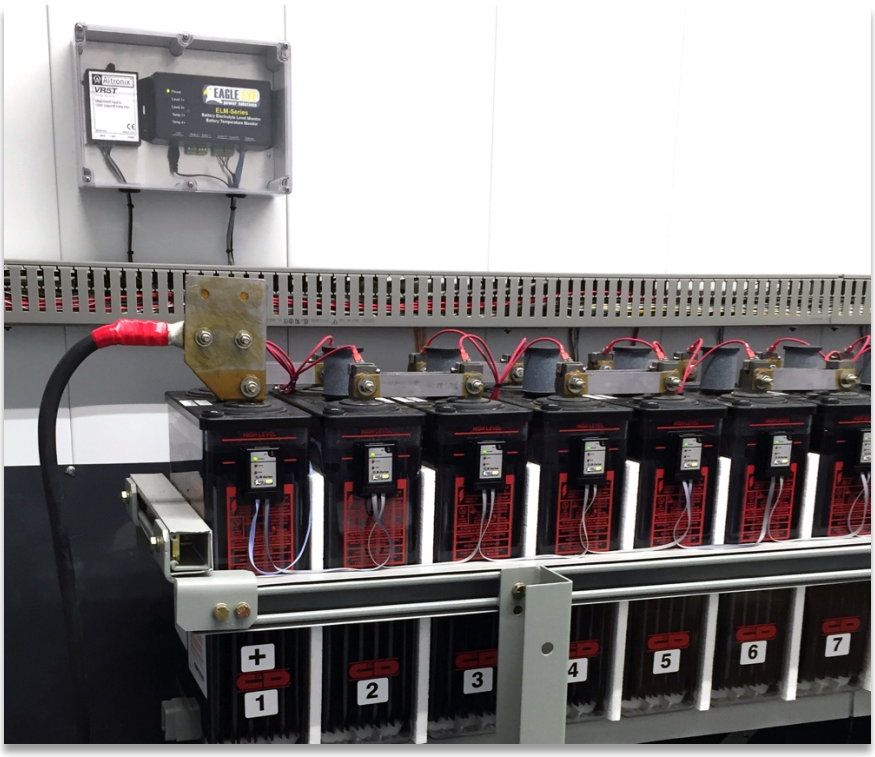
ELM-Series

Battery Electrolyte Level Sensing System

Installation Manual, Revised 7/13/20



Note 1: This manual applies to the ELM-Series as a standalone system or when supplied with a BQMS. If provided with the Vigilant solution, refer to the Vigilant Installation manual.

Note 2: All instructions and information in red text are extremely important and should be followed implicitly for a problem-free installation.

Note 3: Sections 2.3, 2.4 & 2.5 must be read carefully before proceeding to install the system.

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1.0 The Monitor

ELM-Series Monitor

1.1 System Description

The ELM system consists of a monitor and a number of sensors. The sensors are attached to the battery cells (jars), one per cell; the monitor supplies the power for the sensors and monitors the system in real-time for sensors in an alarm condition, responding in a few milliseconds to a change of state in any sensor. Volt-free relay outputs for both electrolyte level and temperature alarm conditions are provided. The sensors are connected to the monitor and each other by 'daisy-chained' four-way ribbon cables, terminated in IDC (Insulation Displacement Connectors). These connectors are extremely easy to assemble, and may be provided in short (12") pre-terminated lengths or, if longer lengths are required, made up on-site.

As described in (1.2) 'Inputs and Outputs', various alarm indications are provided by LEDs, and output relays provide volt-free alarm outputs for various conditions.

1.2 Monitor Inputs & Outputs

The new ELM monitor is interchangeable with previous versions with respect to alarm signals, sensors and input DC voltage.

1.2.1 LED Indications:

- Power supply available (Green)
- 1+ Electrolyte level sensors in alarm
- 4+ Electrolyte level sensors in alarm
- 1+ Temperature sensors in alarm
- 4+ Temperature sensors in alarm

Note: the indicator LEDs may perform additional functions, as described in (1.3)

1.2.2 External Connections:

- 12VDC input supply from the standard mains adapter
- 12VDC input supply via two way plug
- Temperature warning for four or more sensors (3 way)
- Temperature warning for one or more sensors (3 way)
- Low level warning for one or more sensors (3 way)
- Low level warning for four or more sensors (3 way)
- ELM sensor connection into the monitor (In)
- Return connection to the monitor from the ELM sensors (Rtn)

Monitor Connections

Additional features:

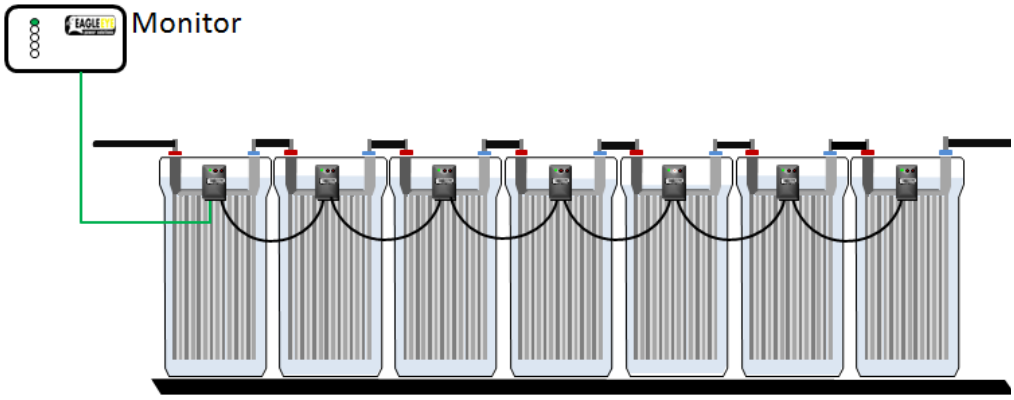
- Reset button to remove all warnings following electrolyte adjustment.
- Slide switch L –S to select loop or single string sensor operation

1.3 Connecting the Sensors to the Monitor

The monitor has been designed to accept one of two options for connecting to the ELM sensors: either a full loop or a single connection back to the monitor. The full loop should be used for systems with 24 or more sensors.

1.3.1 Connection Option 1 – Single Return:

The system connection is a single open-ended string connection to the monitor.
The sensors are daisy chained with no loop return to the monitor. The single connection to the monitor should be connected to “In” (7) with the “Rtn” (8) not being used.



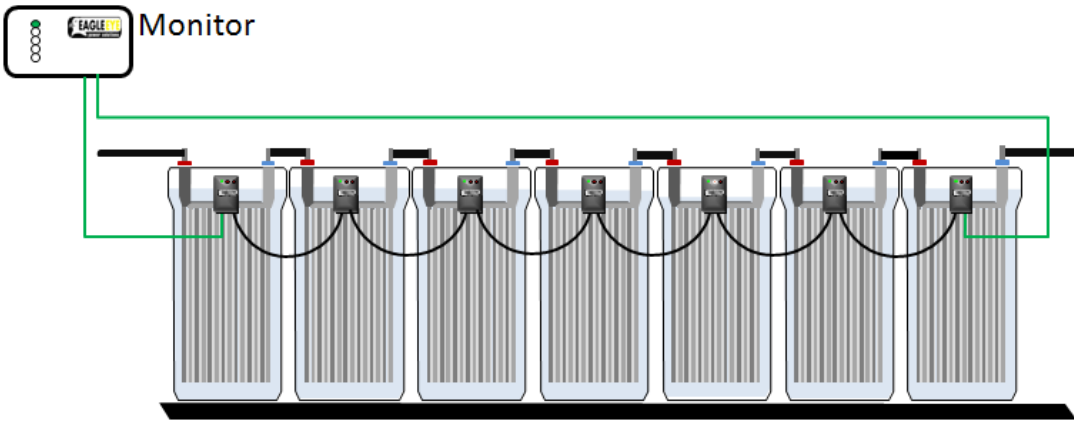
Option 1: Single Ended Connection

With this string connection the slider switch “L – S” (10) on the monitor should be switched to the “S” position (right hand side). In this mode breaks in the cable/bad connections will not result in an alarm.

Note: Using a single return for systems with more than 24 cells may result in voltage drop across the system which can cause erroneous alarms.

1.3.2 Connection Option 2 – Loop Connection:

The second option is a closed loop connection of the sensors starting at “In” and returning to the monitor at “Rtn”.



Option 2: Loop Connection

With this option there are two further options.

a. **Option 2.1** – The slider switch “L –S” in the “S” position will allow the system to work normally with one broken connection between sensors or a missing sensor cable. This option does not give a warning of a break in the cable.

b. **Option 2.2** – If the slider switch “L – S” is in the “L” position the unit will give an indication and an output warning of a break in the sensor wiring.

1.3.3 The Warning Signals for Option 2.2 are as Follows:

1. A broken connection in the wire for the **level** sensing will illuminate “**Level 4+**” LED on the monitor and connect C to FT on the Level 4+ warning relay. During a “true” Level 4+ indication the Level 1+ would also be activated.

2. A broken connection in the wire for the **temperature** sensing will illuminate “**Temp 4+**” LED on the monitor and connect C to FT on the Temp 4+ warning relay. During a “true” Temp 4+ indication the Temp 1+ would also be activated.

3. A broken connection in the positive, negative, both or missing cable will result in both “Level 4+” and “Temp 4+” LED’s illuminated on the monitor along with activation of the corresponding relay outputs.

NOTE: Both “Level 4+” and “Temp 4+” LED’s illuminated could also mean that both level and temperature wires are broken but for this condition the green LED (No Fault) will be illuminated on all sensors.

1.4 Detecting a break in the wiring: LED indications

1. Both “Level 4+” and “Temp 4+” LED’s illuminated on the monitor (not “Level 1+” and “Temp 1+”) indicates a break in the supply to the sensors. The supplies travel from the monitor “In” connector to the

"Rtn" so sensors starting at the "In" will be illuminated up to the broken wire and sensors from the break to the "Rtn" will show no indication of power.

2. "Level 4+" LED (only) illuminated indicates that there is a break in a level sense wire. Starting at the sensor closest to the "In" connection press the sensor R/S button and hold in for two seconds to put it into the test mode. Both LED's will light up on the sensor and also the "Level 1+" LED on the monitor if there is a connection. Move down the line of sensors repeating the operation until the LED "Level 1+" on the monitor fails to illuminate, the break is between this sensor and the previous one tested.

3. "Temp 4+" LED (only) illuminated indicates that there is a break in a temperature sense wire. Fault finding is the same procedure as (2) but with the temperature LED's.

1.5 Warning Relay Outputs

The operation of the output relays have been changed slightly from the MK1 monitor but the action of the fault warning is **unchanged** i.e. a fault is indicated by connection of "C" contact to the "FT" contact. **An input power fail will now only be indicated by the "Temp 4+" output and not the other outputs.**

This operation conflicts with a break in the temperature wiring but obviously with a power failure there will be no LED's illuminated at all.

1.6 Monitor Reset Button - Function

The purpose of this button is to reset all the sensors after topping up the battery with acid following a low level alarm. Pressing this button for approximately one second will illuminate all the LED's on the monitor and extinguish all LED's on the sensors.

After using this reset button the sensors will give a correct reading after approximately 40 minutes (standard version) or 90 minutes (extended version). There is no requirement to press any reset buttons if there was no alarm active before top up.

1.7 Monitor Power Requirements

The monitor has the same requirements as the MK1 with the exception of an extra two pin plug (2).

If the 12V mains adapter supplied with the monitor is not suitable then an alternative 12VDC supply may be used by using the two pin plug (2) and observing the correct polarity.

The basic specification for the supply output is:

Voltage	12V ±5%
Max. current	1A
Max. power	12W

2.0 The Sensor

2.1 Introduction

The sensor is a patented non-intrusive transducer designed to detect the level of electrolyte within the transparent container of a flooded battery cell, assisting in the prevention of low electrolyte and dry-out conditions.

The sensor will also monitor battery case temperature and report any temperature above the programmed value, to assist in the detection of thermal runaway conditions.

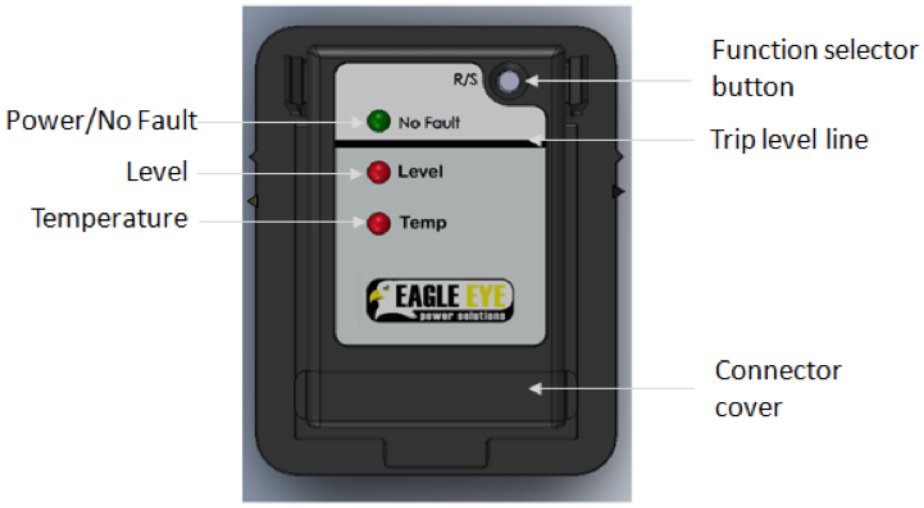
The sensor is designed such that minimal adjustments are required; it may be attached to the cell and will begin to monitor the electrolyte level and temperature automatically as soon as power is applied. No further adjustments are necessary; however there are some service checks and alternative temperature settings if the application has special requirements.

The sensor receives power from, and reports to, a remote monitor via a four-way ribbon cable. The cable is daisy-chained from one sensor to the next, terminating at the monitor.
The sensor body is clipped into a cradle, which is attached to the outside of the battery container by double-sided tape. In the event of the cell having to be removed the sensor may be unclipped and re-used with another cradle. The sensor in its cradle may be seen below.

The ELM Sensor

2.2 Functions & Indications

The ELM-sensor has several LED indications and functions, as set out below:



2.2.1 Power/fault LED:

This green LED is lit when the power is on and there is no fault present. The power LED also has the function of indicating selections of temperature and service/test sampling

2.2.2 Level LED:

This red LED is lit when the level of electrolyte has fallen below the minimum level

2.2.3 Temperature:

This red LED is lit when the set temperature is exceeded

2.2.4 Trip Level Line:

When the electrolyte level falls below this line the level alarm is triggered. The line is for general indication only and should not be used to position the sensor. On alarm the red level LED will light and a signal is sent to the monitor

2.2.5 The Connector Cover:

Can be released and the connections accessed by pressing on both ends, compressing the cover longitudinally, and lifting off

2.2.6 The Selector Button:

Has several functions, as described under the heading **'ELM Sensor Operation'.**

2.3 Installation

2.3.1 Cleaning the Jars for Maximum Adhesion of the Sensor

! MOST IMPORTANT !

Although most flooded battery jars look quite clean when they are delivered, they are actually covered with various chemicals. There are slip agents for release from the plastic moulds, ink and detritus from screen printing the manufacturer's information, or release agent and chemicals on any labels which contain manufacturer's information, and all this doesn't take into account any dirt from transport, etc.

Since the slip (release) agents used on the jars and labels are designed to prevent the jar or label adhering to anything, it is therefore **essential** that the area in which the ELM unit is to be mounted is **thoroughly cleaned.**

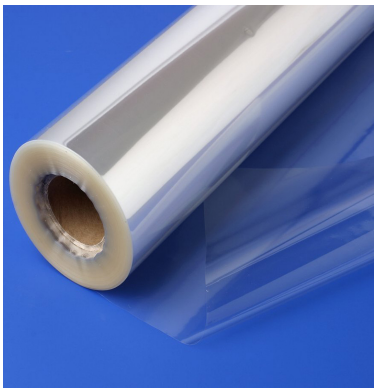
Eagle Eye Power Solutions recommends CRC PF Precision Cleaner, P/N: 03190 (US), for use on the jars and labels.

This fluid has been extensively tested and is warranted effective, and free from any possibility of damage to the plastic of the jars and labels. If other cleaning agents, such as Isopropyl alcohol are used special care must be taken to ensure the contaminants are thoroughly removed.

The second (buffing) cloth should be inspected to ensure it is free of any remaining residue

It has been proven on many different types of jars and labels that the tape adhesive used by the ELM unit is extremely strong and provides an excellent high strength adhesive bond to the jar/label. The only time the adhesion of the module to the jars has been found to be less than perfect is when the jar or label has not been properly cleaned.
Note: Some cells or jars have printed labels attached with the manufacturers name and details of the cell, such as the rating of the cell and the maximum & minimum electrolyte levels. These labels can be difficult to identify, so care must be taken to ensure that there is in fact a label in place.

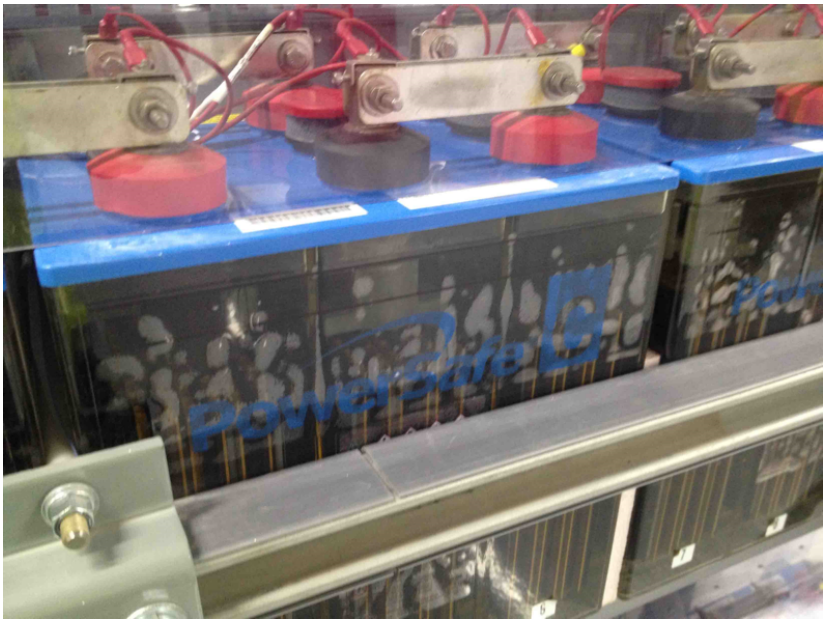
The during manufacture, the labels are serially printed in a continuous roll and an adhesive applied to one side; in order to prevent the roll sticking to itself there is a release or 'slip' agent applied to the other side.



In order for the ELM cradle to adhere successfully to the label, this release agent MUST be cleaned off.

The cleaning agent recommended is very effective for this purpose, however it is important to allow The cleaner to dry thoroughly before sticking the ELM in position.
LABELS

As mentioned above, some jar sides are covered with manufacturer's labels. It is normally perfectly fine to attach the sensor to these labels, provided they are properly cleaned. However some labels have been attached to the jars in a slipshod manner, such that they have air bubbles under the plastic label:

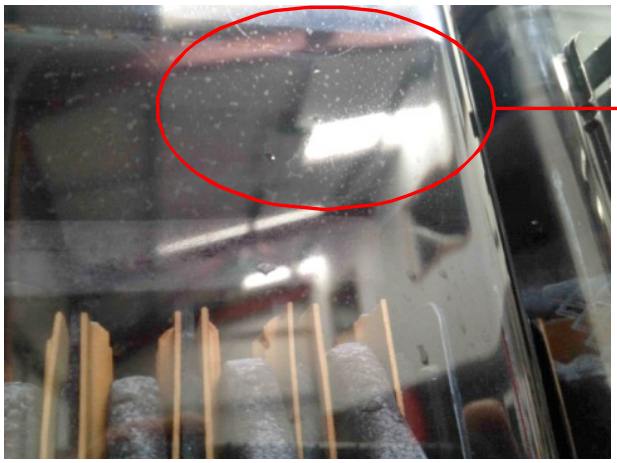


It would not be possible to fit the ELM sensor to a label with any air pockets. If the label has air pockets, the section of the label which would be under the sensor and cradle must be removed and the area cleaned particularly well.

Procedure for Cleaning the Jars:

1. A small amount of cleaner should be sprayed on to either the cell or label and then rubbed vigorously with a clean soft dry cloth, to remove any release agents or chemical contaminants.

   At this stage the jar may look clean, however there is likely to be a deposit remaining, even after wiping. The jar in the photograph below was cleaned with isopropyl alcohol and thoroughly wiped dry.



2. A second clean dry cloth should then be used to vigorously Buff (polish) the area.

Note: EEPS recommends Scott shop cloths, or similar

Below is an example of a clean cloth after buffing a previously cleaned jar. It is important that the jar is polished and that the polishing cloth used is changed every two or three jars.

Battery units on which the cradle is attached directly to the surface of the unit, may be wiped with isopropyl alcohol and then buffed with a dry cloth to ensure that the area is dry and clean. However, it has been found that the isopropyl alcohol can react with any silk screen printing in the area that is being cleaned, and that this can create a surface film which will prevent the cradle from being firmly attached. To ensure that any contamination caused by the potential ink/alcohol reaction is completely removed before attaching the cradle, the surface should be buffed a second time with a clean cloth and the surface of the cloth checked to ensure it is not soiled by any remaining residue.

IMPORTANT!

Please read this section before proceeding with any installation; to avoid problems it is important that the sensor is positioned correctly.

The user must ensure that there are no marks, lines or text obscuring the electrolyte in front of the sensor. Therefore, the sensor has two ‘pip’ indicators on each side of the cradle; these are for ensuring the correct positioning of the sensor relative to the minimum electrolyte level line

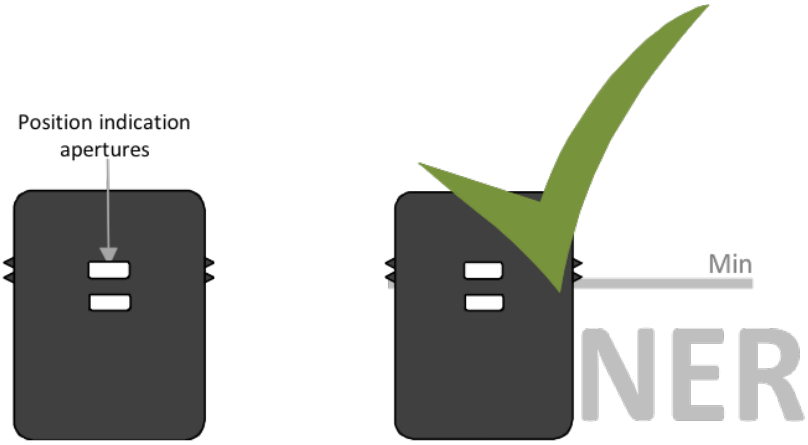
A positioning location device is provided with every system to ensure the optimum position for the sensors. It has vision apertures in the base. The cradle should be used for fitting the ELM sensors wherever possible, to allow the sensor to be easily removed and refitted if the cell requires a change-out. Should it be necessary to fit the sensor directly to the cell the cradle should still be used for positioning.

<u>It is important for the operation of the sensor that the apertures are not obscured by text when siting the sensor on the battery enclosure.</u>

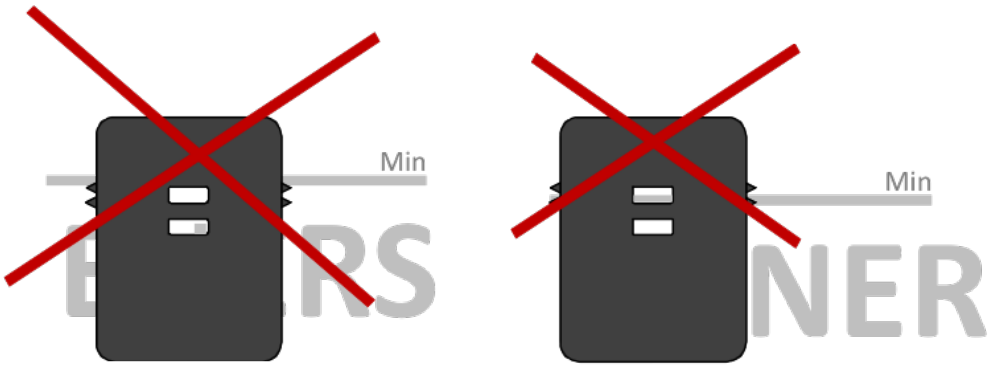
The cell surface must be clean and free of dust and acid residue before fitting the cradle in position. See the previous section 'Cleaning the cell'.

Whichever mounting option is chosen, the position indication aperture should be positioned in the same way, with no text or other means obscuring the vision window.

2.3.2 Cradle Mounting



The patented detection system employs twin sensors to ensure totally reliable operation; these sensors are located in the sensor enclosure within the top and bottom locating windows. It is important that these positions are not obscured.



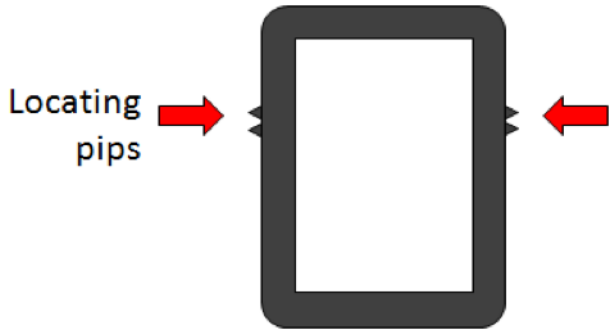
It is possible however to position the electrolyte minimum line on the cell/jar in the center of the apertures, providing it does not appear at all in the areas of the top and bottom windows.

2.3.2 Enclosure Mounting

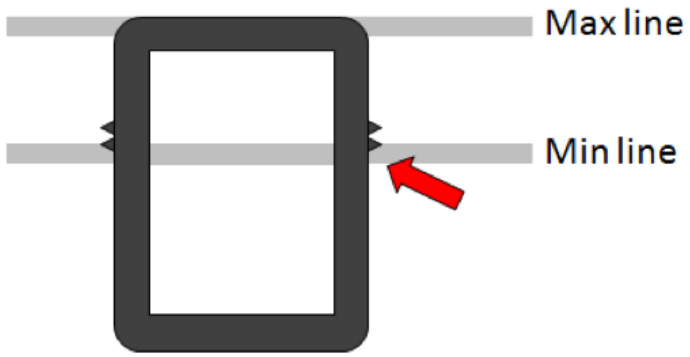
The same rules must be followed when using the enclosure without the frame.

2.3.3 Positioning for Alarm Level

The sensor cradle has four locating pips, two on each side, one above the other, spaced 3/16” (4mm) apart.

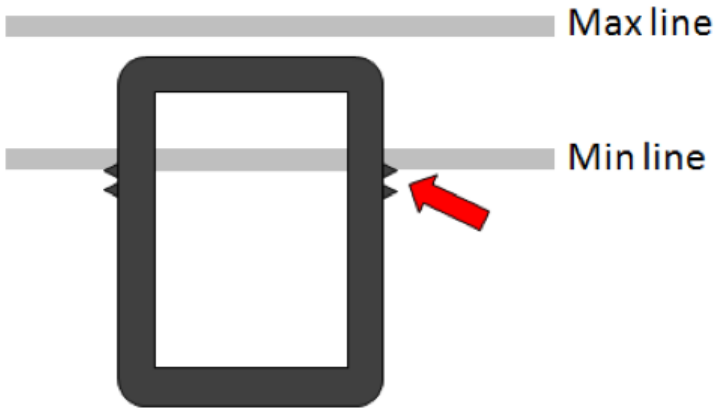


FOR AN ALARM LEVEL ABOVE THE MINIMUM LINE



Aligning the lower pips with the top of the electrolyte minimum line as marked on the cell/jar will set the alarm level to 1/16” (1-2mm) above the minimum line

FOR AN ALARM LEVEL BELOW THE MINIMUM LINE



Aligning the upper pips with the bottom of the electrolyte minimum line as marked on the cell/jar will set the alarm level to 1/16” (1-2mm) below the minimum line

Once the cradle position has been determined and the surface cleaned, the protective film may be removed from the double-sided tape and the cradle attached to the cell, as described above. The user should try to make the attachment as accurate as possible. The cradle should be pressed firmly in position using the thumb

and forefinger and held for several seconds to initiate the bond. The constant pressure tool (Appendix 1) may also be used. The adhesive bond will strengthen during the next 24 hours.

Note: The special double-sided tape used to attach the sensor cradle to the cell is guaranteed by the tape manufacturer not to have any harmful effect on the cell plastic. The manufacturers of the sensor have conducted practical tests over several years and no discernible effect of the tape adhesion on the battery enclosure has been observed.

The sensor may now be located in the cradle by approaching the cradle from slightly above and inserting the locating lug on the base of the sensor into the recess in the cradle, then pushing the sensor towards the cell at the top.

Once all the sensors are in position the system network may be connected, calibrating each sensor as the power is connected (2.4.1), using the cables and connectors provided. Once this has been done the sensors may be tested and the default settings adjusted, if required, as set out below.

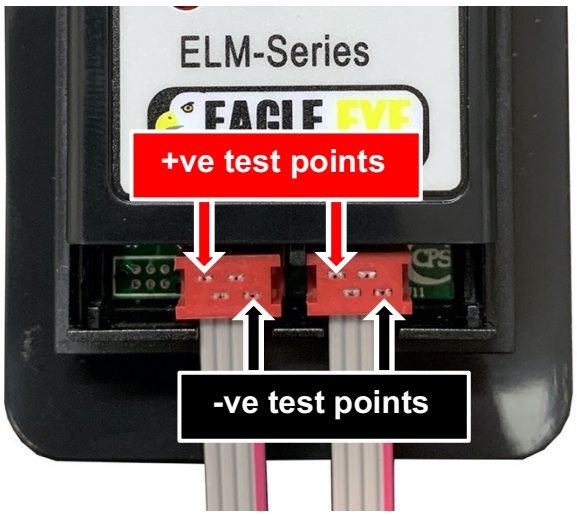
All the connection cables are point to point, i.e. no reversed connections.

2.4 General Operation

When a sensor is powered on, the green 'No Fault' LED will light up and flash for 5 seconds (standard version), or 10 seconds (extended version).

2.4.1 Sensor Power Requirements

Each sensor has a minimum working voltage of 5.5 volts. If the supplied voltage is lower than this, the sensor may lose power or show erroneous alarms. To test the supplied voltage at the sensor, use a voltmeter to check the points shown below:



For most installations, voltage supply should not be an issue when the return loop connection is established. If voltage drop is still an issue, refer to Appendix 2 for information on voltage boosters.

2.4.2 Calibration

Once the unit is firmly in position the unit **must be calibrated** to take account of the various conditions in the battery environment.

Calibration: While the green LED is flashing press and hold the programming button for 2 seconds; the green LED will stop flashing and after a further 10 seconds the unit will carry out an automatic calibration process.

On completion of calibration the sensor will automatically carry out a level measurement to check its functionality and then begin its normal monitoring process.

Should it be required to repeat the calibration process for any reason, the power may be removed from the sensor; when the power is reconnected, the sensor will begin start-up again and the green LED will flash as before.

NB: If the system is connected in a loop, the power must be removed from both sides.
Alternatively, the reset (R/S) button on the monitor may be pressed between each sensor calibration, this will momentarily remove the power from the system and restart the desired sensor. **This operation is best**

carried out with two people, one resetting the monitor and the other at the chosen sensor, since the sensor button must be pressed while the green LED is still flashing on start-up.

The power **must not** be removed from a sensor, or the monitor reset button pressed, while a sensor is in the calibration process. At least 30 seconds must be allowed from pressing the sensor button to start the calibration process and the removal of power/pressing the monitor rest button to energise the next sensor.

Electrolyte level: In order to avoid spurious alarms when monitoring the electrolyte level, the sensor is designed to make repeated measurements over a period of approximately 40 minutes (standard version) or 90 minutes (extended version) from the time a low electrolyte level is first detected. If the low electrolyte level persists beyond this period the sensor will initiate an alarm. When an alarm is initiated the red 'Level' LED on the sensor will illuminate and the green LED will go out.

Temperature: Should the temperature rise above the selected alarm level the sensor will initiate an alarm immediately. When an alarm is initiated the red 'Temperature' LED on the sensor will light up and the green LED will go out.

Should the level alarm LED be 'on', the green 'No Fault' LED will go out.

2.5 Operation & Settings

2.5.1 Testing the Alarm Indications & Sensor/Monitor Continuity

After the sensor has powered up and begun monitoring the electrolyte level and temperature the user may wish to check the alarm signals and the continuity of the system wiring to the monitor.

To test the alarm indications on the individual sensor and the monitor, ***press the selector button and hold for two seconds;*** the power indication will change state when the button is pressed and the button should now be released. After two seconds all three LEDs (low level, temperature and power) will be enabled.

Also, at the monitor, the 1+ Low Level and 1+ temperature alarm LEDs will light up. If one or both the LED's on the monitor do not light up then there is a bad connection between that sensor and the monitor

This mode can be exited with a further single press of the selector button, OR, after 10 seconds the sensor will automatically exit this mode and return to normal operation.

Testing the Alarm Indications

2.5.2 Electrolyte Level Check

This service test circumvents the 40/90 minute elapsed time for the detection of a low electrolyte level. A level test is done immediately (taking 2-3 seconds) and the result is indicated by the 'Level' LED.

Press the selector button once, briefly.
The green 'No Fault' LED will FLASH for 2 seconds indicating a measurement is being performed. If the level is good (in excess of minimum) the sensor will return to normal operation. If the level is low (on or below minimum) the 'Level' LED will remain on and an alarm will be indicated at the monitor.

2.5.3 After Topping Off the Electrolyte

If the sensor detects a low electrolyte level condition it will signal the monitor and illuminate the 'Level' LED. The electrolyte should be topped up to the maximum line on the cell immediately, or according to the user's procedures.

Once it has detected a low electrolyte level the sensor will not detect the cell has been topped up without being reset, therefore

When the electrolyte has been topped up, the sensor selector button should be pressed briefly, once.

The sensor will carry out a measurement; if the level is above minimum the sensor will extinguish the 'Level' LED and then automatically begin monitoring the electrolyte level again.

2.5.4 Temperature

When the sensor is dispatched from the factory it will be set to alarm above 95°F (35°C); this is the optimum setting for the detection of thermal runaway.

Should the user wish to change the temperature alarm setting the procedure is set out below.

Temperature Settings - There are three possible temperature settings, these are:

- 95°F (35°C)
- 120°F (49°C)
- 145°F (63°C)
- Temperature alarm off

2.5.5 Temperature Settings:

Note: All actions to change the temperature setting, including saving the changes, must be carried out within 30 seconds, after which the sensor will revert to normal operating mode.

Press and hold the selector button for two seconds

The sensor goes into 'Indication & continuity test mode' (as described above, 2.5.1), all the LEDs will be 'on'.

While in indication & continuity test mode:

Press and hold the selector button for four seconds

The level indicator LED will go out and the temperature LED will remain on; the green power LED will flash regularly once, twice, three or four times in succession.

- If the green power LED is flashing once, the temperature alarm level programmed is 95°F
- If the green power LED is flashing twice, the temperature alarm level programmed is 120°F
- If the green power LED is flashing three times, the temperature alarm level programmed is 145°F
- If the green power LED is flashing four times, the temperature alarm level is switched off

2.5.6 To Change the Temperature Setting

When the green power LED begins to indicate the current temperature alarm level setting, e.g. flashing once to indicate a setting of 95°F a further brief press of the button will advance the alarm setting by one. So, if the power LED is flashing once, pressing the button briefly will advance the program to setting two (120°F). Setting two can be advanced to three and so on

2.5.7 To Save the Temperature Setting

When the flashing power LED indicates the desired setting (1, 2, 3, or 4)

Press *and hold the selector button for a further 2 seconds*

The Green 'No Fault' LED will change to continuously on and the red temperature LED will go off.

The new setting is now the default condition and will be used even after power is removed from the sensor. The sensor returns to normal operation after storing the value.

If the selector button is not pressed the sensor will exit the temperature setting mode after 30 seconds and the values will not be changed. The sensor will return to normal operation and continue to operate with the last saved value. In all cases if the Low Level indicator was 'on' before going into temperature setting mode the LED will remain set to the 'on' condition after exiting the temperature setting mode.

3.0 Additional Functions

Mode	Action	Function
Power Up	**No Fault LED Flashes for 10 Seconds**	**Possible to select New Calibration**.
New Calibration	Press Button for 2 seconds Until LED stops flashing	Calibrates sensor to its current environment
Quick Measurement	Short press on button(1)	Measures and reports current status
The following actions can be performed after the calibration process is complete:		
Toggle between Lead Acid and NiCad mode	Press button for 10 seconds(2)	In Test Mode the No fault LED flashes to indicate NiCad mode.
Test Mode	Press Button for 2 Seconds(3)	All led's Light up and fault is indicated on Level and Temp.
Temp setting mode.	Press Button for 2 seconds Release button and press for a further 5 Sec.(4)	Allows change of temp setting same as before.

1) When powered up and No Fault LED is Flashing a short press on the R/S button will cancel the calibration time out and take a measurement.

2) After 2 seconds the no fault LED will toggle state. DO NOT remove finger from button keep it pressed until the Level and Temp LED's illuminate. If New mode is NiCad No Fault LED will flash, if new mode is normal no fault led will be solid on.

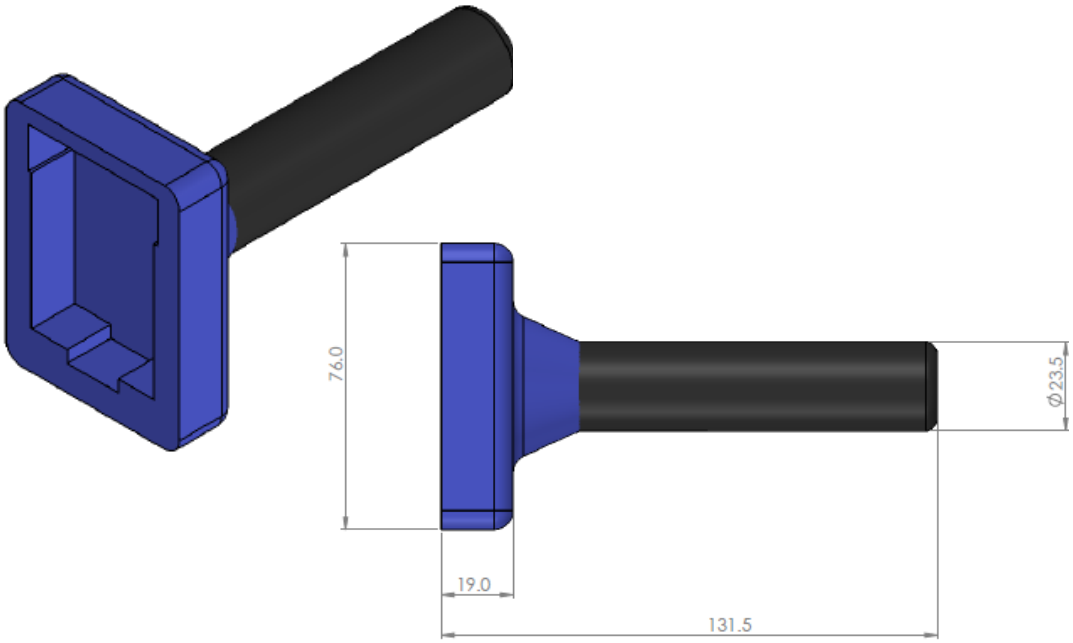
3) After 2 seconds, no fault LED will change state. Release button; Level LED and Temp Led will be illuminated. IF mode is NiCad no fault led will flash if mode is normal no fault LED will be solid on. Other operation is the same as before.

4) After 2 seconds no fault LED changes state, release button to enable test mode. Press the button for a further 5 seconds until the temp led illuminates. Operation is the same as existing manual.

APPENDIX 1: Installation Accessories

Sensor Positioning Tool:

Constant Pressure Tool:



APPENDIX 2: Voltage Booster Kit

In some instances, the full loop connection may still not provide enough voltage to all of the sensors. This may occur when very long jumpers are used or the batteries are split between several racks with longer jumpers in between cells.

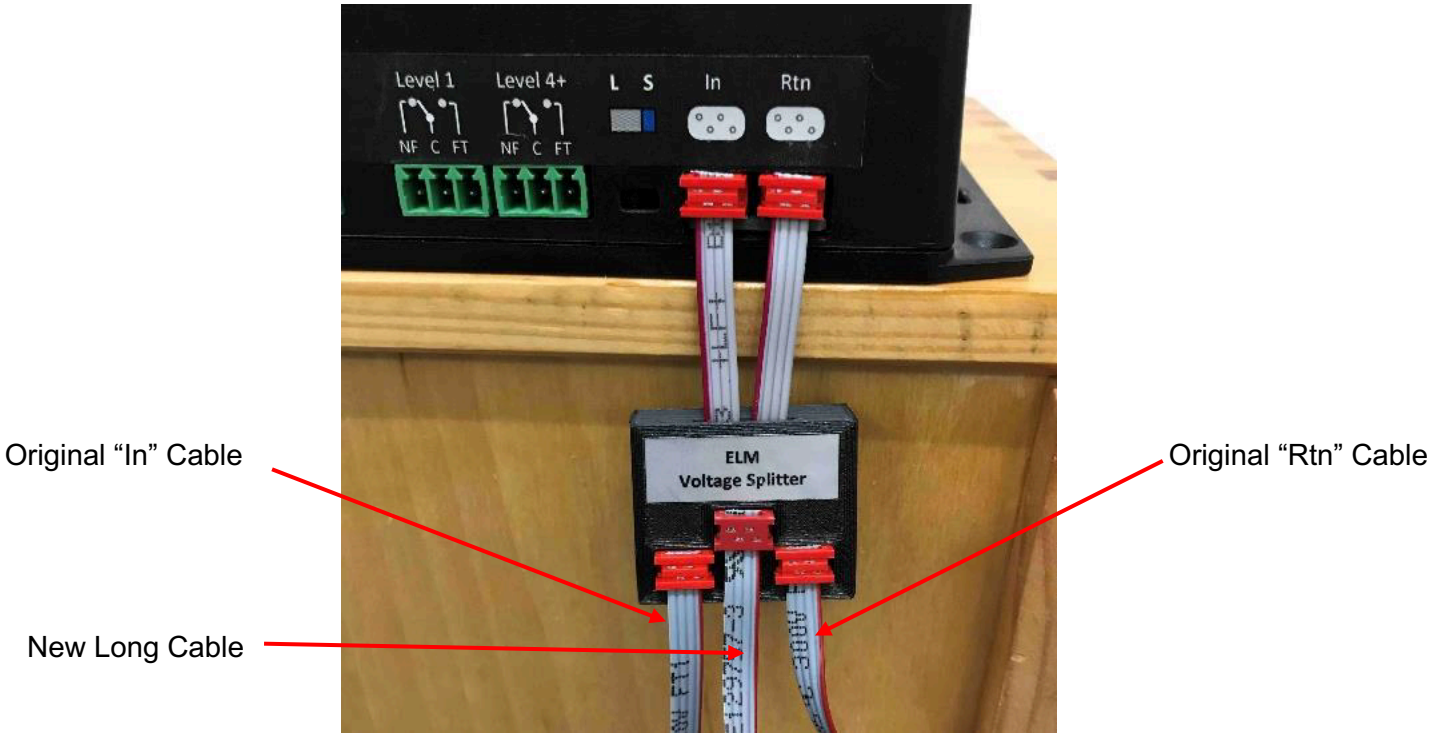
Fitting the ELM Splitter and Booster

The purpose of the ELM splitter and booster is to provide backup voltage to the mid-point of a large cell system or one that has longer wire loop connections than normal.

The “splitter” is inserted in the system at the monitor supply and the “booster” is fitted at approximately the mid-point of the cells.

Fitting the ELM Splitter:

1. Remove the “In” and “Rtn” connections from the ELM monitor.
2. The cables that have been removed from the monitor plug into the splitter as shown below.
3. Plug the cables into the ELM monitor as shown.
4. A new long cable (to reach the mid-point) is now plugged into the third (centre) socket.



Fitting the ELM Booster

1. Select the point at which the booster is to be inserted.
2. Disconnect the cable from one of the ELM sensors at the midpoint and plug into the socket on the booster board (A or B)
3. Make a cable connection from A or B to the ELM sensor that has been disconnected.
4. Plug the new long cable into the third (centre) socket.
5. Ensure that polarisation of the LONG cable is correct. The cable marker should connect to the same pin on each end (in this case the pin on the right-hand side)