DTEC Ltd.

Telemetry System

Customized for the

Ventana ROV

CONTENTS

..0 Telemetry Overview

1.1 Introduction:

This document contains an overview of the operation and maintenance of the DTEC telemetry system. It is assumed that the maintenance personnel have a basic understanding of electronics and computers running under the Linux environment. The ability to isolate problems down to a board level will enable an operator to replace each of the system modules. As well the software has been designed to aid the operator in maintenance and operation procedures.

The software developed by DTEC Ltd. incorporates overlaying a computer graphic display onto a video signal that can be observed on the operators monitor as well as two graphics pages to be displayed on VGA monitors. The Monitors are referred to the Pilots Monitor and the Co-pilots Monitor. These graphics displays are totally user configurable by the user in the maintenance menu.

I/O element concept:

The software is developed around the concept that the digital and analog channels are data elements. These data elements are connected and configured by appropriate selections in the menus. Each input element can be configured to connect to any output element. Any input element can be used to display any of the graphics functions on any of the monitors. Input elements can be combined in formulas to generate any of the output elements.

There is a listing of all of the elements available via the menu to allow the user to observe the system configuration and how the telemetry is connecting inputs and outputs.

When a graphics item is selected the user is prompted to fill all of the fields for that graphics item (alarm levels, x and y coordinates of where the element should be placed etc.). Many of the graphics items have specific requirements, therefore the fields for each graphics item are different.

The Pilots page and Co-pilots page are shipped from DTEC with the following configuration and with the following aphics items displayed. A heading compass, a depth display with history, a sub display with thrusters and a sub display with lights, an attitude display, and various alarm and status displays. The main menu items at the top of the page are not user definable.

Each of the displayed pages are fully configurable and can be changed by the user. Therefore it is appropriate to consider changes carefully as it is possible to reconfigure the system so that it no longer functions. The user should be especially careful when making changes to the element connections fields. This is where the outputs are connected to the various inputs. It is possible to connect any output to any input. When making changes to element software connections there probably would be changes to the wiring to acComodate the re-routing of the specific output element.

1.2 Graphics Items:

The following graphics items are available in the surface and vehicle menus. See the menu descriptions in Section 3 for instructions fro setting up these graphics:

1.2.1 Bar Graph:

The bar graph displays an analog channel linearly and vertically on a rectangular graph. Units, title, and the value are all shown in the bar graph frame. There are also alarm levels which can be assigned to the bar graph to enable the analog value to generate an alarm condition at the levels set by the user. These alarm levels are set in the element menu.

1.2.2 Ground Fault Bar Graph:

The Ground fault bar graph is virtually identical to the Bar Graph above with one difference. The bottom of the bar graph is the higher value (infinite ohms) and the top of the bar graph is the lowest value (0 ohms). Alarm levels and labeling are the same as the normal bar graph.

1.2.3 Compass Display:

The compass display contains all of the information pertaining to the heading of the vehicle. Vehicle heading, auto heading set point, turns counter, and a track deviation indicator are displayed. This display can also show a historical accounting of the headings that the vehicle has had for a given period of time. All of the setup for the compass display is done in the maintenance menu. The compass display has the vehicle always facing up and the compass rose rotating around the vehicle. There is a indicator that displays the status of the FOG gyro. When this indicator is red the bit in the status string from the FOG is set indicating a FOG gyro fault. It is up to the pilot to disengage any autopilots when this indicator is red. There are a number of reasons why this bit could be set, for further information please refer to the FOG gyro literature.

1.2.4 Depth Scale with History:

The depth display is a larger bar graph specifically designed to display the depth information. Depth, auto depth set points, altitude, auto altitude set point, vertical speed, and historical depth information are all displayed. When in auto depth mode the auto depth set point can be incremented or decremented by the depth jog up and down switches. The increment is 0.1 meters.

1.2.5 Sub Display:

The sub display is a 3 dimensional rendering of the sub showing, vehicle attitude, camera pan and tilt attitudes, and thruster intensities. Optionally other peripherals are added to the display for visual feedback of the operation of those peripherals. The vehicle moves in 3 axis with the cameras moving around inside this rendering also in 3 axis. Numerical Representations of the Vehicle Attitude, Camera FB angles, And Thrusters are displayed. The camera tilt angle is an addition of the shoulder angle and the tilt angle.

1.2.6 Lights Display:

The Lights graphics item shows the lights and their status (White for on, Blue for off). Each light can be placed on the sub as per the x and y co-ordinates in the menu. Each light can be operated via the touch screen. Each light control can be mapped to any of the digital outputs on the sub.

1.2.7 Alarm Display:

Alarms are indicated by a "button" being produced by the software onto the screen. The operator can acknowledge the alarm by touching the button. This however only acknowledges the alarm. It remains active until the alarm condition ceases. In addition to the alarm being generated there is a historical database in the form of a list detailing the alarms that have occurred. This list can be reset and cleared by the user via the top menu item labeled "Alarms". This label appears red when an alarm condition that has been acknowledged still exists.

1.2.8 Control Button:

The user can place control buttons onto the graphics pages in any location that the user chooses. These control buttons are for on/off devices and can be alternate or momentary. These buttons are activated by the touch screen/pointer. The buttons are connected to any one of the digital outputs in the sub as specified in the setup menu.

1.2.9 Slider Bar:

The slider bar is for the control of analog channels. The value that is on the slider is assigned to the analog channel. The analog channel is specified in the element menu.

1.2.10 Time and Date:

The time and date is displayed on the overlay by enabling the time and date in the overlay menu.

1.2.11 Enable Arm Button:

The arm is enabled is two places. There is a switch input that is mounted on the master and there is a software button located on the screen. For the valve that supplies hydraulics to the arm servo pack to be activated both of these inputs have to be on. After the arm is enabled each function has to be picked up by moving the master within 10 degrees of the slave. Once the function has been "picked up" the Comand to the servo valve is enabled and the arm will follow the master.

1.2.12 Enable Camera Button:

The main camera pan and tilt control is enabled via this switch. As with the arm functions each camera function must be picked up by moving the control pots to the same relative position of the slave. After the funcion is picked up the master will control the slave.

1.2.13 Enable Teleos Button:

The control to the Teleos is accepted when this button is on. When the Teleos is controlling the vehicle the joystick inputs are summed with the Teleos inputs to give the pilot the ability to override the Teleos control inputs.

1.2.14 Enable Bellypack:

The control from the belly pack is used to control the thrusters when enabled. While the bellypack is enabled autoheading is still useable but the auto heading set point cannot be changed.

1.3 Alarms:

The displays an alarm button on the graphics pages. The alarm error list accessible in the graphics pages displays a historical account of alarms generated within the system. This list can be cleared within the graphics menu system via the top level menu item labeled "alarms".

1.4 Time:

The time is displayed as per the overlay menu information. The time can be changed either by using a terminal and typing "date MMDDhhmmYYYY", where MM is the month, DD is the day, hh is the hour, mm is the minute, and YYYY is the year. There are also many Linux programs that run within the x server which you can use to change the time and date.

1.5 Text Overlay:

Text can be typed onto the overlay screen to add description to the recorded video. To write text onto the video screen use the top menu item labeled "Annotate". An area in the middle of the overlay screen has been reserved for the annotated text. To erase the text, use the annotate menu clear function.

1.9 Quitting the program:

Use the top menu item "File then Exit" to end the telemetry session.

1.10 Pilots and Co-pilots Screen:

Any data can be displayed on the pilots page in any graphics configuration in any position. The element menu allows manipulation of each of the data elements including the graphics that are to be used for each element.
Table

Available Graphics Functions.

Item Name	Description
Bar Graph	Displays an analog level in the form of a bar graph, with alarm level and digital value
Ground Fault Bar Graph	Same as above but with high value on bottom and low value on top
Sub Picture with Thruster Levels	Displays a sub in 3 D with the thruster levels an camera pan and tilts
Sub with Light Levels	Displays the lights on the sub
Compass Rose	Displays the heading value in the form of a compass rose
Alarm Button	Displays a digital alarm value as an alarm condition if active
Control Button	Displays a digital soft switch
Slider Bar	Displays an analog input as a slider bar with increment/decrement arrows and numerical digital input
Depth Scale with History	Displays an analog level.as a depth readout

1.11 Telemetry status and alarm:

Telemetry Status is normal unless a pop up alarm indicating otherwise. The popup alarm will be self explanatory.

1.12 Backup and Printing the configuration file:

Each configuration file should be backed up onto a floppy disk. Also each configuration file may be printed in the event that for some reason the program can not read either the configuration file or the backup file. DTEC has provided a program to translate the configuration file into an ascii format. This ascii format is for a hard copy only. This hard copy contains all the information that the user would need to re-enter previously used data back into a new configuration file after a catastrophic failure.

?.0 Logging

Logging String on Com 5 (Rocket Port 2)

Logging data is done to the logging system provided by the client. The information is available serially from the telemetry computer and it is intended that the logging system manipulate and save the data as desired by MBARI. String conventions are coded in the source code and changes require a re-compilation of the surface software. String conventions are as follows:

There are first 11 integers: represented in order as follows:

Vehicle current raw depth in PSI as a long integer
CTD Power State
Vehicle in water (depth is more than 2 meters true, depth less false)
Port Thruster as an integer.
Lateral Thruster as an integer.
Spare Thruster as an integer.
Stbd Thruster as an integer.
Vertical Thruster as an integer.
Sony cam Pan angle as an integer.
DVL output
Dive Number

There are 11 floats: represented in order as follows:

Vehicle Heading
Vehicle Pitch
Vehicle Roll
Vehicle Altitude
Joystick Turns
Joystick Fore-aft
Joystick Lateral
Joystick Vertical

Ventana Disk Logging

All of the data collected by the vehicle and the surface can be logged to disk. The logging menu allows the user to create a list of elements to be logged. Select the logging types on the left side of the menu then add them to the list on the right side of the menu. Each of the analog values from the surface and the sub can be logged. Select the sample time that the data is to be logged at in milliseconds in the Sample Time Box. The disk enable button must be checked to start logging. The data will be logged for the amount of time in the Time to Log Box.
An additional indicator is on the operators page indicating by green that the logging is enabled.

Disk Logging Format

The data is logged to disk in a Coma delineated line. Each logging sample is separated by a CR/LF. This format can be used by Excel. One sample is the entire list and a time stamp. String is as follows: HH:MM:SS MM:DD:YY, Lable1, Value1, Lable2, Value2, Label3, Value3,......CR/LF.

3.0 Top Menu Functions

3.1 Menu Overview:

With the menus the user is able to see the data elements (analog and digital IO) and manipulate the various parameters controlling that data element. There are also the standard program functions such as for saving and opening files etc. Also there are menus devoted to specialty items that need specific control functions; such as the detritus and tool packages.

3.2 File:

3.2.1 File Open:

This function will prompt the user for the file name to be opened and then will open the file and use it as the present configuration. Only valid files can be retrieved.

3.2.2 File Save:

This function will save the present configuration using the name that the user has previously entered. If no name has been previously entered then the user is prompted to provide one.

3.2.3 File Save As:

This function will save the present configuration using a name entered by the user.

3.2.4 Quit:

This function will cause the telemetry program to halt. All control functions on the surface will cease and the Communications wit each peripheral device will shut down. The telemetry window is closed and the user can operate the computer like any other linux based computer.

3.2.5 Download New software:

This function will download a new version of software to the sub end GESPAC SBS-47 processor board. There are two programs in the sub end. The first is a DOS based program which is used to interface with the SBS47 EEPROM flash disk. The driver for this flash disk only supports DOS. When the sub end is turned on the DOS program checks the linux version and then copies the image from EEPROM flash to RAM. DOS then spawns a second program or process which starts the RTLinux Kernal. While the Linux is running DOS is not used.
This download new software interacts with the DOS program and loads a new RTLinux image into the Flash Disk.

3.3 Maintenance Settings :

3.3.1 Auto Pilot

- **Joystick Input Fields:** These fields contain the analog channels that have the joystick, fore and aft, lateral, and turns Commands.
- **Auto Pilot Enable Field for Switches:** The four fields labeled Auto Heading, Auto Depth, Auto Altitude, and Auto Cruise, are for selecting the digital inputs on the surface that have the respective switches for enabling those functions. This is an On/Off function to enable/disable the individual auto pilots. All auto pilots except auto depth and auto altitude can be selected together. If auto depth and auto altitude are both selected then auto depth will be enabled only.
- **Heading Input Field**: The heading input can be selected to be either the FOG gyro or the backup compass. This input is from the sub.
- **Depth Input Field:** The depth input must be connected to the only depth transducer. This input is from the sub.
- **Altimeter Field:** The altimeter to be used fro the auto altitude can be selected here.
- **DVL Field:** The DVL is selected as the input device for cruise control.

- **PID Fields:** The P(proportional), I(integral), and D(differential) gains must be entered here. See the section on setting the gains and offsets. Enter the gain desired fro each of the auto pilot functions. The gains must be the same polarity, all positive or all negative.
- **Output Fields:** These fields set the analog outputs for each thruster. Port, Stbd, Lateral, and Vertical thrusters can be wired up to any of the analog output channels. These analog outputs are on the sub.

3.3.2 Arm Control

The arm control algorithms will try to position the arm so that the angle feedback from the arm matches the maste, angle input. The surface master and subsea feedback hall effect sensors need to be set up so that the span of these angles matches as closely as possible. The user must enter the gains and offsets as well as the angle offset to the feedback signals.

The first step is to make the feedback angle be in a range such that it's center point is about 180 degrees. Or in other words make the range of the feedback travel from about 130 degrees to about 230 degrees. This range will be different for each function as each function has a slightly different range of motion. It may be necessary to set the master for a range which is much greater then the feedback range in this step to be able to make the slave move through its full motion range. Care must be taken here as the control of the function will not be very good, may be backwards or may not have positive control of the function at all. The exercise here is to get the feedback angle not control the function.

The second step is to make the master range match as closely as possible (without going under) the range of the feedback. If the master is setup to be slightly under the feedback range the master will not be able to make the slave move through the entire motion range. If the master is to be slightly over the feedback range there will be "dead band" at the end of the range of the master. A little dead band is probably better than not being able to move the slave through its full range. To set up the master select the connected analog channel from the Command pull down box and enter into the minimum and maximum the range of the feedback for that function. Then auto calibrate the master following the directions for "auto calibrate". If the master moves the arm the wrong way but seems to have positive control of the slave the maximum and minimum fields need to be swapped and the auto calibrate procedure needs to be done again. It is not necessary that the maximum and minimum values are the highest and lowest respectively. The maximum could be the lower number if that is what is required by the control loop. This is the analogy of reversing the polarity on the pot.

The third step is to make the slave follow the master by entering a "gain" into the "P" field. Usually a value from 1 to 10 is used. The higher the gain the more the control but the more noise that will be induced onto the slave. Depending on the loop configuration it may be that a negative "P" value may be required. This is the same as reversing the wires on the servo valve.

- **Sine and Cosine Fields:** Each function has a field for identifying which analog channel on the sub is being used for the input of the sine and cosine values. In the menu for the specific analog channel that is being used for sine and cosine the user must setup the gain and offset for those channels to produce a value in the calculated analog field in the range of +1.00 to –1.00. The computer will use the calculated analog field (not the raw analog field value) to calculate the arm feedback angle. This feedback angle is not displayed in either menu. To get the angle of the function the user should place 0 into the Offset Field (below). Then the angle of the arm function will be in the "Feedback" Field (also described below).
- **Offset Field:** Each function has a field to be filled by the user for the angle offset value. The number entered will be added to the angle produced by the sine and cosine values above. This value can be negative or positive as required. The offset field should be used to make the arm feedback range be around 180 degrees. This will prevent the software from having to deal with the change that takes place when the feedback goes through 0 degrees.
- **Command Field:** Each Function has a field to indicate where the Command input is hooked up on the surface. This hookup is to an analog input I/O element.
- **Servo Field:** Each function has a field to indicate the analog channel that the servo valve is hooked up to on the sub.
- **Master Field:** Each function has a field displaying the value from the master controller. This is the angle which is from the master after the gain and offset has been applied for that function. The user must set up the gain and offset fields in the BPM for this function. This field is for diagnostics purposes only. The user should make sure that the arm feedback angles and the master angles are as closely matched as possible.
- **Enable Arm:** This field is to indicate to the system which digital input has the arm enable function.

3.3.2 Camera Control

The camera control algorithms will try to position the camera so that the angle feedback from the camera matches the camera joystick angle inputs. The surface camera controller and subsea feedback hall effect sensors need to be set up so that the span of these angles matches as closely as possible. The user must enter the gains and offsets as well as the angle offset to the feedback signals. The same procedure that sets up the arm is the procedure to set up the camera functions.

- **Sine and Cosine Fields:** Each function has a field for identifying which analog channel on the sub is being used for the input of the sine and cosine values. In the menu for the specific analog channel that is being used for sine and cosine the user must setup the gain and offset for those channels to produce a value in the calculated analog field in the range of +1.00 to –1.00. The computer will use the calculated analog field (not the raw analog field value) to calculate the arm feedback angle. This feedback angle is not displayed in either menu. To get the angle of the function the user should place 0.00 (zero) into the Offset Field (below). Then the angle of the arm function will be in the Feedback Field (also described below).
- **Offset Field:** Each function has a field to be filled by the user for the angle offset value. The number entered will be added to the angle produced by the sine and cosine feedback values above. This value can be negative or positive as required.
- **Command Field:** Each Function has a field to indicate where the Command input is hooked up on the surface. This hookup is to an analog input I/O element.
- **Servo Field:** Each function has a field to indicate the analog channel that the servo valve is hooked up to on the sub.
- **Master Field:** Each function has a field displaying the value from the camera controller. This is the angle which is from the camera controller after the gain and offset has been applied for that function. The user must set up the gain and offset fields in the BPM for this function. This field is for diagnostics purposes only. The user should make sure that the arm feedback angles and the master angles are as closely matched as possible.

4 Maintenance Elements:

3.4.1 Surface

- **Button:** Buttons can be added, removed, and edited. Input fields for buttons are: x and y coordinates for the position of the button on the screen; color of the button; the output(s) on the sub that will be operated by the button; and if the button operation is to be momentary or alternate.
- **Slider:** The slide bar menu is used to generate a slide bar on the desired screen. The user must input the position of the slide bar, the channel that is to be used to output the analog level and the name.
- **Digital In:** Each of the digital input channel can be individually selected. The selection causes the Element Properties Menu (BPM) to be displayed. The user will have to fill the required fields to use the digital input (see 3.3.3)
- **Analog In:** Each of the analog input channel can be individually selected. The selection causes the Element Properties Menu (BPM) to be displayed. The user will have to fill the required fields to use the analog input (see 3.3.3)

3.4.2 Vehicle

- **Compass:** There can be two compass displays, one for each graphics monitor. Fields for position on the screens, if left empty, then the position is defaulted to (0,0)
- **Lights:** There can be two lights displays, one for each graphics monitor. The fields for the position of each light inside the graphics must be filled, in addition the fields that indicate the respective output channel that the individual lights are connected to must be filled. The lights can be activated by touching the respective light.
- **Vehicle:** There can be two vehicle displays, one for each graphics monitor. There are fields for the x and y position on the displays, and if left empty, the position is defaulted to (0,0).
- **Digital Input:** Each of the digital input channel can be individually selected. The selection causes the Element Properties Menu (BPM) to be displayed. The user will have to fill the required fields to use the digital input (see 3.3.3)
- **Analog Input:** Each of the analog input channel can be individually selected. The selection causes the Element Properties Menu (BPM) to be displayed. The user will have to fill the required fields to use the analog input (see 3.3.3)

3.4.3 BPM Fields:

- **Element Name:** Text describing the element name.
- **Graphics Type:** There are only graphics for the Vehicle Analog channels which can be Depth graph and Bar graph. If no graphics are required select none in this field.
- **Digital, Analog, and Analog raw:** These fields are display only. The user is able to see the value of corresponding channel of the input.
- **Offset:** This field will set the offset value applied to the raw analog value to get the calculated analog value.
- **Gain:** This field contains the gain value multiplied to the raw analog level to get the calculated analog value.
- **Minimum:** This is a user filled field that contains the desired minimum value that the user wants the analog to go down to after the offset has been applied. This field is used for auto calibrate only.
- **Maximum:** This is a user filled field that contains the desired maximum value that the user wants the analog to go up to after the gain has been applied. This field is used for auto calibrate only.
- **Coordinate x and y:** This is the coordinate of either the depth or bar graph.
- **Output Connection:** The user are able to select the destination(s) of the input. If the input come from the surface, then the output will go to the sub. If the input come from the sub, then the output will be either graphic or surface output.
- **Auto-Calibrate:** When auto-calibrate checkbox is enabled, the user can press the auto-calibrate button to auto-calibrate. The Maximum value and the Minimum value need to be entered by the user. These two numbers are the values that are desired to be the channels lowest and highest values after the gain and offset are applied. The Gain and Offset are automatically filled in by the auto calibrate procedure. The user will be required to cycle the analog input through the desired analog span. After the analog input has been cycled and the user clicks on the "finish auto calibrate button" the computer will calculate the gain and the offset and will place these calculated values into the appropriate boxes.
- **Enable Channel:** Enabling a channel allows the signal to pass through the system to the output. This signal can be on or off. If the Enable Channel is unchecked the output will always be off.

?.5 Lights Isolate:

The lights Isolate menu is designed to be a pull down menu that can be used one time or "torn" away from the top menu level and used multiple times. The lights isolation is controlled via this menu. Operation of the isolation of one of the lights will automatically turn off the power for that light first.

3.6 Instruments

All of the instruments on the vehicle are available in this menu. Each can be turned On or Off here.

3.7 Tools

3.7.1

The Tools menu contains the functions Drawer Open and Close, Spare Valve S1 Open and Close, Spare Valve s2 Open and Close, and Swing Arm In and Out. It and is used to select which of these functions is to be operated by the joystick rocker switch. Selecting "None" will disable the rocker switch.

3.8 Samplers:

3.8.1 Detritus:

The samplers menu allows the user to select which Detritus item is to be controlled by the joystick trigger switch. Only one Detritus function can be selected at one time, however the Detritus functions can also be set up to be operated by individual switches. Select the digital input to be used and the Detritus channel to be operated in the BPM. Then both the Detritus menu and the BPM input will operate the Detritus channel. Selecting "None" on the detritus menu disables the joystick trigger switch.

3.9 Annotate:

3.9.1 Clear All:

Removes the text from the video overlay and the annotate box on the graphics.

3.9.2 Clear:

Removes the text from the annotate box on the graphics but leaves the test on the Video.

3.9.3 Enable:

Allows the user to either have the annotated information to be displayed or not.

3.9.4 Close:

Closes the annotate menu box.

3.9.5 Page 1 – Page 4:

Allows the user to select one of four pages to be displayed by the overlay page. These pages can be updated with the update button. Select the page desired then the text to be used for that page. Then select the update button while the page is still selected and that text will now be saved to that page.

3.9.6 Update Page:

Allows the user to update the page selected.

3.10 Overlay:

3.10.1 Line:
This sets the y position of the overlay text. The lines input field can take a value of 1 – 22, this will depend upon the size of font chosen and the screen resolution.

3.10.2 Column:
This is the x position of the overlay text. The screen is partitioned into 4 columns, the fields can be set up in the menu to show a specific analog value. The only value that will always be shown is the Heading value.

3.10.3 Color:
The color can be chosen from the overlay menu, there is a total of 7 colors to choose from.

3.10.4 Overlay items list:
The Overlay item list is a list of the current overlay items being displayed. The line number and column is displayed beside the item.

3.10.5 Units:
This field is a text string that describes the value displayed. The units could be Volts, %, Pressure, for example. This string will be displayed on the overlay after the analog value.

3.10.6 Analog Channel:
The user can chose any analog channel coming from the sub, or the ones that come from the serial strings of the sub.

3.11 Alarm:
Alarms are displayed as red windows on the center of the graphics page. Text describing the alarm is in the window. They are acknowledged by "clicking" on them. Once the alarm is acknowledged it is placed into the alarm list where is stays until the alarm list is cleared. To see if an alarm is still present the operator must acknowledge the first alarm, clear it from the list, and then see if it is regenerated by the alarm source.

3.11.1 Alarm List:
Alarm List will show the history of alarm(s) that occur during runtime.

3.11.2 Alarm Description:
This field will describe the selected alarm item from the list on the left side.

3.11.3 Clear:
This will clear the alarm history list. Note: Previous alarms that have not be corrected will be displayed again.

3.11.4 Close:
Close the alarm list history.

4.0 PID Control

The PID gains of the auto pilots, auto depth/altitude and auto heading, are to be used to "tune" the auto pilots for maximum responsiveness without oscillations. You can increase the gain of an auto pilot to reduce the error between the set point that you give to the computer and the actual depth or heading that the vehicle acquires. There will be a point where increasing the gain will start to make the vehicle oscillate at which time you should decrease the gain to a stable level. The optimum gain is at the point where upon a change in set point the vehicle oscillates 4 times before coming to rest on the set point. (1/4 wave damping). First the user should adjust the "P" (proportional) value then the "D" (differential) value then the "I" (integral) value. However because this routine is a general routine for many control loops the user should experiment with each individual part of the PID control to get the best response. An offset entered for the auto pilots will give the vehicle a steady thrust in the direction of the offset. This is not useful in auto heading, however it can be used with auto depth if the vehicle is positive or negative. You can offset the auto depth by a few feet to counteract the effects of the ballast. This will decrease the static error of the actual depth maintained by the vehicle and will not affect the responsiveness of the auto pilot.

4.1 PID control loop is broken down:

The output is equal to the summation of:

1/ The proportional error between the set point and feedback, and
2/ The integration of the error between the set point and feedback with time, and
3/ The differentiation of the error between the set point and feedback over time.

From a users standpoint and in simpler terms see the following descriptions:

4.1.1 Proportional:

The more proportional gain that is applied the stronger the control systems response will be to a steady state error between the set point and the feedback points. The Proportional part of PID corrects for error as it occurs not taking into account whether the error has been there a long time, is increasing, or is decreasing.

4.1.2 Integral:

The more integral gain that is applied the stronger the control systems response will be to an accumulation of error over time. A small steady state error that cannot be corrected with proportional gain can be corrected for by integral gain. The integral part of PID slowly corrects for error over a period of time. It is used for correcting errors that are caused by steady state phenomenon, such as the effect of negative ballast during auto depth. Over time the control loop will detect that a steady up thrust is needed to counteract the negative ballast. The integral function accumulates the error. On each sample of the set point and feedback the integral function adds this error between the two levels to all of the previous errors.

4.1.3 Differential:

The more differential gain that is applied the stronger the control systems' response will be to rates of changes of the error between the set point and the feedback. The differential part of PID corrects for the proportional control not taking into account the motion of the vehicle or arm or other system. The differential takes into account the motion of the object, putting into the control response a signal counteracting the motion of the object. For example as the proportional control tries to get the vehicle to head in a specific direction the differential control will try to keep the vehicle from accelerating and subsequently going past the given heading. As soon as the vehicle starts to have movement towards the heading no more thrust is needed (or much less) and as the vehicle approaches the heading thrust in the opposite direction is required to stop the vehicle from going past the heading.

Each of the gains applied to the PID control loops can be set high enough to make the system oscillate. Sometimes these oscillations are quite violent. Care must be taken to increase each part of the control PID gains slowly. Ideally the fastest response time will produce a ¼ wave dampening effect. This is where the object upon a change in set point makes 4 oscillations around the set point before coming to rest on the given set point. Sometimes it is not acceptable for any oscillations and in this case the time to get the set point will be longer. In some cases oscillations are not a problem and the fastest response time is required. In most cases the fastest response time is ¼ wave dampening. Because there is such a variety of control loop scenarios the user invariably must use trial and error to get the best response.

4.2 Automatic Gain and Offset:

The control system can automatically set the gain and the offset of an analog channel if enable by the user. The user is prompted for the final values at the extreme positive and negative ends of the desired span, then the analog channel is made to go from its lowest level to its highest level. The software then calculates the required gain and required offset to apply to the analog signal to achieve the users desired positive and negative swings. For example the pan and tilt feedback units could be set up with automatic gain and offset. The user would place (as an example) +45 degrees and –45 degrees into the positive and negative values. Then the Pan (and Tilt after the pan is complete) would be rotated through its motion. Then the computer will calculate the necessary gain and offset values to change the analog level for pan into a degree value.

5.0 Help Page

5.1 Help:

Not implemented.

6.0 Video Overlay

The VGA output dedicated to the overlay graphics is from VGA output #3. This VGA signal is connected to the NTSC Genlock overlay box. This overlay board is chroma keyed to replace any Black from the VGA output with the NTSC video. Any text and graphics that is not Black is placed onto the NTSC video stream.

6.3 Video Annotate:

Text is entered via the keyboard. The user must enable annotation at the top level menu to have the text come up on the overlay.

6.4 Arm Lock Display:

The video overlay contains five letters in the bottom left corner of the screen. These are SSEPY which stand for Swing, Shoulder, Elbow, Pitch and Yaw. These letters become visible when the arm is enabled. As each function is "locked" in the letters get an asterisk under them. A + sign indicates that the master is above the slave and a – sign indicates that the master is below the slave. When the last arm function has been locked in the letters and asterisks again are hidden. The arm functions are "locked" in when the master position matches the arm position. Disabling the arm does not cause the letters to re-appear. They only re-appear when the arm is re-enabled.

6.5 Camera Lock Display:

The video overlay contains three letters in the bottom left corner of the screen. These letters are SPT which stand for Shoulder Pan and Tilt. These letters become visible when the camera is enabled. As each function is "locked" in the letters get an asterisk under them. When the last Camera function has been locked in the letters and asterisks again are hidden. The arm functions are "locked" in when the master position matches the arm position. Disabling the arm does not cause the letters to re-appear. They only re-appear when the arm is re-enabled.

6.6 Time and Date:

The Time and Date is displayed in the lower right corner.

'.0 System Errors

The alarm listing can be displayed by pressing the alarm button on the top level menu. This is a historical accounting of the errors encountered since the program started up to 100 errors.

7.1 Alarm Description

The following tables describe alarm conditions and how the software deals with these alarm conditions.
All errors in the following table are displayed on the operators page(s) as alarms. With the serial ports some of the strings that would be discarded can be requested to be sent again. Some strings cannot be requested to be resent. In this case the peripheral probably is set up to send automatically in loop fashion and the control system will simply wait to be updated as the new string comes in.

Surface Computer Errors

Error Name	Description	Handling
Com 1 Framing Error	Com 1 has received either two few or too many bits in the stream.	Data Discarded. Request to send again.
Com 1 Overrun Error	Com 1 has received too many characters and/or the processor has not been able to read them fast enough.	Data Discarded. Request to send again.
Com 1 Parity Error	Com 1 has received a bad parity check bit.	Data Discarded. Request to send again.
Com 1 Bad CRC Error	Com 1 has received a bad Cyclic Redundancy check number.	Data Discarded. Request to send again.
Com 2 through to Com 10 same as Com 1	Com 1 and are on the motherboard. Com 3 to 10 are on the Rocket Port Board	

D

Sub Sea Computer Errors

Error Name	Description	Handling
Com 1 Framing Error	Com 1 has received either two few or too many bits in the stream.	Data Discarded. Request to send again.
Com 1 Overrun Error	Com 1 has received too many characters and/or the processor has not been able to read them fast enough.	Data Discarded. Request to send again.
Com 1 Parity Error	Com 1 has received a bad parity check bit.	Data Discarded. Request to send again.
Com 1 Bad CRC Error	Com 1 has received a bad Cyclic Redundancy check number.	Data Discarded. Request to send again.
Com 2 through to Com 12 same as Com 1	Com 1 through 4 are on the SBS47 and are not isolated. Com 5 to 12 are on the isolated SIO-14 Board	
GESSBS-47 RAM Error	The GESSBS 47 is out of RAM or has a RAM Error	Subsea probably will hang and watchdog restart.
GESSBS-47 ROM Error	The GESSBS 47 has a ROM Memory Fault	Subsea probably will hang and watchdog restart.
GESSBS-47 Error	The GESSBS 47 is not responding properly	Same as Telemetry Error. User will need to cycle power to sub if watchdog doesn't restart.
Water Alarm 1 through to 16	There has been a water alarm detected. The description is included in the alarm.	All water alarms sent to Displays including overlay. User must ACK and then has access to description via menu.
Ground Fault Alarm 1 through 24	There has been a water alarm detected. The description is included in the alarm.	All GFI alarms sent to Displays not including overlay. User must ACK and then has access to description via menu.
Bar Graph Alarm	There has been a bar graph alarm detected. The description is included in the alarm.	Same As GFI alarm
FOG Invalid Alarm	The output from the FOG is either incorrect or invalid.	Auto Pilot Turned Off. User must switch to Backup sensor to reuse autopilot. Flag on Compass turns red.
DVL Invalid Alarm	The output from the DVL is either incorrect or invalid.	Auto Cruise Turned off.
Altimeter Invalid Alarm	The output from the Altimeter is either incorrect or invalid.	Auto Altitude turned off.
Aux Heading Invalid Alarm	The output from the C100 is either incorrect or invalid.	If using Backup compass for auto head. Auto heading turned off.
Depth Transducer Alarm	The output from the Depth Transducer is either incorrect or invalid.	Auto Depth turned off.

7.2 Resetting Errors

The error list can be reset and erased by entering the error menu and selecting erase error history.

.0 Surface control

8.1 Computer:

The surface control system involves the computer, cards within this computer, and peripheral equipment (e.g. printer, monitor and switches). The Computer has an 800MHz Pentium 2 processor, 64 Meg of RAM, 1 Multi VGA board (4 outputs), 10 serial ports (Telemetry, TMS, Teleos, Ships Heading, Logging, Touch Screens) , 1 parallel port (printer), a 20G hard drive, CD-ROM and a 1.44 Meg floppy disk drive. As well the following interface boards are used to connect the various analog and digital inputs to the computer.

8.2 Analog interface cards:

The surface analogs are interfaced through the DB37s, ribbon cables, and the 50 pin terminal blocks to the AIO-16F(A and B). The inputs are from 0-5VDC and are not protected from noise spikes before entering the computer. So it is important to be careful not to subject the analog inputs to voltages outside the input range. The 50 pin interface blocks are direct input pin to output pin. Pin 1 on the header is pin 1 on the terminal side. Pin 2 is Terminal 2 and so on. Both Analog I/O boards are set for 0-5 VDC range by setting the gain on the cards to 2. This is done via the dip switch at the connector end of the boards. Both boards are set for single ended inputs, addresses are 0300Hex and 0310Hex . See the AIO16 Section for more information. One thing hard to find in their manual is that for the DAC sections to work properly the DAC ref has to go to the Vref. This is odd in that the Vref is –5VDC. Tie terminal 8 to 10 and 26.

8.3 Digital inputs:

The surface digital controls are Off when the level is 5VDC and On when the level is 0VDC. There is not any protection on the inputs against noise spikes. The 50 pin interface blocks are input pin direct to output pin. Pin 1 on the header is pin 1 on the terminal side. Pin 2 is Terminal 2 and so on.

8.4 Serial ports:

There are 10 serial ports in the surface computer all set up for RS-232 Communications. Each serial port is capable of Communications to 115Kbaud.

Com 1: /dev/Hys0 see telemetry.cpp

The computer serial port Com 1 is the telemetry port. The serial port is set to 7 data bits, 1 stop bit, even parity, and 115k baud.

Com 2: /dev/Hys1

The computer serial port Com 2 is the TMS link. The serial port is set to 7 data bits, 1 stop bit, even parity, and 9600 baud.

Com 3 (Rocket Port 0):

The computer serial port Com 3 is Touch Screen #1. The serial port is set to 9600 Baud.

Com 4 (Rocket Port 1):

The computer serial port Com 4 is Touch Screen #2. The serial port is set to 9600 baud.

Com 5 (Rocket Port 2):

The computer serial port Com 5 is the Logging link. The serial port is set to 7 data bits, 1 stop bit, even parity, and 9600 baud.

Com 6 (Rocket Port 3):

The computer serial port Com 6 is the Teleos link. The serial port is set to 7 data bits, 1 stop bit, even parity, and 38.4k baud.

Com 7 (Rocket Port 4):

The computer serial port Com 7 is the ships heading (gyro) input. It is set at 9600 baud, 8 data, and no parity.

Com 8 (Rocket Port 5)

The computer serial port Com 8 is the HDTV link. The serial port is set to 7 data bits, 1 stop bit, even parity, and 9600 baud.

Com 9-12 (Rocket Port 6-8):

Unused Serial Ports.

8.5 Mathematics for analog channels:

8.5.1 Down Traffic:

Each analog input can be "adjusted" from its raw input span to a desired span. This is done by providing the computer with 2 numbers which can be applied to the raw span to calculate the desired span. The computer uses the first number to multiply with the raw value. This first number therefore can increase or decrease the range between the top and bottom of the span. This first number can be called the gain or the proportional gain (in PID control loops). This gain can be positive or negative to invert the raw span from positive to negative or negative to positive as desired. The second number is added (or subtracted if the number is negative) to the raw span. This second number is called the offset and can shift the span up or down. The arithmetic applied is as follows:

Analog Desired Span = Gain * Analog Raw Span + Offset

8.5.2 Up traffic:

Each analog input can be "adjusted" from its raw input span to a desired span. This is done by providing the computer with 2 numbers which can be applied to the raw span to calculate the desired span. The computer uses the first number to multiply with the raw value. This first number therefore can increase or decrease the range between the top and bottom of the span. This first number can be called the gain or the proportional gain (in PID control loops). This gain can be positive or negative to invert the raw span from positive to negative or negative to positive as desired. The second number is added (or subtracted if the number is negative) to the raw span. This second number is called the offset and can shift the span up or down. The arithmetic applied is as follows:

Analog Desired Span = Gain * Analog Raw Span + Offset

115200 7 1 even
wet side starts up
PNG'f PNG'f PNG'f

9.0 Subsea Control

9.1 Subsea Overview:

Each card has an exclusive address and only outputs data when the card is addressed through the telemetry. Communications are started by the surface computer. After the initial Communication both surface and subsea can initiate Communication. In fact both ends are programmed to Communicate on a priority level to enable both the sub and the surface control the sub the most efficiently. The subsea end is responsible for the control of the sub. To this end the control loops are closed at the sub. The only Communication that is required for any of the digital or analog IO is the Command set point. The sub end computer will produce an output that will either match the Command (digital and analogs without feedback) or output a Command that will align the feedback signal with the Command.

The sub end computer has the ability to enact a default value on any of the outputs in the sub should a signal loss to the surface be encountered. These default values can be a succession of values or a specific mission of sorts to enable the sub to be recovered. See the menu fields for default value.

9.2 Water Alarm and Ground Fault Board GFIWATER:

The water alarm section of the board provides isolation and amplification of the water alarm sensors. Each transistor buffer has two wires attached to it that are placed a the bottom of the housing to be monitored. When these two wires conduct through the intrusive water the transistor is turned on and produces a digital signal. This signal is isolated from Logic or other power supplies and so is routed through an opto-isolator which provides a logic level output to be wired into the GESIN board.

The ground fault section of the board is similar the system ground fault board but is more suited to lower voltage circuits. In this system it is used to monitor the isolated analog circuits that cannot be monitored by the system ground fault board (because they are isolated). There is about 25VDC placed onto the sense wire of each circuit through a high impedance source. This voltage is with respect to chassis ground. When this sensed voltage is pulled down by a Ground Fault it reduces the voltage to the analog isolator. The analog isolator is inverting which means that the lower the sense voltage the higher the output from the analog isolator. 5.00VDC output corresponds to a Short on the Ground Fault side and 0.00 VDC on the output corresponds to an open or infinite Ground Fault impedance. See the section on the GFIWATER board for more information.

9.3 Ground Fault Board GFIV1.2:

See Appendix Ground fault board description and setup procedure.

9.4 GESPAC IO Boards:

For information on the GESPAC system IO boards such as the GESADC, GESDAC, GESIN, GESOUT, and GESSIO see the appendixes in the manufacturers section on the GESPAC electronics. For register and interrupt settings see the table in appendix A. For jumper placement and description see appendix A. For further information on the MPL4205 card see appendix A.

^.5 I/O Terminal Boards:

Each Termination Board has a section in this manual that contains the General Arrangement and Schematic Diagrams as well as a text description of the Board. See these sections for more information on Specific Termination Boards.

9.5.1 GESOUT Term Board:

There are 2 GESOUT Termination Boards installed in the system. The GESOUT term boards provide buffering of the digital channels to 60VDC and 4 Amps. The outputs are open collector.

9.5.2 GESIN Term Board:

There is one GESIN Termination Board installed in the system. The GESIN Term Boards are set up for active high inputs at 12VDC. The last byto of the GESIN has been used for the special bus connections that are available. G96 Reset, G96 Halt and interrupts are available here. Note that most of these are not jumper selected on the GESIN board. Only the interrupt for the RPM is selected.

9.6.3 GESADC Term Board:

There are 2 GESADC Termination Board installed in the system. Analog levels are limited to +/-15 VDC by zener diodes on the Termination Board. This protects the GESADC board from over voltage. The GESADC boards are set up for +/-5 VDC input.

9.6.3 GESADC Isolating Term Board:

There are 2 GESADC Isolating Termination Boards in the system. The analog voltage levels are +/-5VDC maximum, and are not protected from larger voltage swings. The accuracy of the analog isolators is +/-0.025% and there is 2000VDC of isolation protection.

9.6.4 GESDAC Term Board:

There is one GESDAC Termination Board It is capable of interfacing 3 GESDAC boards. The GESDAC Boards are set up for +/-5VDC.

9.6.5 MPL Term Board:

There are 3 MPL Termination Boards installed in the system.

..6.6 GESSIO14 Term Board:

Each of the 8 serial channels has optical isolation between the GESSIO14 and the external connections. These isolated ports are also isolated from each other. The external section of the optical isolators is port powered and must have the Tx and the Rx wires connected to work. The Transmit from the external device powers the board transmitter generating the signal for the external device receive.

9.6 GESSBS-47

The Processor board contains the processor , 8 Meg EEPROM, 8 Meg RAM, VGA driver, 4 serial ports, 1 parallel port, keyboard controller, watchdog timer, PC104 interface, and much more.

9.6.1 Programming the EEPROM:

See appendix E.

9.6.2 Jumper Selection:

9.7 Logic Power Supplies:

The logic power supplies are solely for the purpose of providing power to the GESPAC Bus. The levels are +5VDC, +12VDC, -12VDC, and an additional supply that is for the Ground Fault Boards and the analog isolator board of +15VDC. These logic supplies have a Common ground but this ground does not have any other connection to any of the other power supply grounds. This isolates the GESPAC system completely from the other electronics in the system. Each of the logic supplies is monitored via the telemetry and the levels can be displayed on the surface graphics.

9.8 Peripheral Power Supplies:

There are 4 power supplies for the peripheral equipment such as cameras, sonars, and other navigation and operation equipment. Levels are 24VDC.

9.9 Analog Isolation Board:

The analog isolation board provides protection for the GESPAC control system. It uses the AD202KN modular device to optically isolate the analog levels before they are sent to the GESADC board. The AD202KN provides 2000VDC of isolation at an accuracy of +/-0.025%. The analog isolation board can isolate analog voltages in the range of –6.5 to +6.5 VDC. The GESADC input board #1 is configured for a range of 0.00 to 10.00VDC. This is to accommodate the voltage signal from the arm and camera feedback hall effect sensors. The GESADC analog input board #2 is configured for an input from –5.00 to +5.0VDC. This is to accommodate the signals from the FOG Gyro.

9.10 Serial Port Connections:

9.10.1 Non-isolated Serial Ports

There are 4 non-isolated serial ports each connected directly to the SBS47 Processor board. Each of these Com. Ports are setup for RS-232 Communications to 115kBaud. These Com ports use the DB-9 standard connection.

9.10.2 Optically Isolated Serial Ports

There are 8 optically isolated Com ports which are set up for RS232 Communications to 38kBaud. These Com. ports use terminal block connections on the GESIO-3 Termination Board.

9.11 Fusing:

Fusing is provided by an 18 channel relay board without the relays installed and the relay contact positions jumpered closed. Each of the relay contact circuits comes complete with a 250mAmp to 5 Amp fuse. These fuses protec each individual power supply as well as the peripheral equipment that these power supplies operate.

9.12 Water Alarm Terminal Board:

The water alarm terminal board provides isolation and amplification of the water alarm sensors. When there is enough moisture across the sensor contacts a reed relay is closed The contacts for these reed relays provide 12VDC to the GESIN termination board turning on the respective digital channel. This digital channel is sent via the telemetry to the surface and the control system on the surface recognizes that this is a water alarm condition and indicates that condition on the graphics pages.

9.13 Paroscientific Pressure Transducer Interface:

The paroscientific transducer interface converts the frequency output of the depth pressure transducer to a serial string. There are frequency signals from the depth transducer for the pressure and temperature read.

9.14 MIN Connectors:

All penetrations to and from the can are through Brantner Seacon MIN series connectors. These connections are define in the telemetry can wiring diagram.

9.15 Solid State Relay

A single SSR has been installed in the subsea housing to allow the user to switch 120/240 VAC loads. This SSR is a single unit with 4 individual SSRs. Each SSR can be operated individually and can switch isolated circuits. Presently one of the SSR circuits is being used to operate the Core Can 120VAC circuit.