MEG ARTS® Controller Operating Manual

The MEG ARTS® controller provides the control and power element for the MEG ARTS® system.

CHALLENGE ACCEPTED

Online Electronics Limited
+ 44 (0) 1224 714714
OEL-Sales@ik-worldwide.com

online-electronics.com

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Rev	**Date**	**By**	**Summary of change**
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COMMENTS:

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1. GENERAL DESCRIPTION

The Monoethylene Glycol (MEG) Analyser Real Time with Sampling (ARTS®) skid is a self-contained MEG analysis, logging and sampling system for the detection and analysis of the MEG slug used when commissioning pipelines. The Controller forms part of the MEG ARTS® system and provides date, time, density, pressure, temperature, sample control and data logging.

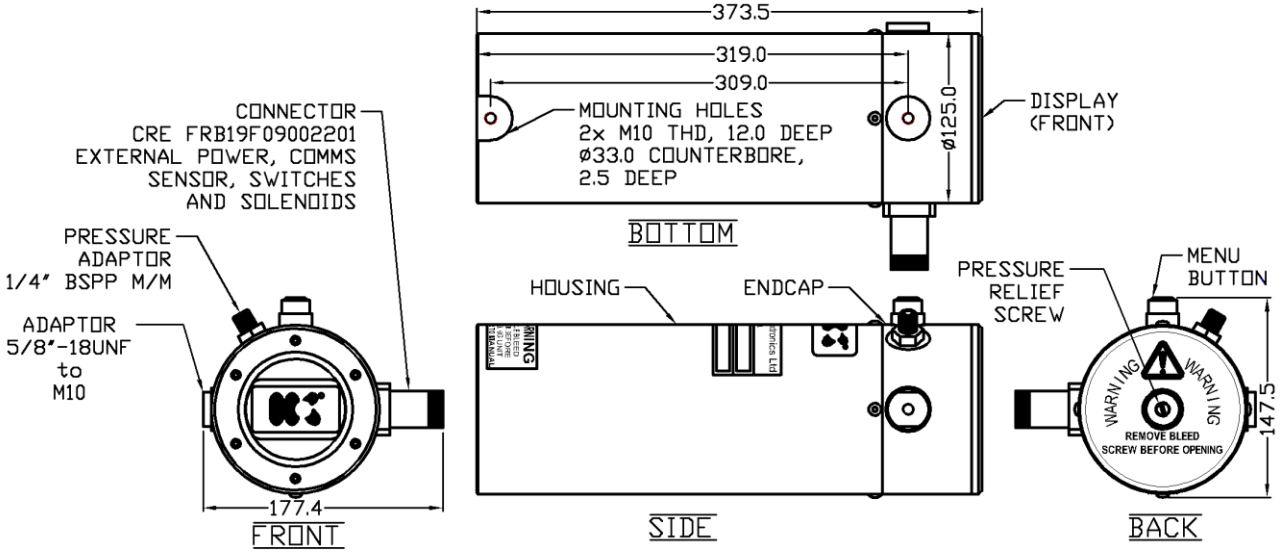

Figure 1 – Controller

MOUNTING OPTIONS: As standard, the unit is supplied with 2x 12mm deep, M10 threaded mounting holes, 309mm apart as shown in Figure 1 – Controller above.

POWER OPTIONS: The unit can be powered from an internal battery OR an external +23VDC to +28VDC supply. Note that the external power connection does not power the solenoid valves.

RS485 OPTION: The user can monitor sensor readings and configure the unit via an optional RS485 link using standard terminal software such as HyperTerminal or TeraTerm.

BATTERY LIFETIME: The system is designed to operate for a minimum of 10 days at +5°C including all 6 samples taken at the maximum sample capture time of 10 seconds.

The operating temperature at which the controller is used affects the operating lifetime. Typically, colder temperatures will shorten the battery lifetime.

Please contact Online Electronics Ltd for more details or to discuss your requirements.

2. SPECIFICATIONS

GENERAL

Minimum battery life at 5°C including sampling ..... 10 Days

Operating temperature range ..... -5°C to +30°C

Maximum operating depth 3000m

Density sensor range ..... 500-1500kg/m^3

Density sensor accuracy (and resolution) ..... ±0.5 kg/m^3 (0.1 kg/m^3 resolution)

Pressure sensor range 0-300barg

Pressure sensor accuracy (and resolution) ..... ±0.1% Full Scale (0.1 bar Resolution)

Temperature sensor range ..... 0°C to +70°C

Temperature sensor accuracy (and resolution) ..... ±1.0°C (0.1°C resolution)

Logging capacity ..... 258,000 records of Date, Time, Density, Pressure, Temperature, Status

Logging options ..... 1 second to 10 second rate, memory wrap etc

Weight in air 16.9kg

MATERIALS:

Housing material ..... Alloy Bronze CA104 EN 12163

Endcap material ..... Alloy Bronze CA104 EN 12163

Bleedscrew material ..... Alloy Bronze CA104 EN 12163

Window material ..... Acrylic

Endcap O-rings ..... 2x 50-243 NBR70 with 2x 250-243 PTFE BURs

Window O-ring 1x 50-236 NBR70

Bleedscrew O-ring 1x 50-008 NBR70

OPTIONS:

External Power (controller) ..... +23VDC to +28VDC

Data Communication ..... RS485 Half Duplex

3. OPERATION

3.1. CONTROLS

The primary method for operating the Controller is via the MENU BUTTON mounted on the top of the unit. This single button is used to activate the unit, navigate the menus and adjust the settings, see section 3.4 SINGLE BUTTON MENU INTERFACE.

In addition to the integrated MENU BUTTON, the controller is also interfaced with two external ROV operable switches as per section 3.11 EXTERNAL ROV SWITCHES. One replicates the integrated MENU BUTTON and the other is the manual SAMPLE SWITCH which can be used to manually trigger samples that have been set for manual trigger.

The controller also features an RS485 serial interface as per section 3.8 SERIAL INTERFACE which can be used to set up the controller as well as monitor the sensor readings and download logged data.

3.2. TURN ON SEQUENCE

Refer to Figure 2 - MEG ARTS® Controller Initialisation Screens on the next page.

To turn the unit on simply press and hold the MENU BUTTON until the ONLINE LOGO appears on the display and then release it, this takes approximately 5 seconds.

The ONLINE LOGO will be displayed for 5 seconds as shown by the COUNTDOWN TIMER located at the bottom left hand side of the display. A the controller BATTERY INDICATOR is shown at the bottom right hand side of the display.

When the COUNTDOWN TIMER reaches zero or the MENU BUTTON is pressed the next screen (MEG ARTS LOGO) will appear. As before, when the COUNTDOWN TIMER reaches zero or the MENU BUTTON is pressed the next screen (STATUS 1) will appear.

In between the MEG ARTS LOGO screen and the STATUS 1 screen the unit will carry out a self-check of the state of the Real Time Clock (RTC) circuitry and memory. If a problem is detected then a RAM memory error will be displayed. The most likely problem is that the RTC coin cell needs to be replaced. See section 7 MAINTENANCE.

STATUS 1 and STATUS 2 screens show the configuration of all settings.

After displaying these four screens the controller will begin taking and displaying readings from all sensors as per section 3.3 DEFAULT SCREEN.

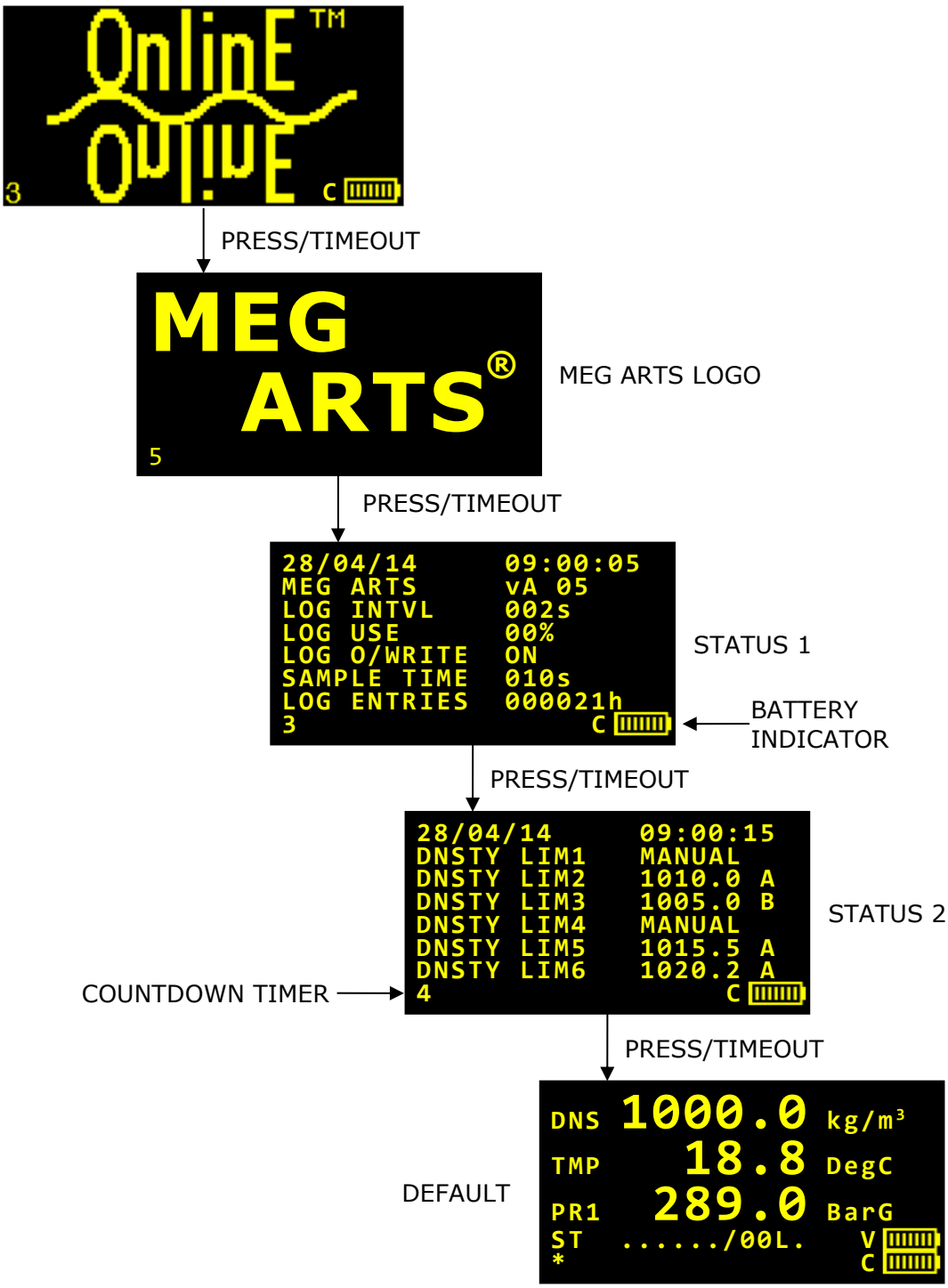

Figure 2 - MEG ARTS® Controller Initialisation Screens

3.3. DEFAULT SCREEN

The default screen provides the following information with readings updated every second. If a sensor is not working then the reading will show 'ERROR'. Serial commands will only be received by the controller when the default screen is displayed.

Figure 3 - MEG ARTS® Controller Default Screen

- DNS is the density reading from the density sensor in kg/m^3.
- TMP is the temperature reading from the density sensor in Degrees Celsius.
- PR1 is the pressure reading from the internal pressure sensor in Bar gauge. If the internal sensor fails, the manifold pressure sensor will be displayed (PR0).
- ST provides some status information:
  - **.....**: Provides sample status information as per section 3.7.1 SAMPLING OVERVIEW. Each position relates to a sample vessel. A dot shows the sample has not been taken. While a sample is being taken the dot is replaced by the sample vessel number and the letter "O" which alternate every second until the sample is complete. A steady sample number shows the sample has been taken and is complete. A flashing "E" shows that the sample has been triggered but cannot be taken.
  - **00**: Provides status information for the density sensor as per section 3.5 DENSITY ANALYSER.
  - **L**: Provides logging status information as per section 3.9.1 DATA LOG OVERVIEW. An "L" indicates that the system is configured to log data. Following the "L" is a "log taken" symbol which alternates between a "." or a "," for 1 second each time a log is taken. E.g. if the logging frequency is set to 1 second then the log taken symbol will alternate between a "." and a "," every second.
- There are two battery indicators which are representative of the controller battery level (C) and solenoid valve battery (V) battery levels, the latter is indicative when no samples are actively being taken. Refer to section 3.10 Batteries for further battery information and 3.7.1 SAMPLING OVERVIEW to determine when samples are in progress.

  If either battery shows empty the MEG ARTS® Skid should be retrieved and the appropriate battery replaced. The Controller battery will last at least 10 days, the solenoid valve battery will allow a single collection of a full set of samples using the longest SAMPLE TIME of 10 seconds.
- The asterisk in the bottom left of the screen is the HEARTBEAT SYMBOL which flashes every second to show that the system is running.

3.4. SINGLE BUTTON MENU INTERFACE

Figure 4 – Top Level Menus below shows all available menu items and their location. At any point while on the default screen described in section 3.3 DEFAULT SCREEN the MENU BUTTON can be pressed to enter the menu interface where the user can view and change several parameters which are discussed in this section.

While navigating the menu system, pressing the MENU BUTTON will move the CURSOR down one line and reset the COUNTDOWN TIMER to 5. Once the CURSOR is pointing at the desired menu item the user simply allows the COUNTDOWN TIMER to reach 0 and the selected item will be executed. The menu system is designed so that if the control button is not pressed then the unit will always exit and resume taking readings as normal.

When modifying parameters, pressing the MENU BUTTON will increment or scroll through the available settings. Allowing the COUNTDOWN TIMER to reach 0 will save the setting.

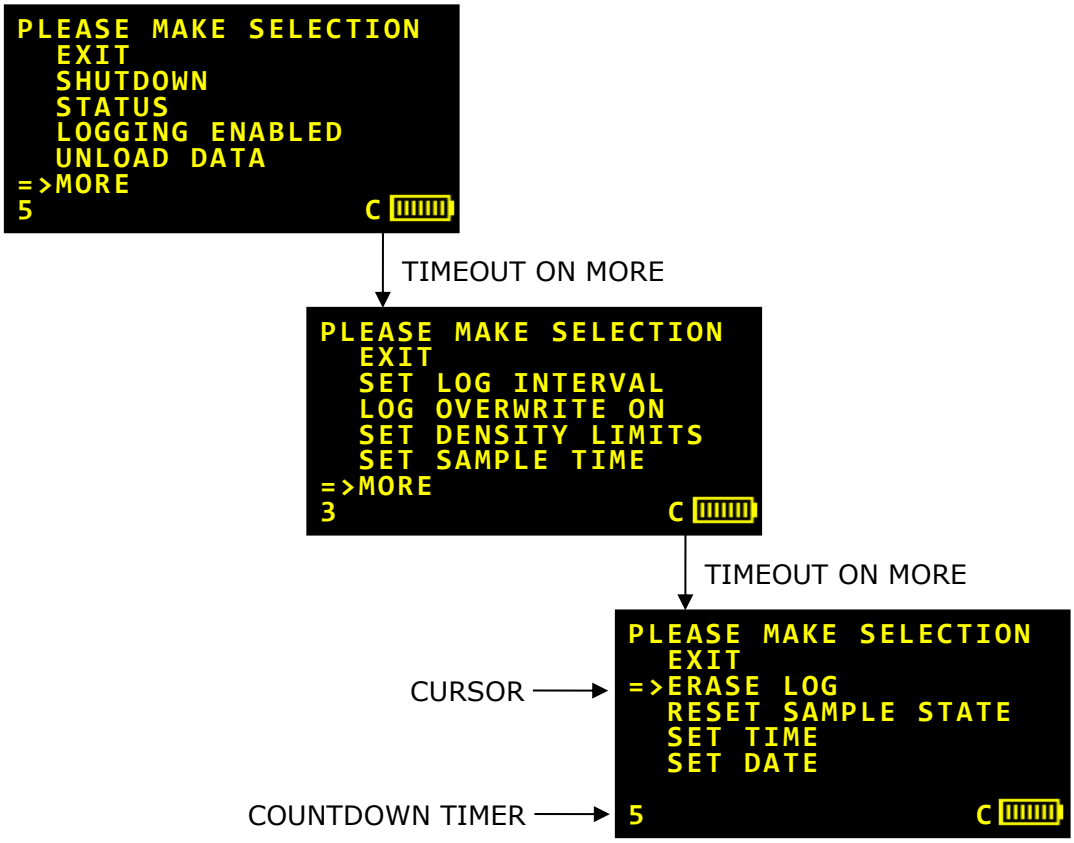

Figure 4 – Top Level Menus

3.4.1. MENU BUTTON ERROR

If the MENU BUTTON is held for more than 10 seconds (or is damaged and sticks on) then the switch will be assumed to be faulty and the controller will return to the DEFAULT SCREEN where a MENU SW ERROR message shall appear as per Figure 5 - Default Menu showing MENU SW ERROR below. If the MENU BUTTON is released then the error message shall remain visible until cleared by entering and then exiting the menu system. If this message appears unexpectedly then please contact Online Electronics Ltd.

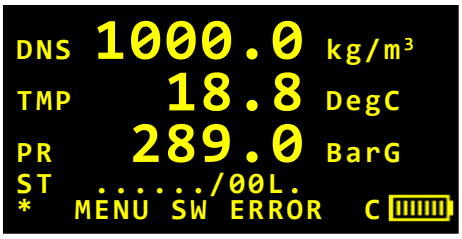

Figure 5 - Default Menu showing MENU SW ERROR

Error messages with time and date will also be sent via the serial port each time the MENU BUTTON ERROR is detected.

3.4.2. EXIT

Every page of the menu system starts with EXIT. If EXIT is selected then the controller will exit the menu system and display the DEFAULT screen as shown in section 3.3 DEFAULT SCREEN.

3.4.3. MORE

Where there are further menus the MORE option will be present. Selecting MORE will take you to the next menu.

3.4.4. SHUTDOWN

Selecting this item will switch off the controller. The controller is fitted with non-volatile memory which will remember all settings (such as LOG INTERVAL and SAMPLE TIME) the next time the unit is switched on. It is imperative that the controller unit is turned off using this command rather than simply disconnecting the battery/external supply as this allows any memory storage processes to terminate properly prior to turning OFF.

Upon selecting SHUTDOWN, the POWERING DOWN screen will be displayed (see Figure 6). At this point the SHUTDOWN sequence can be aborted by pressing the MENU BUTTON before the COUNTDOWN TIMER reaches 0. Sending a serial command will also abort the SHUTDOWN sequence.

The controller can also be shut down via the serial interface using the "~" serial command as per section 3.8 SERIAL INTERFACE. The POWERING DOWN screen will be displayed as when shutdown is chosen from the menu. Note that the controller cannot be turned on via the serial interface.

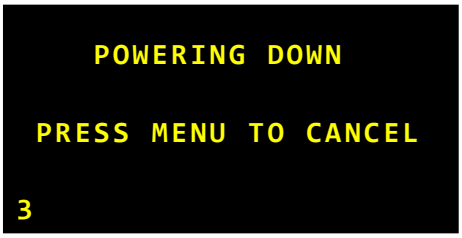

Figure 6 - Powering Down Screen

3.4.5. STATUS

The STATUS screens are also shown as part of section 3.2 TURN ON SEQUENCE and can also be viewed at any time by selecting STATUS from the menu system. The Status Screen shows the Date, Time, Firmware Version, Log Interval, Log Percentage Used, Log Overwrite Status, Sample Time, Number of Log Entries (in hex) and Density Trigger Levels.

The STATUS screen can be halted by pressing and holding the MENU BUTTON however note that if MENU BUTTON is held for longer than 10 seconds then an error message shall be displayed as per section 3.4.1 MENU BUTTON ERROR.

The status can also be downloaded using serial command "S" as per section 3.8 SERIAL INTERFACE.

3.4.6. LOGGING ENABLED/DISABLED

The LOGGING ENABLED/DISABLED item shows whether the logging state is ON or OFF. Selecting the item will toggle the logging function on or off and the menu will be updated with the new logging state.

Logging can also be enabled/disabled using serial command "N" as per section 3.8 SERIAL INTERFACE.

3.4.7. UNLOAD DATA

Selecting this item causes the MEG ARTS® Controller to unload all logged data via the RS485 serial interface. Refer to section 3.9.5 DATA UNLOAD for instructions for retrieving logged data. The unload process can be cancelled at any time by pressing the MENU BUTTON or sending a serial command. Note that selecting this item does not erase any data.

The unload data screen (Figure 7 - Unload Data Screen) shows the unload status, number of log entries unloaded and the number of entries in total. These numbers are shown in hexadecimal format. Refer to section 3.9.3.1 HEXADECIMAL NUMBER SYSTEM for more information regarding the hexadecimal number system.

The log can also be unloaded using serial commands "U" or "O" as per section 3.8 SERIAL INTERFACE. The unload menu screen will be shown during either action.

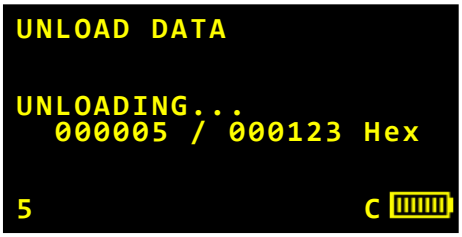

Figure 7 - Unload Data Screen

3.4.8. SET LOG INTERVAL

The LOG INTERVAL determines how often the live data is saved to the log. Selecting this item allows the user to change the LOG INTERVAL, which can be set to log every 1 second, 2 seconds, 5 seconds, or 10 seconds.

This item can be changed using command "I" as per section 3.8 SERIAL INTERFACE.

3.4.9. LOG OVERWRITE ON/OFF

This option defines what will happen when the log memory becomes full. The two options are LOG OVERWRITE OFF to stop logging or LOG OVERWRITE ON to overwrite existing log segments, starting with the oldest first. Overwriting the oldest will erase the oldest log memory segment before writing new log data. The setting cannot be changed from LOG OVERWRITE OFF to LOG OVERWRITE ON without first performing an ERASE LOG if the memory has been filled. Refer to section 3.4.13 ERASE LOG for more information.

This item can also be changed using command "J" as per section 3.8 SERIAL INTERFACE.

3.4.10. SET DENSITY LIMITS

This selection contains sub-menus to allow the Density Trigger Levels to be defined.

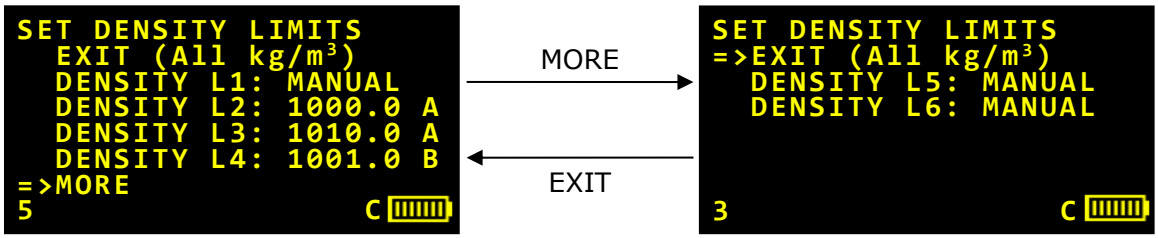

Figure 8 - Set Density Limits Menu

The SET DENSITY LIMITS menus (Figure 8) provide a summary status of each density trigger level. The level can be changed by scrolling to the desired density level and allowing the COUNTDOWN TIMER to timeout.

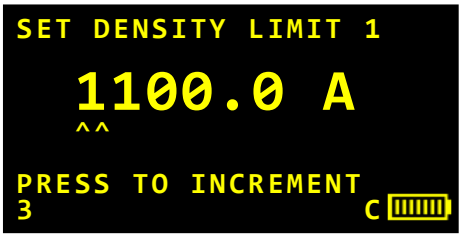

Figure 9 - Setting density limit sub-menu

The SET DENSITY LIMIT sub-menu (Figure 9) allows the modifying of the trigger value and state. This menu works in a slightly different way from the standard menus. On this screen, pressing the MENU BUTTON will increment the underlined digit, while allowing the timer to time out will move the cursor onto the next digit.

The final character determines the type of trigger and can be set to "A" to trigger when the reading is the same or above the trigger level, "B" to trigger when the reading is same or below the trigger level or "M" for manual trigger using the SAMPLE SWITCH.

These values can also be changed using command "L" as per section 3.8 SERIAL INTERFACE.

3.4.11. SET SAMPLE TIME

This item allows the time that the sample valve is held open when taking a sample to be changed. Pressing the MENU BUTTON cycles through the valve open times available; 1 seconds, 2 seconds, 5 seconds and 10 seconds.

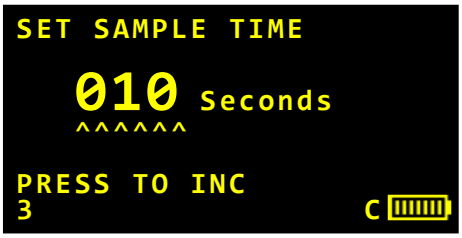

Figure 10 - Sample Open Time Menu

This item can also be changed using command "K" as per section 3.8 SERIAL INTERFACE.

3.4.12. RESET SAMPLE STATE

This item allows the sample state to be reset. Confirmation is required before the sample state is reset. Care should be taken to ensure the samples have been physically emptied and recharged prior to resetting the states. Triggering the samples without physically emptying the sample bottle will cause a new sample not to be taken. This function will also clear the logged Sample Trigger Times described in section 3.8.3.5 Command "Q" – Get Sample Trigger Times).

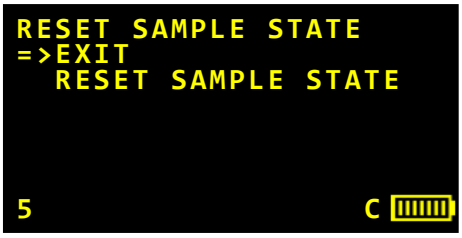

Figure 11 - Reset Sample State Menu

The sample status can also be reset using command "GR" as per section 3.8 SERIAL INTERFACE.

3.4.13. ERASE LOG

When ERASE LOG is selected, a screen similar to Figure 12 - Confirm Erase Menu will be displayed which requires that you confirm that the logged data is to be erased. Confirmation will erase all logged data. Configuration settings will remain unchanged. Ensure that any important logged data has been unloaded and saved before selecting this item as logged data cannot be retrieved once it has been erased.

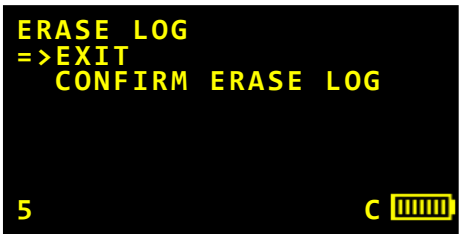

Figure 12 - Confirm Erase Menu

On confirmation, the ERASE LOG menu will show the ERASING LOG as shown in Figure 13 and the counter will increment every second. The erase process takes approximately 26 seconds to complete and once finished an ERASE SUCCESS screen will then be shown.

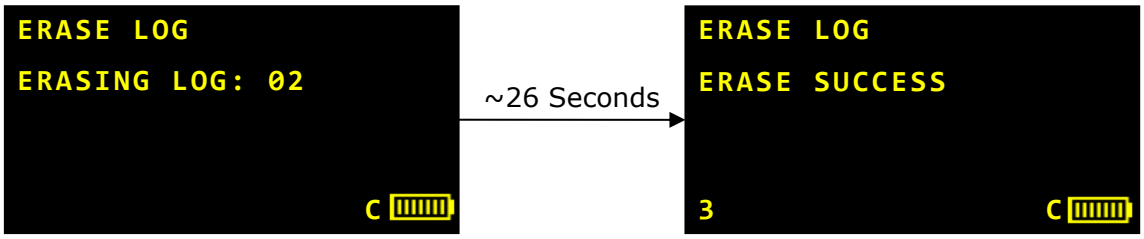

Figure 13 - Erasing Log and Erase Success Menus

The log can also be erased using command "E" as per section 3.8 SERIAL INTERFACE. This command requires confirmation and will show the ERASE LOG screens shown in Figure 13.

3.4.14. SET TIME/DATE

Selecting this item allows the time and date to be adjusted. Pressing the MENU BUTTON increments the underlined digit. Leaving the COUNTDOWN TIMER to timeout moves onto the next digit or exits if finished. While setting the seconds field the MENU BUTTON can be held down to freeze the current time to help synchronise with an external reference.

Figure 14 –Time and Date Menus

The time and date use HH:MM:SS and D/MM/YY formats and can also be changed using commands "T" and "D" respectively as per section 3.8 SERIAL INTERFACE.

3.5. DENSITY ANALYSER

The density analyser is a separate unit cabled to the controller which provides a temperature compensated density value, sample temperature and status. The unit is calibrated prior to shipping and cannot be accurately checked in the field. The DENSITY ANALYSER should be returned to OEL for verification/recalibration if the density measurements are believed to be incorrect.

The density value range is 500kg/m^3 to 1500kg/m^3. Values outside this range may still be displayed but will cause an ERROR STATUS to be displayed and logged. Density readings below 500kg/m^3 are likely to be caused by air (or gas) in the sample loop.

The density status value consists of a 2 digit hexadecimal number which can be decoded using Table 1 - Density Status below. It is possible to have more than one status entry occurring at the same time. In this case the numbers are added together (see binary representation) e.g. status code 03 (0000 00011 in binary) represents "density measuring value not stable" (status code 01, 0000 0001 in binary) and "medium temperature outside 0-70°C range" (status code 02, 0000 0010 in binary).

Status Code	Status	Binary representation
00	No error	0000 0000
01	Density measuring value is not stable	0000 0001
02	Medium temperature outside of 0-70° range	0000 0010
04	Density below from 500 kg/m^3 = air detection	0000 0100
08	Density outside from 1500 kg/m^3	0000 1000
16	Error temperature sensor	0001 0000
32	Error electronic	0010 0000
EE	No Sensor or major failure	1110 1110

Table 1 - Density Status

3.6. PRESSURE SENSORS

There are two pressure sensors contained within the MEG ARTS® system. One mounted within the controller (PR1) and one within the Sample Manifold. The controller pressure sensor is displayed as standard in the DEFAULT MENU.

The PRESSURE SENSOR is contained within the controller. The calibration can be checked by applying a known reference pressure at the ¼" BSPP MM Pressure Adapter using a pneumatic/hydraulic line and comparing the displayed reading against the reference. If the calibration is out or suspect then the control unit should be returned to OEL for calibration or replacement.

Both pressure sensor values are logged.

3.7. TAKING SAMPLES

3.7.1. SAMPLING OVERVIEW

The controller has the capability to trigger the collection of up to 6 samples. These samples can then be analysed in the laboratory once the MEG ARTS® system has been recovered. These samples can be triggered automatically when the density is above or below predefined density limit or manually triggered via the SAMPLE SWITCH. Only 3 samples can be taken at any one moment in time.

Referring to section 3.3 DEFAULT SCREEN the sample status provides the following information:

Sample status	Description
"."	Samples not taken
Alternating between "O" and the sample number	Sampling in progress
Sample number	Sample complete
"E"	Sample triggered but not taken

Table 2 - Sample States

For example, a sample status of ".23.O." shows that samples 1, 4 and 6 have not been taken, samples 2 & 3 have been completed and sample 5 is in progress.

The SAMPLE TIME defines the time that the sample valve is held open to allow a sample to be taken. The time required to take a sample is related to sample capacity and sample pressure. Refer to section 3.7.5 SAMPLE TIMES for suggestions based on sample pressure.

This value is set in the menu system as per section 3.4.11 SET SAMPLE TIME or via the serial interface as per section 3.8 SERIAL INTERFACE.

The sample status may be reset using the menu system as per section 3.4.12 RESET SAMPLE STATE or using command "GR" as per section 3.8 SERIAL INTERFACE.

The sample status should only be reset when the physical samples have been emptied. It is not advisable to re-sample a previously triggered sample.

The time and date at which a sample is triggered along with total time the sample valve was open is recorded and may be downloaded via the serial interface. Refer to Section 3.8.3.5; Command "Q" – Get Sample Trigger Times.

3.7.2. SAMPLING LIMITATIONS

It is only possible to take one samples at any one time. If more than one sample are triggered at once, only the first (numerically) sample will be taken and the remaining will be shown alternating between the sample number and the letter "E".

If the trigger condition is still present (automatic trigger only) when the current sample is completed, the sample will then trigger. In the case of manual sampling, the sample will have to be re-triggered using the SAMPLE SWITCH.

If the battery voltage drops to a critical level while one or more of the sample valves are open, all sample valves will be switched off and treated as sample complete. The recorded sample open time in the "Q" commands will represent the actual time the valve was open and not the time it should have been open. This critical voltage level should never be reached providing the system is operated in accordance with instructions within this manual.

3.7.3. AUTOMATIC SAMPLES

Automatic samples are taken immediately when the density value matches the density limit criteria. The density limit criteria is set either via the menu system as described in section 3.4.10 SET DENSITY LIMITS or using command "L" as per section 3.8 SERIAL INTERFACE.

Sample limits are defined by setting the density level in kg/m^3 in the format NNNN.N followed by "A" if the sample is to trigger when the density equals or is above the limit, or "B" if the sample is to trigger when the density is equal to or is below the limit.

Automatic samples will not be triggered if the density sensor is not present or faulty, i.e. when ERROR is displayed on the default screen. Once triggered, a sample will not be re-triggered until the sample status has been reset. This should only be done once the physical sample accumulators have been emptied and recharged with gas.

3.7.4. MANUAL SAMPLES

When the DENSITY LIMIT is set to MANUAL, the samples shall be taken in numerical order using the ROV SAMPLE SWITCH or serial command "F". E.g. if samples 2, 4, and 5 are set to MANUAL, the first activation of the SAMPLE SWITCH will cause sample 2 to trigger, the next activation will cause sample 4 to trigger and the third activation will cause sample 5 to trigger.

Once a sample has been triggered, it cannot be retriggered until the samples status has been reset. This should only be done once the physical sample accumulators have been emptied and re-charged with gas.

To activate a sample manually, the ROV SAMPLE SWITCH must be closed for at least 1 second. A second sample will not be triggered until the switch has been opened for at least 1 second and then closed again. If no samples are set to MANUAL then no manual sampling will occur. Samples can be manually taken even if the DENSITY SENSOR is faulty or is not present, i.e. when ERROR is displayed for the density on the default screen.

3.7.5. SAMPLE TIMES

When triggered, the sample valve will be held open for the set SAMPLE TIME. This can be from 1 seconds to 10 seconds. The time chosen will depend on the sample pressure differential; the difference in pressure between the incoming sample pressure and sample accumulator pre-pressure. A guide to selecting the best sample time is provided in Table 3 - Sample Time Settings.

Sample Pressure Differential (BarG)	SAMPLE TIME (Seconds)
1	10
100	5
300	1

Table 3 - Sample Time Settings

3.8. SERIAL INTERFACE

The controller can be configured using the RS485 serial interface using a communications terminal program such as HyperTerminal. The controller will only respond to serial commands when the DEFAULT MENU is displayed.

3.8.1. PROTOCOL

Type: RS485 2-wire half-duplex
Baud Rate: 115,200
Bits 8
Start bits: 1
Stop bits: 1

3.8.2. START UP OUTPUT

On power-up, the following information is broadcast on the SERIAL INTERFACE.

```
*****************************************
MEG ARTS: Online Electronics Ltd 2013 vE 03
*****************************************
(T)  Time:                14:06:31
(D)  Date:                28/03/19
(N)  Logging status:      Enabled
(I)  LOG Interval:        02 Sec
(M)  LOG Use:             65 %
(J)  LOG Overwrite:       ON
(K)  Sample Time:         010 Sec
(G)  Sample State:        ......
(L1) Density Limit 1:     Manual
(L2) Density Limit 2:     Manual
(L3) Density Limit 3:     Manual
(L4) Density Limit 4:     Manual
(L5) Density Limit 5:     Manual
(L6) Density Limit 6:     Manual
*****************************************
```

This provides the same information as found in the STATUS screens and can be re-sent using serial command “S”.

3.8.3. SERIAL COMMANDS

There are serial commands for all menu functions as described in section 3.4 SINGLE BUTTON MENU plus some serial only commands which are described here. The syntax of all commands are given in Table 4 - Serial Commands.

When using terminal software, commands typed are "echoed" back to the user and hence you can *see* the commands that have been received. If commands entered are not returned, there is an issue with the controller or serial link.

There is no delete or backspace function so if an error is made when typing a command the command should be aborted by pressing return and starting again.

For commands that require confirmation, serial command "Y" is required to be sent within a 10 second timeout period. If confirmation is not received in that time then the command is aborted.

Only power the unit off if you are certain operations have finished or you have the ability to turn the unit back on manually by pressing and holding the MENU BUTTON.

Command	Function	Format	Comment
A	Get sensor data	A	Returns Controller time, Date, Density, Temperature, Pressure, Density Status and Sample Status
D	Change Date	D dd/mm/yy	
E	Erase Log	E	Requires confirmation
F	Trigger Manual Sample	F	Only if manual trigger is available Required confirmation
G or GR	Sample Valve Reset/Status	G (get) GR (reset)	Reset requires confirmation
H or ?	Help	H or ?	Displays command list
I	Set Log interval	I nn	Where nn is time in seconds
J	Set Log Overwrite action	J n	where n = S for OFF or O for ON (Overwrite)
K	Set Sample Time	K nn	where nn is time in seconds
L	Set Density limits:	Lx M (manual) Lx l nnnn.n (auto)	x = sample number l = A (above) or B (below) nnnn.n = density limit
M	Return Log Use	M	
N	Set Logging Status	N l	l = D for disable or E for enable
O	Unload Segment	O nn	nn = segment number
P	Return Log Memory Status	P	
Q	Get Sample Trigger Times	Q	
S	Return Status	S	
T	Change Time	T HH:MM:SS	
U	Unload Log	U	
~	Shut Down Controller	~	Requires confirmation

Table 4 - Serial Commands

3.8.3.1. Command "A" – Get Data

This command requests that the controller sends out the current sensor status and data readings. The data is returned in the following format:

(A) Sensor Values: HH:MM:SS P:ppp.p T:ttt.t D:dddd.d C:n DS:nn VS:mm

Where:	HH:MM:SS	time
	ppp.p	pressure
	ttt.t	temperature
	dddd.d	density
	n	Controller status
	nn	density status
	mm	valve status

3.8.3.2. Command "H" or "?" – Help

This is the help command and provides a list of commands available and their syntax.

3.8.3.3. Command "G" or "GR"– Get/Reset Sample State

The "G" command returns the sample status and the "GR" command resets the sample status (requires confirmation). Care should be taken when resetting the sample status as this should only be done once the samples have been physically emptied and re-charged with gas.

3.8.3.4. Command "P" – Return Log Memory Status

This command returns the log memory size in segments see Section 3.9.3 LOG MEMORY CONFIGURATION, the current segment being logged to and whether the log is "filling" or "looped". Filling is where no memory has been overwritten whereas looped is where segments have been erased to make way for new log data.

"Filling" or "looped" will still be reported if logging is disabled irrespective of the setting of LOG OVERWRITE.

3.8.3.5. Command "Q" – Get Sample Trigger Times

This command returns the start dates and times that the samples were taken. If no sample has been taken then "No Sample" is shown, see below:

Sample triggered times:
Valve 1: 15/07/14 10:22:40 [020s]
Valve 2: 15/07/14 10:22:40 [020s]
Valve 3: 15/07/14 10:22:40 [020s]
Valve 4: No Sample
Valve 5: No Sample
Valve 6: No Sample

This example shows that sample 1,2 and 3 were triggered all together at 10:22:40 on the 15th July 2014, and sample valves were open for 20 seconds. Sample 4, 5 and 6 have not yet been triggered.

3.9. DATA LOG

3.9.1. DATA LOG OVERVIEW

There is approximately 4 Mbytes of non-volatile memory for logging data. Each data entry consists of density, pressure, temperature, density status and sample status. The times at which the samples were triggered are also logged separately. Each log entry is time/date stamped and stored in a log memory location.

Providing logging is enabled, as detailed in Section 3.4.6 LOGGING ENABLED/DISABLED. Log entries are taken at a rate defined by the LOG INTERVAL as detailed in Section 3.4.8 SET LOG INTERVAL , usually every 1, 2, 5 or 10 seconds. Once the log is full, logging will either stop or loop (where the oldest log segment is overwritten) as defined in section 3.4.9 LOG OVERWRITE ON/OFF.

3.9.2. LOGGING CAPACITY

The controller unit is fitted with 4 Mbytes of internal memory available for logging. This allows it to store over 250,000 readings. Estimated log durations are given in Table 5 - Log Durations. There are two options when the logging memory becomes full; the first is to stop logging and the second is to overwrite the oldest data segment. The latter option is the default setting.

Log Interval (Seconds)	**Logging capacity**
1	2 days 23 hours
2	5 days 23 hours
5	14 days 22 hours
10	29 days 20 hours

Table 5 - Log Durations

3.9.3. LOG MEMORY CONFIGURATION

The log memory is split into 62 segments, each holding 4,096 (1000_{16}) log entries. The log memory is addressed using the hexadecimal number system. Therefore, the log memory is represented by segments 00_{16} (00) to $3E_{16}$ (62), with each segment holding 1000_{16} (4,096) log entries.

3.9.3.1. HEXADECIMAL NUMBER SYSTEM

The log memory is addressed using the hexadecimal number system. The hexadecimal number system operates on a base of 16 rather than a base of 10 for decimal. Hexadecimal numbers count from 0_{16}..9_{16} and then A_{16} (10_{10}), B_{16} (11_{10}), C_{16} (12_{10}), D_{16} (13_{10}), E_{16} (14_{10}), F_{16} (15_{10}). The subscript shows the number base, for simplicity there is no subscript when writing base 10 (decimal) numbers. Conversion between decimal and hexadecimal can be easily achieved using the Microsoft Windows 7 (or later) calculator in the PROGRAMMER view.

3.9.4. FINDING INFORMATION IN THE LOG

The log can be downloaded as a whole or by segments. The time taken to download a large log can be significant, therefore downloading individual segments may be more appropriate. Refer to Section 3.9.7 UNLOAD TIME.

The time and date that the log entry was recorded is provided in the log entry. To find a particular section of log first establish the current logging segment using the serial command "P" as shown in Section 3.8.3.4 Command "P" – Return Log Memory Status. This will return the current segment being logged and the number of segments available in memory.

Using Table 6 - Log Segment Time Spans below, work out which memory segment contains the target data based on the start time/date of the current segment, and download that segment. Once it is downloaded, use the time/date information to confirm that the segment contains the required data. If not, repeat this process using the new time and date information. Note that if the memory has been looped then earlier entries may have a higher segment number than the current segment.

Log Interval (Seconds)	**Segment Time Span (HH:MM:SS)**
1	01:08:15
2	02:16:31
5	05:41:19
10	11:22:39

Table 6 - Log Segment Time Spans

3.9.5. DATA UNLOAD

Data unload can be initiated from the menu interface as described in section 3.4.7 UNLOAD DATA or from the serial interface. In each case the data is sent out over the serial interface which can be monitored/recorded using a terminal program.

1. Connect the USB end of the controller download cable to the PC and the BURTON end to the download connection on the MEG skid.

2. Start the terminal program and connect to the appropriate port. Refer to Section 3.8.1 PROTOCOL for further guidance.

3. Turn the controller unit ON by pressing and holding the MENU BUTTON until the COMPANY LOGO appears on the display. Release the MENU BUTTON and the STATUS information will be transmitted to the terminal program just before the DEFAULT MENU is displayed.

4. In the terminal program, select "Capture to File" or "Capture Text" option (terminology may vary between terminal programs) and select the filename and location to save the log to.

5. Initiate the data unload by either selecting UNLOAD DATA through the menu system as described in section 3.4.7 UNLOAD DATA or send the "U" command to unload all data. The "O" command can be used to unload a single data segment.

6. Once data unload is complete stop the capture by selecting "Stop Capture" or "Capture Text/Stop" in the terminal program. The captured txt file may now be opened in Excel (or similar) which will invoke the text import wizard.

7. In the import wizard, choose delimit as the type of file that best describes your data and then NEXT. Ensure the delimiter is the TAB character and select NEXT. In the Column Data Format, select Text.

8. The data will be tabulated with columns as per section 3.9.6 DATA FORMAT.

3.9.6. DATA FORMAT

A single log entry consists of the Date, Time, Battery, Pressure, Temperature, Density, Controller Status, Density Status and Sample Status separated by tab characters:

LOG Address	Date/Time	BATTERY	PRESSURE (barg)	TEMP. (degC)	DENSITY (kg/m^3)	CONTROLLER STATUS	DENSITY SENSOR STATUS	SOV STATUS
00:000	20/03/2019 08:00:25	CD	0.0	17.2	1000.0	7	4	0

Where:

- Log Address is the segment and memory location number in hexadecimal for each sample, format SG:NUM. See section 3.9.3 LOG MEMORY CONFIGURATION.
- Battery represents the internal battery levels, the controller and solenoid batteries are logged alternatively. The controller status shows which has been logged
- PRESSURE is the pressure sensors value, NNN.N barg. Both sensors are logged alternative. The controller status shows which is logged.
- DENSITY is the density sensor value, NNNN.N kg/m^3
- CONTROLLER STATUS is the controller status
- DENSITY SENSOR STATUS is the density sensor status, refer to section 3.5 DENSITY ANALYSER.
- SOV STATUS is the sample status.

If a sensor is not connected then readings from this sensor will be logged as EEEE.E kg/m^3, EEE.E degC or EEE.E barg depending on the sensor.

The Controller Status is made up of binary 4-bits as shown:

Bit Number	3	2	1	0
Function	Reserved Usually 0	Pressure Sensor 0 = Manifold 1 = Controller	Battery Source 0= Controller 1= SOV	Reserved Usually 1

A status of 7 (0111_2) shows Battery Source = SOV and Pressure Sensor source = Controller

3.9.7. UNLOAD TIME

The unload times are presented to provide guidance for how long logged data will take to download. It would take approximately 52 minutes to download the entire log memory. Each segment takes approximately 49 seconds to download.

Log duration (days)	Log Interval (seconds)	number of log entries	Segments (decimal)*	Segments (hex)*	Download time
1	1	86400	21.1	15.1_{16}	00:17:13
1	2	43200	10.5	$A.8_{16}$	00:08:36
1	5	17280	4.2	4.4_{16}	00:03:26
1	10	8640	2.1	2.2_{16}	00:01:43
10	1	258048#	63.0	$3F.0_{16}$	00:51:27
10	2	258048#	63.0	$3F.0_{16}$	00:51:27
10	5	172800	42.2	$2A.3_{16}$	00:34:27
10	10	86400	21.1	15.1_{16}	00:17:13

Table 7 - Log Configurations and Unload Times

These are max log size as the number of entries would exceed the memory size, therefore either logging would stop or loop around overwriting the oldest log items first.

* The segment number will be 1 less than the number of segments as segments start from 00 rather than segment 01. Therefore the highest segment value of $3F_{16}$ will be physical memory segment $3E_{16}$ when entered into the download segment command ("O 3E"). Refer to section 3.9.3.1 HEXADECIMAL NUMBER SYSTEM.

3.10. BATTERIES

There are two batteries located within the controller. Once for the controller and one for the solenoid valves. Both battery levels are shown on the DEFAULT screen Figure 3 - MEG ARTS® Controller Default Screen.

There unit will shut down in a controlled fashion if the controller battery reaches a critical level.

If the solenoid valve battery is allowed to reach a critical level, the solenoid valves may not actual and hence samples may not be collected.

3.11. EXTERNAL ROV SWITCHES

The MEG system includes two ROV switches. Refer to section 6 DEPLOYMENT for guidance on where these switches are installed on the MEG ARTS® skid.

The ROV MENU SWITCH provides the same functionality as the controller mounted MENU BUTTON. Refer to section 3.4 SINGLE BUTTON MENU INTERFACE for further information. Note that if the MENU switch is left in the ON position for more than 10 seconds or has developed a fault then the controller will show an error message as per section 3.4.1 MENU BUTTON ERROR.

The ROV SAMPLE SWITCH provides an option to take manual samples using an ROV. Only samples set to MANUAL can be triggered with the SAMPLE SWITCH. Refer to section 3.7.4 MANUAL SAMPLES for further information.

The switches themselves are robust, rotary switches which can be rotated indefinitely in either direction. The switch contact closes when in the ON position and will open after turning the switch approximately 45° in either direction. When not in use the switches should be rotated 180° away from the ON position to prevent accidental activation. They may also be fixed in this position with a plastic tie wrap using the 'locking' hole provided.

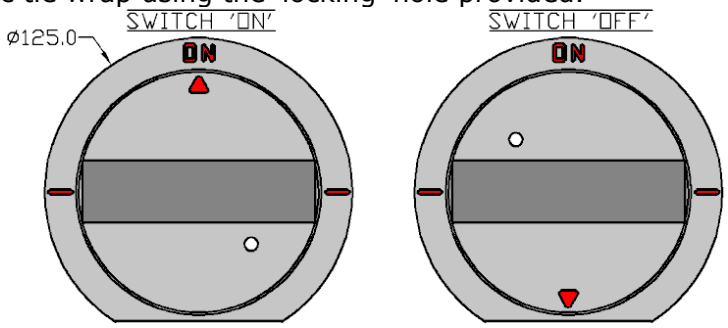

Figure 15 - ROV Switch

4. EXTERNAL CONNECTIONS

A CRE-FRB19F090022-01, 19 way bulkhead connector is used to provide an interface connection from the controller to the MEG ARTS® JUNCTION BOX through which all externally connections are made as below.

FUNCTION	PIN
EXTERNAL POWER GND	1
EXTERNAL POWER IN (+)	2
DENSITY POWER	3
DENSITY GND	4
DENSITY RS232 Rx	5
DENSITY RS232 Tx	6
RS232 GND	7
RS485 (-) SURFACE	8
RS485 (+) SURFACE	9
SOLENOID 1 +24V	10
SOLENOID 2 +24V	11
SOLENOID 3 +24V	12
SOLENOID 4 +24V	13
SOLENOID 6 +24V	14
SOLENOID 6 +24V	15
ROV SWITCH 1 +24V	16
ROV SWITCH 2 +24V	17
GND	18
NOT USED	19

Figure 16 - CRE Size B Bulkhead Connector

5. COMPENSATING DENSITY FOR PRESSURE AND TEMP

The DENSITY ANALYSER provides a temperature compensated value, however the value is not compensated for pressure.

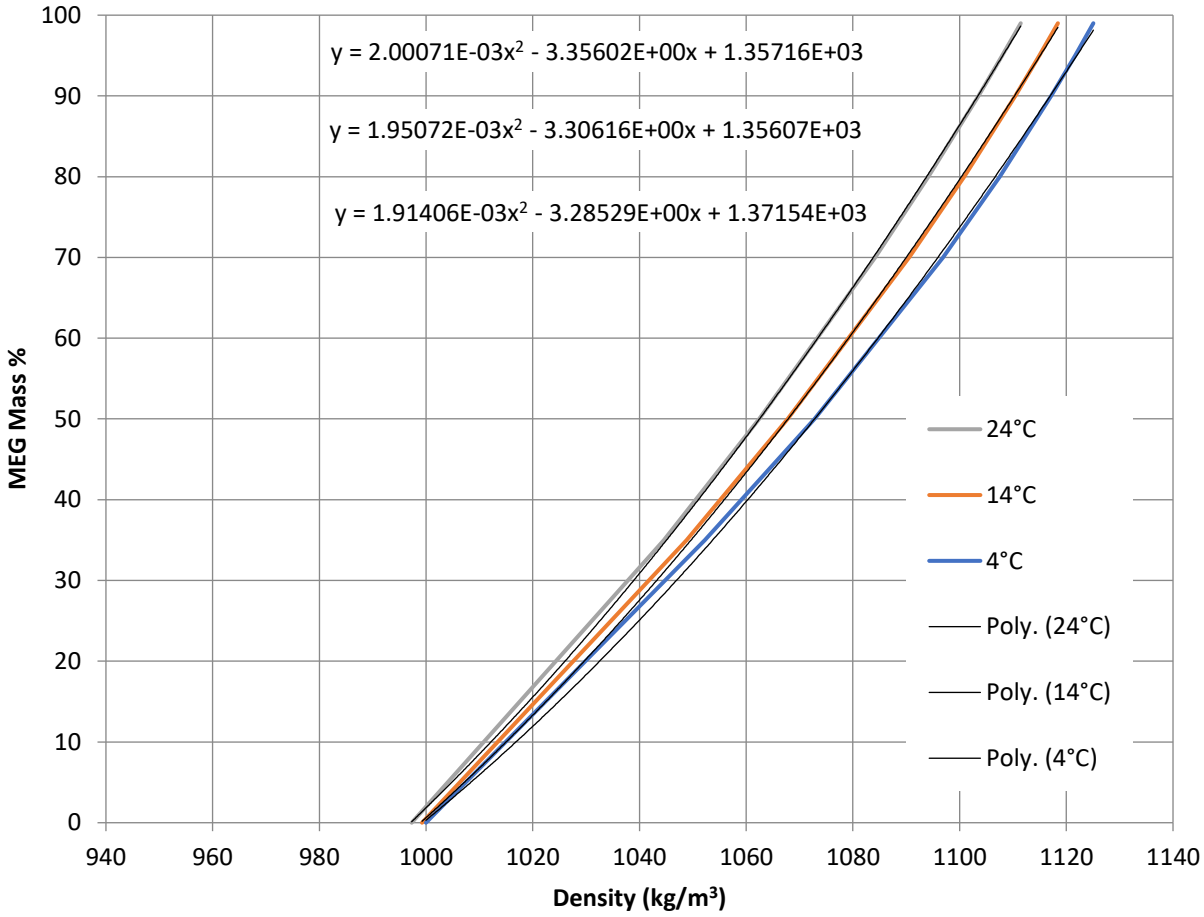

Figure 17 - Concentration of MEG in Water

The density of a mixture of MEG and water varies with the following parameters

- MEG concentration
- Water salinity
- Temperature
- Pressure

MEG concentrations are usually expressed as a percentage of total mass. Concentrations can alternatively be expressed as a volume fraction or a mole fraction although there are significant differences between the 3 values.

Seawater with salinity 35 g/kg is 27.7 kg/m^3 denser than freshwater at standard temperature and pressure. The effect on mixture density of water salinity reduces with increasing MEG concentration. Pipeline conditioning trains often include freshwater between the MEG and the line fill of seawater. Salinity can be neglected in these cases.

The sea temperature is close to 4°C at depths greater than 1000m in most areas of the world. The effect of pressure in deep water must be considered. Figure 18 shows the MEG concentration in freshwater at constant 4°C temperature for a range of densities and pressures.

The plot is constructed with a linear horizontal scale for pressure and density to enable interpolation. For example, take a density reading of 1123 kg/m^3 at 300 BarG. The right hand blue line gives MEG concentrations for constant 300 BarG. The intersection with 1120 kg/m^3

constant density line is at 82.5% MEG mass concentration on the vertical axis. From this intersection follow the pressure line moving right 3 units horizontally giving a density of 1123 kg/m^3 and concentration 86%. Similarly, moving left 5 units horizontally along the 1120 kg/m^3 line gives 250 BarG pressure and a concentration of 84.5%.

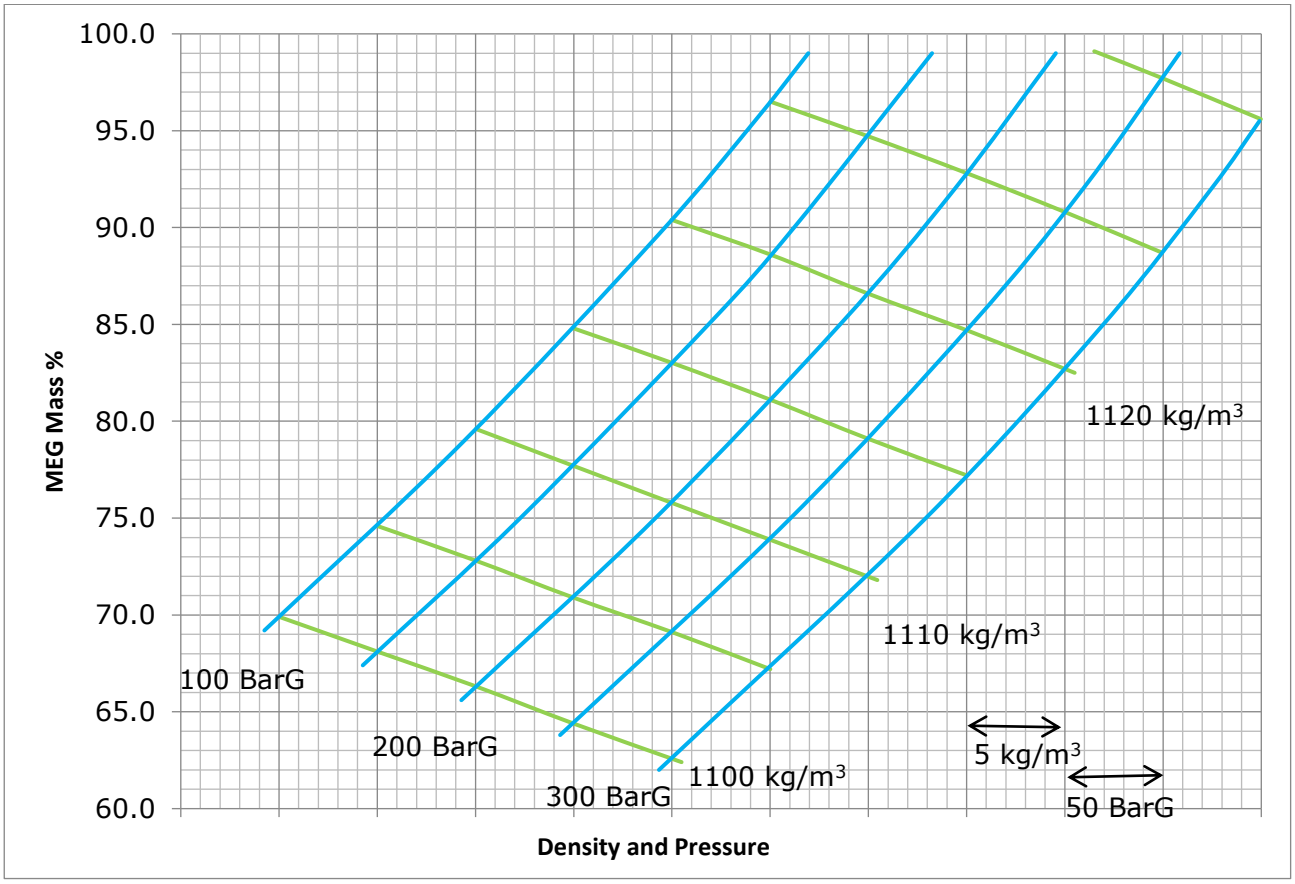

Figure 18 - MEG concentration at 4°C

In shallower water, for example on the continental shelf, the effect of pressure is less but temperatures vary significantly. Figure 19 - MEG concentration at 10BarG shows the MEG concentration in freshwater at a constant 10BarG pressure for a range of densities and temperatures.

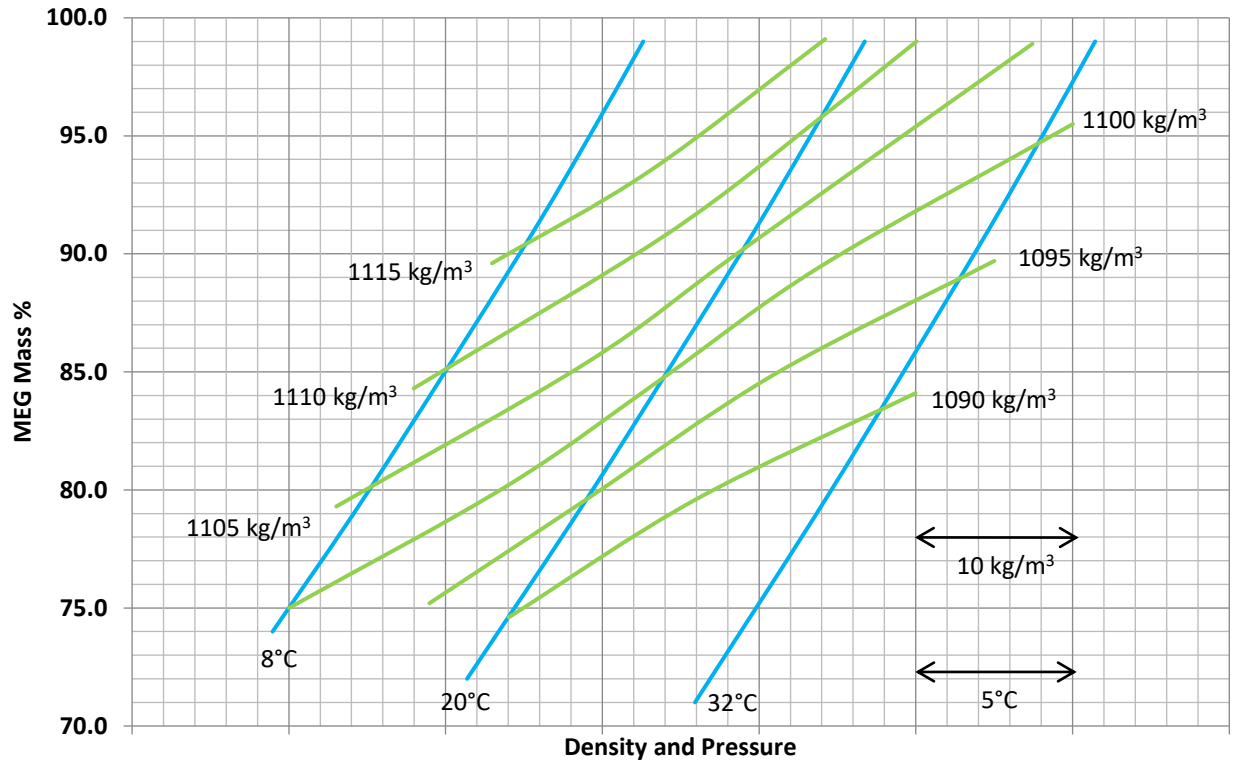

Figure 19 - MEG concentration at 10BarG

OEL can construct graphs or tables for project-specific conditions. The method uses curve fits to published data and is not intended to replace specialist calculations with equations of state.

6. DEPLOYMENT

The controller forms part of the MEG ARTS® system and mounts to the MEG ARTS® skid as shown in Figure 20 - MEG ARTS® Skid below with all covers removed. The controller sits vertically within the skid allowing an ROV to easily read the display from above.

Prior to deployment, ensure that any unused connectors are suitably blanked to prevent conduction between pins and malfunction when submerged in saltwater.

OEL recommend fitting a new battery packs before each deployment to ensure the longest possible lifetime, and to provide a safety margin should the job be extended unexpectedly.

The controller is mounted to the MEG ARTS® skid using two M10 bolts.

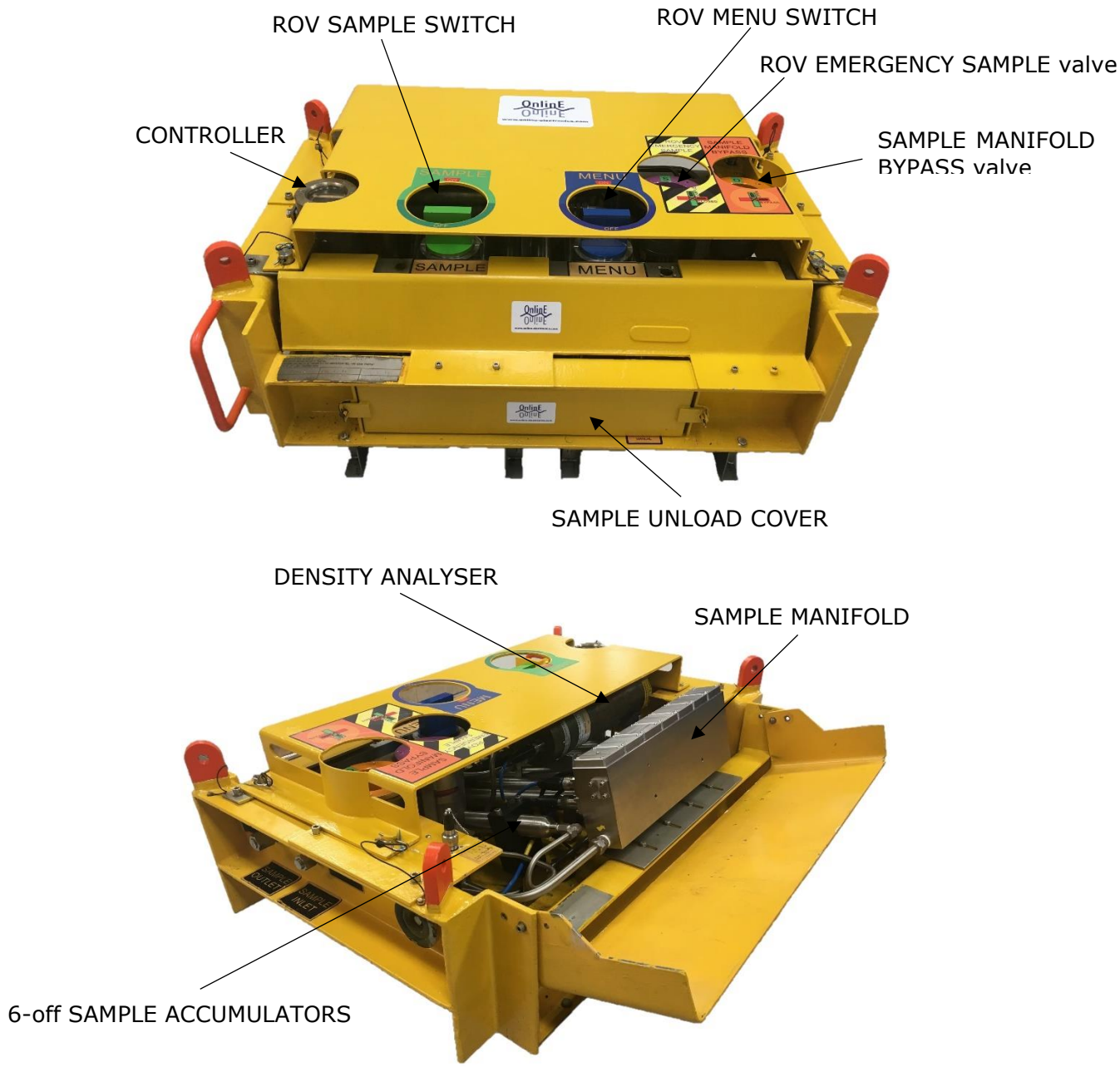

Figure 20 - MEG ARTS® Skid

7. MAINTENANCE

7.1. BATTERY REPLACEMENT

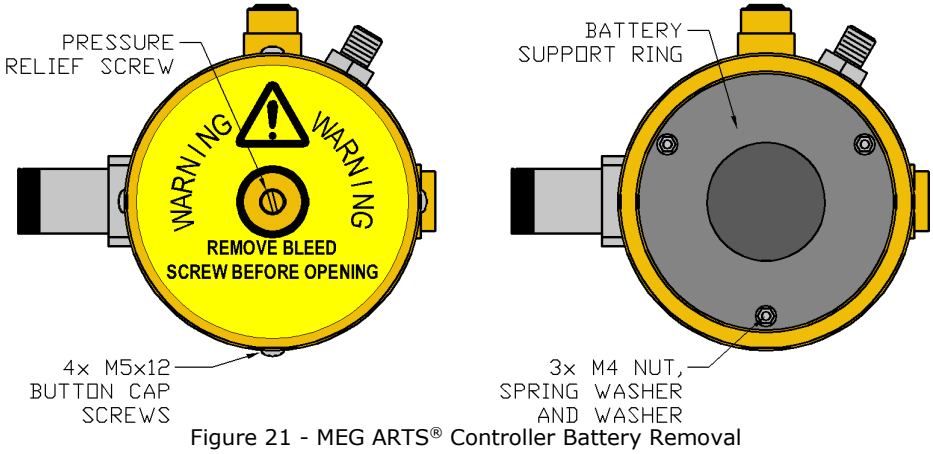

Figure 21 - MEG ARTS® Controller Battery Removal

1. The unit should only be opened in a clean, dry, laboratory environment.

2. To prevent the formation of condensation within the unit, allow the temperature of the unit to stabilise within the laboratory environment for a minimum of 6 hours prior to opening.

3. Ensure that the unit is turned off.

4. Loosen the bleed screw / pressure relief screw to relieve any internal pressure prior to opening.

5. Remove the 4x M5x12 screws around the perimeter of the HOUSING.

6. Carefully remove the housing from the endcap. Ensure that the O-Ring seals are protected from damage and contamination while the unit is open. Note that the battery will be attached to the endcap at this point.

7. Place the ENDCAP face down on a soft non-abrasive surface and remove the 3x M4 nuts, M4 spring washers and M4 washers, followed by the BATTERY SUPPORT RING.

8. Replace the battery packs, the controller pack is the OEL-004845-00V00 battery pack, and the solenoid valves pack is the OEL-004846-00V00 battery pack. The solenoid battery pack is a dual pack, once one part is used, cut the connector off before it is disconnected to remove doubt as to which has been used

9. Ensure all wires are installed neatly and protected from accidental damage. The controller battery packs should be inserted with the exit wires near the PCB and the solenoid valve battery pack should be inserted with the exit wires near the ENDCAP end.

10. Re-fit the BATTERY SUPPORT RING retaining it with the 3x M4 nuts, M4 spring washers and M4 washers. Take care not to over tighten.

11. Examine the O-Ring seals for any signs of damage or contamination. Replace and / or lubricate with Molykote 111 compound if necessary.

12. Reassemble the unit by re-fitting the HOUSING onto the ENDCAP, taking care not to trap any wires. Ensure the mounting holes in the HOUSING and ENDCAP are aligned.

13. Secure the HOUSING using the 4x M5 Screws around the perimeter of the housing.

14. Tighten the bleed screw / pressure relief screw.

7.2. O-RING REPLACEMENT

The product uses the following O-rings:

1x 50-008 O-Ring - Bleedscrew Piston Groove.
2x 50-243 O-Ring - Endcap Piston Grove with 2x 250-243 PTFE Back Up Rings.
1x 50-236 O-Ring - Window Flange Grove
1x 50-237 O-Ring - Window Piston Grove.

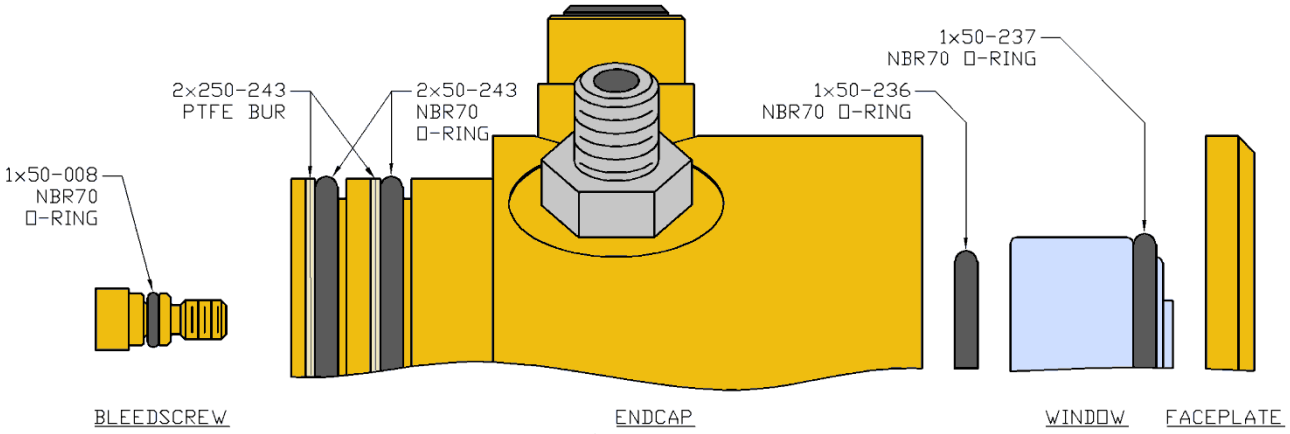

Figure 22 – MEG ARTS® Controller O-Ring Arrangement

7.3. ROUTINE MAINTENANCE AND STORAGE

All Online Electronics Ltd products are designed to require minimum maintenance. The housing should be cleaned using fresh water and cleaning agents as necessary. Do not use chemicals which could be damaging to the housing, nitrile rubber O-rings, acrylic window, or any connectors.

The controller contains a coin cell (BR2032) used to power the Real Time Clock circuitry which stores the date and time as well as other system variables (such as the LOG INTERVAL) while the unit is turned OFF. This battery should be replaced every 5 years at Online Electronics Ltd premises.

If the unit is to be placed in storage for a long period of time, ensure that the unit has been cleaned and disconnect the main battery.

8. DISPOSAL OF UNIT

Online Electronics Ltd (OEL) takes its responsibilities under the WEEE Regulations extremely seriously and has taken steps to be compliant in line with our corporate and social responsibilities. In the UK, OEL has joined a registered compliance scheme WeeeCare (registration number **WEE/MP3538PZ/SCH**).

Electrical and electronic equipment should never be disposed of with general waste but must be separately collected for the proper treatment and recovery.

The crossed out bin symbol, placed on the product, reminds you of the need to dispose of it correctly at the end of its life.

When buying a new product you will have the possibility to return, free of charge, another end of life product of equivalent type that has fulfilled the same functions as the supplied equipment. These items may be deposited at:

Online Electronics Ltd
Online House
Blackburn Business Park
Woodburn Road
Aberdeen
AB21 0PS
UK

Alternatively, to arrange a collection of any waste electrical equipment, obligated to OEL please telephone WeeeCare on **0844 800 2004**.

9. WARRANTY

Online products are guaranteed for one year from the date of purchase. Goods should be returned transportation prepaid to Online Electronics Limited, Blackburn Business Park, Woodburn Road, Aberdeen, AB21 0PS.

There is no charge for parts or labour should any product require repair due to a manufacturing deficiency during the guarantee period.

In the event of a manufacturing deficiency the inward transportation costs will be repaid to the client.