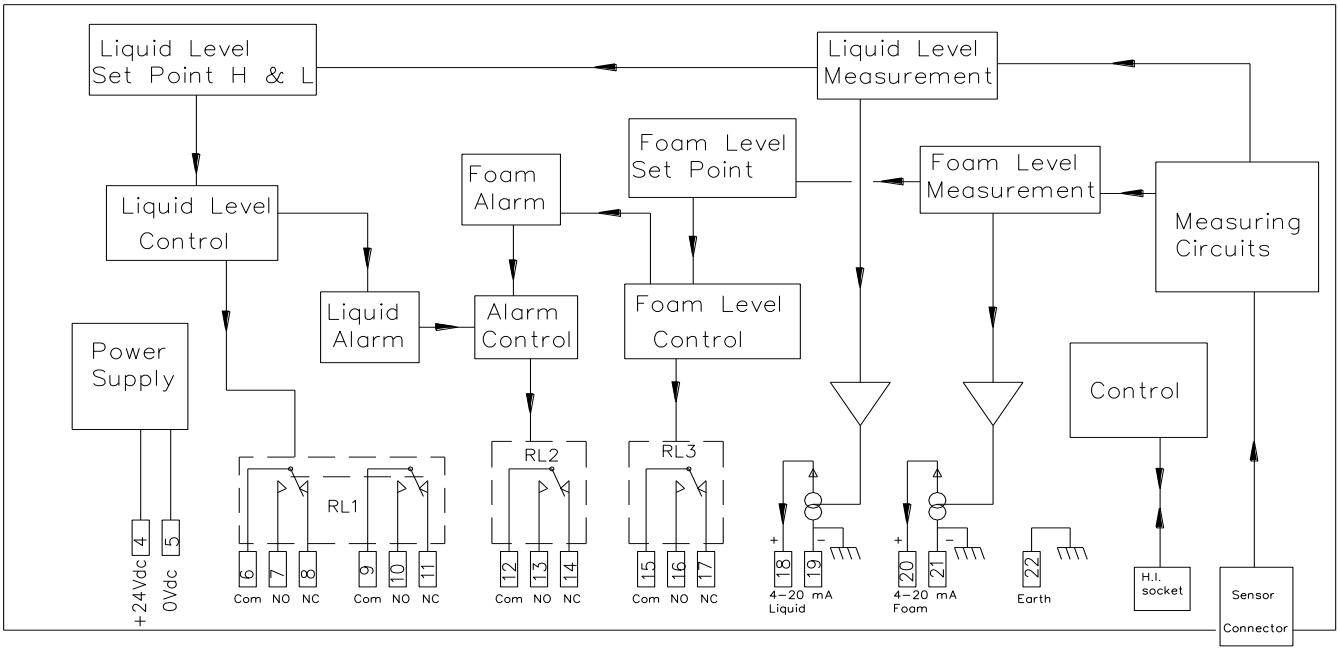
DC Supply Function Blocks and Terminals



24V dc supply versions – Terminals

Terminal No	Function	Terminal No	Function
1	Not used	12	Alarm common contact
2	Not used	13	Alarm normally open contact
3	Not used	14	Alarm normally closed contact
4	+ 24 Vdc	15	Foam Control common contact
5	0 Vdc	16	Foam Control normally open contact
6	Liquid Control A common contact	17	Foam Control normally closed contact
7	Liquid Control A normally open contact	18	Liquid level 4-20 mA output +
8	Liquid Control A normally closed contact	19	Liquid level 4-20 mA output -
9	Liquid Control B common	20	Foam level 4-20 mA output +
10	Liquid Control B normally open contact	21	Foam level 4-20 mA output -
11	Liquid Control B normally closed contact	22	0V return – for earth to vessel.

DC Supply Function Blocks and Terminals



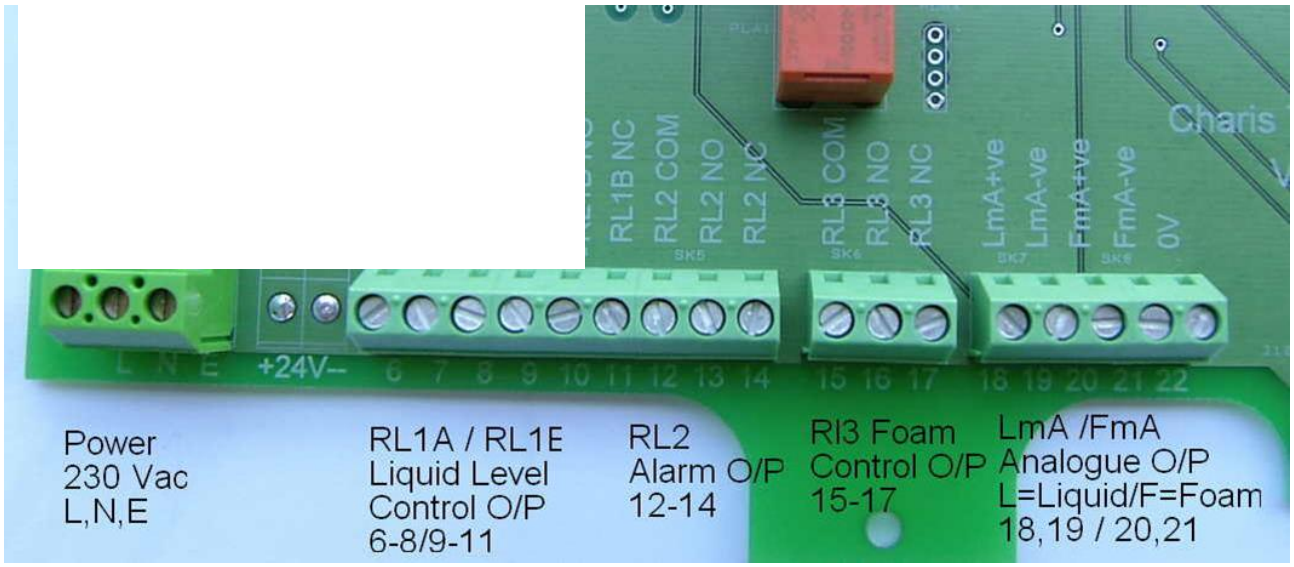
The supply cable must be suitable for the appropriate supply used e.g. 110vac or 230Vac. Please ensure that the power is connected to the correct terminals and no loose wires can make contact with any other terminals.

The sensor cable is a proprietary type which is supplied with the system. Each end is marked to show its for the controller or sensor. It can be fitted reversed but then the system will not work correctly. The sensor cable can be routed as required but should not come into contact with any hot pipework as this may cause damage. An earth cable is now provided inside the sensor cable loom connected to the body of the sensor, to provide an earth return from the vessel to the controller for the measurement. This earth cable ensures a good signal return path from the vessel but is not intended to carry fault currents, so the vessel should be bonded to earth for safety in the normal way.

The interface cabling required depends on the application. The relay outputs are volt-free and can be connected to any voltage up to 230Vac. Alternatively these can be used with d.c. voltages up to 28v if required. The rated current is 3 amps. The cable used must be suitable for the voltage and current chosen.

The 4-20 ma outputs can be used to send an analogue signal for the liquid level and foam level. These are active signals and do not require an external supply. They are not isolated, and the return is at earth potential.

Terminals for AC Supply Controllers



5 Commissioning

5.1 Introduction

Ensure that the sensor, the controller and the interface are installed correctly and that they are connected together as indicated on the schematic in section 0. Also ensure that the correct power supply has been connected i.e. 110/230Vac The controller can then be powered up. When power is first applied all the front panel lights will flash as the self-test begins. The initialisation of the module requires few minutes. The display will show the following sequence: -

Init. Stage 1…..
Init. Stage 2 ….
Init. Stage 3 …..

After which the display should revert to the control screen which will look similar to this: -

33	FoamD H
78.45	L(mm)

The exact parameters displayed may be different but these will be changed during the set-up procedures.

If the self-test does not terminate, or nothing appears or if a "fatal error" message is displayed then refer to the troubleshooting section at the end of the manual.

Setting up the system requires the following steps, which should be done in this order:

a) Sectioning	Capture of section Factors
b) Scaling the vessel	Setting the height and volume references

The sectioning process is essential for the instrument to function correctly and must not be omitted. However the scaling process is only needed if the liquid level is required to be measured by volume. The system can measure the liquid level from the bottom of the sensor in mm without this step.

The setting up is carried out by filling the vessel as explained in section 5.2 below. The same fill level can be used for both sectioning and scaling processes to save time if a known level is available close to the working volume. If this is not available it may be worth calibrating the vessel with a measuring cylinder or balance to create a calibration point. This is a tedious procedure but does result in an accurate result and only needs to be done once.

The resolution of the set-up parameters should be set to be accurate enough for the vessel being used. The only disadvantage of this is that changing the data could be slower. The parameter resolution is set in the display menu. (See 3.5.1)

After this the following may be required: -

a) Engineering	Adjust 4-20 mA ranges to suit the application
b) Parameters	Basic data relating to measurements

5.2 Sectioning (Essential Calibration)

This process captures the Section Factors in order to calibrate the function of each section in relation to its surroundings. The section factors are individual calibration factors for each of the sections, except section 1 which has a special function. It is essential and if omitted will mean the measurements will not work correctly. This enables the sensor to adapt itself to the position of the vessel wall, stirrers, baffles and other nearby metal parts. It needs to be carried out only once so that the factors can be stored in the memory of the instrument. However if the sensor is moved to another vessel or the structure of the vessel is changed, the process will have to be repeated.

To check that a sectioning process has been carried out the section factors can be displayed in the Sectioning menu. If all the section factors are set to 1000, which is the factory default, then the sectioning has not be completed.

Sectioning must be done with the vessel filled to the top of the topmost active section or above. If this is impossible for any reason it can be done with less liquid but any section factors above the liquid surface will be estimated and may not be accurate. The liquid should ideally be close to the media in normal use. However normal tap water can be used. It is best not to use de-ionised water for sectioning unless some salts are added to increase the conductivity. Ensure the contents are well mixed but turn off the stirrer during the capture process. The conductivity of the contents should be > 1mS/cm which can be displayed on the controller.

If the sectioning process fails for any reason so that the controller is not measuring volume properly the default values can be restored to get the system working again. (See 5.8 below).

The capture of the Section Factors is best carried out automatically by the controller as described below. However the factors can be entered manually if required. (See 5.8). For example if for example two identical installations are used then the set-up data can be copied from one to the other to avoid doing the same procedure twice. Section factors along with all other parameters are stored in the FEC board in the controller. If boards are swapped between controllers the data could be moved with the board.

5.3 How to Carry Out Sectioning (Capture Factors)

This process is normally only required for a new installation. Set the displayed variables *to Liquid (mm)* and *Conductivity* K to help the sectioning process. Ensure the vessel is filled to the top of the active part of the sensor which is at the top of the highest measurement section (not the top terminator) and that the displayed conductivity is >1 mS. The liquid level displayed in mm is the height from the bottom of the sensor, and should be close to the expected level.

Before entering the Sectioning Mode, make sure you have set the permission level to administrator (See 3.4.4). Then go to the sectioning menu and proceed as follows

a. Press enter then right arrow to reach the capture factors option.
b. Press enter to start the capture.
c. Display will show “capturing factors wait….” Then display the section with the liquid surface.
d. Display will then show the capture factors in turn which should all be in the expected range.
e. The display will then prompt to save or escape.
f. Press enter to save the data (or escape to quit)

At any time, this operation can be cancelled by pressing the “escape” button. None of the factors will be saved and the procedure will have to be started from the beginning.

The number of section factors will be one less than the number of active sections. (Typically 7 factors for 8 sections). These should be reviewed in the Section Factors option to check they are valid. To do this press left arrow to reach the section factors option then press enter. The display will show “wait…” and then display section factor 2. Scroll through the factors using the right and left arrow keys. The section factors should be in the range 500 – 1500 for most applications. Note that section factor 1 does not exist.

5.4 Scaling the Vessel (Volume Calibration)

The system measures the liquid height accurately and converts this to volume by means of the vessel diameter and a calibration point. To enable accurate volume measurements the system requires the scaling information to be stored. This includes the following parameters: -

Vessel Diameter	– effective diameter of the vessel in mm
Reference volume	– a known level in litres, preferably close to the working volume
Reference height	– liquid height when filled to the reference volume, mm.

The diameter can be adjusted using the MultiSense to be accurate if the diameter is not known accurately at the outset simply enter the estimated diameter initially. The diameter can be set accurately by using the controller to measure the volume. See section 5.9 for details of how to adjust the diameter if necessary. If the process being measured is not in a vessel but an open pond for example, and the volume is not important and the measurement should be set to height. In this case the diameter is irrelevant.

5.5 How to Carry Out Scaling

Fill the vessel to a level, which is known accurately in litres. This is preferably close to the working volume but any level can be used which is within the active range of the sensor. As with the sectioning process, the conductivity should be >1mS/cm. This can be displayed on the screen as described in 3.3 above.

Before entering the Scaling menu, make sure you have set the permission level to administrator (See 3.4.4) and the filter factor to 1 (see 3.5.1). Then go to the Scaling menu and proceed as follows:-

1) Diameter

a. Press enter at Scaling menu
b. Display will show “Diameter” – press enter to display set value
c. Default value will display – press enter to change
d. “?” will appear – change data using the up and down arrow keys.
e. Press enter to update new value
f. Esc. to revert to menu

2) Reference Volume

a. Press right arrow to go to Ref. Volume Option
b. Press enter to display set value
c. Default value will display – press enter to change
d. “?” will appear – change data using the up and down arrow keys
e. Press enter to update new value
f. Display will indicate that height is being captured.
g. Esc. to return to menu
h. Press right arrow to go to review Ref. Height.
i. Press enter to display captured Ref. Height.
j. Esc. to return to menu.
k. Esc. to return to control screen.

If the reference height is not captured automatically then check that the Capture Mode parameter in the scaling menu is set to “Auto” and if not change it to “Auto”.

It is a good idea to carry out some checks by adding and/or removing known amounts of liquid, and check that the measurement responds as required. This is easier to do if the filter is set to a low value as this makes the response quicker. (See section 3.5.1) If the response in litres is not accurate it is most likely that the set diameter is not correct. If the vessel contains baffles, pipes or stirrers, the effective diameter will be slightly smaller than the actual diameter. This can be accommodated by reducing the set diameter slightly. See section 5.9 for a method to accurately set the diameter if it proves to be incorrect.

5.6 Liquid Measurement Units Height vs. Volume

The control mode for the liquid level control can be set to height or volume. This results in all the corresponding parameters and secondary units changing. In the Volume mode the Reference height, Reference volume and diameter are used to calculate the volume. In the Height mode the reference volume and height have no use and are set to zero. However these values are stored and will reset if the mode is returned to volume.

In some applications volume is the sensible choice for example in a self-contained and closed tank. However in some applications volume has no meaning, for example in a river or flume, and height is more meaningful.
The table below shows the recommended resolution for the volume mode. It is possible to set the resolution to be too high and therefore see changes that may not be significant.

Maximum volume capacity of the vessel	Advised Resolution
0 – 10 L	0.001
10 – 100 L	0.01
100 – 1000 L	0.1
+1000 L	1

5.6.1 Changing the Measurement Mode Height <>Volume

To change the measurement mode first set the permission to administrator by means of the password. Then follow the procedure below: -

a. Go to the Scaling menu and select by pressing enter.
b. Press the left arrow key to reach the volume/height option.
c. Press enter to select
d. Press enter to change – "?" will appear if permission is correct
e. Press up arrow key to change option
f. Press enter to update new option.
g. Esc. esc esc to return to the control screen.

5.7 Recording Set-Up Parameters

It is highly recommended to note on paper the parameters concerning the sectioning and concerning the scaling of the vessel. Indeed, in case of the replacement of the system with a newer unit, we could reset quickly the system without going through the tedious process of sectioning and scaling.

The procedure is:

a. Writing below the parameters "section factors" for each of the sections of the probe (available in the menu *Sectioning).*

Factor Name	Factor value	Factor 09		Factor 17	
Factor 02		Factor 10		Factor 18	
Factor 03		Factor 11		Factor 19	
Factor 04		Factor 12		Factor 20	
Factor 05		Factor 13		Factor 21	
Factor 06		Factor 14		Factor 22	
Factor 07		Factor 15		Factor 23	
Factor 08		Factor 16		Factor 24	

b. Writing below the following parameters available in the menu *Scaling Vessel*

Diameter (mm)	
Ref Volume	
Ref height (mm)	

5.8 Entering the Commissioning Parameters Manually

All the set-up parameters can be entered manually if required. However, this should only be done by someone who has a clear understanding of the instrument functions. The section factors and reference height are best captured automatically.

The procedure is:

a. Set the permission level to "administrator" using the admin password.
b. Set the "Capture Mode" option to "manual" (available in the menu *Scaling Vessel)*
c. Set the parameters Diameter, Ref Volume and Ref Height in the menu *Scaling Vessel*
d. Set each of the section factors in the menu Sectioning (default values =1000)
e. Set the system in "Capture Mode = auto" (available in the menu *Scaling Vessel)*

Each parameter can be changed as follows: -

g. Go to the appropriate menu option e.g. Ref height.
h. Press enter – "?" appears if manual change is permitted
i. Press down or up arrow to change data.
j. Press enter to update.
k. Display responds -wait…. then reverts to previous.
l. Press esc to exit.

It is useful to record all set-up parameters and any changes.

5.9 Manual Correction of Diameter

The diameter is the single most important parameter for volume accuracy. This can be difficult to measure conventionally and may not be strictly correct as described by the vessel drawings. Also the vessel may have hardware inside which displaces liquid e.g. stirrer shaft. The following procedure can be used to correct the set diameter to be equal to the effective diameter. It can also be used if the vessel is not circular in section.

Fill the vessel to a fixed volume using a liquid with a reasonable conductivity preferably >1 mS/cm. Do not use just de-ionised water. The exact volume is not important. Then remove (or add) a known volume of liquid and comparing that to the change of volume on the display. It is important that the volume of liquid is known accurately for example by using a measuring cylinder or by weighing. Then by adjusting the diameter until the new volume shows the same exact change from the initial volume as the amount of liquid removed, the diameter will now be accurate. For example if the volume displayed is 50.4 L and then exactly 1.50 L is removed, the new volume should be 48.9 L. But if the display shows 48.7 L for example then the diameter setting must be too large.

The % error in volume change is given by:- 100 * (48.9 - 48.7) / 1.5) = 13.33 %.
Adjust diameter by ½ of the above percentage = 13.33/2 = 6.67 %.

So reduce the diameter by 6.67%. This correction can be verified by checking the display of volume which should then show 48.9. If it is still not quite correct the diameter can be adjusted slightly. The 1/2 %error is an approximation but it's a good one.

5.10 Setting-Up the 4-20 mA Output

The 4-20 ma range can be adjusted in the *Engineering* menu to give the optimum range for the application. The following adjustments are possible: -

Liquid mA min.: - This is the value in Litres or mm which corresponds to the bottom of the range i.e. 4 mA
If the controller is set to operate in volume units then this parameter will be in L.
If the controller is set to operate in height units then this parameter will be in mm.

Liquid mA max.: - This is the value in litres or mm that corresponds to the top of the mA range i.e. 20mA.
The value will be in L or mm depending on the volume/height selection.

Liquid mA range: - Sets the mA range as 0-20 or 4-20 as required.

Offset mA range: - Adjustment for the minimum to enable accurate 0.00 to be set or 4.00.
This can also be used to manually adjust the mA output for testing and to accommodate a scale change between the controller and a process computer. The value here is mA. Adjust up or down.

Note that the mA output is active and not isolated and the negative side of the signal is at ground potential. This means that the voltage to drive the signal is supplied in the controller and it does not need an external voltage supply. Take care that the output is not connected to an external 24Vdc supply as this could cause an excessive fault current to flow. The maximum resistance the output can drive is 500 ohms.

6 Level Control

6.1 Measurements and Control Outputs

The MultiSense controller has a number of outputs which can be used to indicate measurements and to generate feedback to control a process. These include the analogue outputs and on/off contacts for switching purposes. Some or all of these outputs can be used to control a process or to retransmit a measurement. In many applications customer connect the analogue outputs (4-20mA) to a process controller which in turn then generates feedback to control the process. The switched outputs can be used instead or in addition to the analogue outputs to controls pumps, valves or other devices to affect the process. A common approach is to use the analogues to capture levels and to use the foam relay output to control an antifoam addition when the foam level exceeds a set point.

6.2 Controlling Liquid Level

The liquid level can be monitored using the liquid 4-20mA output and controlled via a process controller if required.

A liquid level can also be controlled in a process by means of the two set points provided and a pump, which can be connected externally via relay 1. The set points can be adjusted individually and used to start and stop a pump at two levels. The output consists of two sets of volt-free change over contacts which can be connected to a valve or pump. The level is typically controlled between the two set points. One possible scheme is to turn on a fill pump when the liquid level falls below the low SP and turn off the pump when the liquid is above the high SP. However the logic can be reversed if a pump is used to reduce the level by using the LPump mode feature set to "Auto Inverse" as described below. The two sets of contacts operate together but are isolated from each other so that different voltages can be used.

When the liquid pump is on, the yellow indicator on the front panel is lit. There is a delay time provided which can be set in the *Delay time* function to enable a delay between operations. This is helpful if the set points are close to prevent the pump from 'hunting' – i.e. rapidly switching on and off. The value is set in seconds.

To use the liquid level control outputs the *Lpump mode* function in the liquid control menu should be set to *Auto Direct or Auto Inverse* to enable Relay 1 outputs and the yellow Led.

The LPump mode has the following actions:

- LPump mode = "on" - pump is always on. (useful for testing or priming)
- LPump mode = "off" - pump is always off. (always set after power up)
- LPump mode = "Auto Direct" – output activates when the level is low compared to the set points.
- LPump mode = "Auto Inverse" – output when the output is high compared to the set points.

Please note that at power- up the LPump mode is always set to off. This is a safety feature to prevent power fluctuations from causing the pump to run unexpectedly.

The liquid level can be expressed in terms of height in mm, or as volume in litres. This is set in the *Scaling* menu as the rightmost function – volume/height. If this function is set to volume all the liquid level controls work in terms of litres. This includes the set points and the alarm. If it is set to height all the parameters then operate in mm. *If this function is changed it will be necessary to change the set points and alarm level settings as the figures will not automatically convert from one unit to the other.*

6.3 Liquid Level Alarm

The liquid level alarm can be used as a safety or a control feature. The high and low level alarms cause the alarm output contacts to operate (Relay 2) and the red front panel indicator to light. The alarm output could be used for a variety of functions including additional level controls, audible or visual alarms, or safety interlocks.

When the alarm condition is triggered the red indicator comes on and a character appears in the top line of the display on the right as an indication of the type of alarm as follows:

H: - high liquid level alarm
L: - low liquid level alarm
F: - foam high alarm

The alarm resets automatically when the alarm condition is removed. Note that the foam level alarm operates the same output contacts.

The liquid level alarm can be enabled in the liquid alarm menu by means of the *LAlarm* mode function – set to "Auto" to enable. If set to "off", the liquid alarm has no effect.

6.4 Controlling Foam Level

The foam level measurement is defined in two different ways:-

- Foam Depth = the measured distance from the liquid surface to the top of the foam column.
- Foam Height = the measured distance from the bottom of the probe to the top of the foam column.

It is important to understand the difference. The foam depth does not vary if the liquid level changes. However the foam height measurement is effectively the liquid height plus the foam depth and so represents the absolute position of the top of the foam. Both parameters can be displayed on the screen but a choice must be made for the foam control output as to which is used. A useful approach is to set the foam control output to "foam depth" and the foam alarm output to "foam height" which gives the best of both measurements.

The foam level control is similar to the liquid level but there is only one set point. This is effectively a high set point and operates when the foam level exceeds the set value and activates Relay 3. However there is a dosing function , which can be used to regulate the operation of an antifoam pump, or a valve by a delay and shot algorithm. Alternatively it could be used to interface with a process controller to regulate the process variables such an agitator speed or gas flow rate.

To use the Foam level control outputs the *FPump mode* function in the foam control menu should be set to *Auto*.

The *FPump mode* has the following actions:

- FPump mode = "on" - pump is always on. (useful for testing or priming)
- FPump mode = "off" - pump is always off.
- FPump mode = "Auto" – pump is controlled by level in relation to the set point.

The *FPump AutoMode* has the following functions:

- FPump AutoMode = Depth (mm) - foam control output (Relay3) is activated by foam depth.
- FPump AutoMode = Height (mm) – foam control output is activated by foam height.

The dosing function is defined as follows:

Delay time: - time after the foam exceeds the set point before the pump starts to operate. This avoids splashing from activating the antifoam pump.

Shot time: - on time of the pump.

Waiting time: - off time of pump, i.e. time between shots.

6.5 Foam Alarm

The foam alarm operates in a similar way to the liquid alarm but has only a high level. The foam alarm shares the same contacts with the liquid alarm. If both liquid and foam alarms are set to operate, then any alarm will cause the alarm contacts to switch. The foam alarm can be set to action on either depth or height of foam. To enable the foam alarm the *FAlarm mode* should be set to "Auto". The foam alarm can be used as a control mechanism if the liquid alarm is off.

The *FAlarm mode* has the following actions:

- FAlarm mode = "off" - alarm is always off.
- FAlarm mode = "Auto" – contacts are controlled by foam level in relation to the Alarm set point.

The *FAlarm AutoMode* has the following functions:

- FAlarm AutoMode = Depth (mm) - Alarm output (Relay2) is activated by foam depth
- FAlarm AutoMode = Height (mm) – Alarm output is activated by foam height

The advantage of using the foam alarm as a control mechanism is that it allows the control of foam on both depth and height. For example if the foam level output is set to depth control, and the foam alarm is set to height then two different actions can be taken in two conditions. The alarm set to height could be used to start a fast antifoam pump or to shut down a process, for example, if the foam reaches a critical level in the vessel.

7 Troubleshooting

Symptoms	Possible Causes
Display does not respond at power up	If the unit is new this is most likely due to a board being shaken loose during transit. Power down and remove the 4 screws holding the front aluminium panel. Then push all the boards firmly back into the controller to ensure a good connection. Then replace the front panel and power up.
Display stops at "Init. Stage 1"	Internal Comms from display module (HI) to controller board is not synchronising. If the unit is new this is most likely due to a board being shaken loose during transit. Check the boards are connected correctly as described above.
Display "sticks" at wait……	Keys pressed too fast. Press enter to return to display menu. If remote display used, comms cable connection faulty.
Liquid is present but is not sensed by the system.	1. check sensor is connected to controller 2. Check the earth is connected between the sensor fitting and the tank. 3. Check the cable is not reversed. The end for the sensor is marked "sensor". 4. if pure water is in the vessel it could be the Threshold residual value is too high – see section 3.5.10
"Fatal error" message and flashing yellow Led	The controller has found an incorrect no of "Expander" channels to match the sensor configuration. 1. An expander board may not be connecting correctly. Open the controller and check the boards as described above. 2. Check the factory set up details. 3. Cycle power to reset warning message.
Changes in volume not accurate.	Diameter setting could be incorrect. This can be corrected by adding or removing a known volume and adjusting the diameter until the display reads the correct change.
Controller indicates a level when the vessel is empty.	Residual Threshold value is too low. See parameters menu. The residual value should be larger than the largest section data (see diagnostics menu) when the vessel is empty.
Display shows foam when there is no foam and the liquid level shown is too low.	1. The section factors are not correct. The sectioning process should be carried out or repeated.
Display shows foam when there is no foam and the liquid level shown is about right.	1. The foam sensitivity is too high. Reduce the Foam % Min value in the Parameters menu.
Foam is present but is not sensed by the system.	The foam sensitivity is too low. Increase the Foam % Min value in the Parameters menu.

8 Definitions of Terms Used

TERM	DEFINITION
Foam Depth	the thickness of the foam blanket as measured from the liquid surface to the top of the foam in mm.
Foam Height	the distance from the bottom of the sensor to the top of the foam in mm.
Liquid Height (mm)	the distance from the bottom of the probe to the liquid surface in mm
Liquid Volume (L)	the volume of liquid in litres which can be calibrated for the vessel in use
Section Factors	individual calibration factors for each section in the probe which must be set for the measurement to work correctly.
Capture Factors	the procedure in which the controller measures and stores the section factors required to calibrate the probe sections.
H.I.	Human Interface – the screen and keypad mounted usually on the front panel which the operator uses to set parameters in the controller.
FEC	Front End Controller – the control board inside the controller which carries out measurement and control functions and communicates with the HI.