TRAX

Intelligent Pipeline Technology

MEG ARTS® Operating Manual

Real-Time Data & Sampling

www.iktrax.com

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C	BG	CR-24-01-04-01: New format	21/03/24

1. INTRODUCTION

MEG ARTS® is a system for Mono-Ethylene Glycol Analysis, Real Time display of results, and Sampling subsea. The system displays and logs measurements of density, pressure and temperature of Mono-Ethylene Glycol or other fluid received subsea from a pipeline conditioning pig train. These measurements can be used to demonstrate conformity with project purity, dryness, or hydrate suppression requirements. Status can be monitored by ROV camera on a real time high visibility OLED display. Up to 7 physical samples can be captured for recovery to the surface to confirm composition. Samples SA1 to SA6 can be captured manually by ROV switch or when there is no ROV present sample capture may be autonomous using pre-set density trigger levels. The 7th sample SAM is fully manual and can only be captured by ROV.

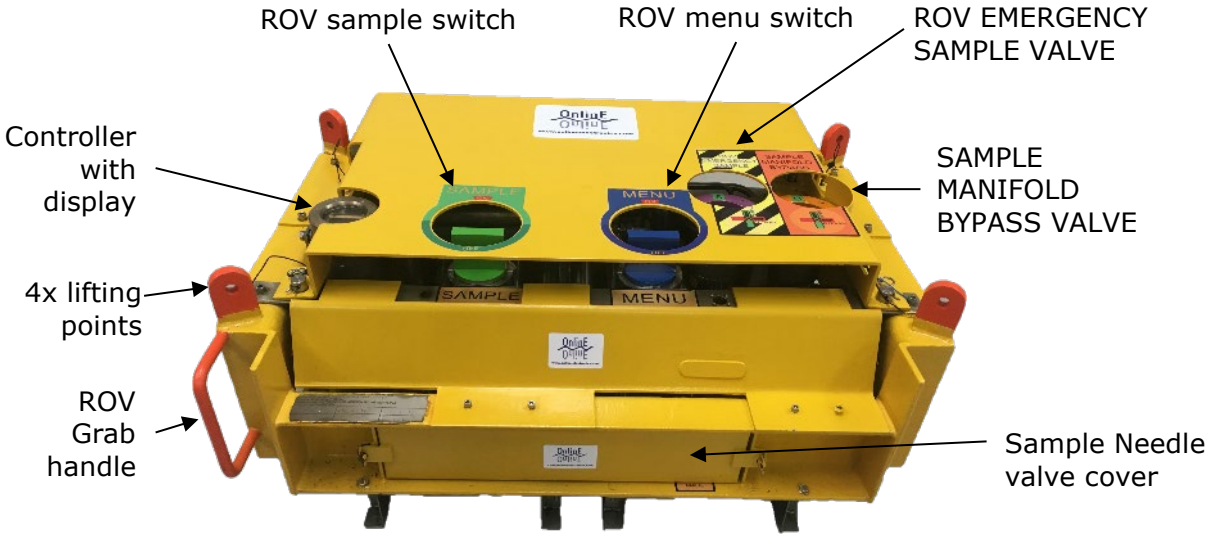


Figure 1 MEG ARTS® skid front view

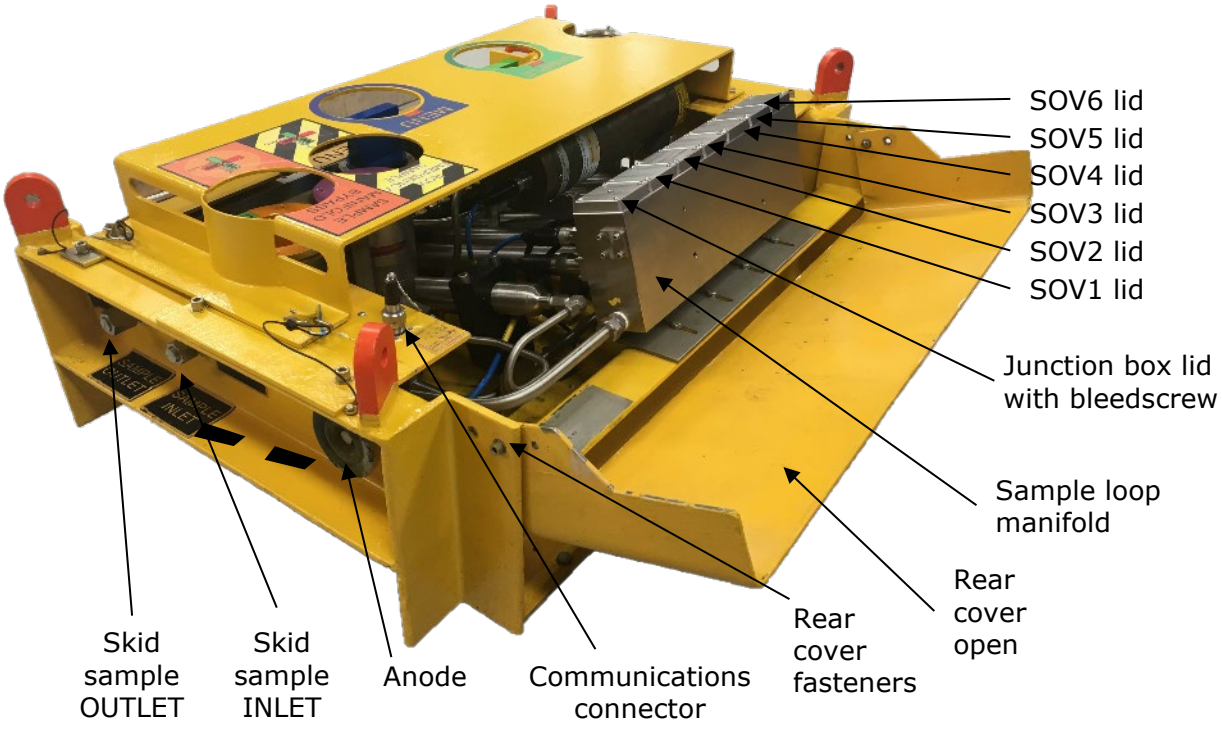


Figure 2 MEG ARTS® skid with rear cover open

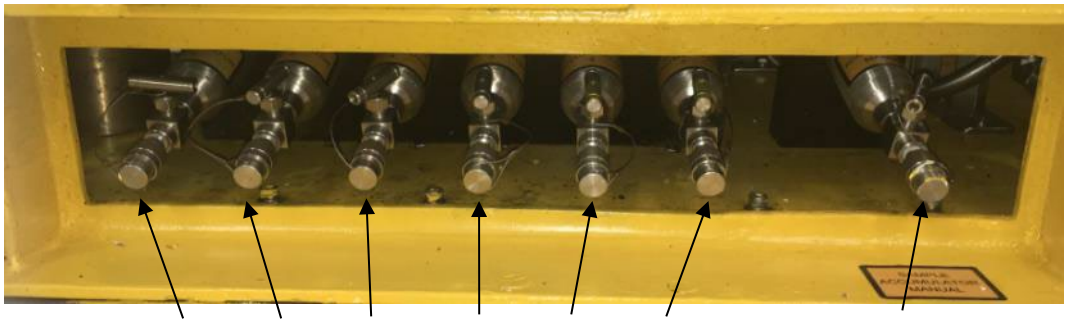


Figure 3 Needle valve cover access

1.1. SYSTEM SCHEMATIC

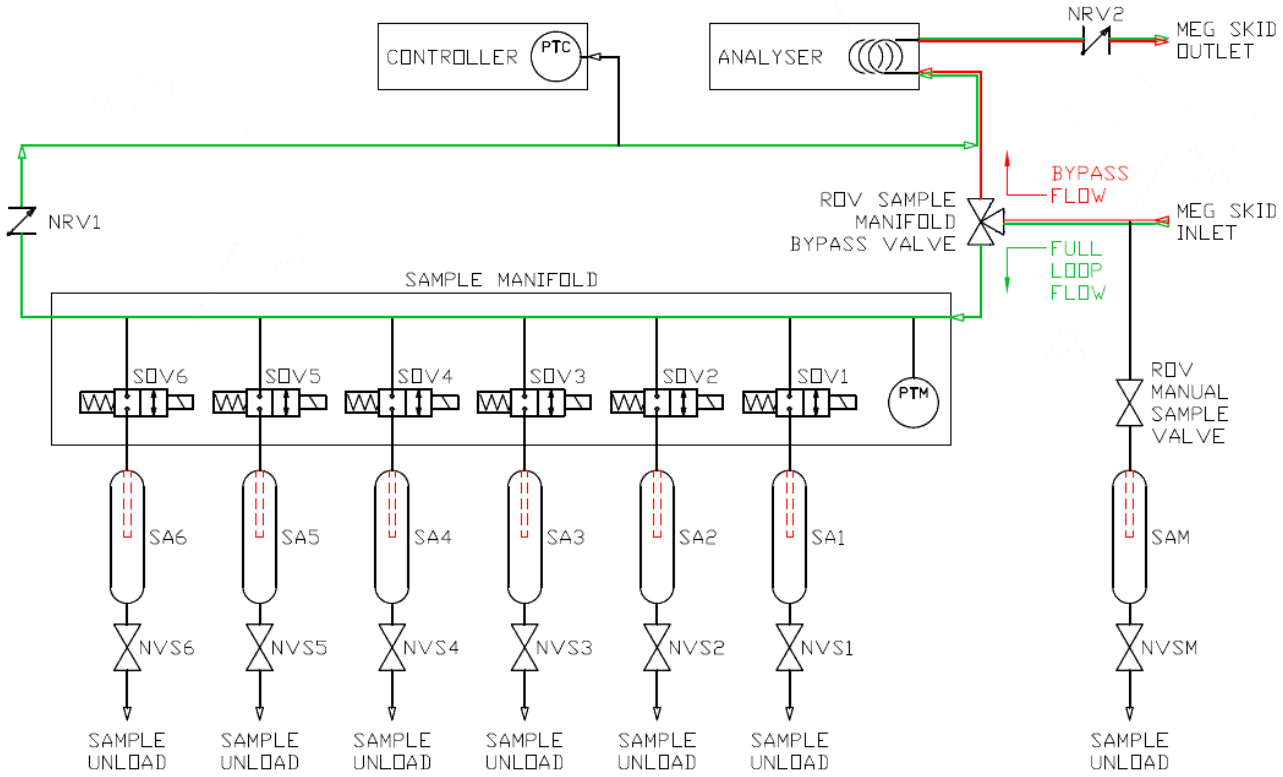


Figure 4 System schematic

The MEG ARTS® skid is typically connected to the discharge of a pipeline via the sample INLET and OUTLET ports. The sample INLET and sample OUTLET connections on the skid are JIC 12 male fittings which are typically fitted with closed caps for protection during transit. The pipeline discharge pressure is normally close to the subsea ambient pressure however in some operations there may be significant overpressure.

The pipeline discharge flows into the skid via the skid sample INLET port, past the ROV MANUAL SAMPLE valve and into the ROV SAMPLE MANIFOLD BYPASS valve. The flow can then either go direct to the density analyser (BYPASS FLOW) or via the sample loop manifold (FULL LOOP FLOW) where it passes 6x Solenoid Operated Valves (SOV*n*) and the sample manifold Non-Return Valve (NRV1). From the density analyser the flow exits via NRV2 and the skid sample OUTLET port. Recommended flow rate through the skid is between 5l/min and 50l/min.

The ROV EMERGENCY SAMPLE valve provides a for a fully manual sample to be collected in the unlikely event that the system is unable to capture a sample via ROV SAMPLE switch or automatically.

When the ROV EMERGENCY SAMPLE valve or SOV is opened a sample is drawn into one of seven sample cylinders (SAn) and captured. Each sample cylinder is fitted with a sample needle valve (NVS*n*) for unloading of a captured sample as per section 5.2 SAMPLE UNLOADING. Each sample needle valve is fitted with a Swagelok SS-QF4-S full flow quick connect stem. IK Trax provide all required hoses and fittings.

The controller provides logging and display of date, time, density, controller pressure (PTC), manifold pressure (PTM), temperature and status as well as providing control of the SOVs. The ROV sample and menu switches allow ROV interaction with the controller and manual control of the SOV sampling.

1.2. CONTROLLER DEFAULT SCREEN

Figure 5 Default controller screen shows the default controller screen which will appear when the controller is turned on and updates once per second.

Figure 5 Default controller screen

- DNS is the density reading from the density sensor in kg/m^3.
- TMP is the temperature reading from the density sensor in °C.

  PTn is the pressure reading from the controller pressure sensor (PTC) or the sample loop manifold pressure sensor (PTM) in barg. Readings alternate every second.

- ST provides status information:
  - .2...6 provides sample status information for each of the six samples. A dot shows that the respective sample has not been triggered. A steady sample number shows the sample has been triggered and is complete. E.g. ".2...6" indicates that samples 2 and 6 have been triggered and all other samples are un-triggered. See 1.6 SAMPLES.
  - 00 provides status information for the density sensor. "00" indicates that there are no errors. See 2.4.1.2 Density Status.
  - L provides logging status information. An "L" indicates that the system is configured to log data. The "." or "," after the "L" alternates between "." and "," each time a log is taken. See 2.4 LOGGING.
- Two battery indicators are located at the bottom right corner of the screen. The "V" indicator shows the SOV battery level and the "C" indicator shows the controller battery level. See 2.6 CONTROLLER AND SOV BATTERY REPLACEMENT.

1.3. SPECIFICATIONS

GENERAL DATA:

Maximum operating depth ..... 3000 m (9800 ft)

Minimum operating depth ..... 50m (164ft) depending on MEG batch size and speed

Sample loop inlet and outlet connections ..... JIC 12 male

Recommended loop flow rate ..... 5 to 50 litres per minute

Density sensor ..... range 500 kg/m^3 to 1500 kg/m^3, accuracy ±0.5 kg/m^3, resolution 0.1 kg/m^3

Temperature sensor ..... range 0°C to 70°C, accuracy ±1.0°C, resolution 0.1°C

Pressure sensor ..... range 0 barg to 300 barg, accuracy ±0.1% full scale, resolution 0.1 bar

Display ..... 63 mm x 33 mm (2.5" x 1.3")

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

Minimum battery life at +5°C logging including taking 6 samples ..... 10 days

Minimum volume of each sample ..... 0.35 litres

Operating temperature ..... Controller -5°C to +30°C (23°F to 86°F)

Weight in air ..... 450 kg (992 lbs)

Dimensions ..... 1250 mm x 900 mm x 410 mm

MATERIALS:

Controller and sensor housings ..... Alloy Bronze CA104

Frame, manifold, sample cylinders, tubing and ROV switches ..... Stainless Steel

OPTIONS:

External power ..... +23V to +28V, 1 A maximum

Data communication ..... RS485 Half Duplex

Logging ..... Various regimes available

1.4. DENSITY ANALYSER

The density analyser is a separate unit cabled to the controller which provides a temperature compensated density value, sample temperature and status information. The unit is calibrated prior to shipping and cannot be accurately checked in the field. The density analyser should be returned to IK Trax for calibration 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. See 2.4.1.2 Density Status.

1.5. PRESSURE SENSORS

There are two pressure sensors in the system, one in the controller (PTC) and one in the sample manifold (PTM). Both sensors are logged and the live display alternates between the two every second as per 1.2 CONTROLLER DEFAULT SCREEN.

Sensor PTC is used for density compensations.

Both pressure sensors are logged as per 2.4 LOG.

1.6. SAMPLES

The controller has the capability to trigger the collection of up to 6 physical samples. There is also a 7th fully manual and mechanical sample available as per 1.10 ROV EMERGENCY SAMPLE VALVE.

These physical samples can be analysed in a laboratory once the MEG ARTS® system has been recovered.

The 6x controller samples may be configured to trigger manually as per 1.6.1 MANUAL SAMPLES or automatically as per 1.6.2 AUTOMATIC SAMPLES.

Referring to 1.2 CONTROLLER DEFAULT SCREEN the sample status provides the following information:

Sample status	**Description**
.	Samples not taken
O (alternating between O and sample number)	Sampling in progress
Sample number	Sample complete
E	Sample triggered but not taken

Table 1 Sample States

For example a sample status of ".23.O." shows:

- Samples 1, 4 and 6 have not been taken.
- Samples 2 and 3 have been taken.
- Sample 5 is in progress.

Only 1x of the 6x controller samples can be collected at a time. If a second sample is requested while another sample is in progress then the new sample shall not be taken. If the trigger criteria for the second sample is still met when the first sample is complete then the second sample will start. If the trigger criteria for the second sample is no longer met when the first sample is complete then the second sample will not start.

If there are multiple samples with trigger criteria which have been met then the samples are captured in numerical order SOV1 to SOV6. Manual samples are also taken in numerical order SOV1 to SOV6.

The time and date at which individual samples were triggered along with the time the individual sample valves were open for is logged and may be downloaded using 2.3.16 Serial Command Q | Get Sample Trigger Times.

Once a sample has been captured it cannot be retriggered without resetting the sample status as per 2.2.12 RESET SAMPLE STATE or using 2.3.6 Serial Command GR | Reset Sample State. Resetting the sample status also clears the logged data available from 2.3.16 Serial Command Q | Get Sample Trigger Times.

Care must be taken to ensure that the samples have been physically emptied and recharged prior to resetting the sample status.

1.6.1. MANUAL SAMPLES

Samples configured in manual mode as per 2.2.10 SET DENSITY LIMITS will trigger when the ROV SAMPLE switch as per 1.8 ROV SWITCHES is rotated from the OFF position to the ON position and held in this position for at least 1 second. The next sample will not trigger until the ROV sample switch has been moved back to the OFF position first.

1.6.2. AUTOMATIC SAMPLES

Samples configured for automatic trigger will trigger when the density reading is above or below a configured density trigger level. Each sample can be configured with a different density trigger level.

E.g. if sample 1 is configured with trigger level 1024.0 ABOVE then it will be triggered if the density reading is equal to or above 1024.0kg/m^3.

E.g. if sample 6 is configured with trigger level 1035.6 BELOW then the trigger will be ignored until the density rises above the 1035.6kg/m^3. The sample will then be triggered if the density reading falls to equal to or below 1035.6kg/m^3.

1.6.3. SAMPLE TIMES

The sample time setting defines how long each SOV shall remain open for when a sample is triggered. The time chosen will depend on the expected pressure differential between the skid sample INLET and the sample cylinder pre-charge pressure (see section 3.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE). Any significant pressure drops at the expected sample flow rate prior to the skid sample INLET must be considered. Guide values are provided in Table 2 Guidance sample time settings.

Pressure differential between skid sample INLET and sample cylinder pre-charge at sample flow rate (bar)	**Assumed sample flow rate** (litres/minute)	**SAMPLE TIME** (seconds)
3..7	6	5
7..40	15	2
40..300	30	1

Table 2 Guidance sample time settings

A sample time that is too short may not collect a full sample. A sample time that is too long may risk losing nitrogen pre-charge (see section 3.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE).

Sample time can be set as per 2.2.11 SET SAMPLE TIME or using the applicable serial command as per 2.3 SERIAL INTERFACE.

1.7. DENSITY CALCULATIONS

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

- MEG or Methanol initial purity
- Water salinity
- Temperature
- Pressure

IK Trax can construct graphs or tables for project-specific conditions. The method uses curve fits to published data and is provided with no guarantee or warranty and is not intended to replace specialist calculations with equations of state.

Note that MEG concentrations are usually expressed as a percentage of total mass (all values below are expressed as a percentage of total mass). Concentrations may also be expressed as a volume fraction or a mole fraction and there are significant differences between the 3 values.

> E.g. IK Trax curve fits indicate that the expected density of a mixture of 95% MEG and 5% fresh water at +4°C and 100barg is 1123.8kg/m^3.

> E.g. IK Trax curve fits indicate that the expected density of a mixture of 90% MEG and 10% fresh water at +4°C and 100barg is 1119.6kg/m^3.

Typically seawater is 27kg/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 and salinity can be neglected in these cases.

> E.g. IK Trax curve fits indicate that the expected density of a mixture of 95% MEG and 5% saltwater at +4°C and 100barg is 1125.4kg/m^3.

The sea temperature is close to 4°C at depths greater than 1000m in most areas of the world. In shallow water temperature may vary significantly.

> E.g. IK Trax curve fits indicate that the expected density of a mixture of 95% MEG and 5% fresh water at +10°C and 100barg is 1120.5kg/m^3.

The effect of pressure must be considered.

> E.g. IK Trax curve fits indicate that the expected density of a mixture of 95% MEG and 5% fresh water at +4°C and 50barg is 1122.4kg/m^3.

1.8. ROV SWITCHES

The MEG system includes two ROV switches.

- The ROV MENU switch provides the same functionality as the small push button mounted on the side of the controller which allows access to the controller menu system as per 2 CONTROLLER OPERATION.
- The ROV SAMPLE switch allows manual triggering of samples as per 1.6.1 MANUAL SAMPLES.

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 be fixed in this position with a cable tie using the 5mm 'locking' hole provided.

If the ROV 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 and the controller will attempt to resume normal function. Please contact IK Trax if this error message appears without explanation.

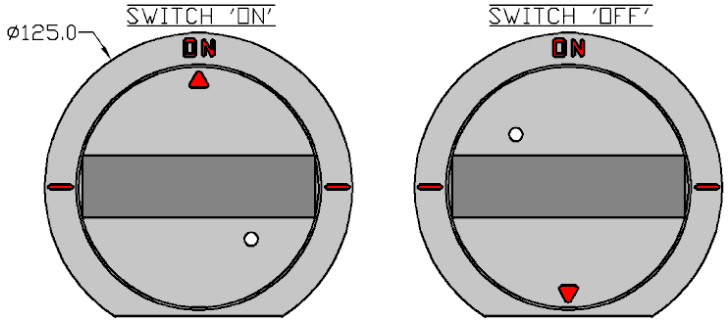


Figure 6 - ROV Switch

1.9. SAMPLE MANIFOLD BYPASS VALVE

To minimise the risk of sample contamination (SOVn leakage) the MEG skid should be deployed with the ROV SAMPLE MANIFOLD BYPASS VALVE positioned for BYPASS FLOW configuration until just before the first sample is required. This means that the samples are protected by a double seal (BYPASS VALVE/NRV1 plus SOVn) until the last possible moment.

While in BYPASS FLOW configuration the discharge fluid will still pass through the density sensor and values for density, pressure and temperature will be available in the log as well as on the subsea display.

Deploying the MEG skid with the ROV SAMPLE MANIFOLD BYPASS VALVE positioned for FULL LOOP FLOW (OPEN) configuration will increase the risk of sample contamination (SOVn leakage).

The SAMPLE MANIFOLD BYPASS Valve is dimensionally compliant to ISO 13628-8 and has a maximum operating torque of 250Nm.

The SAMPLE MANIFOLD BYPASS Valve is operated by turning the valve ¼ turn between BYPASS and OPEN (FULL LOOP FLOW).

1.10. ROV EMERGENCY SAMPLE VALVE

The MEG system includes a fully manual and mechanical sample capture option. This sample can only be captured by an ROV and is a single capture sample.

The ROV EMERGENCY SAMPLE Valve is dimensionally compliant to ISO 13628-8 and has a maximum operating torque of 250Nm.

The ROV EMERGENCY SAMPLE Valve is operated by turning the valve ¼ turn into the SAMPLE position, holding for at least 5 seconds and then returning to the CLOSED position.

1.11. COMMUNICATION CONNECTION

See Figure 2 MEG ARTS® skid with rear cover open in section 1 INTRODUCTION for connector location. This interface allows logged data to be downloaded from the controller, allows the controller to be powered externally rather than using the internal battery, and allows the controller to be quickly configured from a PC using serial commands. A download cable is provided to allow connection of the skid to a PC USB port.

The skid connector is a Burton 55A6-1504 which must be fitted with a Burton 5501-1504-0000 Blanking Plug prior to and during deployment to prevent water ingress, conduction across pins and malfunction.

A terminal program such as Hyperterminal or RealTerm with the settings below is required.

- Baud Rate: 115200
- Bata Bits: 8
- Parity: None
- Stop Bits: 1

1.12. LIFTING AND MOVEMENT

The skid has a maximum gross weight of 500 kg and has been designed and tested for a 4-point lift. Each pad eye is suitable for a 3.25 tonne shackle.

The skid can be conveniently moved on its bolt-on fork pockets or on a pallet but will overhang as the length is greater than 48” (~1250 mm).

The unit may be crated, shipped in a basket suitable for offshore deployment, or shipped in a container with a service subcontractor’s equipment as nominated by the client.

1.13. CHARGE MANIFOLD

The charge manifold is provided to allow isolation and a pressure monitoring during pre-charging of the sample cylinders as per section 3.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE, during unloading of the samples as per section 5.2 SAMPLE UNLOADING, and during several of the operations described in section 6 RETURN / RE-DEPLOYMENT OPERATIONS.

Figure 7 Charge manifold

2. CONTROLLER OPERATION

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 as per 2.2 SINGLE BUTTON MENU INTERFACE.

In addition to the integrated MENU BUTTON the controller is also interfaced with two external ROV operable switches as per 1.8 ROV SWITCHES.

The controller also features an RS485 serial interface as per section 2.3 SERIAL INTERFACE which can be used to set up the controller as well as monitor the sensor readings and download logged data.

2.1. TURN ON SEQUENCE

Refer to Figure 8 MEG ARTS® Controller Initialisation Screens on the next page.

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

The IK Trax LOGO will be displayed for 5 seconds as shown by the COUNTDOWN TIMER located at the bottom left 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.

During the time 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.

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 1.2 CONTROLLER DEFAULT SCREEN.

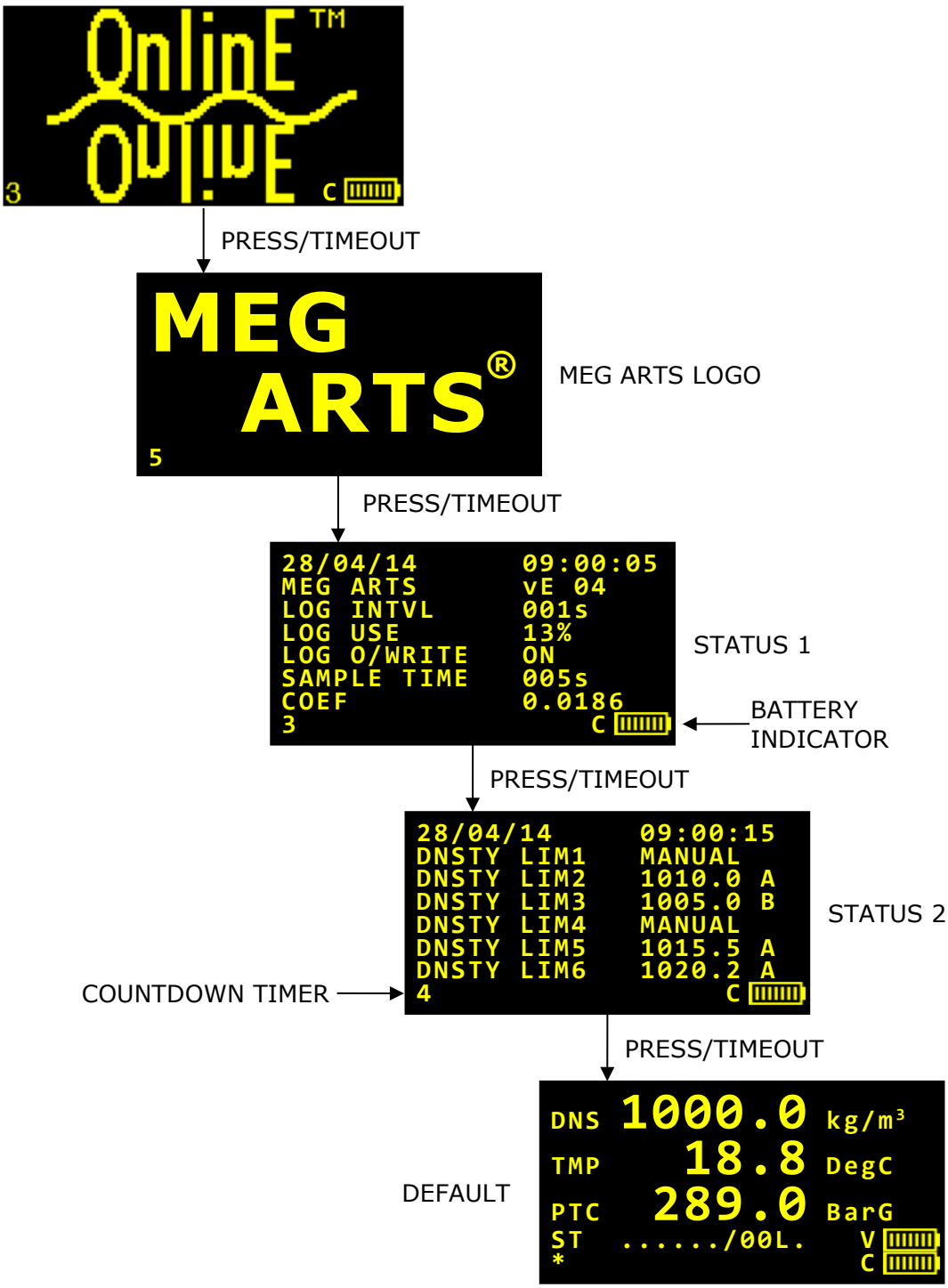


Figure 8 MEG ARTS® Controller Initialisation Screens

2.2. SINGLE BUTTON MENU INTERFACE

Figure 9 Top Level Menus below shows all available menu items and their location. At any point while on the default screen described in section 1.2 CONTROLLER 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.

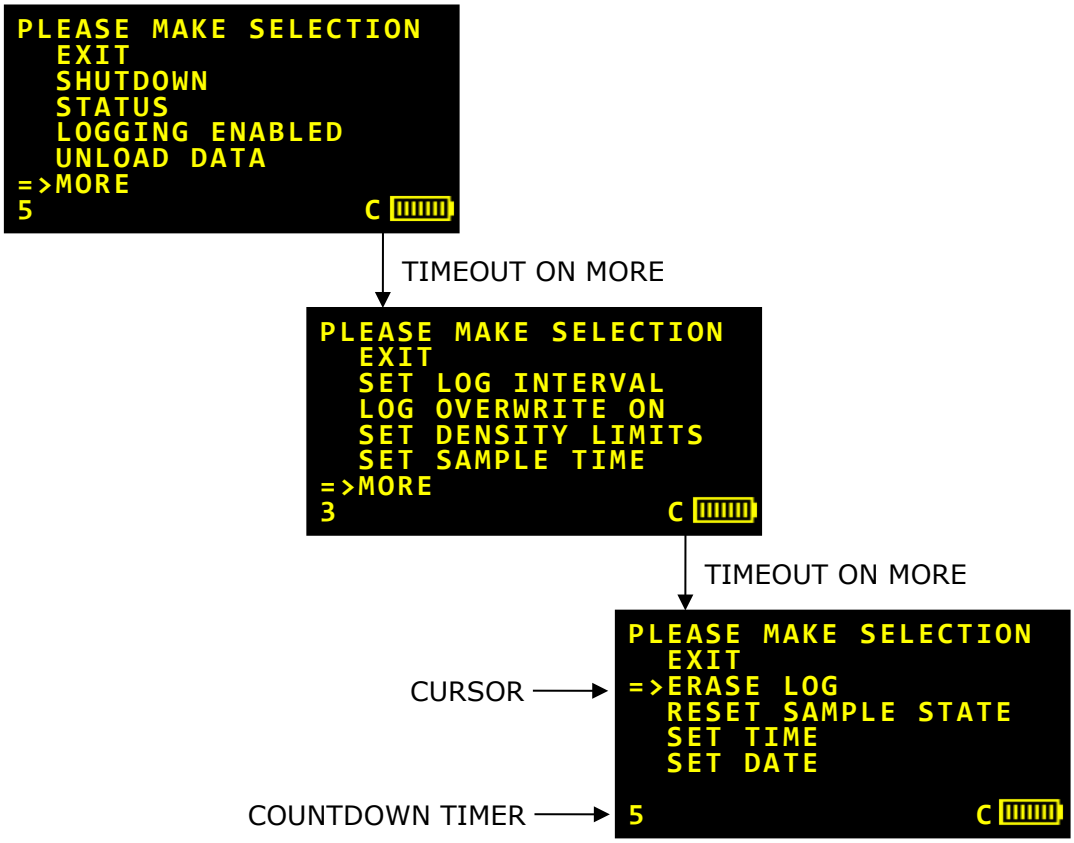


Figure 9 Top Level Menus

2.2.1. 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 10 Default Screen showing MENU SW ERROR and the unit will continue functioning as normal. 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 IK Trax.

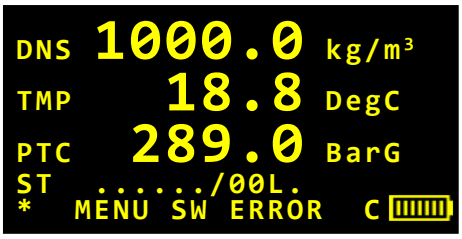


Figure 10 Default Screen showing MENU SW ERROR

2.2.2. 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.

2.2.3. MORE

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

2.2.4. 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 a POWERING DOWN screen will be displayed. 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 2.3 SERIAL INTERFACE. The POWERING DOWN screen will be displayed as per when shutdown is chosen from the menu. The controller cannot be turned on via the serial interface.

2.2.5. STATUS

The STATUS screens are shown as part of section 2.1 TURN ON SEQUENCE and can also be viewed at any time by selecting STATUS from the menu system.

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 2.2.1 MENU BUTTON ERROR.

The status can also be viewed using 2.3.17 Serial Command S | Get Status.

Figure 11 Status Screens

2.2.6. 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 2.3.13 Serial Command N | Set Logging.

2.2.7. UNLOAD DATA

Selecting this item causes the MEG ARTS® Controller to unload all logged data via the RS485 serial interface. Refer to section 2.4.5 LOG 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 12 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.

The log can also be unloaded using 2.3.19 Serial Command U | Unload Log or 2.3.14 Serial Command O | Unload Log Segment.

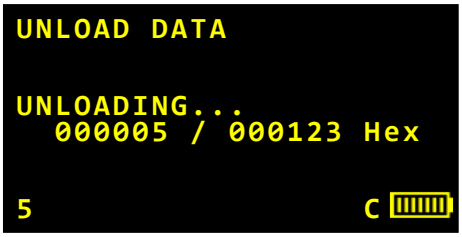


Figure 12 Unload Data Screen

2.2.8. SET LOG INTERVAL

The LOG INTERVAL is the period at which the controller logs readings as per 2.4 LOGGING. Options are 1, 2, 5, or 10 seconds as per 2.4.2 LOGGING CAPACITY.

Log interval can also be set using 2.3.8 Serial Command I | Set Log Interval.

2.2.9. LOG OVERWRITE

If the LOG OVERWRITE setting is ON then when the controller memory becomes full the controller shall continue logging by overwriting the oldest data first.

If the LOG OVERWRITE setting is OFF then when the controller memory becomes full the controller shall stop logging.

The setting cannot be changed from OFF to ON without first performing an ERASE LOG if the memory has been filled. Refer to section 2.2.13 ERASE LOG for more information.

Log overwrite can also be set using 2.3.9 Serial Command J | Set Log Overwrite.

2.2.10. SET DENSITY LIMITS

This selection contains sub-menus to allow the Density Trigger Levels to be defined. See 1.6 SAMPLES for an overview of the system sampling functionality.

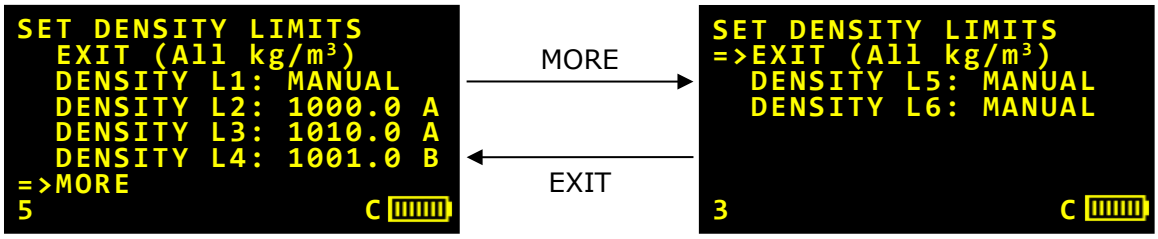


Figure 13 Set Density Limits Menu

The SET DENSITY LIMITS menus (Figure 13) 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.-

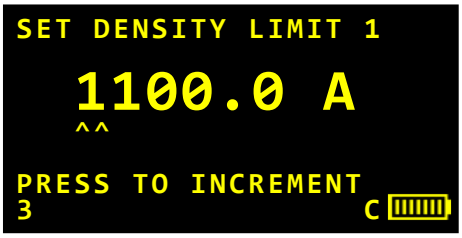


Figure 14 Setting density limit sub-menu

The SET DENSITY LIMIT sub-menu (Figure 14) 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.

The sample triggers can also be configured using 2.3.11 Serial Command L | Set Density Limits.

2.2.11. 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 available valve open times 1, 2, 5 and 10 seconds. See 1.6.3 SAMPLE TIMES.

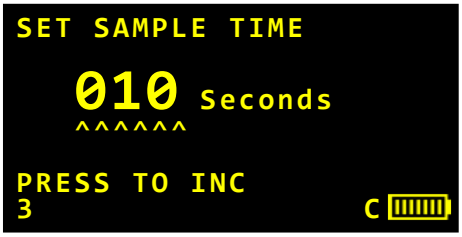


Figure 15 Sample Open Time Menu

Sample time can also be set using 2.3.10 Serial Command K | Set Sample Time.

2.2.12. RESET SAMPLE STATE

This item allows the sample state to be reset as per 1.6 SAMPLES.

The sample status can also be reset using 2.3.16 Serial Command Q | Get Sample Trigger Times.

2.2.13. ERASE LOG

When ERASE LOG is selected a confirmation screen will be displayed which requires that you confirm that the logged data is to be erased. On confirmation an ERASING LOG screen will be shown. The erase process takes approximately 26 seconds to complete and once finished an ERASE SUCCESS screen will be shown.

All other configurations 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.

The log can also be erased using 2.3.4 Serial Command E | Erase Log.

2.2.14. SET TIME/DATE

Every logged reading is time stamped using the controller date and time. The time is normally synchronised with GMT.

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 16 Time and Date Menus

The time and date use HH:MM:SS and DD/MM/YY formats and can also be changed using 2.3.3 Serial Command D | Set Date and 2.3.18 Serial Command T | Set Time.

2.3. SERIAL INTERFACE

The controller can be configured using the RS485 serial interface and a terminal program such as HyperTerminal or RealTerm configured with the settings below. The controller will only respond to serial commands when the 1.2 CONTROLLER DEFAULT SCREEN is displayed.

Baud rate 115,200
Data bits 8
Start bits 1
Stop bits 1

There are serial commands for all menu functions as described in section 2.2 SINGLE BUTTON MENU and several additional serial only commands.

The controller "echoes" all commands received so you can see the commands as you type them. If you do not see the commands in the terminal program as you type them then there is an issue with the controller or the serial link.

All commands are upper case and must be terminated with a carriage return character which is achieved by pressing the Enter key on your keyboard.

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

For commands that require confirmation the character "Y" must be sent within 10 seconds. If confirmation is not received within 10 seconds then the command is aborted.

Serial Command Format	**Description**
A	Get sensor data.
CR N.NNNN	Set Coefficient.
D DD/MM/YY	Set Date where DD/MM/YY is desired date.
E	Erase Log.
F	Trigger Manual Sample.
GR	Reset Sample Status.
H	Get command list.
I NN	Set Log Interval where NN is time in seconds.
J N	Set Log Overwrite action where N is S (Off) or O (On).
K NNN	Set Sample Time where NNN is time in seconds.
Lx M (manual) Lx N XXXX.X (auto)	Set Density limits where x is sample number, N is A (Above) or B (Below) and XXXX.X is threshold in kg/m^3.
M	Get Log Use
N X	Set Logging Status where X is D (Disabled) or E (Enabled).
O HH	Unload Log Segment where HH is hex address 00 to 3E.
P	Get Log Memory Status.
Q	Get Sample Triggers.
S	Get Status.
T HH:MM:SS	Set Time where HH:MM:SS is desired time.
U	Unload Log.
W	Get Number of Starts
X	Get Run Time Flash
Y	Get Run Time RAM
Z	Get Flash Erases
~	Shut Down Controller.

Table 3 Serial Commands Quick Reference

2.3.1. SERIAL COMMAND A | GET SENSOR DATA

Gets the current sensor readings and status.

2.3.2. SERIAL COMMAND CR | SET COEFFICIENT

Sets the current pressure coefficient (typically 0.0186). The current value can be viewed using 2.3.17 Serial Command S | Get Status. **Do not alter this number**.

2.3.3. SERIAL COMMAND D | SET DATE

Sets the system date. The current value can be viewed using 2.3.17 Serial Command S | Get Status. See also 2.2.14 SET TIME/DATE.

2.3.4. SERIAL COMMAND E | ERASE LOG

Erase log. Ensure that any required data has been downloaded before erasing. See also 2.2.13 ERASE LOG.

2.3.5. SERIAL COMMAND F | TRIGGER MANUAL SAMPLE

Trigger next available manual sample as per 1.6.1 MANUAL SAMPLES.

2.3.6. SERIAL COMMAND GR | RESET SAMPLE STATE

Resets the sample status as per 1.6 SAMPLES. The current value can be viewed using 2.3.17 Serial Command S | Get Status.

2.3.7. SERIAL COMMAND H | HELP

Gets list of available commands with syntax.

2.3.8. SERIAL COMMAND I | SET LOG INTERVAL

Sets Log interval as per 2.4 LOGGING. The current value can be viewed using 2.3.17 Serial Command S | Get Status.

2.3.9. SERIAL COMMAND J | SET LOG OVERWRITE

Sets Log Overwrite value as per 2.4 LOGGING. The current value can be viewed using 2.3.17 Serial Command S | Get Status.

2.3.10. SERIAL COMMAND K | SET SAMPLE TIME

Sets Sample Time as per 1.6.3 SAMPLE TIMES. The current value can be viewed using 2.3.17 Serial Command S | Get Status.

2.3.11. SERIAL COMMAND L | SET DENSITY LIMITS

Sets sample triggers as per 1.6 SAMPLES. The current value can be viewed using 2.3.17 Serial Command S | Get Status.

2.3.12. SERIAL COMMAND M | GET LOG USE

Gets percentage log use. See 2.4 LOGGING.

2.3.13. SERIAL COMMAND N | SET LOGGING

Enables or Disables logging as per 2.4 LOGGING. The current value can be viewed using 2.3.17 Serial Command S | Get Status.

2.3.14. SERIAL COMMAND O | UNLOAD LOG SEGMENT

Unloads logged data from specified segment. See 2.4 LOGGING.

2.3.15. SERIAL COMMAND P | GET LOG MEMORY STATUS

Gets the log memory size in segments, 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 oldest segments have been erased to make space for new data.

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

See 2.4 LOGGING.

2.3.16. SERIAL COMMAND Q | GET SAMPLE TRIGGER TIMES

This command returns the dates and times that each SOV was triggered as well as how long each SOV was held open for. If no sample has been taken then "No Sample" is shown. In the example below SOVs 1 to 4 were triggered sequentially starting on 23/04/21 at 12:07:26, each was held open for 5 seconds, SOVs 5 and 6 have not been triggered.

```
Valve 1:  23/04/21 12:07:26 [005s]
Valve 2:  23/04/21 12:07:31 [005s]
Valve 3:  23/04/21 12:07:36 [005s]
Valve 4:  23/04/21 12:07:41 [005s]
Valve 5:  No Sample
Valve 6:  No Sample
```

2.3.17. SERIAL COMMAND S | GET STATUS

Gets system status as shown below. This status is also transmitted during whenever the system is turned on just before 1.2 CONTROLLER DEFAULT SCREEN appears.

```
****************************************
MEG ARTS: Online Electronics Ltd 2021 vE 04
****************************************
(T)  Time:               12:29:09
(D)  Date:               23/04/21
(C)  Coefficient         0.0186
(N)  Logging status:     Enabled
(I)  LOG Interval:       01 Sec
(M)  LOG Use:            09 %
(J)  LOG Overwrite:      ON
(K)  Sample Time:        005 Sec
(G)  Sample State:       1234..
(L1) Density Limit 1:    1100.0 Above
(L2) Density Limit 2:    1050.0 Below
(L3) Density Limit 3:    0900.0 Below
(L4) Density Limit 4:    Manual
(L5) Density Limit 5:    Manual
(L6) Density Limit 6:    Manual
****************************************
```

2.3.18. SERIAL COMMAND T | SET TIME

Sets the system time. The current value can be viewed using 2.3.17 Serial Command S | Get Status.

2.3.19. SERIAL COMMAND U | UNLOAD LOG

Unloads logged data. See 2.4 LOGGING.

2.3.20. SERIAL COMMAND W X Y Z | RELIABILITY

Reliability information.

2.3.21. SERIAL COMMAND ~ | SHUT DOWN

Turns the system off. Only power the system 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. The system cannot be turned back on via the serial interface.

2.4. LOGGING

2.4.1. LOGGING FORMAT

Providing logging is enabled as per 2.2.6 LOGGING ENABLED/DISABLED and the system is turned on readings are logged at a rate defined by the log interval which can be configured using 2.2.8 SET LOG INTERVAL or 2.3.8 Serial Command I | Set Log Interval. Once the log is full as per 2.4.2 LOGGING CAPACITY logging will either stop or start overwriting oldest data first as per 2.2.9 LOG OVERWRITE. Each log entry consists of a line of tab separated values as shown below.

```
00:000   28/04/21   10:02:20   9F   099.9   020.0   0998.3   7   00   30
00:001   28/04/21   10:02:25   80   099.5   020.0   0998.3   1   00   30
00:002   28/04/21   10:02:30   9F   099.9   020.0   0998.3   7   00   30
```

- `00.000` shows the log memory segment and memory location as per 2.4.3 LOGGING MEMORY STRUCTURE.
- `28/04/21` shows date.
- `10:02:20` shows time.
- `9F/80` shows either controller or SOV battery level. See 2.4.1.1 Controller Status.
- `099.9/099.5` shows either controller (PTC) or manifold (PTM) pressure in bar.
- `020.0` shows temperature in °C.
- `0998.3` shows density in kg/m^3.
- `7/1` shows controller status. See 2.4.1.1 Controller Status.
- `00` shows density sensor status. See 2.4.1.2 Density Status.
- `30` shows SOV status. See 2.4.1.3 SOV Status.

If a sensor is not connected or has suffered a failure then the applicable reading will be logged as EEE.E.

2.4.1.1. Controller Status

The controller status is a 1 digit number indicating which pressure sensor and which battery has been logged.

A status of 1 shows Battery Source = Controller and Pressure Sensor = Manifold.

A status of 7 shows Battery Source = SOV and Pressure Sensor = Controller.

2.4.1.2. Density Status

The density status value consists of a 2 digit decimal number indicating any errors being experienced by the density sensor.

More than one density status may occur at the same time in which case the numbers are added together. E.g. density status code 05 represents "Density unstable" density status 01 plus "Density below 500 kg/m^3" density status 04.

Density Status	Description
00	No error
01	Density unstable
02	Temperature outside +0°C to +70°C range
04	Density below 500 kg/m^3 (gas detection)
08	Density above 1500 kg/m^3
16	Temperature sensor error
32	Electronic error

2.4.1.3. SOV Status

The SOV status value consists of a 2 digit hexadecimal value indicating which SOVn has captured a sample as per the table below.

When more than one SOVn has captured a sample the numbers are added together. E.g. SOV Status 3F indicates all samples were captured.

Hexadecimal SOV Status	SOVn
00	None
01	SOV1
02	SOV2
04	SOV3
08	SOV4
10	SOV5
20	SOV6

2.4.2. LOGGING CAPACITY

The controller 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 below. When the log becomes full 2.2.9 LOG OVERWRITE may be used to start overwriting oldest data first.

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 4 Logging capacity

2.4.3. LOGGING MEMORY STRUCTURE

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. The log memory is represented by segments 00_{16} (0) to $3E_{16}$ (62) with each segment holding 1000_{16} (4,096) log entries.

2.4.4. 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 of interest may save time. Refer to Section 2.4.6 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 per 2.3.15 Serial Command P | Get Log Memory Status. This will return the current segment being logged and the number of segments available in memory.

Using Table 5 - Log Segment Time Spans below work out which memory segment contains the target data based on the start time/date of the current segment. 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 5 - Log Segment Time Spans

2.4.5. LOG UNLOAD

Data unload can be initiated from the menu interface as described in section 2.2.7 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 such as Hyperterminal or RealTerm.

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 2.3 SERIAL INTERFACE 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 1.2 CONTROLLER DEFAULT SCREEN is displayed.
4. In the terminal program select "Start capture to file" or equivalent (terminology may vary between terminal programs) and select the filename and location to save the log to. It is recommended to use *.txt format.
5. Use 2.3.17 Serial Command S | Get Status to get system status.
6. Use 2.3.16 Serial Command Q | Get Sample Trigger Times to get sample trigger times.
7. Use 2.2.7 UNLOAD DATA or 2.3.19 Serial Command U | Unload Log or 2.3.14 Serial Command O | Unload Log Segment to initiate unload of main log.
8. Once main log unload is complete select "Stop capture to file" or equivalent within the terminal program (terminology may vary between terminal programs).
9. The logged data should now be available within the specified *.txt file. This data can be copied and pasted directly into IK Trax chart template excel document MEG_5004 following the instructions found within the template to produce the appropriate charts.
10. See 2.4 LOG for expected data format etc.

2.4.6. UNLOAD TIME

The unload times below 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	**Log Interval** (seconds)	**number of log entries**	**Segments** (decimal)*	**Segments** (hex)*	**Download Time** (HH:MM:SS)
1 day	1	86400	21.1	15.1_{16}	00:17:13
1 day	2	43200	10.5	$A.8_{16}$	00:08:36
1 day	5	17280	4.2	4.4_{16}	00:03:26
1 day	10	8640	2.1	2.2_{16}	00:01:43
2 days 23 hours	1	258048#	63.0	$3F.0_{16}$	00:51:27
5 days 23 hours	2	258048#	63.0	$3F.0_{16}$	00:51:27
10 days	5	172800	42.2	$2A.3_{16}$	00:34:27
10 days	10	86400	21.1	15.1_{16}	00:17:13

Table 6 Log Configurations and Unload Times

These are max log size as per 2.4.2 LOGGING CAPACITY.

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

2.5. 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-	8
RS485+	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

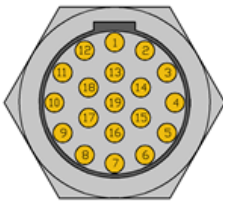


Figure 17 - CRE Size B Bulkhead Connector

2.6. CONTROLLER AND SOV BATTERY REPLACEMENT

There are two batteries located within the controller. One for the controller and one for the solenoid valves (SOV sampling). Both battery levels are shown on the controller default screen as per 1.2 CONTROLLER DEFAULT SCREEN. It is recommended that new packs are fitted before each deployment.

The controller pack has part number OEL-004845. The pack is constructed from 14x Alkaline D cells and has nominal voltage 21.0V.

The SOV pack has part number OEL-004846. The pack contains 2x independent sub-packs each constructed from 18x Alkaline AA cells and having nominal voltage 27.0V. The 2x sub-packs mean the SOV pack can be used twice. It is recommended that once the first sub-pack has been used the sub-pack dummy connector is marked to prevent it being accidentally used again.

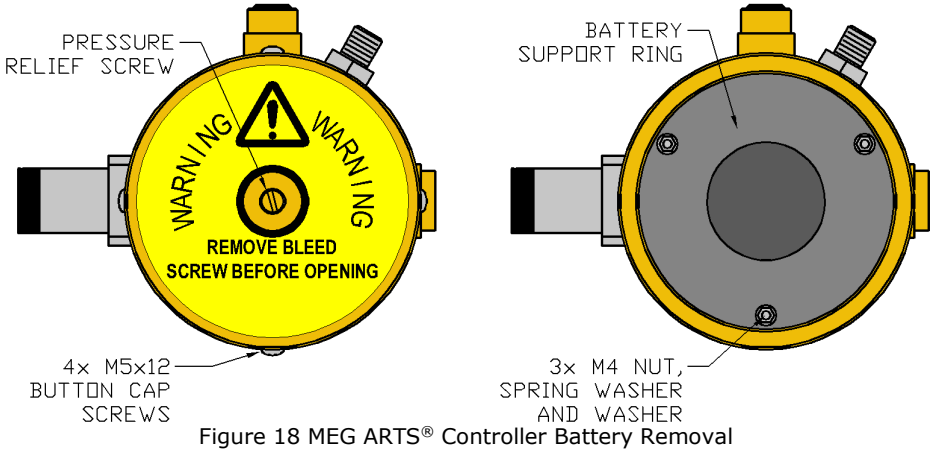


Figure 18 MEG ARTS® Controller Battery Removal

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 batteries 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.
9. Ensure all wires are installed neatly and protected from accidental damage. The controller battery pack should be inserted with the exit wires near the PCB, the SOV battery pack should be inserted with the exit wires at the opposite 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. Ensure the spiral tails of the Back-Up Rings do not protrude from the assembly before fitting the Endcap. These can be secured in place with silicone grease.
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.

3. PRE-DEPLOYMENT OPERATIONS

The MEG ARTS® system will normally be prepared by IK Trax at their premises prior to mobilisation for a project. Where possible the system will be mobilised ready for almost immediate deployment subsea.

Pre-deployment operations are completed on-vessel by the MEG ARTS operator prior to the system being deployed subsea.

3.1. PRE-DEPLOYMENT GENERAL CHECKS

OPERATION	RESULT/COMMENT
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification label.	
6. Visually inspect the unit for any signs of damage in transit and record damage or confirm no damage.	
7. Check that all cables are connected, undamaged and secure. Refer to 7.3 CONNECTOR MAINTENANCE.	
8. Confirm that new battery packs have been fitted as per 2.6 CONTROLLER AND SOV BATTERY REPLACEMENT.	
9. Check that the communication connector is blanked. Refer to 1.11 COMMUNICATION CONNECTION	
10. Check that all sample needle valves (NVS*n*) are closed. Note that NVS1 is on the right and NVS6 is on the left when looking into the needle valve access.	NVS1
	NVS2
	NVS3
	NVS4
	NVS5
	NVS6
	NVS Manual
11. Check that the SAMPLE ROV switch is rotated 180° away from the ON position and secure if required as per 1.8 ROV SWITCHES.	

OPERATION	RESULT/COMMENT
12. Check that the MENU ROV switch is rotated 180° away from the ON position and secure if required as per 1.8 ROV SWITCHES.	
13. Ensure the ROV EMERGENCY SAMPLE Valve is in the CLOSED position as per 1.10 ROV EMERGENCY SAMPLE VALVE.	
14. Ensure the SAMPLE MANIFOLD BYPASS valve is in the desired position as per 1.9 SAMPLE MANIFOLD BYPASS VALVE. Record the position here.	
15. If in BYPASS, the SAMPLE MANIFOLD BYPASS valve must be opened by ROV before any samples may be captured. Confirm the customer is aware that this is the case.	
16. Confirm that the INLET connection fitted is suitable and ready for termination to the pipeline subsea.	
17. Confirm that the OUTLET connection fitted (if any) is suitable and ready for termination subsea. If no connection is required on the OUTLET ensure the blanking cap is removed.	
18. Confirm that all relevant parties (e.g. divers, ROV operators) are familiar and trained with the operations of the system relevant to them.	
19. Confirm that all operations within section 6 RETURN / RE-DEPLOYMENT OPERATIONS have been completed. These operations must be repeated if this is a re-deployment.	6.1 RE-DEPLOYMENT SAMPLE LOOP FLUSHING — tick:
	6.2 RE-DEPLOYMENT SAMPLE CYLINDER FLUSHING — tick:
	6.3 RE-DEPLOYMENT SAMPLE CYLINDER DRYING — tick:
	6.4 RE-DEPLOYMENT SOV INSTALLATION — tick:
	6.5 RE-DEPLOYMENT SAMPLE LOOP PRESSURE TEST — tick:
	6.6 RE-DEPLOYMENT MANIFOLD BYPASS VALVE INTEGRITY TEST — tick:
	6.7 RE-DEPLOYMENT SAMPLE CYLINDER PRESSURE TEST — tick:
20. Confirm all SOV lids and the bleedscrew on the sample loop manifold are secure.	Tick: 1 2 3 4 5 6 BS
21. Confirm all NVSn sample needle valves are closed and stem protectors fitted.	1 2 3 4 5 6 M
22. Confirm that all skid covers are fitted and secure.	
23. Check skid anodes and replace if necessary as per 7.2 ZINC ANODES.	

OPERATION	RESULT/COMMENT	
24. Confirm system PTC still valid? pressure sensor calibration is in date and suitable for the project requirements. Record certificate number.	Cal. Cert No	Cal. Date
25. Confirm system PTM still valid? pressure sensor calibration is in date and suitable for the project requirements. Record certificate number.	Cal. Cert No	Cal. Date
26. Confirm system density sensor calibration is in date and suitable for the project requirements. Record certificate number.	Cal. Cert No	Cal. Date
27. Confirm skid lifting certification is in date and suitable for the project requirements. Record certificate number.	Cert No	Inspection Date
NOTES:		

3.2. PRE-DEPLOYMENT CONTROLLER CONFIGURATION

While completing this section compare the controller configuration against the requirements for the project. The density sample trigger levels may need to be adjusted if the expected sea temperature or sample pressure has changed since last configuration.

<table>
<tr><th>OPERATION</th><th colspan="4">RESULT/COMMENT</th></tr>
<tr><td>1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.</td><td colspan="4"></td></tr>
<tr><td>2. Record the name of the operator completing these operations.</td><td colspan="4"></td></tr>
<tr><td>3. Record the date that these operations were completed.</td><td colspan="4"></td></tr>
<tr><td>4. Record project and pipeline names and/or reference numbers.</td><td colspan="4"></td></tr>
<tr><td>5. Record MEG skid serial number which can be found on the frame identification plate.</td><td colspan="4"></td></tr>
<tr><td>6. Power on the controller as per 2.1 TURN ON SEQUENCE.</td><td colspan="4"></td></tr>
<tr><td>7. Set and record controller time and date so that it is synchronised with the required time zone. See 2.2.14 SET TIME/DATE.</td><td colspan="4"></td></tr>
<tr><td>8. Record controller firmware version from status screen. See 2.2.5 STATUS.</td><td colspan="4"></td></tr>
<tr><td>9. Set and record the controller log interval from status screen. See 2.2.8 SET LOG INTERVAL.</td><td colspan="4"></td></tr>
<tr><td>10. Confirm logging is enabled from 1.2 CONTROLLER DEFAULT SCREEN.</td><td colspan="4"></td></tr>
<tr><td>11. Set and record controller log overwrite status from status screen. See 2.2.9 LOG OVERWRITE.</td><td colspan="4"></td></tr>
<tr><td>12. Set and record controller sample time from status screen. See 1.6.3 SAMPLE TIMES.</td><td colspan="4"></td></tr>
<tr><td rowspan="8">13. Set and record controller sample trigger modes and trigger levels. For all samples record target trigger level. Record the trigger level, (A)bove, (B)elow or (M)anual) and the expected (target) MEG % purity.

The ROV EMERGENCY SAMPLE can only be triggered by an ROV as per 1.10 ROV EMERGENCY SAMPLE VALVE.</td><td>Sample No</td><td>Trigger Level (kg/m^3)</td><td>A/B/M</td><td>Target %</td></tr>
<tr><td>SA1</td><td></td><td></td><td></td></tr>
<tr><td>SA2</td><td></td><td></td><td></td></tr>
<tr><td>SA3</td><td></td><td></td><td></td></tr>
<tr><td>SA4</td><td></td><td></td><td></td></tr>
<tr><td>SA5</td><td></td><td></td><td></td></tr>
<tr><td>SA6</td><td></td><td></td><td></td></tr>
<tr><td>SAM</td><td></td><td>M</td><td></td></tr>
</table>

14. Record who supplied the density/purity levels.				
15. Record the expected sample temperature used to calculate any trigger levels above.				
16. Record the expected sample pressure used to calculate any trigger levels above.				
17. Confirm that the controller and SOV battery indicators reads full. It is recommended to fit new battery packs prior to each deployment as per 2.6 CONTROLLER AND SOV BATTERY REPLACEMENT. Record number of bars displayed on each battery indicator.	MAN:	/7	SOV:	/7
18. Record density reading and confirm that it is as expected. If the sensor is filled with air then this may be low. Refer to 1.2 CONTROLLER DEFAULT SCREEN.				
19. Record temperature reading and confirm that it is as expected. Refer to 1.2 CONTROLLER DEFAULT SCREEN.				
20. Record PTC pressure reading and confirm that it is as expected (e.g. 000.0barg). Refer to 1.2 CONTROLLER DEFAULT SCREEN.				
21. Record PTM pressure reading and confirm that it is as expected (e.g. 000.0barg). Refer to 1.2 CONTROLLER DEFAULT SCREEN.				
22. Record the controller status information and confirm all sample are un-triggered and ready. E.g. "**ST...../00L**". Refer to 1.2 CONTROLLER DEFAULT SCREEN. Reset the samples if required as per 2.2.12 RESET SAMPLE STATE.				
23. Erase the controller log as per 2.2.13 ERASE LOG.				
24. Shutdown the controller as per 2.2.4 SHUTDOWN.				
NOTES:				

3.3. PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE

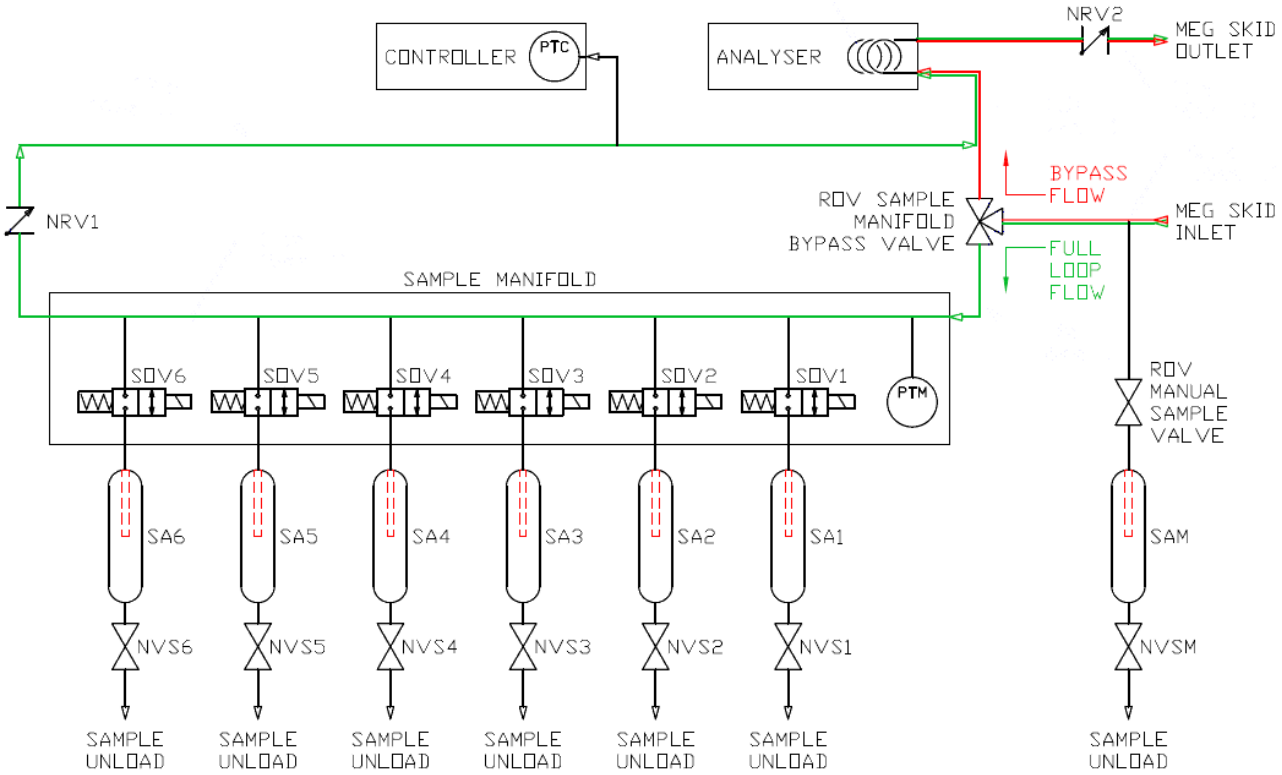


Figure 19 System schematic

Nitrogen pre-charging of the sample cylinders is required to restrict the potential pressure increase of the samples caused by thermal expansion of the sample. The required nitrogen pre-charge pressure is related to the expected sampling pressure subsea (water depth plus any pipeline pressure), sample fluid properties, and the temperatures during pre-charging, sampling and unloading. Guide values for pre-charge pressures are provided in Table 7 Guidance nitrogen pre-charge levels which assume a surface temperature during pre-charge and sample unload of +40°C, a subsea temperature of +4°C and a target sample pressure limit of 344barg.

SAMPLE PRESSURE (barg)	**PRE-CHARGE** (barg)	**EXPECTED SAMPLE VOLUME** (ml)
5..30	0	>430
30..150	7	>390
150..250	50	>350

Table 7 Guidance nitrogen pre-charge levels

Nitrogen charging must be from a gas cylinder fitted with a regulator. Nitrogen pumps which may be available for pipe purging or other operations are not suitable for the small volumes within the sample cylinders. Gas regulators have different pressure ranges. Ensure the regulator range is suitable and set for the required pressure. If the intended charge pressure is 0 barg (atmospheric pressure) then no pre-charge is required.

OPERATION	**RESULT/COMMENT**
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	

3. Record the date that these operations were completed.							
4. Record project and pipeline names and/or reference numbers.							
5. Record MEG skid serial number which can be found on the frame identification plate.							
6. Remove all NVSn stem protectors.	Tick:						
	1	2	3	4	5	6	M
7. If the required pre-charge is 0barg then fully open and then fully close each NVSn in turn to ensure each sample is at atmospheric pressure. Record pressure (0barg) in each sample at step 13 and then jump to step 16.							
8. Otherwise connect the charge manifold to the NVSn quick connect stem. See 1.13 CHARGE MANIFOLD.							
9. Connect the nitrogen supply to the charge manifold.							
10. Open the charge manifold needle valve.	Tick:						
	1	2	3	4	5	6	M
11. Open NVSn.	1	2	3	4	5	6	M
12. Open the nitrogen regulator valve and increase nitrogen pressure until the desired pressure is reached. Refer to Table 7 Guidance nitrogen pre-charge levels.							
13. When pressure is stable record the charge pressure and close NVSn. Note that NVSM is in the far right then NVS1 through to NVS6 on the left when looking into the needle valve access.	NVS1:						barg
	NVS2:						barg
	NVS3:						barg
	NVS4:						barg
	NVS5:						barg
	NVS6:						barg
	NVSM:						barg
14. Remove the pressure from the nitrogen regulator and hose. Nitrogen is an asphyxiant and must be vented to a well ventilated area. Remove the charge manifold.							
15. Repeat steps 8 to 14 for each sample cylinder.							
16. Replace all NVSn stem protectors.	Tick:						
	1	2	3	4	5	6	M
17. Replace and secure all skid covers.							
NOTES:							

4. DEPLOYMENT OPERATIONS

4.1. DEPLOYMENT POWER UP

The unit may be powered up on deck shortly prior to deployment or powered up while on the seabed utilising a diver or ROV to manipulate the ROV MENU switch.

1. Turn the ROV MENU switch to the ON position. See 2.1 TURN ON SEQUENCE.
2. Wait for the IK Trax logo to appear on the controller display (approximately 5 seconds).
3. Turn the ROV MENU switch 180° away from the ON position and leave in this position.
4. If required lock ROV switches in place with cable ties or equivalent.
5. The system will scroll through several status screens before displaying sensor data as per 1.2 CONTROLLER DEFAULT SCREEN..
6. Confirm that valid sensor readings are being displayed.

4.2. DEPLOYMENT LOCATION

Make sure the unit is lifted according to the project lifting plan or other controlled procedure and lowered into the sea.

Ensure the unit is to be placed on a protective structure (if required) near the pipeline system as defined by interface engineering and within the sample hose length from the sample point. Typical distance would be 5m or 10m.

If the identified location is on the seabed then mattresses may be needed for support.

The MEG ARTS® sample hose should be connected to the nominated stab or other connection.

Pipeline valves may be operated as required.

4.3. DEPLOYMENT ANALYSIS AND SAMPLING

MEG ARTS® will log data and capture samples according to the settings recorded in section 3.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION.

Samples configured in manual mode during section 3.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION will trigger when the ROV SAMPLE switch is rotated from the OFF position to the ON position and held in this position for at least 1 second. See 1.6.1 MANUAL SAMPLES for more details.

Samples configured in automatic mode during section 3.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION will trigger when the live density value matches or passes the configured trigger level. See 1.6.2 AUTOMATIC SAMPLES for more details.

5. RECOVERY OPERATIONS

5.1. RECOVERING UNIT TO DECK

After pipeline conditioning MEG ARTS® can be disconnected and recovered to deck. The unit may be shutdown subsea to limit logging of unnecessary data but this is not recommended due to the possibility of inadvertent menu selections.

Subsea shut down can be achieved using the ROV MENU switch to select the SHUTDOWN menu item and then leaving ROV MENU switch rotated 180° away from the ON position.

5.2. SAMPLE UNLOADING

The skid will be recovered from subsea deployment with the samples stored at pressure. The pressure may be above the subsea ambient pressure due to thermal expansion of the sample. The Nitrogen pre-charge will be at the same elevated pressure.

OPERATION	**RESULT/COMMENT**
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification plate.	
6. Disconnect the sample inlet hose and then plug to prevent possible contamination.	
7. Disconnect the sample outlet hose and then plug to prevent possible contamination.	
8. Confirm that the sample cylinders are pointing at least 15° downwards with each NVSn at the lowest point so that any liquid in the sample runs downwards to the needle valves. This will be achieved if the skid frame is level. If this is not the case then this unload procedure shall not work.	
9. Confirm the charge manifold is clean and dry to prevent contamination of the sample. Blow through with clean water and then clean air or Nitrogen if required. Nitrogen is an asphyxiant and must be vented to a well ventilated area. See 1.13 CHARGE MANIFOLD.	

10. Connect the charge manifold to NVSn. Ensure that the charge manifold is positioned so that the pressure gauge can be observed and the outlet will safely discharge any contained pressure away from personnel. Note that NVS1 is on the right and NVS6 is on the left when looking into the needle valve access.	Tick						
	1	2	3	4	5	6	M
11. Ensure manifold gauge powered on and reading 0barg							
12. Close the charge manifold needle valve.							
13. Open sample needle valve NVSn which will equalise pressure between sample SAn and the manifold. Note that NVS1 is on the right and NVS6 is on the left when looking into the needle valve access.	Tick						
	1	2	3	4	5	6	M

14. Before unloading sample SAn record pressure of sample SAn. Note that this should be at pipeline pressure if a sample was triggered or pre-charge pressure (see section 3.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE) if no sample was triggered. If the sample is not at either of these pressures then it indicates a problem and should be recorded and reported.	SA1	barg
	SA2	barg
	SA3	barg
	SA4	barg
	SA5	barg
	SA6	barg
	SAM	barg
15. Slowly open the charge manifold needle valve to eject the sample into the sample container (expect 350 to 500ml). Note that once the liquid sample has been ejected any residual gas shall be released. Record the pressure when the last of the liquid is ejected and gas starts to be released for each sample. This should be at the pre-charge pressure if a full liquid sample was captured. If this is not the case then the pressure should be recorded and reported. Nitrogen is an asphyxiant and must be vented to a well ventilated area. NOTE: The MANUAL sample may have a larger capacity due to the pipework supplying the cylinder	SA1	ml
	SA2	ml
	SA3	ml
	SA4	ml
	SA5	ml
	SA6	ml
	SAM	ml

16. If it is suspected that 0barg was reached before the complete liquid sample was unloaded (which can occur if e.g. the SOVs have failed to re-seal after sample capture or the sample is "foamy") then sample cylinder SAn can be temporarily re-charged to an elevated pressure with Nitrogen via NVSn to eject the remaining sample as per step 15. Ensure that sample pressure is 0barg before attempting re-charge. Ensure the sample needle valve is closed while changing connections when re-charging and connecting back the sample bottle.							
17. Confirm sample pressure is 0barg before proceeding.	Tick						
	1	2	3	4	5	6	M
18. Close NVSn valve.	1	2	3	4	5	6	M
19. Seal and label the sample container with the following information. • Project number/name • Sample cylinder number • Sample time and date (see step 22) • Sample volume • Name of person extracting sample • Current Time/Date	1	2	3	4	5	6	M
20. Record and report the presence of any significant debris in any of the samples. E.g. take a sample of the debris and/or take photographs.	SA1						
	SA2						
	SA3						
	SA4						
	SA5						
	SA6						
	SAM						
21. Repeat steps 9 to 20 for each sample.							
22. Connect a PC to the communication connector using the download cable and power on the controller. Using the "Q" command, record the sample time/date on the sample bottle labels.							

23. Clean the charge manifold by flushing through with clean water and then dry by blowing through with clean air or Nitrogen. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	
24. Within 72 hours of recovering the MEG skid to the deck section 6.1 RE-DEPLOYMENT SAMPLE LOOP FLUSHING should be completed to prevent permanent debris build up within the density sensor.	

NOTES:

5.3. DATA DOWNLOAD

Download logged data following 2.4.5 LOG UNLOAD.

OPERATION	RESULT/COMMENT
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification plate.	
6. Using the supplied download cable connect the MEG communications connector to a PC USB port.	
7. On the terminal program, set the baud rate to 115,200, 8 data bits, no parity and 1 stop bit.	
8. Start the recording feature in the terminal program and assign filename in format "YYMMDD HHMM - PROJECT NAME - PIPELINE NAME.txt" where "YYMMDD" is the current date backwards and "HHMM" is the current time. Record the filename.	
9. Send serial status "S" command to receive status of the controller.	
10. Send serial "W", "X", "Y", "Z" commands to receive reliability information.	
11. Send serial "Q" command to receive the trigger times.	
12. Send serial "U" command to unload the entire log. This may take up to 50 minutes depending on the amount of logged data.	
13. Once all data has been received, close the recording feature and confirm that the file has been saved and copy a backup onto a USB pen drive. IK Trax excel template MEG_5004 may be used to generate charts.	
14. Disconnect the PC and power down the controller.	
NOTES:	

6. RETURN / RE-DEPLOYMENT OPERATIONS

All operations within this section should be completed in the order written after recovery from the seabed and unloading of samples and data so that the system is ready for re-deployment.

If the unit is to be returned to IK Trax before the next re-deployment then only 6.1 RE-DEPLOYMENT SAMPLE LOOP FLUSHING needs to be completed.

The system is typically transported depressurised with all needle valves (NVs) closed and sample loop ends capped to prevent contamination. Solenoid operated valves (SOVs) are normally closed when not energised. There may be trapped pressure due to temperature changes or previous inadvertent or incomplete operations.

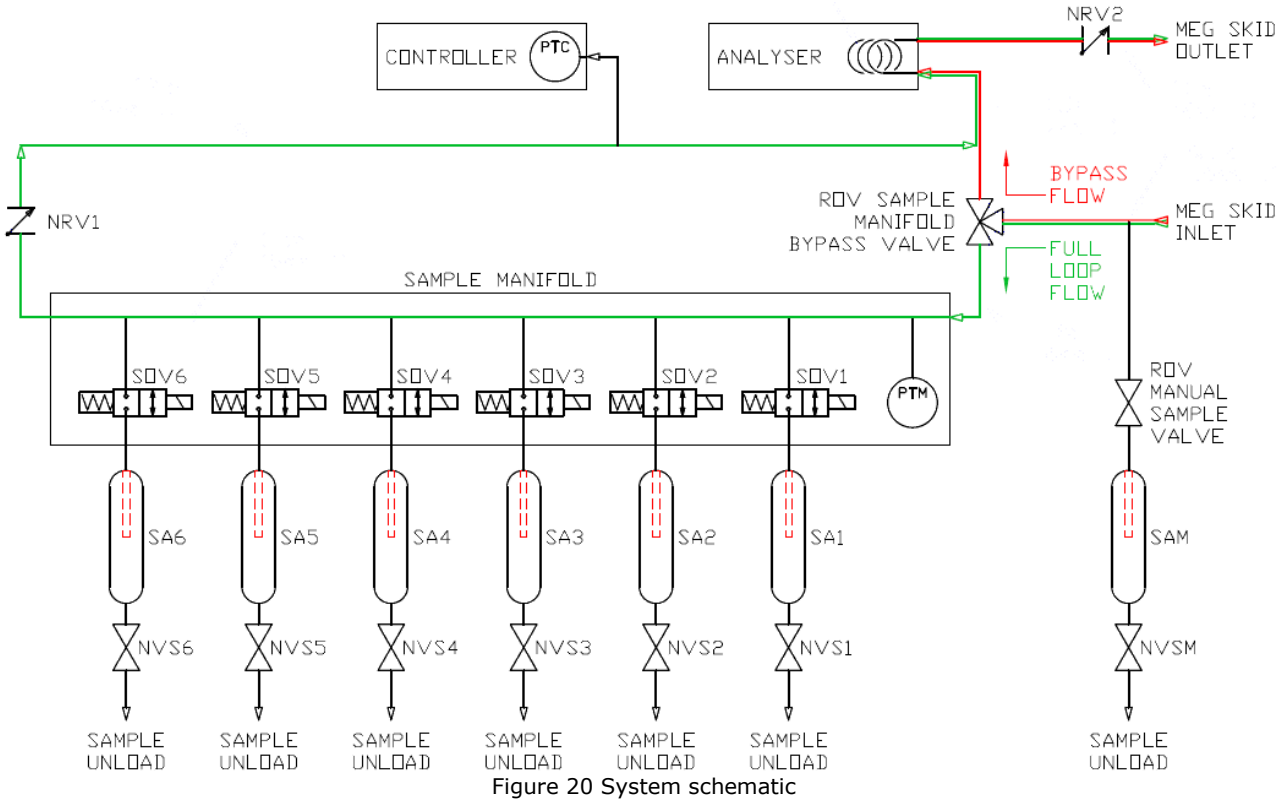


Figure 20 System schematic

6.1. RE-DEPLOYMENT SAMPLE LOOP FLUSHING

The sample loop must be flushed with clean water within 72 hours of being recovered to deck after deployment to prevent permanent debris build up within the density sensor. This operation should be completed prior re-deployment or prior to returning the MEG skid to IK Trax.

OPERATION	RESULT/COMMENT
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	

5. Record MEG skid serial number which can be found on the frame identification plate.	
6. Put the 1.9 SAMPLE MANIFOLD BYPASS VALVE into the FULL LOOP FLOW position.	
7. Connect a filtered water supply to the skid sample INLET	
8. Connect a waste hose to the skid sample OUTLET.	
9. Direct the waste hose into a container so that any debris ejected can be witnessed.	
10. Flush water through the loop for at least 5 minutes.	
11. Put the 1.9 SAMPLE MANIFOLD BYPASS VALVE into the BYPASS position.	
12. Flush water through the loop for at least 5 minutes.	
13. Record and report the presence of any significant debris. E.g. take a sample of the debris and/or take photographs.	
NOTES:	

6.2. RE-DEPLOYMENT SAMPLE CYLINDER FLUSHING

All sample cylinders should be flushed with clean water within 72 hours of being recovered to deck after deployment to remove any debris. This operation involves opening the sample loop manifold and should only take place somewhere clean, dry and tidy.

OPERATION	RESULT/COMMENT					
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.						
2. Record the name of the operator completing these operations.						
3. Record the date that these operations were completed.						
4. Record project and pipeline names and/or reference numbers.						
5. Record MEG skid serial number which can be found on the frame identification label.						
6. Open the rear cover by removing the 2x inner fasteners and hinging the cover open on the 2x outer fasteners.						
7. Using a Phillips head screwdriver remove the manifold bleedscrew from the junction box lid to relieve any internal pressure. Once removed refit the manifold bleedscrew so that it is not lost.						
8. Using a 3mm Allen key remove the 6x SOV lids from the sample loop manifold. Do not remove the junction box lid (which has the manifold bleedscrew attached). While these lids are removed be very careful not to damage or contaminate the lid Orings in any way. Keep the workplace clean, dry and tidy.	Tick					
	1	2	3	4	5	6
9. Remove the thumb screw from each SOV cartridge.	1	2	3	4	5	6
10. Pull apart the bullet connectors connected to each SOV coil and withdraw the SOV coil from each SOV cartridge. Note that there is an Oring fitted on either side of the SOV coil which must not be lost. Set aside the SOV coils, Orings and thumb screws somewhere clean, dry and tidy.	1	2	3	4	5	6
11. Using a 27mm box spanner unscrew and withdraw each SOV cartridge and set aside somewhere clean, dry and tidy.	1	2	3	4	5	6
12. For future investigations individually tag and bag each SOV. Record at least project reference, current date, and SOV position on the tag.	1	2	3	4	5	6
	SOV1					

13. Record the presence of any significant debris within the SOV cavities. Remove any larger debris prior to flushing to prevent unnecessary contamination of the sample cylinders or needle valves during flushing.							
	SOV2						
	SOV3						
	SOV4						
	SOV5						
	SOV6						
14. Using an 8mm Allen key fit an M22 blank over each SOV port within the manifold.	Tick						
	1	2	3	4	5	6	
15. Open the ROV EMERGENCY SAMPLE valve							
16. Put the 1.9 SAMPLE MANIFOLD BYPASS VALVE into the FULL LOOP FLOW position.							
17. Connect a filtered water supply to the skid sample INLET.							
18. Blank off the skid sample OUTLET.							
19. Connect a waste hose to sample cylinder needle valve NVSn. Direct the waste hose into a container so that any debris ejected can be witnessed.	Tick						
	1	2	3	4	5	6	M
20. Close all NVSn and then open only the NVSn to be flushed.	1	2	3	4	5	6	M
21. Flush water through sample cylinder SAn for at least 5 minutes. Close NVSn momentarily on at least two occasions half way through to ensure the sample cylinder is filled. Record and report the presence of any significant debris. E.g. take a sample of the debris and/or take photographs.	SA1						
	SA2						
	SA3						
	SA4						
	SA5						
	SA6						
	SAM						
22. Repeat steps 19 to 21 for each sample cylinder SAn.							
NOTES:							

6.3. RE-DEPLOYMENT SAMPLE CYLINDER DRYING

All sample cylinders should be dried of as much liquid as possible to prevent contamination of samples during the next deployment. Drying is accomplished by flowing dry, clean nitrogen (preferred) or air through each sample cylinder SA*n* to blow any liquid downwards and out of the sample cylinder NVS*n*. When the skid is on a level surface the sample cylinders are oriented tilted approximately 15° downwards to facilitate drying. This operation involves opening the sample loop manifold and should only take place somewhere clean, dry and tidy.

OPERATION	**RESULT/COMMENT**						
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.							
2. Record the name of the operator completing these operations.							
3. Record the date that these operations were completed.							
4. Record project and pipeline names and/or reference numbers.							
5. Record MEG skid serial number which can be found on the frame identification plate.							
6. Confirm that the skid is on a level surface so that the sample cylinders are oriented tilted approximately 10° downwards to facilitate drying.							
7. Put the 1.9 SAMPLE MANIFOLD BYPASS VALVE into the FULL LOOP FLOW position.							
8. Connect a Nitrogen supply to the skid sample INLET.							
9. Blank off the skid sample OUTLET.							
10. Put skid into FULL FLOW configuration.							
11. Open ROV EMERGENCY SAMPLE valve.							
12. Close all sample cylinder needle valves and then open only the NVSn to be dried.	Tick						
	1	2	3	4	5	6	M
13. Blow through sample cylinder SAn until no more liquid is ejected from the sample cylinder needle valve. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	1	2	3	4	5	6	M
14. Blow through sample cylinder SAn with at least 5 sharp bursts and until no more liquid is ejected from the sample cylinder needle valve. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	1	2	3	4	5	6	M
15. Repeat steps 12 to 14 for each sample cylinder SAn.							
16. Close the ROV EMERGENCY SAMPLE valve.							

6.4. RE-DEPLOYMENT SOV INSTALLATION

SOV cartridges which have been previously deployed should not be re-used and should be returned to IK Trax for refurbishment. A complete set of new SOV cartridges should be fitted prior to each re-deployment.

OPERATION	RESULT/COMMENT					
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.						
2. Record the name of the operator completing these operations.						
3. Record the date that these operations were completed.						
4. Record project and pipeline names and/or reference numbers.						
5. Record MEG skid serial number which can be found on the frame identification plate.						
6. Fill a small container with 20mm depth of clean Enerpac HF95 hydraulic oil which will be used to prime the SOV cartridges before fitting.						
7. Remove the M22 blank from SOVn cavity within the sample loop manifold.	Tick					
	1	2	3	4	5	6
8. Confirm the new SOV cartridge Orings are clean and undamaged.	1	2	3	4	5	6
9. Prime the SOV cartridge by fully submerging the wetted end in the hydraulic oil above and agitating to wet out the sealing surfaces. Keep the SOV vertical to retain the pool of oil in the SOV valve seat until fitted into the sample loop manifold.	1	2	3	4	5	6
10. Use a 27mm box spanner to fit the SOV cartridge into the sample loop manifold with fastening torque 8.9Nm.	1	2	3	4	5	6
11. Refit the SOV coil ensuring that an Oring is fitted above and below the SOV coil. The thumb screw should be tightened by hand only.	1	2	3	4	5	6
12. Remake the bullet connectors to the SOV coil and tuck into the SOV cavity beside the SOV coil.	1	2	3	4	5	6
13. Refit the SOV cavity lid ensuring that all Orings are clean and undamaged.	1	2	3	4	5	6
14. Repeat steps 7 to 13 for each SOVn.						
15. Ensure the bleedscrew on top of the junction box lid of the sample loop manifold is tight.						

6.5. RE-DEPLOYMENT SAMPLE LOOP PRESSURE TEST

Completing a sample loop pressure test after replacement of SOVs for a re-deployment is essential. The test involves sealing all sample cylinders with atmospheric pressure inside and then increasing the sample loop pressure to 50barg with Nitrogen and holding for a period of time. If any of the SOVs are leaking then the corresponding sample cylinder pressure will increase.

Nitrogen charging must be from a gas cylinder fitted with a regulator. Nitrogen pumps which may be available for pipe purging or other operations are not suitable for the small volumes within the sample cylinders. Gas regulators have different pressure ranges. Ensure the regulator range is suitable and set for the required pressure.

OPERATION	**RESULT/COMMENT**						
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.							
2. Record the name of the operator completing these operations.							
3. Record the date that these operations were completed.							
4. Record project and pipeline names and/or reference numbers.							
5. Record MEG skid serial number which can be found on the frame identification plate.							
6. Fully open all sample cylinder needle valves to vent the sample cylinder to atmospheric pressure 0barg.	Tick						
	1	2	3	4	5	6	M
7. Fully close all sample cylinder needle valves to trap atmospheric pressure 0barg inside each sample cylinder.	1	2	3	4	5	6	M
8. Ensure the ROV EMERGENCY SAMPLE valve is in the CLOSED position							
9. Ensure the SAMPLE MANIFOLD BYPASS valve is in the OPEN (FULL FLOW) position.							
10. Seal the skid sample OUTLET.							
11. Connect a Nitrogen supply to the skid sample INLET.							
12. Increase the sample loop pressure to 50barg.							
13. Record pressure at PTM and PTC which should closely match.	PTM:			PTC:			
14. Hold the sample loop pressure until the pressure drop is within 0.1barg/minute and for at least 1 hour.							
15. Record pressure at PTM and PTC which should closely match.	PTM:			PTC:			

16. Connect the charge manifold to sample cylinder needle valve NVSn. See 1.13 CHARGE MANIFOLD.	1	2	3	4	5	6	M
17. Close the charge manifold needle valve.	1	2	3	4	5	6	M
18. Open sample needle valve NVSn.	1	2	3	4	5	6	M
19. Confirm that the sample cylinder contains atmospheric pressure 0barg. If the sample cylinder contains elevated pressure then it indicates that SOVn or ROV MANUAL SAMPLE valve is leaking.	SA1						
	SA2						
	SA3						
	SA4						
	SA5						
	SA6						
	SAM						
20. Slowly open the charge manifold needle valve to vent any pressure and remove the charge manifold.	1	2	3	4	5	6	M
21. Repeat steps 16 to 20 for each sample cylinder Sn.							
22. Bleed off all pressure from the sample loop and remove the Nitrogen supply. Nitrogen is an asphyxiant and must be vented to a well ventilated area.							

NOTES:

6.6. RE-DEPLOYMENT MANIFOLD BYPASS VALVE INTEGRITY TEST

Completing a SAMPLE MANIFOLD BYPASS valve integrity test is required if the system is going to be deployed in sample manifold bypass mode. The test involves isolating the sample manifold by closing the SAMPLE MANIFOLD BYPASS valves and then pressurising the outer sample loop (with OUTLET blanked). Any pressure rise in the sample manifold pressure sensor (via the Controller LOG) will illustrated that either the SAMPLE MANIFOLD BYPASS valve or sample manifold NRV are passing.

OPERATION	**RESULT/COMMENT**	
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.		
2. Record the name of the operator completing these operations.		
3. Record the time and date that these operations were completed.		
4. Record project and pipeline names and/or reference numbers.		
5. Record MEG skid serial number which can be found on the frame identification plate.		
6. Ensure the sample manifold is at atmospheric pressure by observing PTM readings on the controller.		
7. Seal the skid sample OUTLET.		
8. Ensure the SAMPLE MANIFOLD BYPASS valve is in the BYPASS position		
9. Power on the Controller		
10. Connect a Nitrogen supply to the skid sample INLET.		
11. Increase the sample loop pressure to 50barg.		
12. Record pressure at PTM and PTC. PTM should remain at atmospheric pressure and PTC should remain at 50barg if there are no leaks.	PTM:	PTC:
13. Hold the sample loop pressure until the pressure drop is within 0.1barg/minute and for at least 1 hour.	Pressure change: barg/min	
14. Record pressure at PTM and PTC. Any increase in PTM indicates a leak in either the SAMPLE MANIFOLD BYPASS valve or NRV1.	PTM:	PTC:
15. Vent all pressure and remove the OUTLET seal. Nitrogen is an asphyxiant and must be vented to a well ventilated area.		
NOTES:		

6.7. RE-DEPLOYMENT SAMPLE CYLINDER PRESSURE TEST

Completing a sample cylinder pressure test after replacement of SOVs for a re-deployment is essential. The test involves sealing the sample loop with atmospheric pressure inside and then charging each of the sample cylinders with 50barg of nitrogen and holding for a period of time. If one of the SOVs are leaking then the sample loop pressure will increase. If one of the sample cylinder needle valves are leaking then the sample cylinder pressure will decrease but sample loop pressure will remain constant.

Nitrogen charging must be from a gas cylinder fitted with a regulator. Nitrogen pumps which may be available for pipe purging or other operations are not suitable for the small volumes within the sample cylinders. Gas regulators have different pressure ranges. Ensure the regulator range is suitable and set for the required pressure.

OPERATION	**RESULT/COMMENT**						
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.							
2. Record the name of the operator completing these operations.							
3. Record the time and date that these operations were completed.							
4. Record project and pipeline names and/or reference numbers.							
5. Record MEG skid serial number which can be found on the frame identification plate.							
6. Fully open the skid sample INLET to vent the sample loop to atmospheric pressure 0barg.							
7. Seal both the skid sample INLET and skid sample OUTLET to trap atmospheric pressure 0barg inside the sample loop.							
8. Ensure the SAMPLE MANIFOLD BYPASS valve is on the OPEN (non-bypass) position.							
9. Ensure the ROV EMERGENCY SAMPLE valve is in the CLOSED position							
10. Power up the controller and confirm PTC and PTM are at atmospheric pressure.	PTC:			PTM:			
11. Connect the charge manifold to the NVSn quick connect stem. See 1.13 CHARGE MANIFOLD.	Tick						
	1	2	3	4	5	6	M
12. Connect the nitrogen supply to the charge manifold.	1	2	3	4	5	6	M
13. Open NVSn.	1	2	3	4	5	6	M
14. Open the nitrogen regulator valve and increase nitrogen pressure to 50barg.	1	2	3	4	5	6	M

15. When pressure is stable, close the sample charge manifold isolation valve and record the charge pressure.	SA1						barg
	SA2						barg
	SA3						barg
	SA4						barg
	SA5						barg
	SA6						barg
	SAM						barg
16. Remove the pressure from the nitrogen regulator and hose. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	1	2	3	4	5	6	M
17. Hold pressure until the pressure drop is less than 0.1barg/minute.	SA1						barg/min
	SA2						barg/min
	SA3						barg/min
	SA4						barg/min
	SA5						barg/min
	SA6						barg/min
	SAM						barg/min
18. Confirm pressure at PTM and PTC remains at 0barg (as recorded in step 10). Any increase shows a leakage across the SOV which should be re-oiled or changed as per 6.4 RE-DEPLOYMENT SOV INSTALLATION.	1	2	3	4	5	6	M
19. Vent the sample cylinder. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	1	2	3	4	5	6	M
20. Repeat steps 11 to 19 for each sample cylinder.							
21. Power off the controller and remove any seals from the INLET and OUTLET.							
NOTES:							

7. MAINTENANCE

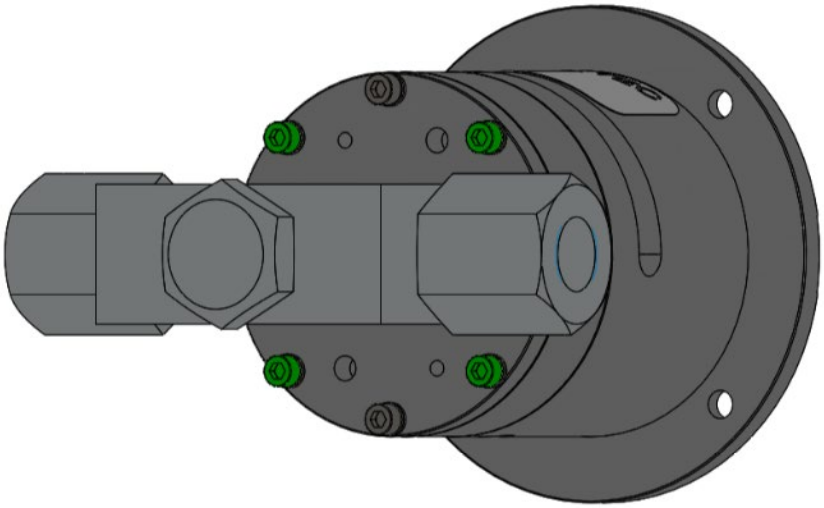
All IK Trax products are designed to require minimum maintenance. The unit should be cleaned externally using fresh water and cleaning agents as necessary. Do not use chemicals which could be damaging to the paint, housing, the nitrile rubber O-rings, the acrylic window, or any connectors.

Internal tubing, cylinders, valves etc can be cleaned as per section 6 RETURN / RE-DEPLOYMENT OPERATIONS.

7.1. ROV VALVE MAINTENANCE

The ROV EMERGENCY SAMPLE valve and SAMPLE MANIFOLD BYPASS valves are designed to be low maintenance valves. However, if the valves are found to be passing, the following procedure can be used to change the ball seat assembly.

Remove the valve from the skid, the valve must be split from the ROV actuator via 4x hexagon cap screws in green below:



Ball Seat Assembly Replacement

1. Both ball seat assemblies should be replaced at the same time to ensure even seal quality.
2. While securely holding the seat glands and body, loosen the tubing connections.
3. Hold the body in a vice and unscrew and remove the seat gland assembly. Note the orientation of all the components. Remove the ball seat assembly.
4. Place the replacement ball seat assembly into the seat gland assembly.
5. Lubricate all threads with an anti-seize lubricant.
6. Assemble the seat gland assemblies into the valve body until hand-tight.
7. Complete assembly of the seat glands evenly using a wrench, using the following recommendations:
   -71, -72, -73: 50ft-lb
   -74, -75, -76: 70ft-lb
   -80, -81, -82: 100ft-lb

Reassembly valve into the skid and pressure check using procedures as appropriate:
6.5 RE-DEPLOYMENT SAMPLE LOOP PRESSURE TEST
6.6 RE-DEPLOYMENT MANIFOLD BYPASS VALVE INTEGRITY TEST
6.7 RE-DEPLOYMENT SAMPLE CYLINDER PRESSURE TEST

7.2. ZINC ANODES

The skid is fitted with 2x zinc anodes to prevent corrosion of the unit. When new the anodes have dimensions of ø100mm x 25mm and weight 1.4kg. If the anodes are wasted by 50% or more then follow the steps below to replace them.

1. Remove old Zinc anodes by removing M5 nut and washers
2. Replace Zinc Anode and refit M5 nut and washers
3. Ensure continuity between zinc anode and an exposed part of the skid is less than 1Ω
4. Confirm electrical continuity of less than 1Ω between the new anode and an exposed part of the skid frame.

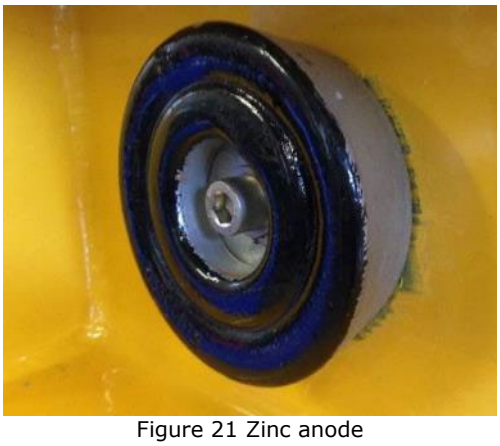


Figure 21 Zinc anode

7.3. CONNECTOR MAINTENANCE

Subsea connectors require regular cleaning and lubrication to ensure that contacts are clean, electrically isolated from each other and to prevent water intrusion when submerged. Before every deployment all subsea connectors and cables should be visually inspected for any visible signs of damage or mistreatment such as cable sheath damage, crush damage, bending damage, poorly mated or misaligned connectors etc. All subsea connectors must be sealed if submerged subsea to prevent water ingress and corrosion. Seal all unused connectors with appropriate blanking caps or plugs.

Every time a connector is unmated and at least every 12 months all connectors should be inspected as follows:

1. Un-mate the connector without pulling on the cable and with no rocking or twisting motions.
2. Inspect both mating halves of the connector. Check that all connector contacts are free of any accumulation of chemical deposits, saltwater, sand, mud or other debris. Check that all contacts are undamaged and aligned properly.
3. Accumulation of debris or corrosion should first be removed with fresh water and a brush where required and then cleaned with a suitable contact cleaner and lubricant. Do not use chemicals which could damage the connector rubber such as WD40.
4. Any O-rings must be inspected and if marked or damaged they must be replaced.
5. Before mating ensure that all connector rubber surfaces and any O-rings are lightly lubricated to prevent delamination of the rubber during mating. Molykote 111 grease is a suitable lubricant but should be used sparingly as too much build-up of the grease can affect electrical connection integrity and can deform the connector.
6. When mating connectors the two halves should be pushed squarely together with no rocking or twisting motions. If the connectors have to be forced together then something is probably wrong. Do not use the locking sleeve to pull or force the connectors together. Do not over tighten the locking sleeve as this can deform the contact alignment. Locking sleeves should be tightened firmly by hand only, when the connector is subsea the water pressure will hold the connections tightly together.

8. DISPOSAL OF UNIT

IK Trax 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, IK Trax 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
Doing business as IK Trax
Blackburn Business Park
Woodburn Road
Aberdeen,
AB21 0PS UK

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

8.1. WASTE HANDLING

The following is related to UK and regulations may vary depending on the country of operation.

MEG remaining from processes is hazardous waste (special waste in Scotland) if it contains 25% or more of a harmful substance according to the European Waste Framework Directive Article 2. Classification according to the European Waste Catalogue is 16 01 14 antifreeze fluids containing dangerous substances. The mirror classification for the non-hazardous mixture is 16 01 15 antifreeze fluids other than those mentioned in 16 01 14. Documentation is required showing concentrations for the non-hazardous mixture. Mixing of waste is not allowed. MEG remaining from samples will have been diluted during the process of flushing defined in this procedure.

Use the portable density meter to confirm whether or not there is less than 25% MEG in the water waste.

The density of 25% MEG in water is given below.

Temperature (°C)	5	10	15	20	25
Density (kg/m^3)	1037	1036	1034	1032	1029

The density of 25% MEG in seawater is given below.

Temperature (°C)	5	10	15	20	25
Density (kg/m^3)	1058	1057	1055	1052	1049

A measured density below the relevant value above shows that the waste is non-hazardous.