SOIL MACHINE DYNAMICS LIMITED

MONTEREY BAY AQUARIUM RESEARCH INSTITUTE

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SURFACE CONTROL OPERATIONAL MANUAL

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1.1 Pilot Control Chair

The main control of the ROV is through the pilots' active chair, shown below in figure 1. Covered in Black PVC, the chair is easy to clean, fully adjustable and heated. The control wago and power supplies are located in the drawer at the base of the chair and the wiring is routed through the arm rest supports to the Touch Screen (TS), desk plates, joystick and other electrical items on the arm rests.

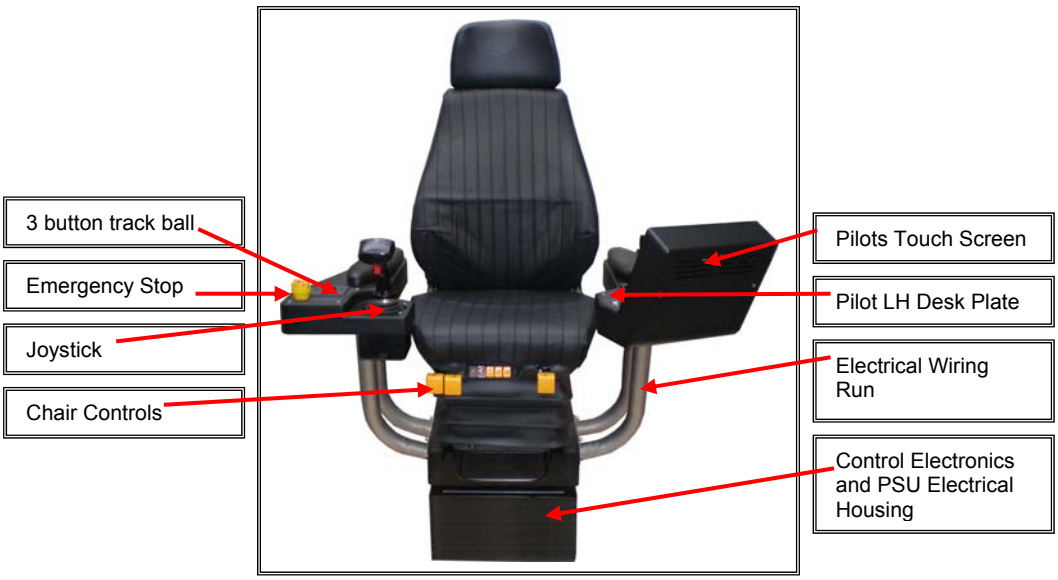

Figure1 – Pilots Active Chair

The chair is powered by 120VAC fed through a hole in the bottom of the Control electronics housing.

1.1.1 Chair Controls

The pilots chair is fully adjustable; the controls for the chair are located at the front just behind the pilots legs. Figure 2

Figure 2 – Pilots chair controls

1.1.1.1 Heater Control

The control of the chair heater is via this button, the button will illuminate red when the heater function is activated. Temperature can be adjusted via the +/- button to the right of the power button, as viewed in figure 2.

1.1.1.2 Angle Adjust

Whilst seated in the chair pull this leaver up towards yourself and lean back and forwards to pivot the chair backwards and forwards around the rear axis, respectively, whilst maintaining the angle between the seat and the back rest.

1.1.1.3 Seat Adjust

Whilst seated in the chair pull this leaver up towards yourself and lean forward to increase the angle of the seat with respect to the backrest.

1.1.1.4 Back Adjust

Whilst seated in the chair pull this leaver up towards yourself and lean backwards to increase the angle of the backrest with respect to the seat. To allow the back rest to come forward, lean back and pull the lever up, slowly lean forward to the desired angle, being careful not to remove pressure from the back rest before pulling the handle.

CAUTION

The back rest can spring forward with sudden and violent speed.

1.1.1.5 Position Adjust

To adjust the position of the chair in a linear direction with respect to the monitors, pull this handle and slide the chair either forwards or back to decrease or increase respectively the distance from the monitor bank.

1.1.2 Pilot Left Hand Desk Plate

The Left Hand arm of the pilots' active chair, shown in figure 3 has the main control plate for the ROV, as well as the pilots touch screen discussed further in section 4. From here the pilot can:

- Operate the ROV auto functions
- Operate the mapped hydraulic valve
- Control the headphone audio features
- Control the ROV's vertical position
- Lock the ROV in a given vertical position.
- Restart the touch screen.

The touch screen restart button is located on the underside of the Left Hand arm rest.

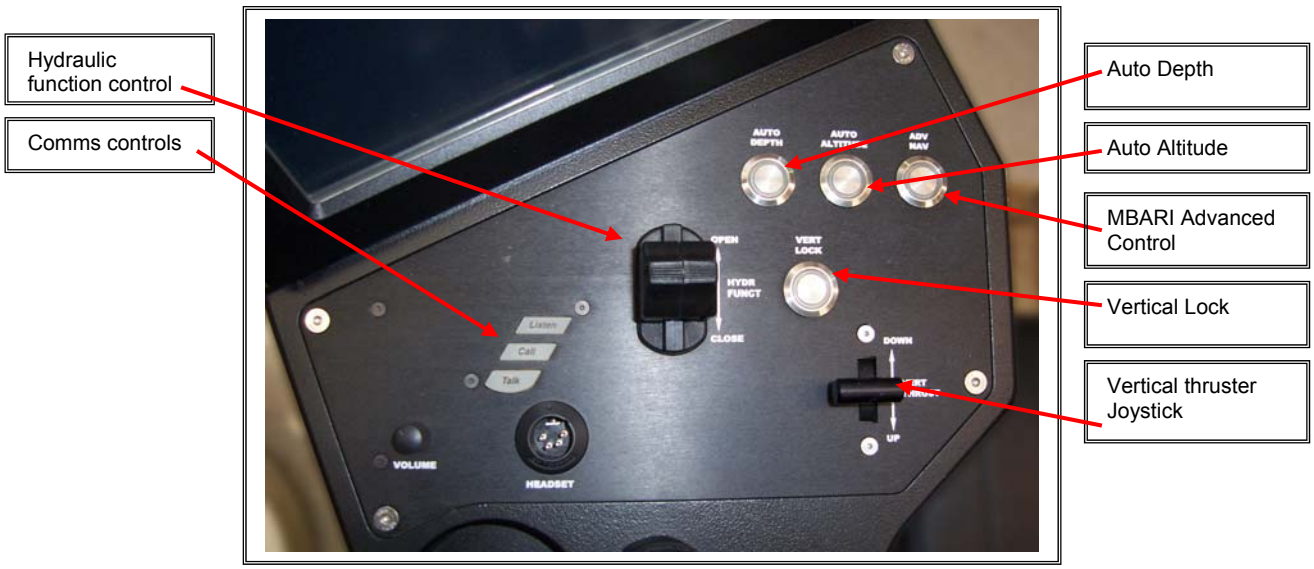

Figure 3 – Left Hand pilot control panel

1.1.3 Pilot Right Hand Desk Plate

The Right hand arm of the pilots' plate shown in figure 4 contains: -

- The main joystick for flying the vehicle
- System emergency stop
- 3-button track ball for use with the pilots PC and associated display.

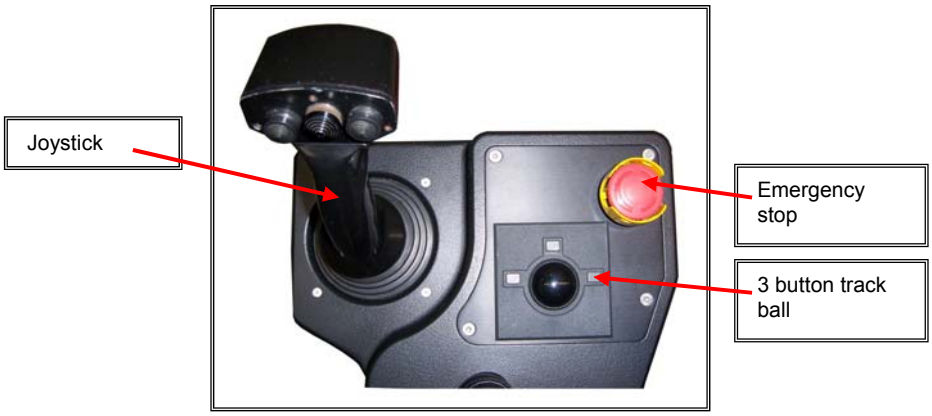

Figure 4 – Right Hand pilot control panel

1.1.3.1 Pilots Joystick

The pilot joystick is a free issue item, wired as described in table 1 below: -

Item	Function
Left Hand Button	Pan & Tilt select
Middle Button	Pan & Tilt control
Right Hand Button	Control of mapped hydraulic valve from tool sled.
Main shaft	Movement of vehicle, Fwd, Aft, Port, Starboard, CW, CCW
Trigger	1st Detent – Select auto heading 2nd Detent – Select MBARI observation mode
Bar	Joystick Lock

Table 1 – Joystick functions

The lead from the joystick mates with a corresponding bulkhead connector mounted in the Left Hand arm rest of the chair, from there through the arm supports to the electronics tray at the base of the chair.

1.1.3.2 3 Button trackball

Wired as per any normal roller ball mouse, where the middle button acts as pressing the scroll bar.

1.1.4 Control electronics and power supply housing

The power supplies and control wago for the chair are housed in the base. Figure 5 shows in more detail the layout.

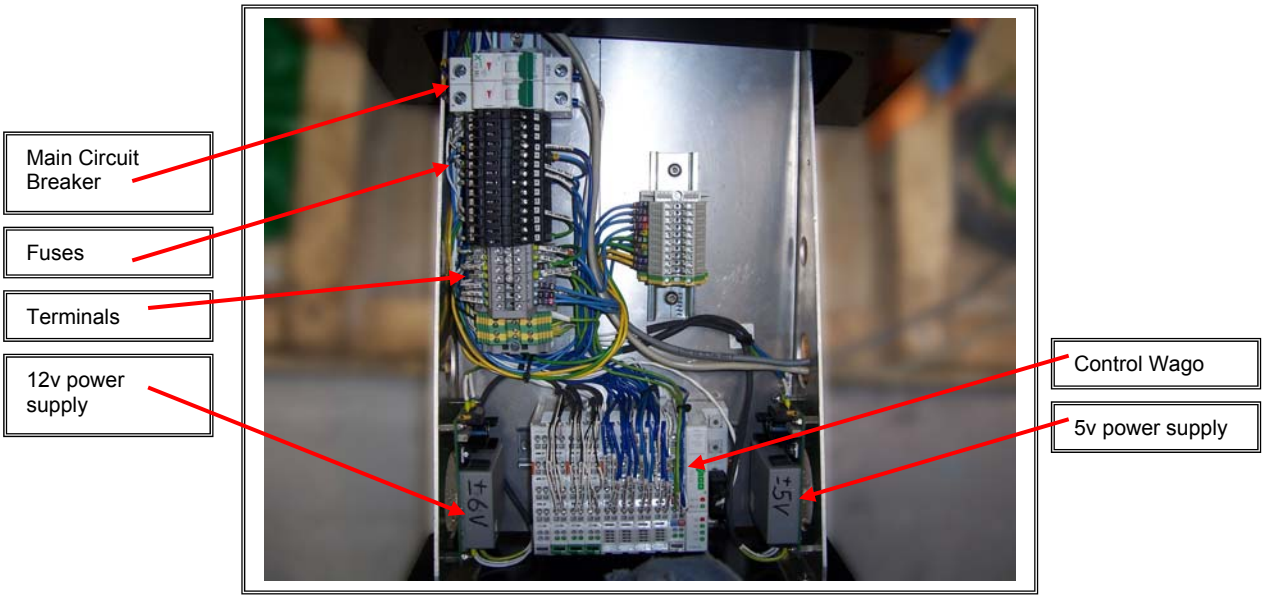

Figure 5 – Control electronics housing

The wiring schematic for the pilots' active chair can be found in drawing AB7022.

1.2 Co-Pilot desk plate

The co-pilot desk plate shown in figure 6 contains the following: -

- ROV Pod Stop/Start buttons
- ROV Motor Stop/Start buttons
- USB port for data logging
- Restart switch for both co-pilot and science touch screens
- Emergency stop for system.

Figure 6 – Co-pilot control panel

2 SUB-SEA POWER SYSTEM

2.1 General

The sub-sea safety system has been designed in accordance with the "Code of Practice for the Safe Use of Electricity Underwater" produced by the UK Department of Energy. The safety system consists of two main elements; the Line Insulation Monitors (LIM) and the Earth Continuity Monitors (ECM).

Motor Protection Relays (MPR) detect prolonged overloading of the motors and phase imbalance in order to protect the motor.

The power circuits for sub-sea equipment are supplied from independent, dedicated transformers. The Line Insulation Monitoring system continuously monitors the insulation value between all the live conductors and earth.

- If the insulation resistance falls below a pre-set warning limit, an alarm is given.
- If the insulation resistance breaks down to a dangerous level, the power to the sub-sea equipment is shutdown and disabled.
- In the event of a trip, the Line Insulation Monitors must be reset manually in the Cabin or from the touchscreen.

The LIM system relies upon a reliable earth conductor connecting the Control Cabin earth to the sub-sea equipment chassis. To ensure a reliable earth path an ECM continuously monitors the integrity of the earthing system.

2.1.1 Line Insulation Monitoring (LIM)

The purpose of the LIM system is to monitor the insulation level between earth and the supply conductors, and to take action accordingly. There are two types of LIM systems: one for the high voltage supplies and one for the sub-sea supply.

2.1.1.1 Surface LIM System

The high voltage system uses Bender IRD1007M-6 LIM units to monitor the high voltage. The LIM units are mounted in the Power Distribution Panel (PDU). Each monitor is connected to the high voltage source by a "High Tension" (HT) coupler, which is connected to the secondary side of the transformers in the Control Cabin.

- To monitor the Pod supply, a HT coupler is connected to one phase of the 2-phase 3000VAC Pod supply.
- To monitor the motor supply, a HT coupler is connected to the star point of the 3-phase 3000VAC motor supply.

The measured insulation value is displayed on an integrated analogue meter at the front of the LIM unit.

Each LIM unit has two alarm settings that can be adjusted manually. The first is the Warning level and the second is the Danger level. It is recommended that the warning level is set around 10MΩ and the danger level is set around 1MΩ.

Each LIM unit is incorporated into the control circuitry of the corresponding sub-sea equipment. The operation of the LIM system is as follows:

- With the LIM unit powered down, the corresponding sub-sea equipment is prevented from being started. This is due to the fail-safe configuration that is used.
- With the LIM unit powered up and the insulation status healthy, the corresponding sub-sea equipment is no longer prevented from being started by the LIM safety system.
- With the LIM unit powered up and the insulation status at “Warning level”, the “Alarm 1” indication light is illuminated on the front of the LIM unit and a warning message is displayed on the Pilot and Co-Pilot screens.
- With the LIM unit powered up and the insulation status at the “Danger level”, the “Alarm 2” indication light is illuminated on the front of the LIM unit and the corresponding sub-sea equipment is prevented from being started (or is shut-down if the Danger level status is reached whilst in operation).

The LIM units are wired such that in the event of any alarm status being reached, the alarm can only be manually reset. This is done using the reset button on the front of the LIM unit. The LIM units can also be tested using the test button on the front of the unit or the touchscreen.

2.1.1.2 Subsea LIM system

The function of the subsea LIM system is to monitor the insulation level between earth and the supply conductors of the 110VAC and 240VAC circuits’ subsea and to take appropriate action.

The LIM system uses Bender IR145Y-421 units, located in the Pod. The LIM unit can be set to compare the measured insulation resistance with any value in the range 10KΩ - 200KΩ.

Upon the detection of insulation resistance equal to or lower than the set value, the LIM unit disables the appropriate circuit and a warning message is presented on the Pilot and Co-Pilot screens. If the fault clears, then the LIM unit can be reset from the Control Cabin.

The LIM unit is set up such that in the event of an alarm, the unit can only be reset by the operator, i.e. it does not automatically reset. It is also configured to operate in fail-safe mode, so that in the event of power failure to the LIM unit, the circuit under protection is disabled.

In order to continue essential operations in the presence of a persistent 110VAC or 240VAC insulation fault, the LIM function can be over-ridden.

2.1.2 Earth Continuity Monitors (ECMs)

The function of the ECM is to monitor and indicate the status of the earth path between the surface power system and the sub-sea equipment chassis. If there is no path, the ECM prevents the Pod, and hence the motor, from being started.

The ECM circuit uses a relay with normally open contacts to provide a safety interlock in the control cabin control circuitry. This is to prevent starting the Pod and hence the motor when there is no earth to the sub-sea equipment.

The coil of the ECM relay is supplied with 24VDC upon the depression of the ECM reset button. The 0V side of the coil is connected to an umbilical loop monitor wire, which is fed through the umbilical. This loop monitor wire effectively connects the 0V side of the ECM relay coil to the sub-sea equipment chassis via the motor connector.

Essentially, the ECM relay relies upon the earth path between the Cabin and the sub-sea equipment to provide a current return path for the 0V side of the ECM relay coil. If there is no earth connection between the Cabin and the sub-sea equipment, the coil cannot energise and the Pod and motor cannot be started.

When the earth loop is complete, the ECM reset button indicator lamp in the Control Cabin is illuminated.

To obtain a healthy ECM status reset the ECM using the push-button on the Power Display Panel.

2.1.3 Earth Connection

The main earth connection to the sub-sea equipment is fed through six drain wires in the main umbilical cable. These are connected to the Control Cabin earth at the surface end and the earth termination point at the sub-sea equipment end.

Armouring and earth wires surround the power cores throughout the entire length of the cable to the sub-sea termination. Both should be terminated at the Cabin earth stud through the winch slip ring and to the winch structure.

The electronics Pod chassis and the motor chassis are connected to the sub-sea electrical termination via individual earth straps.

2.1.4 Motor Protection Relay (MPR)

The high voltage side of the motor circuit is coupled to a Motor Protection Relay, which monitors the motor current via two current transformers on two of the motor phases.

The relay has several adjustable settings, including current trip and trip delay settings. These can be set up to operate in accordance with the current transformers employed.

With the MPR unit energised, the motor functioning within normal operating parameters and no faults detected, depressing the push-button will reset the MPR, illuminating the button on the door.

The operation of the MPR safety system is as follows:

- With the MPR unit powered down, the reset push-button is not illuminated, and the motor is prevented from starting.
- With the MPR unit powered up and no fault condition, the reset push-button is illuminated upon depression, and the motor can be started.
- With the MPR unit powered up and an over-current or current-imbalance fault present, the “supply fault” indication light is illuminated on the front of the HPU, the reset push-button is not illuminated, and the motor is prevented from being started or

is shut-down if a fault condition is reached whilst in operation. An MPR trip message is also displayed on the Pilot and Co-Pilot screens.

The minimum time the MPR can be reset after being in a fault detection status is one minute. This delay time is settable between 1 – 20 minutes. The MPR can be reset using the relevant button on the touch screen.

2.1.5 Voltage Monitor Relay (VMR)

A Voltage Monitor Relay (VMR) is used to detect any under voltage or over voltage on the incoming power to the pod and motor transformers as well as monitoring directional rotation and detecting loss of one or more phases to the motor transformer.

The pod VMR will be energised when the supply is below 180V but will de-energise if the supply voltage exceeds this threshold.

The motor VMR will be energised when the supply is between 400V and 500V but will de-energise if the supply voltage moves outside this bracket for more than 4seconds.

2.2 Activating Vehicle Power

2.2.1 Starting the Pod

Prior to energising the motor or Pod, confirm that:

- All personnel are clear of the vehicle.
- The earth is attached.
- All enclosures are closed and secure.

To start the Pod, the following conditions must be satisfied:

- CB1 closed
- LIM healthy
- VMR healthy
- ECM reset and healthy
- Power Room doors closed
- Emergency-Stop circuit reset

The Pod can now be started by depressing the Pod start button for 3 seconds, during which time a sounder will be heard if not, then a fault is present in the start circuit, check again that the above conditions are satisfied.

If they are, then check the following:

- Check that the circuit breaker in the PDU is in the correct position.
- If the Pod power indicator is on, ensure that the Pod voltmeter indicates the presence of 3000 Volts.
- Ensure the cabin Focal unit is powered.
- Check the integrity of the fibres by examining the lights on the Focal modem unit at the rear of the 19" rack. Also, use the Focal diagnostics software to observe the fibre optic signal attenuation level.

2.2.2 Starting the Motor

To start the motor, the following conditions must be satisfied:

- Pod powered and telemetry established
- CB2 closed
- LIM healthy
- VMR healthy
- ECM reset and healthy
- MPR reset and healthy
- Power room doors closed
- Motor comp level greater than 30%

The motor can now be started by depressing the Motor start button for 3 seconds, during which time a sounder will be heard (if not, then a fault is present in the start circuit). The contactor for the motor transformer closes and the motor is powered up. The Motor start button will be illuminated when the Motor power is on.

If the motor fails to start then, check the following: -

- Volt meter on the PDU door displays 3000v. - If not, then there is a fault in the PDU.
- Ammeter on the PDU door is giving a current reading. – If not then there could be a possible open circuit at the umbilical.
- Does the control system display system pressure – If not and an umbilical re-termination has been carried out then the motor may be spinning the wrong way.

3 CONTROL SYSTEM

3.1 General

The ROV is controlled using a distributed control system; this consists of the following PCs running graphical user interfaces:

- Pilot PC
- Co-Pilot PC
- Science PC
- Navigation PC

Additionally there are three touch-screen computers which are used to control functions on the vehicle.

- Pilot Touch-screen
- Co-Pilot Touch-screen
- Science Touch-screen

As this is a distributed system, the job of interfacing real world / vehicle devices using serial interfaces is shared amongst these computers as detailed in table 2 below, It is therefore a requirement that all PCs on this list are healthy for the normal operation of the ROV.

Pilot PC		
	Pod Wago	TCU PCB
	JB1 Wago	IFG Gyro
	JB2 Wago	Digiquartz
	DVL	MBARI advanced controls interface
	Octans Gyro	
Co-Pilot PC		
	HCU PCB	PDU wago
	Lamp Dimmer PCB	Surface console wago
	Portable deck equipment wago	
Science PC		
	MBARI system variables interface	Altimeter
Co-Pilot Touch-screen		
	USB device for logging	
Pilot Touch-screen		
	Chair Wago	

Table 2 – Computer, serial interface allocation

3.2 Software organisation

The computers communicate with each other using an Ethernet network. Computers are addressed using node numbers 1-7 and are addressed as shown in table 3 below.

1	Pilot PC
2	Co-Pilot PC
3	Science PC
4	Pilot Touch Screen
5	Co-Pilot Touch Screen
6	Science Touch Screen
7	Navigation PC

Table 3 – Computer, address allocation

The computers use an operating system called QNX which is a version of unix with real time control functionality.

The first 6 computers run a program called ucd (user configurable display) that is used to display instrument feedback / control vehicle functions. The PCs run display screens that show the status of the vehicle i.e. system pressures / alarms etc whilst the touch-screens are used to control the vehicle i.e. turn cameras on/off ; operate hydraulics.

The seventh PC is for the vehicle auto positioning software.

3.3 File structure

All control system application files are stored on node 1 in the directory "//1/control_system/bin".

This directory contains:

- Machine database file
- System initialization files
- Startup scripts
- Executable software e.g. ucd
- Layout files for the ucd
- Graphics files used on the ucd

3.4 QNX shell

A Shell can be brought up in QNX using the Alt+Enter keys. This behaves like a standard unix shell.

4 TOUCH SCREEN CONTROLS

4.1 General

The system features a 'Touch Screen' (TS) based operator interface, which provides access to the range of controls and functions for the ROV control system. The Home screen shown in figure 7 below provides the main user controls for the ROV.

All control screen layouts contain three main interaction areas:

- Primary Selection Keys
- Secondary Selection Keys
- User Keys

The **primary** keys can always be activated regardless of the screen function and are common to all the touch-screens. **Secondary** keys can be found on the home page and lead the user to and additional control page. The **user** keys switch instrumentation/surveillance on or off, and operate the hydraulic functions.

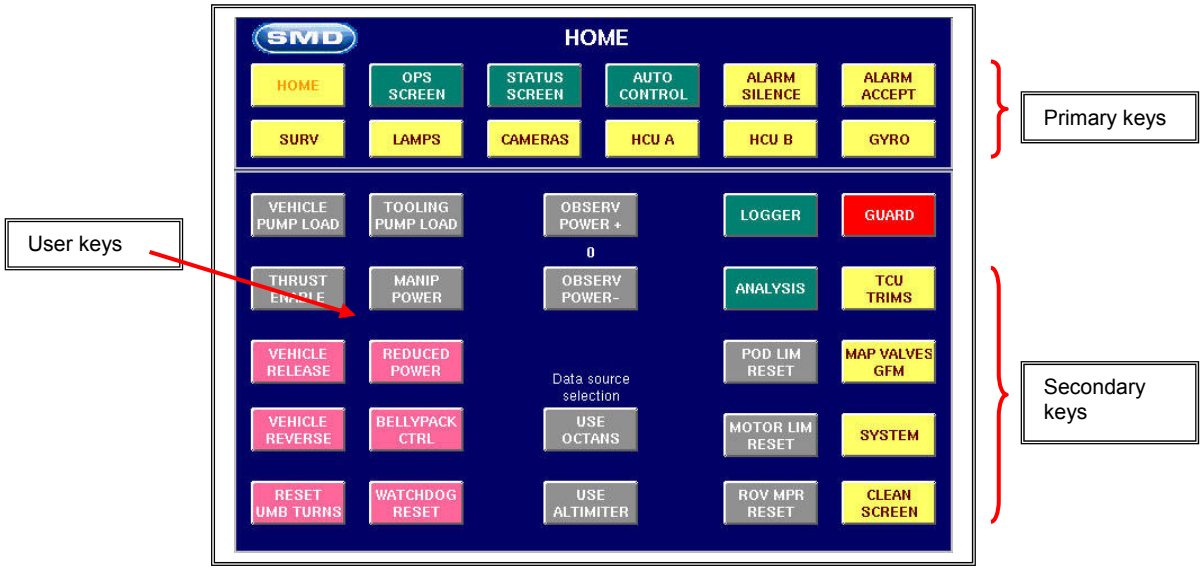

Figure 7 – Touch Screen, Home page

4.2 Primary Keys

4.2.1 Home

The Home screen provides the main user controls for the ROV. Pressing [HOME] at any time returns the touch screen to the display shown in Figure 7.

4.2.2 Ops Screen

Pressing [Ops Screen] changes the current screen to the “Ops Screen” for the monitor associated with that touch screen. See section 5.2 for a more in depth explanation of the Ops Screen.

4.2.3 Status Screen

Pressing [Status Screen] changes the current screen to the "Status Screen" for the relevant monitor associated with that touch screen. See section 5.3 for a more in depth explanation of the Status Screen

4.2.4 Alarm Silence

If any of the control system data channels exceeds its pre-set alarm level, indication on the graphical display is accompanied by an audible alarm.

Pressing [ALARM SILENCE] will mute the audible alarm signal but will not acknowledge or clear the alarm. This is useful when a parameter is oscillating around the alarm threshold level.

4.2.5 Alarm Accept

If any of the control system data channels exceeds its pre-set alarm level, indication on the graphical display is accompanied by an audible alarm.

Pressing [ALARM ACCEPT] will acknowledge the alarm will override an "Alarm Silence" request and mute the audible signal. The alarm message will be removed from the screen as soon as the alarm condition has been cleared.

CAUTION

The operator should not [ACCEPT] an alarm until the alarm condition has been noted and appropriate action taken.

4.2.6 Instrumentation /Surveillance Keys

From the Surveillance screen Figure 8 shown below the operator can activate or de-activate the range of surveillance equipment fitted to the ROV.

The power supply to the surveillance equipment is only applied when the sub-sea pod is turned on and the data link is active.

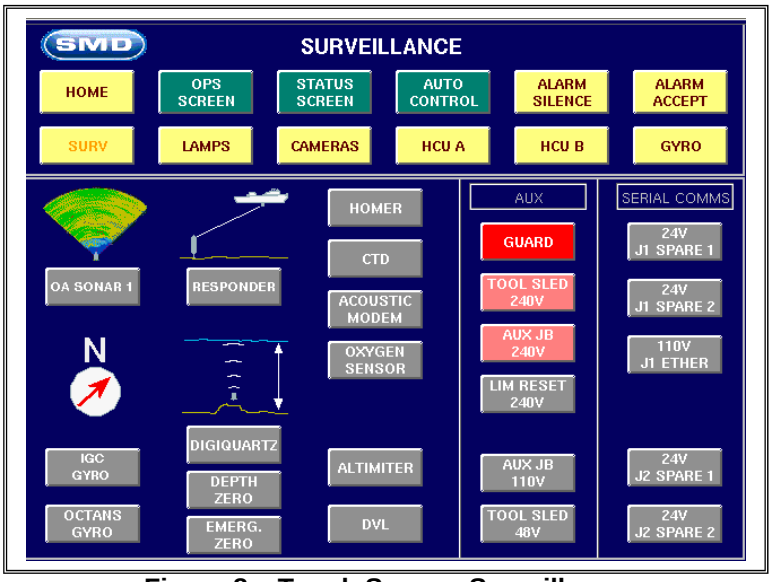

Figure 8 – Touch Screen, Surveillance

Most keys have a latching operation. Press once to activate (switch illuminates green), press again to de-activate.

The Digiquartz depth sensor measures absolute pressure (in air or water). The recommended procedure is during ROV launch to press the 'Depth Zero' button to calibrate the water depth reading to compensate for ambient air pressure 1 bar.

The 'Emergency Zero' facility is intended for use if the power is lost or cycled to the Digiquartz depth sensor during subsea operations. If power is lost or re-cycled the Digiquartz reverts to an absolute pressure measurement and pressing 'Emergency Zero' will remove 1 Bar from the pressure measurement. This facility should not be required as the Digiquartz will normally remain powered while sub-sea.

The 240V DC supplies are guarded functions as they are potentially hazardous on deck.

CAUTION

Ensure Auxiliary Junction Box is OFF load before switching power to it.

4.2.7 Lamps Screen

The Lamp screen, shown in figure 9 is used to control the power supplies to the 110v Lamps on the ROV. There are 6 HMI lamps and 4 standard 110v lamps. Intensity can be controlled on the standard lamps using the + / - buttons provided. A 110v LIM reset facility is provided for re-setting the subsea LIM if it trips or the LIM can be over-ridden using the override facility. Section 6.5 describes the LIM interlock in more detail

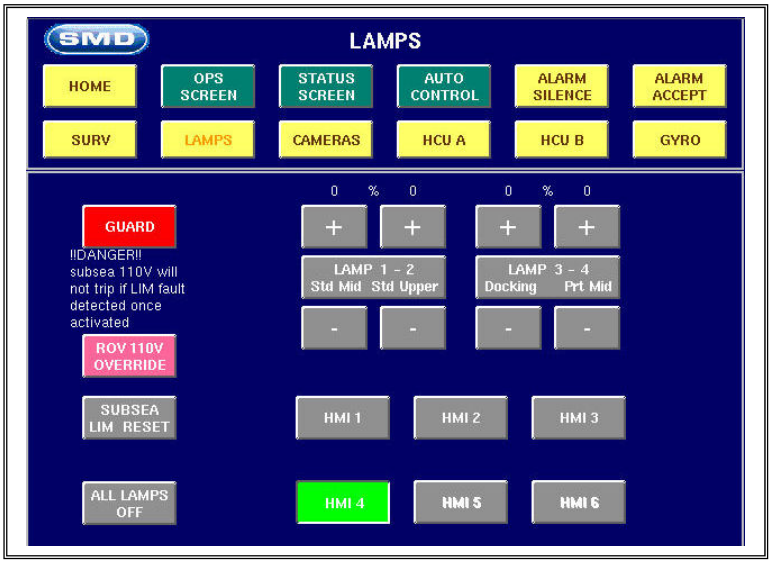

Figure 9 - Touch Screen Lamp Display

4.2.8 Cameras

Control of all cameras is from the relevant touch screen page, as the Signal Isolation relays are automatically closed when the system is running, pressing the camera button controls only power to that camera. There are 12 subsea video channels only 8 of which can be displayed at any one time. The additional 4 channels are displayed using the video switching button. The button is displayed on the touch screen shown in Figure 10, below the channel it switches.

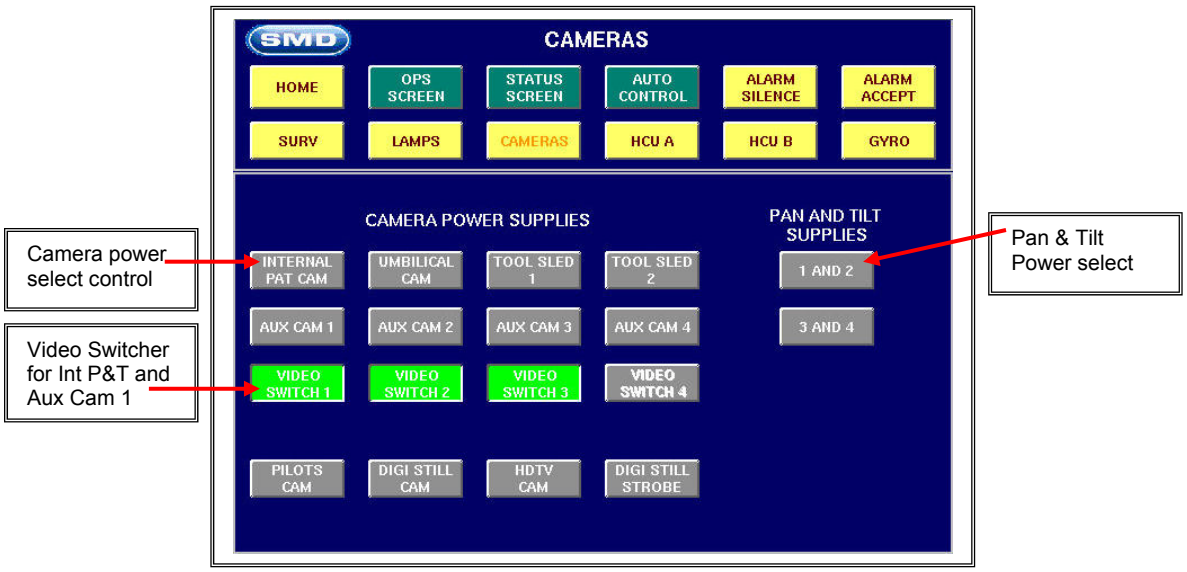

Figure 10 – Camera and P&T touch screen

The camera allocation versus video channel is detailed in table 4 below. Where for example, the pilot camera and digital still camera have their own dedicated channel and are displayed whenever power to the camera is present. The internal camera requires both power to be present and the video switcher to be deactivated in order to display a picture.

	Dedicated Channel	Video Switcher OFF	Video Switcher ON
Pilot Cam (1)	x		
Pilot Cam (2)	x		
Pilot Cam (3)	x		
Digi Still Cam	x		
Int P&T Cam		x	
Umb Cam		x	
Tool Sled Cam 1		x	
Tool Sled Cam 2		x	
Aux Cam 1			x
Aux Cam 2			x
Aux Cam 3			x
Aux Cam 4			x

Table 4 – Video Channel Allocation

4.2.9 Hydraulic Functions

To operate any hydraulic function the following requirements must be met:

- Pod power supply must be energised with telemetry established.
- The motor must be running, or deck power pack connected to achieve any hydraulic function.

- Vehicle Pump load must be enabled on the touch-screen.
- For hydraulic functions powered by the channels on HCU B the Tooling pump load must be enabled.

4.2.9.1 HCU A

This screen provides control of the four proportional valves on the HCU. Additionally a spare TCU proportional valve is controlled from this screen.

The HCU controlled valve can be driven 0-100% in direction A or B. It is not possible to drive both A and B flows simultaneously for any single channel.

4.2.9.2 HCU B

HCU B screen is used to control all the other flows on the HCU. This will be 100% drive in either direction.

N.B. Tooling pump must be loaded for these functions to work.

4.2.9.3 Adjusting HCU flow

As shown in Figure 11, the percentage flow rate in direction A is adjusted by the slider on the left of the associated channel, the control for direction B, is on the right, where the centre of the block signifies the position on the incremented scale.

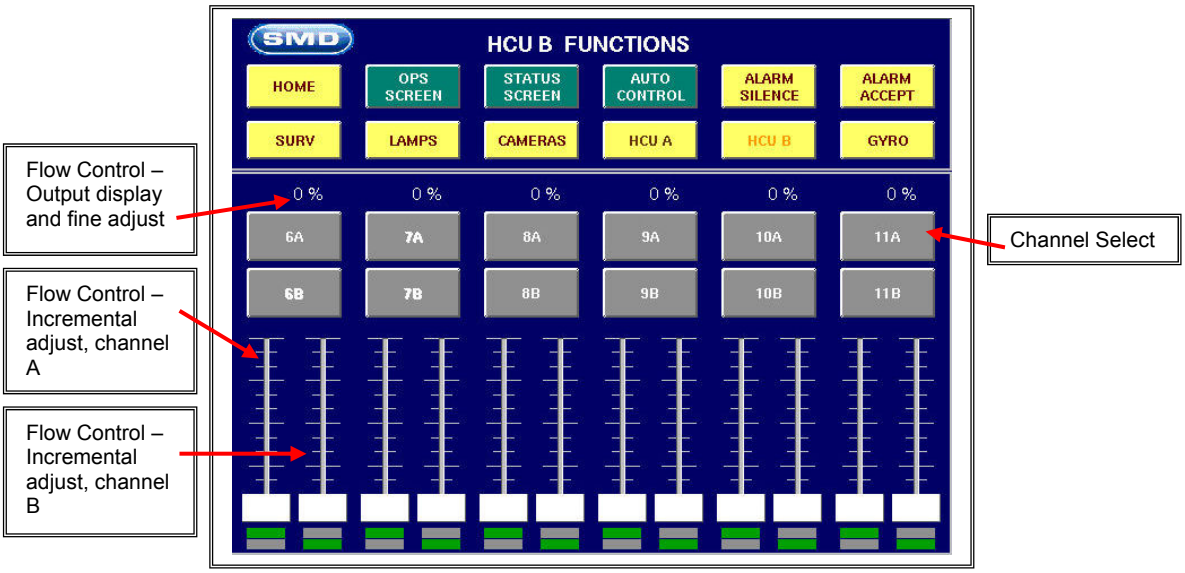

Figure 11 - Spare Valve Pack Functions

The values above each channel show the percentage flow rate to the valve, double clicking on this figure allows for a more precise adjustment of the flow to the valve, via a keypad shown in Figure 12. The value entered will only be applied to the valve after pressing the "enter" button.

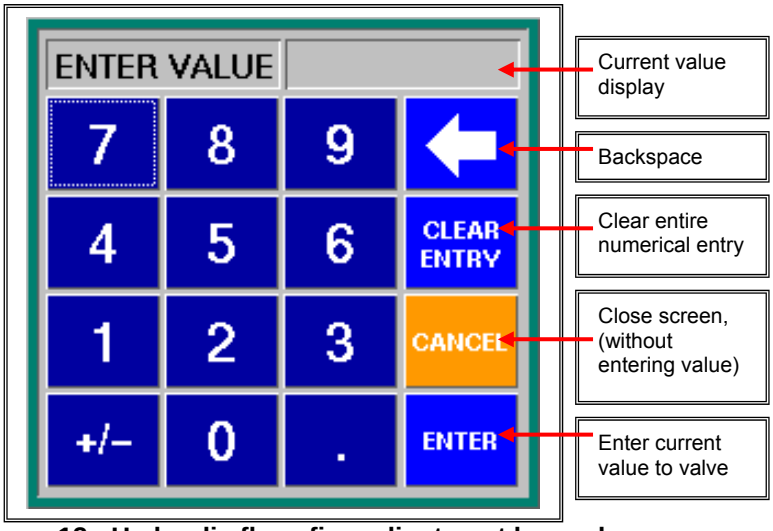

Figure 12 - Hydraulic flow, fine adjustment keypad

If the spare function is to be made permanent, the screens can be modified to provide the user with a user-defined key for this function. (See Section 7 for instructions on modifying the control system.)

4.2.10 Gyro Screen

The Gyro screen, shown in figure 13, allows the operator to configure the Gyro.

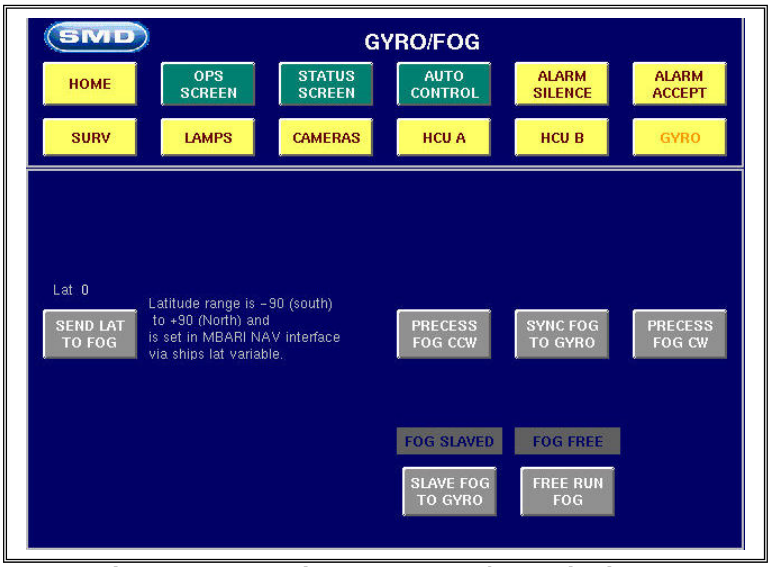

Figure 13 - Touch Screen Gyro/Fog Display

- "Sync Fog to Gyro" button is used to set the Fibre Optic Gyro (the principal heading) to the Flux Gate Gyro (the secondary heading) and is useful to correctly align the vehicle after launch to the magnetic heading, once the vehicle is away from any magnetic influences caused by the vessel.

- "Slave FOG to Gyro" links the fibre optic gyro to the fluxgate element. This is the normal operating mode.
- "Free Run FOG" disconnects the link to the fluxgate element. This mode is used when the ROV is operating in proximity to large steel structures which adversely affect the fluxgate element.
- "Precess FOG CCW" is used to manually reduce the FOG heading when operating in "Free Run FOG" mode.
- "Precess FOG CW" is used to manually increase the FOG heading when operating in "Free Run FOG" mode.
- "Send Lat to FOG" sends the current ROV Latitude to the gyro to allow correct operation worldwide.

4.3 Secondary Keys

4.3.1 TCU Trims Screen

This page shown in figure 14 below is used to apply trims to the ROV. These are to compensate for uneven payloads or prevailing currents.

The emergency power limit selection switch is here also. This allows the operator to select between limiting on vertical or horizontal thrust limit. The mode selected is displayed on the pilot ops screen.

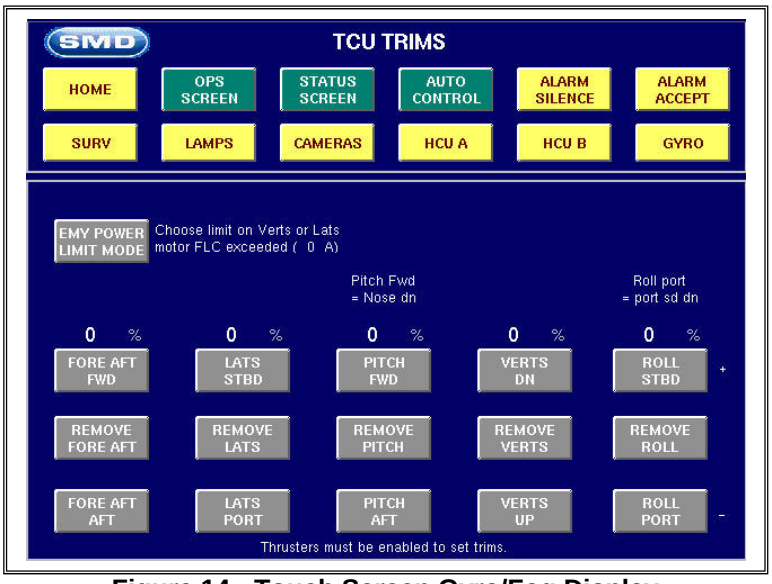

Figure 14 - Touch Screen Gyro/Fog Display

4.3.2 Map Valves GFM

4.3.2.1 Mapping Hydraulic valves

By pressing the relevant button for each of the hydraulic valves, detailed below in Figure 15, the control of that valve is mapped to the joystick on the Left Hand plate of the pilots, control chair, shown in Figure 3.

The number of the valve currently mapped to the joystick is displayed in the centre of the screen.

4.3.2.2 Dive Number

The current dive number variable is passed via the MBARI nav interface and is displayed between the increment and decrement buttons.

4.3.2.3 VB valve

"VB Pump Drive" initiates the variable buoyancy pump, effectively decreasing the vehicle mass. "VB Valve open" allows the variable buoyancy spheres to be filled effectively increasing the vehicle mass.

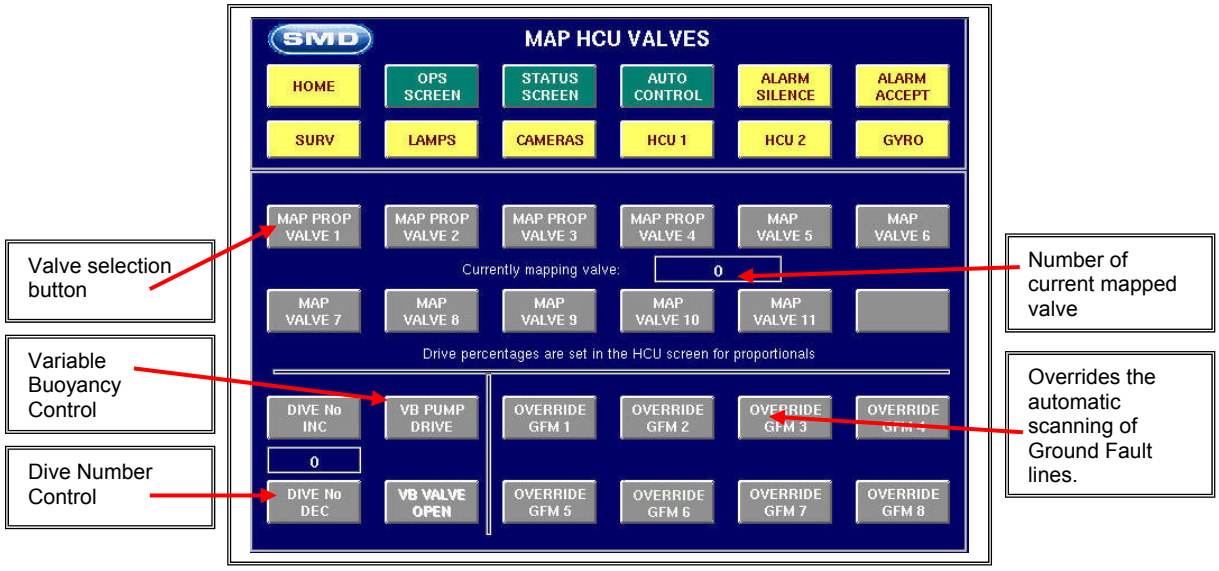

Figure 15 – Hydraulic Valve mapping

4.3.2.4 Ground Fault Monitoring

The control system software cycles through both of the 24v and the 48v regulated power lines monitoring each one for 2 seconds. The actual value of the ground fault is displayed on the bottom left hand corner of the "status" screen, under "GFM Status" If the value of the ground fault reaches a predetermined level an alarm will sound to alert the pilot. This alarm threshold is set in the analysis screen and can be altered subject to requirement. (For more information on altering this value, please refer to section 5.5.2, altering the control system).

If necessary, the control system can be "forced" to look at a dedicated channel by selecting the relevant override button found in the bottom right hand corner of the "map HCU valves" screen shown in Figure 15 above. Table 5 below, details which ground fault channel, monitors a given power line.

	Monitored Line			Monitored Line
Override GFM 1	JB1 24v (24v)		Override GFM 5	JB1 48v (+ive) – Sch Manip,DVL
Override GFM 2	JB1 24v (0v)		Override GFM 6	JB1 48v (+ive) – Sch Manip,DVL
Override GFM 3	JB2 24v (+ive)		Override GFM 7	48v (48v) – ToolSled
Override GFM 4	JB2 24v (+ive)		Override GFM 8	48v (0v) – ToolSled

Table 5 – GFM Override button allocation

4.3.3 System Screen

Shown below in figure 16, the system screen allows the user to adjust the control system variables.

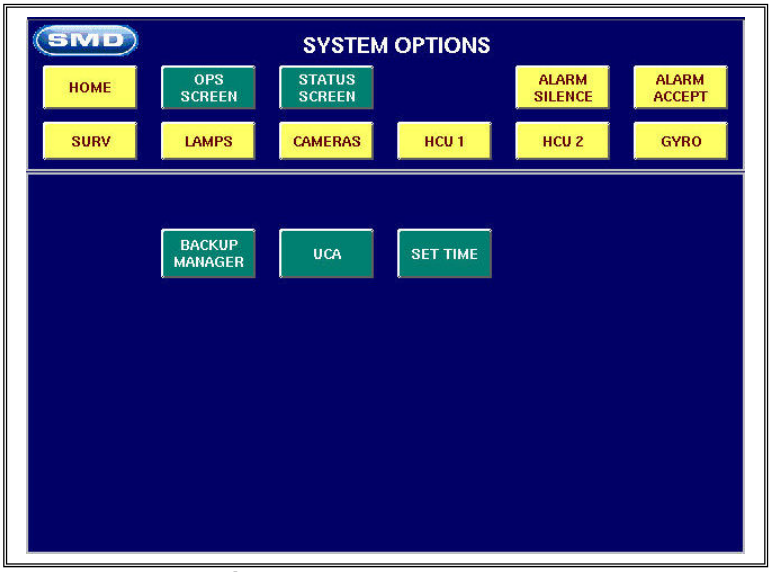

Figure 16 – System Screen

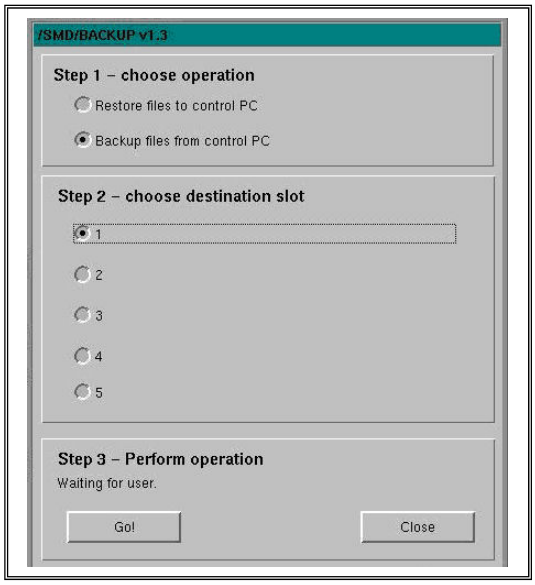

Figure 17 - Software Backup #1

If writing to a memory location, selecting go will lead to the screen in figure 18, where if necessary the user can assign an intuitive file name.

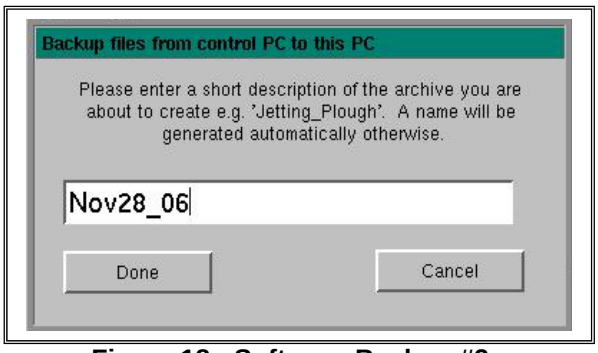

Figure 18 - Software Backup #2

These files can then be stored on a windows computer or mailed back to SMD. The archives contain the application folder '/control_system/bin' and can be used to save all ini files and ucd layouts.

CAUTION

Be sure to stop the USB device after you have performed your backup

4.3.3.1 User Configurable Area Control (UCA)

The UCA can show up to 12 system variables, selected by the operator from the full range of system data channels. Pressing the UCA key on the touch screen, shown in figure 16, activates access to the UCA configuration area.

The ability to change the items displayed in the UCA has been removed during factory set-up. The following sections relating to the UCA describe the options that could be made available but at present are not.

Clicking on the UCA banner from the display screen or the UCA button in the system options screen activates set up of the UCA, shown in figure 19, which is split into the following areas: Data Source, Available Data Items List, Selected Items List, and Master mode area.

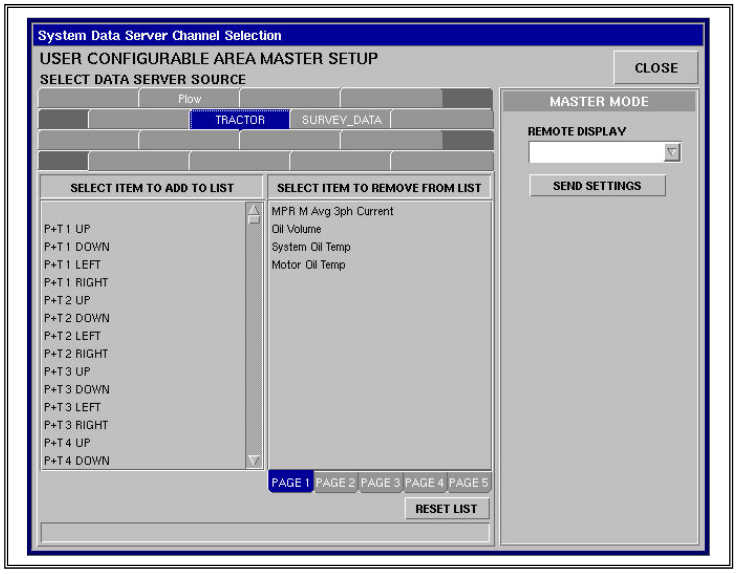

Figure 19 – User Configurable Area, Touch Screen

4.3.3.1.1 Data Source Area

Integrated control systems can have multiple data sources from which data items can be selected, e.g. ROV, survey, Plough etc. Select the required data source from those available.

4.3.3.1.2 Select Items to Add List

This area shows a list of variables from the selected data source, click an item to select it, when selected it will appear in the selected items list.

4.3.3.1.3 Selected Items List

This area shows a list of data items selected for the UCA display. Items can be removed from the list by clicking on them in this list.

4.3.3.1.4 Master Mode

The UCA can run in two modes, Master and Slave. The normal UCA display is slave mode, showing the data items selected. If a UCA slave has no means of configuration, i.e. it runs on a remote display, the Master mode is used to send a selection of data items to the remote display in order to configure the UCA.

When a selection has been made, choose the remote display from the drop down list and click 'Send Settings'. The selected UCA will then be updated

4.3.3.2 Set Time

Selecting this option initiates the screen shown in figure 20 and allows the user to set the system time.

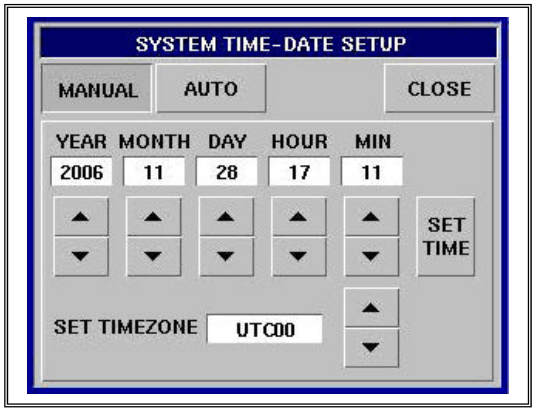

Figure 20 – Time Set, Touch Screen

Selecting [Manual] time set, allows the user to manually input the desired date and time, Set time button must be pressed to allocate the set time. Selecting [Auto], allows the user to automatically sync the date and time to some external device, for example a GPS receiver or an internet based time signal. In order to utilise this mode the DVECS channel names for Date and Time must be linked to the source code for example GPSDate, GPSTime these names are defined by the input task, serial_man, which reads the data from the source and formats it for use by DVECS. Figure 21 shows the time set screen when in auto mode.

Timezone UTC00 sets the system clock to GMT. Incrementing or decrementing, using the relevant arrows will display UTC01, (GMT +1Hr) and UTC-1, (GMT -1Hr) respectively.

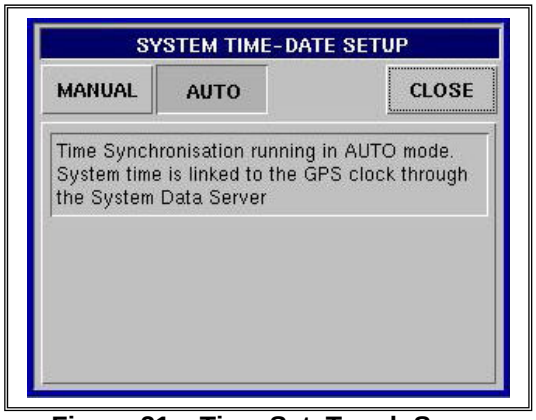

Figure 21 – Time Set, Touch Screen

4.3.4 Clean Screen

Provides a blank touch screen, as shown in figure 22, this allows contamination to be wiped from the screen without operating any functions.

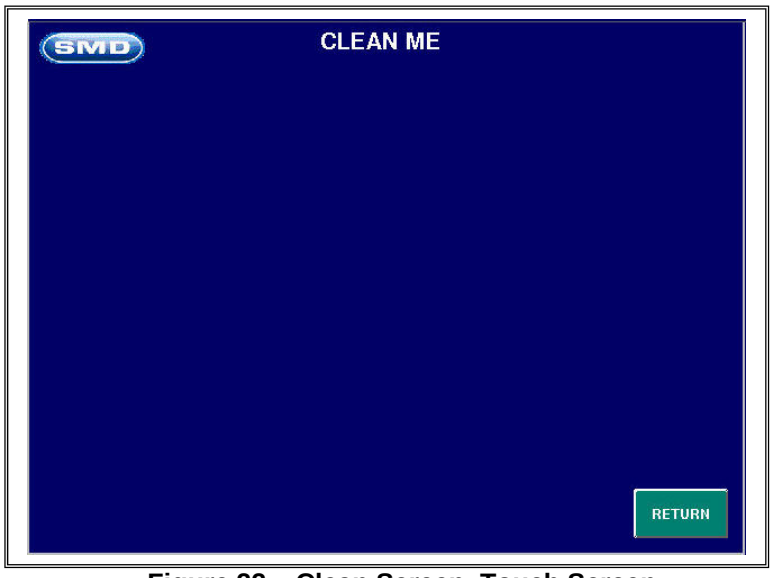

Figure 22 – Clean Screen, Touch Screen

4.4 User Keys

- **Vehicle Pump Load -** loads the system hydraulic circuit allowing full system pressure to be generated. This button should only be pressed after the motor is started as an interlock prevents the motor starting with the pump on load.
- **Tooling pump load -** Energises the tooling circuit.
- **Thruster Enable -** Allows the thrusters to be operated.
- **Manip power -** This controls the 48v power to the manipulator.
- **Vehicle Release -** Pressing this button cuts hydraulic power to all other functions and increases the hydraulic pressure to the vehicle latch point in order to release the vehicle.
- **Reduced Power -** mode reduces the power to the thrusters to 40%, allowing better stick control for delicate manoeuvring. Auto routines are unaffected by this mode. The amount the joystick is scaled to can be controlled using a variable in the analysis screen.
- **Vehicle Reverse -** Reverses the current joystick input for the ROV. The vehicle will handle as though being flown normally but in reality it is reversing.
- **Bellypack ctrl -** This button transfers joystick control to the bellypack.
- **Reset Umb Turns -** This button resets the turns counter for the vehicle. Turns are calculated using the vehicle gyro.
- **Watchdog reset -** Used to reset the watchdog in the subsea pod. In the event of telemetry being lost to the vehicle the 24v control bus is removed by a watchdog circuit. An alarm will be raised when the watchdog has tripped; you will also notice that the vehicle cannot be controlled.
- **Observ power -** These buttons control the maximum thrust of the joystick when in observation mode, this variable can be configured in the analysis screen.

- **Use Octans -** Selects the Octans gyro / IFG gyro as the source for the heading and auto heading routines.
- **Use Altimiter -** Selects the Altimiter / DVL as the source of the altitude and auto alt functions.

An indicator on the main ops screen will indicate which heading source is in use.

- **Logger -** activates the system logger see section 5.4 below (only available from the co-pilot station).
- **Guard -** System functions considered to be potentially dangerous are **guarded** to provide a level of protection against accidental activation. A pale red background indicates a guarded function as seen in figure 23, below.

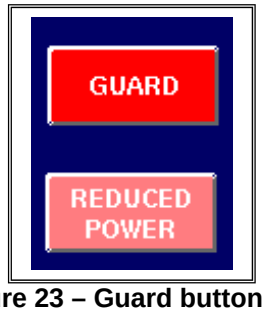

Figure 23 – Guard button

- **Analysis -** Activates the Analysis screen, see section 5.5 below (only available from the co-pilot station).
- **POD LIM reset -** This resets the POD Lim.
- **Motor LIM reset -** This resets the ROV Motor Lim.
- **ROV MPR reset -** This resets the motor protection relay in the PDU.

5 OPERATOR GRAPHICS SCREENS

5.1 General

The control system provides graphical displays for monitoring system status during operations:

- 1-Ops Display
- 2-Status Display

The two main screens share two common sections at the base:

- Alarm window (left)
- User Configurable Area (UCA) (right)

5.2 Ops Screen Display

The pilot screen, shown below in figure 24 contains the basic information to manoeuvre the ROV.

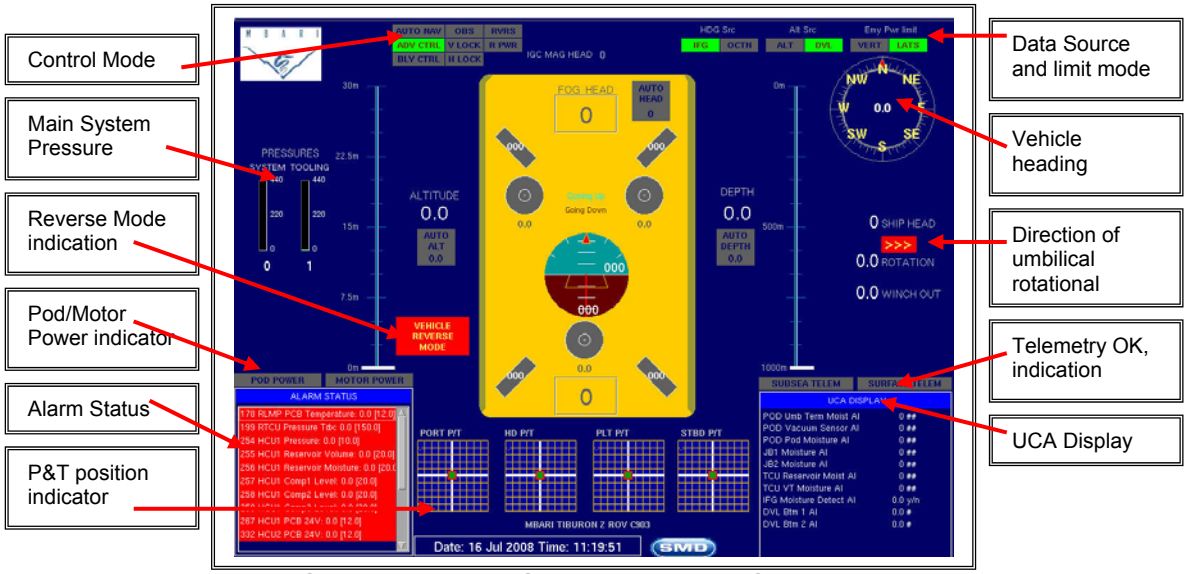

Figure 24 – Operations Screen, Touch screen

5.2.1 Control mode area

The 8 possible ROV control modes are shown in more detail in Figure25 below. These offer a quick reference display to show the pilot which modes are currently in use.

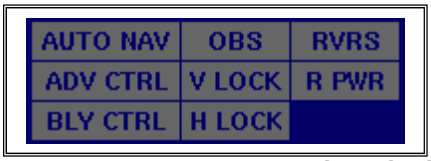

Figure 25 – Ops Screen, control mode displays

- **Auto Nav -** In this mode the ROV is controlled by the navigation PC.
- **Adv Ctrl -** Indicates that the ROV is currently working under MBARI advanced control algorithms.
- **BLY Ctrl -** In this mode the ROV is controlled by the bellypack.
- **OBS Ctrl -** Observation mode active
- **V Lock -** Vertical lock mode active
- **H Lock -** Horizontal lock mode active
- **RVRS -** Vehicle reverse mode active
- **R Pwr -** Reduced power mode active

5.2.2 Data source and limit mode status

These indicators shown figure 26 show how three important options are set:

Figure 26 – Ops Screen, control mode display

- **HDG source -** This shows whether the vehicle heading is coming from the IFG or Octans gyro.
- **Altitude source -** This shows whether the vehicle altitude is coming from the Altimeter or DVL.
- **Emy Pwr limit –** If the motor full load current is exceeded, power is limited to the thrusters, this indicates whether the emergency power limit is giving priority to vertical or lateral ROV movement.

5.2.3 Pan and tilt area

As seen in figure 27, Shows where, within the full motional range, the P&T's are currently sitting.

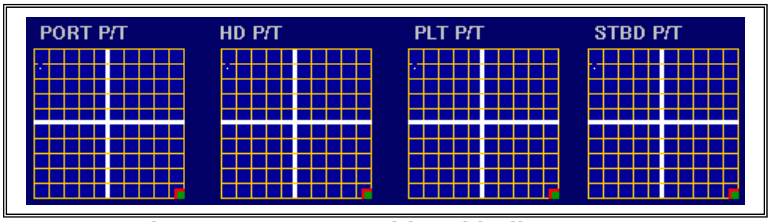

Figure 27 – P&T positional indicators

5.2.4 Telemetry status area

The subsea telemetry will be green when all six essential subsea devices are communicating with the surface. These are:

- HCU PCB
- TCU PCB
- Pod Wago

- Lamp dimmer PCB
- JB1 Wago
- JB2 Wago

The surface telemetry will be green when all four essential surface devices are communicating. These are:

- PDU Wago
- Chair Wago
- Bellypack Wago
- Console Wago

5.2.5 Contactor status area

(Figure 28) Shows the status of the two subsea HV supplies. Green indicates the supply is on.

Figure 28 – Power indication

5.2.6 System / tooling pressure display

Shown in figure 29, gives the pressures of the two hydraulic circuits in Bar. The tooling circuit feeds off the main hydraulic circuit. Off load the system pressure will register circa 40 bar; on load 210.

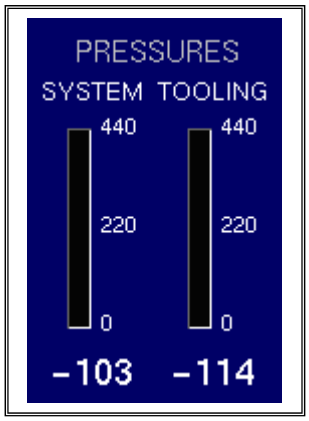

Figure 29 – System Pressure Indication

5.2.7 IGC heading

Shown in figure 30 the IGC compass heading. The IGC is the magnetic compass used to compensate for drift on the IFG compass. This is displayed here to get a feel for how the IFG / IGC are operating

Figure 30 – IGC Heading

5.2.8 Heading / Rotation / Winch out

Figure 31 shows ships heading as supplied by the MBARI nav interface; rotation as calculated from the heading source and ships heading and winch out reading. If rotation of the ROV with respect to the ship is present, then directional arrows will be displayed to indicate to the pilot which direction the ROV should move to undo the rotation.

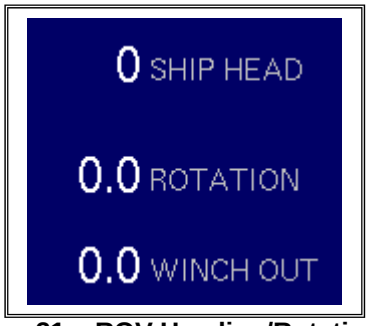

Figure 31 – ROV Heading/Rotation

5.2.9 Basic auto modes

These are for auto heading, depth and altitude. The numerical display shown in figure 32 will show the actual value for the relative variable with the set-point displayed in a grey box. When the grey area is green it means the auto mode is active. These three control modes are controlled using a simple PID controller.

Figure 32 – Auto Control

5.2.10 Thruster power display

The ROV in the centre of the Ops screen shown in figure 33 below, gives an interpretation of the thruster positions and the demand being applied to them from the joystick a graphical interpretation of the thruster "wash" is displayed to give an indication of the direction of movement.

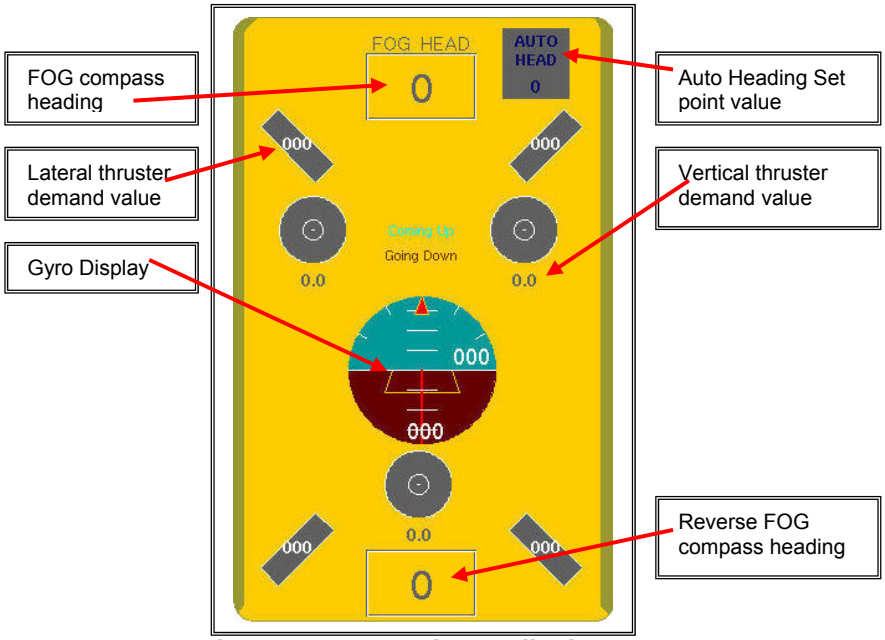

Figure 33 – Central ROV display

5.3 Status Screen

This screen, shown in Figure 34 below, gives a more detailed breakdown of the status of the ROV

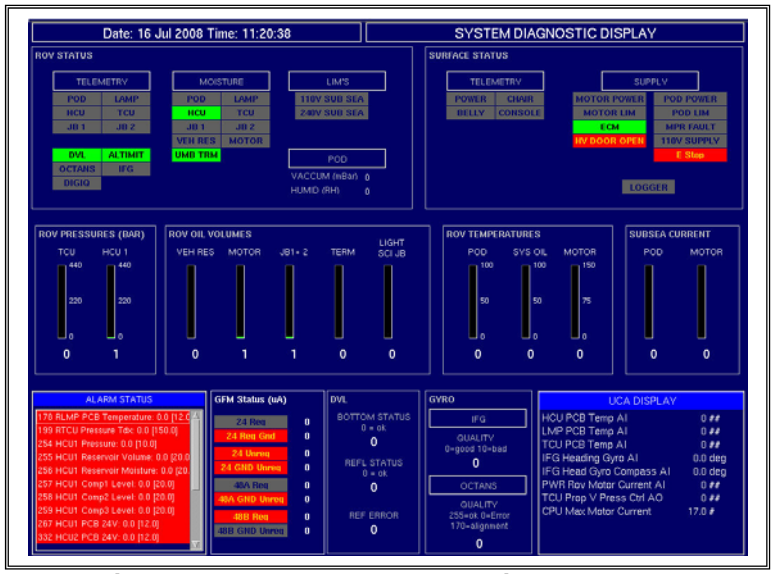

Figure 34 – Status Screen, Touch screen

5.3.1 Rov status area

Telemetry
This displays the comms status of various devices / PCBs. Green indicates the device is healthy.

Moisture
This shows when moisture alarms have occurred for various subsea devices. Red indicates an alarm.

LIMs
Green when the LIM is healthy.

Pod
Vacuum, reads in mBar. Should read roughly 1000mB when the pod vaccum port is open and circa 800mB for operational use when a vaccum is present.

Humidity is displayed beneath and reads as relative humidity (RH).

5.3.2 Surface status

Telemetry
This shows the status of various surface wago modules. Green indicates the device is healthy.

Supply
This shows the status of various devices in the PDU:

- **Motor power -** Green then the motor contactor is closed.
- **Pod power -** Green when the pod contactor is closed.
- **Motor Lim -** Red when the surface (3kv) motor Lim has tripped.
- **Pod Lim -** Red when the surface (3kv) pod Lim has tripped.
- **ECM -** Green then there is a good earth continuity to the vehicle.
- **MPR fault -** Indicates red when the motor protection relay has tripped.
- **HV door open -** Red when this is the case.
- **110v Supply -** Red when there is a 'supply fault' with the incoming 110v supply. This will normally be phase or under / over voltage.
- **E Stop -** Red when one of the E-Stops within the circuit has been pressed.

Logger
Green when the data logger is logging to disk.

5.3.3 Pod pressures

Shows the hydraulic pressures of the two circuits in Bar.

5.3.4 Rov oil volumes

Shows the oil volumes of the five vehicle compensators.

5.3.5 ROV temperatures

Shows the internal pod temperature; the system oil temperature and the motor winding temperature.

5.3.6 Subsea current

Shows the current being passed down the umbilical for the two subsea HV supplies.

5.3.7 GFM status

This shows the current ground fault status. The indicators go red after a threshold level is reached whilst the value to the right indicates the fault current.

5.4 Logger

In SMD control systems, data logging is controlled by a background task based on commands from the user. The logging system is accessed through a dedicated configuration interface as part of the standard control system display. All logging is performed to the USB stick.

When the [LOGGER] key is pressed, the logger configuration screen, shown in figure 35 is displayed on the touch screen. This screen is divided into the following main areas:

- Data Source
- Items to Add to List
- Selected Items List
- Logging Options.

5.4.1 Data Source Area

Integrated control systems can have multiple data sources from which data items can be selected, e.g. ROV, survey, Plough etc. Select the required data source from those available.

5.4.2 Select Item to Add to List

This area shows a list of variables provided from the currently selected data source. Click on required data items to add them to the selected item list.

5.4.3 Selection List

This list shows the data items currently selected for logging to the co-pilot hard disk. To delete an item from the list click on the item and it will be removed.

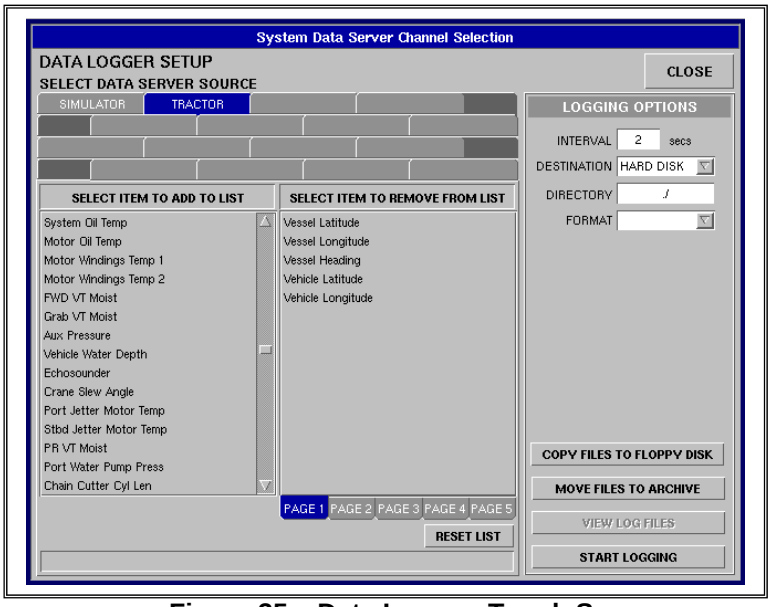

Figure 35 – Data Logger, Touch Screen

5.4.4 Log Options

This area allows configuration of specific logging parameters. These include setting the logging interval between data records and data logging format, (not currently in use, for future expansion).

Before starting the logger ensure that a USB stick is inserted and has been enabled.

To enable data logging press [START LOGGING], press this key again to stop logging.

Filenames are of the format 'Lxxyyyzz.nnn' where xx = day, yyy = month, zz=year. The suffix nnn will increase incrementally from 0 as the each file is completed.

For example the third file on 13th July 2000 would be 'L13Jul00.3'.

5.5 Analysis

This display shows a table containing the control system database Figure 36. It can only be accessed from the co-pilot PC. When the analysis display is activated, the touch screen changes to the screen shown in Figure 37.

5.5.1 Analysis Screen Layout

The data shown defines all machine data channels including analogue, digital, counter inputs and outputs and user definable system variable types. These values in this database are updated in real-time.

The field headings in the database are as follows: -

Ch - Unique channel number from 1 to 999

Use - Data channel enabled or disabled

Description	-	Text description of data channel
Type	-	Digital In/Out Analogue In/Out Counters or System Variables
Link	-	Allows links to other database channels
Raw	-	The current raw data value
Final	-	The current scaled value
Units	-	What units the channel is measured in
Rmin	-	raw value at minimum final value
Rmax	-	raw value at maximum final value
Smin	-	minimum final value
Smax	-	maximum final value
Smul	-	Rmax - Rmin
Sdiv	-	Smax - Smin
Sofs	-	Offset applied to final value to achieve zero
Alarm HI	-	Upper alarm limit
HI ON/OFF	-	Enable / Disable HI alarm
Alarm Lo	-	Lower alarm limit
LO ON/OFF	-	Enable / Disable LO alarm

The final values of channels that are in an alarm state are highlighted in yellow.

The final values of digital channels that are in an active state are displayed highlighted in red.

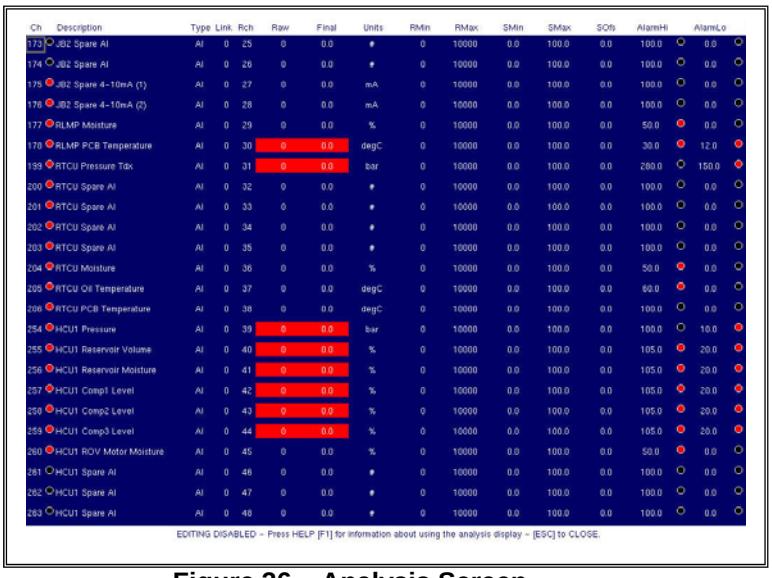

Figure 36 – Analysis Screen

The control system database is defined and configured during system commissioning and under normal circumstances will not require modification during operations.

5.5.2 Editing the Database

To move around the spreadsheet use the following keystrokes as shown on Figure 37:

[Up] [Left] [Right] [Down] [Page Up] [Page Down].

To prevent accidental modification, the analysis screen is password protected.

To enter edit mode the operator must place the cursor over any ***channel number***, and type **'1342'** at the touch screen.

The ***Analysis Status Field*** in the screen base will change indicating that editing is enabled.

Insert the password again to 'write protect' the data. The ***Analysis Status field*** reverts to **Editing Disabled**.

Edit the scaling values by moving the cursor to the required scaling item and typing in the new value.

Press [ENTER] to confirm the change.

Moving the cursor away before pressing [ENTER] will cancel the change being input.

Figure 37 – Analysis Screen, Touch Screen

The ***RAW*** values represent the actual value returned by the hardware connected to each channel for analogue, digital and counter inputs. It is not possible to alter actual raw or processed data item values for channels that are hardware controlled. However, the operator, as required, can modify user defined or system variable type.

5.5.3 Linear Scaling

Linear scaling is performed using the Analysis Screen at the co-pilot workstation. The control systems will automatically re-scale outputs, after new scaling parameters have been input.

Linear Scaling is carried out using the following formula:

Final Value = {[Raw Value/(Rmax - (Rmin)] * (Smax - Smin)} + Soffset

Normally the only values the user has to change are to adjust scaling are:

- **Rmin -** Raw data minimum value
- **Rmax -** Raw data maximum value
- **Smin -** Scale data minimum value
- **Smax -** Scale data maximum value

It is not normally necessary to modify the other scaling parameters listed below.

- **Smul -** Scale multiplier = Smax - Smin
- **Sdiv -** Scale divisor = Rmax - Rmin
- **Sofs -** Scale offset

Alarm fields can also be changed to suit operator requirements:

- **Amin -** Alarm limit minimum value
- **Amax -** Alarm limit maximum value

5.5.4 Alarm Conditions

The Alarm options include the ability to enable or disable alarm monitoring for any channel. Move to the key adjacent to the alarm settings and press [ENTER] to toggle the alarm condition on or off.

Note that alarm limits are entered in engineering units

5.6 Control System Software Maintenance

SMD control systems software is designed to isolate the end user from the underlying operating system and hardware completely. The functions required to maintain or configure the system have been provided through the standard user interface. In the event that low level system access is required, to prevent unnecessary damage to system configuration, a qualified SMDH support engineer must carry out these operations on the system.

The main control PC typically contains all files required to run the control system including configuration, initialisation and executable files for all computers. Typically these files will change throughout the life of a system due to:

1- Calibration data in database changing.
2- Software patches / upgrades.
3- Other configuration changes.
4- Configuration changes to or wholesale changing of onboard vehicle.

The server PC is typically identified as 'Node1' on the system

5.6.1 USB manager

The USB manager is enabled by moving the mouse pointer to the bottom of the co-pilot screen and selecting “USB Manager”, it will bring up a screen as shown in Figure 38.

The USB manager is used to start / stop USB devices much like the one in Windows. Like other computer systems if you unplug your USB memory stick from the computer without first stopping it data loss may occur.

As a rule of thumb, the time taken to stop the device is proportional to the amount of data you have written to it. If you've written a couple off Megs of data, it may take several seconds to stop; if you unplug it during this period you will loose data.

There are 3 buttons on this application:

Start – Start a USB device, may take a couple of seconds to initialise
Stop – Stop a USB device so you can unplug the USB device.
Hide – Make this window go away.

Figure 38 - USB manager

5.6.2 Software Backup

The User Configurable Display (UCD) program provides the graphical user interface for SMD control systems. The UCD uses a library of specially designed display objects as building blocks to produce versatile displays for the vehicle and equipment control systems. Designed specifically for system software backup, the BACKUP object can be used to prepare a compressed archive of all system software and configuration files. The BACKUP object should be placed on a utility function page if required for use.

This option allows the user to backup and restore files. From here, the user can save the current control system files, and perform system updates or re-install previous versions of the control system. The backups are directed to the USB key slot Figure 6.

CAUTION

Ensure USB manager is running **BEFORE** attempting back up.

Selecting the backup manager will lead to the screen displayed in Figure 17, select the appropriate option in Step 1, depending on whether you wish to write to or from the USB drive Then in step 2, select one of the 5 possible locations, to write to or read from.

The purpose of this utility is to back up these files to a safe location (typically usb storage). It is useful to create a backup of the current configuration mainly for disaster recovery purposes (i.e. any spare Server PC will have out-of date configuration files on it at the point of replacement).

This program can also be used for installing software patches from SMD.

5.6.2.1 Installing a patch

Step1 - Copy the patch file to a usb memory device.
Step2 - Use the Usb_man utility to start the usb device
Step3 - Backup current configuration to an empty slot
Step4 - Use the 'Restore' option to install the patch (note patch files have the format SP#_#######)
Step5 - Backup current configuration to an empty slot

5.6.3 System I/O Configuration

SMD control systems provide a basic level of I/O configuration, through the user interface. The functions available allow scaling, channel allocation and linking to be carried out by the user without the need for low-level system access.

The layout of systems I/O hardware is defined and configured during factory commissioning at SMD workshops. Should it become necessary to change the arrangement of system I/O hardware, after the system has been delivered, the control system core software may also require modification or re-configuring. This operation can be complex and currently requires the support of a qualified SMD systems engineer.

6 SOFTWARE FUNCTIONAL DESCRIPTION

This section describes elements of the software that are not covered by descriptions of the GUI.

6.1 Watchdog circuit safety interlock

The pod contains a watchdog circuit that requires a pulse on channel 152 of the database (POD WATCHDOG DO); this is a digital output located in the pod. If this is interrupted by a telemetry glitch or software hang up then the watchdog removes the power to the HCU and TCU that drives solenoids. Channel 151 'POD WATCHDOG RESET DO' must be asserted for this supply to be restored. This is a safety interlock.

6.2 Oil volume / ROV Comms interlock

If Comp1 (motor comp) or the main reservoir compensator levels fall below their alarm_min level for approximately 1 second then the ROV motor supply is turned off at the PDU. This interlock will also prevent the ROV motor being started when the comp levels are too low.

The alarms for either 'HCU Comp 1 Vol AI' or 'TCU Reservoir Vol AI' will be active when this interlock has triggered.

Additionally this interlock is triggered if comms to either the HCU; TCU or Pod Wago are lost.

6.3 Auto heading interlock

Auto heading mode will be disengaged if communications to whatever device is currently in use is lost i.e IGC/IFG or Octans gyro. For this reason you will not be able to enter auto heading if the appropriate gyro device is not first turned on.

A reset indicator alarm will be displayed on the main ops screen when this mode has been disabled in this manner.

6.4 Motor current interlock

If a situation arises where the full load current is exceeded for the ROV motor then the software automatically limits the thrust demands being sent to the vehicle. The full load current is defined as 14.8 A by default. The operator can select whether the verts or the axial thrusters will be scaled back using the button provided on the TCU trims touch-screen page .

6.5 110V LIM interlocks

There is a 110V LIM unit contained within the main electronics pod that monitors impedance between the subsea 110v supplies and earth. When this device is triggered the software automatically drops the 110v supply to these devices. Devices affected are:

- Lamps 1-4
- HMI lamps 1-6
- The 110v Supply in JB1
- The 110v Supply in the Aux JB

A 110v 'LIM Override' button is provided to allow operation of these supplies in the event of a LIM fault. An alarm will be generated when the 110v LIM has tripped : 'POD 110V LIM DI'.

6.6 240V LIM Interlocks

There is a 240V LIM unit contained within the main electronics pod that monitors impedance between the subsea 240v supplies and earth. When this device is triggered the software automatically drops the 240v supply to these devices. Devices affected are:

- Aux JB 240v
- Toolsled 240v

6.7 Pump load interlock

The software prevents the vehicle pump load being enabled whilst the motor is started up. This is because of the higher starting currents associated with starting on-load (see next section).

6.8 Motor start interlock

Whenever the motor is started the following actions are undertaken:

- Turn off TCU hydraulics
- Turn off Vehicle main hydraulics – pump load
- Turn off all auto modes.
- Set all trim values to 0.

6.9 Auto mode exclusions

Concurrent modes are detailed below in Table6

- If I am in 'Bly Ctrl' mode I cannot also be in observation mode.
- If I am in Observation mode I can enable advanced control.

current mode \ mode allowed	Adv Nav	Adv Ctrl	Bly Ctrl	Obs	V Lock	H Lock	Rvrs	R Pwr
Adv Nav	n/a							y
Adv Ctrl		n/a		y	y	y	y	y
Bly Ctrl			n/a					y
Obs		y		n/a	Y	y	y	y
V Lock		y		y	n/a	y		y
H Lock		y		y	y	n/a		y
Rvrs		y		y			n/a	y
R Pwr	y	y	y	y	y	y	y	n/a

Table 6 – Auto Mode Exclusions

6.10 Main joystick bar button

The bar button on the main joystick is used to engage auto-heading and observation mode. The bar has three positions; off one and two which are selected by squeezing the bar. If the bar is squeezed to the first position then released to off observation mode is entered. If the bar is squeezed to the first then second position before being released auto-heading mode is engaged.

6.11 Auto Nav

In auto Nav mode the vehicle is controlled by the auto navigation routines; this controls the vehicle axial thrusters. In this mode vehicle altitude / depth will be controlled by the operator or one of the auto alt / depth functions.

6.12 Adv Nav

This is the MBARI advanced controls interface. In this mode the control joystick commands are added to by values sent by the MBARI interface. This allows for external control of the ROV by MBARI.

6.13 BLY Ctrl

In this mode of operation the joystick commands for control of the ROV come from the belly-pack rather than the pilots active chair.

6.14 OBS Ctrl

In observation mode the joystick maximum thrust can be scaled from 0-100%. Additionally the thrusters are manipulated such that the thrusters do not thrust towards the front of the vehicle i.e. where specemins are being observed.

6.15 V Lock

In V lock mode the vertical joystick command is locked at the point the mode was entered. The mode is exited by depressing the 'V Lock' button or giving a vertical demand greater than fifty percent.

6.16 H Lock

In HV lock mode the axial joystick commands are locked at the point the mode was entered. The mode is exited by depressing the 'H Lock' button or giving a vertical demand greater than fifty percent.

6.17 RVRS

In reverse mode the joystick input commands are reversed so the vehicle can be flown normally whilst viewing through one of the vehicle rear cameras.

6.18 R Pwr

In reduced power mode the vehicle hydraulic pressure is temporarily reduced and the main joystick maximum demand scaled back.

7 WORKING WITH THE UCD AND LAYOUTS

7.1 Introduction

The UCD (User Configurable Display) is the software program that is used to design the pages displayed on the Pilot and Co-Pilot displays and touch-screens. A page is defined by its *layout* which contains all the information used to define the look and functionality of a display / touch-screen.

The UCD operates in one of two modes, *design mode* and *run mode* (see Figure 39). In run mode, the UCD displays real time controls on indicators that can be used to interact with the Control System. In design mode, toolbars and utilities are provided to allow the page layouts to be re-configured.

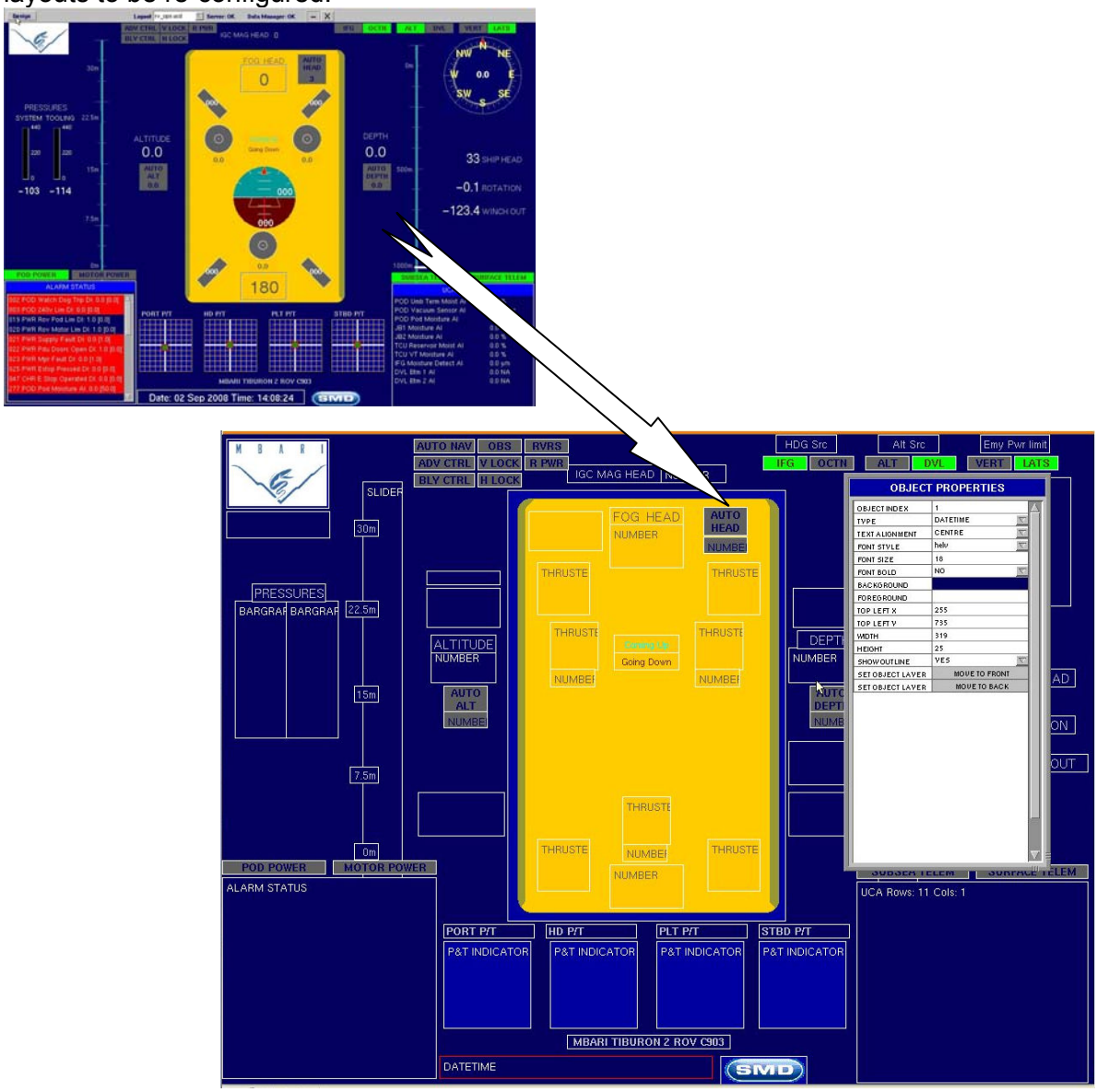

Figure 39 - Run Mode and Design Mode for a Page Layout

7.2 Design components

There are three main design components that are used within the UCD program.

- Firstly, there is the 'Design Button' toolbar (Figure 40).
- This appears only in run mode and is used to gain entry to design mode.
- As the pointing device is moved towards the top of the screen, this toolbar appears.
- Once the design mode is unlocked in the control system files, the 'Design' button can be used to enter design mode.

Figure 40 - Design Button Toolbar

Once in design mode, the 'Design Button' toolbar is replaced with a 'Design toolbar' (Figure 41). This has numerous buttons for loading / saving and objects manipulation.

Figure 41 - Design toolbar

Additionally, an object properties window (Figure 42) is displayed in design mode to display the properties of the currently selected object.

Objects can be selected using the left mouse button, and appear red-highlighted when selected.

From here, the user can define the data to be linked to the object and other properties including its shape, colour and size.

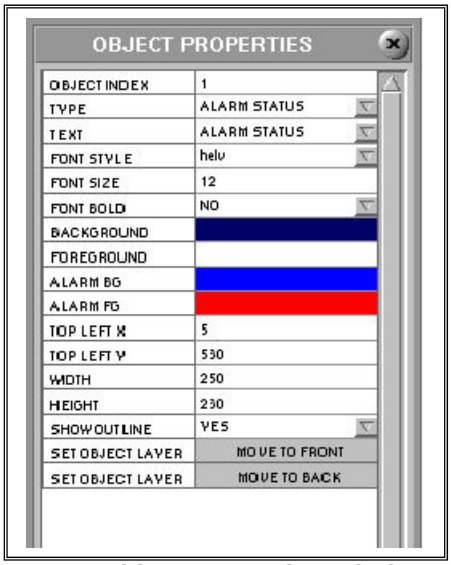

Figure 42 - Object Properties Window

7.3 Working with the design toolbar

The design toolbar is the main method of creating and manipulating layouts.
The following options are available:

7.3.1 New

The new button replaces the currently loaded layout with a blank un-named layout. This is used when creating layouts from scratch.

Note: Hitting this button does not delete the currently selected layout merely de-selects it.

7.3.2 Load

A file dialog appears and a layout file with the extension 'ucd' can be loaded.

7.3.3 Save as

Save the current layout and prompt the user for the filename to save as. This is useful for making copies of layouts you are currently working on.

7.3.4 Add

The add button is used to add a new object to the current layout. A new object appears on the current page of type 'undefined'. This can then be changed to the desired object type.

7.3.5 Delete

The delete button can be used to delete the currently selected object on screen.

7.3.6 Copy

The copy button copies the currently selected object to memory.

7.3.7 Paste

The paste button pastes a previously copied object. For this to work, the previously copied object must first be de-selected.

7.3.8 Options

The options button brings up the options dialog. For each layout, there are a series of options stored in the header of the layout file that describe generic functionality. It is therefore recommended that any new pages be based on existing files (use 'save as' button to duplicate a layout) as to ensure the information here is consistent with the rest of the layouts.

7.3.9 Run mode

The run mode button moves the UCD into run mode using the currently selected layout file as its layout. A dialog appears asking the user if he wishes to save the layout assuming changes have been made. If changes are not saved, they are discarded and not displayed on the run mode layout.

7.3.10 Keyboard shortcuts

As well as the design toolbar, additional functionality is provided by the keyboard:

- **S -** enable / disable screen size indication
- **[ctrl] arrow key** –move selected object(s) around the screen in increments of the snap grid interval
- **[ctrl]N -** same as the NEW function
- **[ctrl]L -** same as the LOAD function
- **[ctrl]S -** same as the SAVE function
- **[ctrl]C -** same as the COPY function
- **[ctrl]V -** same as the PASTE function
- **INS -** paste current copy object into layout
- **DEL -** delete an object from the layout

7.3.11 Designing layouts - general

When designing layouts, time will be spent in the following four areas mainly:

- Creating as many layouts as is required by the application
- Arranging objects on layouts
- Specifying object properties including data links
- Linking layouts together so they are navigable

The first task is to consider what information needs to be presented to the operator and put together a series of layouts that fulfils this need. Layouts designed by SMD tend to have a common look and feel where navigation buttons on touch-screens are in a consistent location and different button types are colour coded. The manner in which the objects are arranged on screen is also particularly important as too much information can overload the operator and make a layout difficult to use.

7.3.12 Designing layouts – style guidelines

When designing layouts, it's important to define and stick to a common style to keep your interface professional-looking and easy to use.

Define standards: -

- Objects with similar functionality should have similar appearance
- Objects w/ diff. functionality should have different appearance
- Informative text should be shadow or transparent fields
- Don't make screens crowded, hard to read
- Avoid using too many colors on one screen (e.g. maximum of 4)
- Avoid using different fonts (maximum of 2)
- Avoid putting too much information on the screen at once
- There is a limited amount of information that the user can Observe at once (st.memory = aprox.7)
- The computer allows non-sequential access, so there is no need to crowd up your information.
- Place information on screen according to importance

- Put in the left/top what the user should look at first
- Use more appealing colors for more important items/less appealing colors for less appealing items.
- Well balanced screen
- Distribute information evenly on your screen.
- Don't crowd up information on 1/2 the screen and leave the other 1/2 empty.
- Don't use similar colours for adjacent objects.
- Example: background of text field purple and letters pink.

8 SYSTEM MAINTENANCE

8.1 Electrical Supply

SMD requires that the power supplies are in accordance with the specific tolerances given in (Table 7) and in general, comply with the requirements of IEE "Regulations for the Electrical and Electronic Equipment of Ships", Supplement 1994 to sixth edition 1990.

Item	Tolerance
Frequency	50/60 Hz +/-5%. Supplies from a multiple source must be synchronous.
Harmonic distortion	To be less than 8% of ship supply fundamental.
Voltage Variation	Maximum at a particular setting +6/-10%.
Short circuit protection	Ship mounted short circuit protection using "High Rupture Capacity Fuses or Circuit Breaker".
Isolation	It must be possible to isolate each supply separately

Table 7 – Power Supply Specific Tolerances

It is the responsibility of the customer to ensure that suitable circuit breakers are provided on the ship supply to SMD equipment.

8.2 Electrical Connections

WARNING

Always isolate the power and discharge the umbilical before working on any part of the system.

The outgoing HV supplies, earth conductors, fibre optics, and ECM loop wires should be fed from the PDU, via a deck cable, to the Winch Umbilical External Termination Box.

8.3 Set up of Transformers

It is necessary to ensure that the correct tappings are connected on the transformer. Throughout the working life of the system it may become necessary to reterminate the umbilical, after several such incidents the umbilical may become significantly shorter, at which point it will become necessary to adjust the tapping on the transformer to avoid an overvoltage of the subsea instrumentation. Table 8 gives an approximation of the subsea voltage for any given length of umbilical.

CAUTION

Stated Susbsea voltage values are only an approximation of the actual voltage

There is no feedback of the actual voltage from the subsea transformer therefore, the voltages listed are only an approximation.
Please note, the voltage at the subsea motor should be as close to 3200v as possible and the voltage on the subsea instrument line (primary side of transformer) should be as close to 3000v as possible.

Length of Umbilical (m)	Secondary tapping value of topside motor transformer (v)	Approximate voltage at subsea motor (v)
5000	3900	3230
4500	3900	3290
4000	3900	3360
4500	3800	3190
4000	3800	3260
3500	3800	3330
4000	3700	3160
3500	3700	3230
3000	3700	3290
Length of Umbilical (m)	**Secondary tapping value of topside pod transformer (v)**	**Approximate voltage subsea (v)**
5000	3200	3015
4500	3200	3030
4000	3200	3050
4500	3100	2930
4000	3100	3950
3500	3100	2970
3000	3100	2980
2500	3100	3010
2500	3000	2900

Table 8 – Approximate Transformer Tappings

8.4 Switching on the Sub-sea supplies

Once the control cabin domestic supplies are operational, the sub-sea supplies can be energised ready for the operators to start sub-sea equipment Pod and motor.

Check that it is safe to energise the sub-sea supplies, particularly if the emergency stop has been activated.

Note: That the emergency stop can also be locked in the ‘stop’ position.

Incoming power is monitored by the combined voltage, current and frequency meter.

The supply fault light illuminates if: -

- Supply frequency is not within ± 3Hz of 50 or 60Hz.
- Supply voltage is outside the limits of the under and over voltage relay.
- These will need to be adjusted depending upon what voltage the ship is providing.

For details of switching on the ROV Pod and ROV motor, please refer to Section 2.2

