Arneson Control System (ACS)

User Manual

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List of Acronyms a and Abbreviations

ACS:	Arneson Control System
ASD:	Arneson Surface Drive
PID:	Proportional Integral Differential
BIT:	Built In Test
SCC:	Solenoids/Steering Control Card
ICT:	In Cylinder Transducer
EICT:	Electronics In Cylinder Transducer
FU:	Follow-Up
NFU:	Non Follow-Up
PWM:	Pulse Wave Modulation
CAN:	Controlled Area Network
STB:	Starboard
N.C:	Not Connected
VM:	Voltage Module
DVM:	Digital Volt Meter

Safety Conventions

In this manual, safety information is presented as warnings, cautions and notes.

WARNING

An operating procedure or practice, which, if not correctly followed, could result in personal injury or loss of life.
Handle the product only as instructed in this manual. Do not attempt to operate or maintain the product in a manner not specifically stated in this manual.

CAUTION

An operating procedure or practice, which, if not strictly observed, could result in damage to, or destruction of equipment.

NOTE

Always observe standard safety precautions during installation, operation and maintenance of this product.

1. Introduction and General information

1.1. Scope

This chapter serves as an introduction to the Arneson Control System (ACS) and provides general system technical data and specifications.

1.2. Purpose and Use

The ACS is an innovative craft/ship digital steering and trim control system based on the well known Arneson Surface Drive (ASD) system.

The system uses state of the art hardware and software technology to implement PID (Proportional Integral Differential) control algorithm to drive and control the craft propellers.

1.3. ACS system structure and block diagram

The main parts of the ACS system are:

- Two control panels (which are also uses as displays).
- An industrial PC.
- An Adaptors box.
- An SCC (Solenoids Control Card) box.
- Steering wheels
- Three dual proportional solenoids
- Four Electronic In Cylinder Transducer (EICT)

Figure 1: ***ACS System Structure***

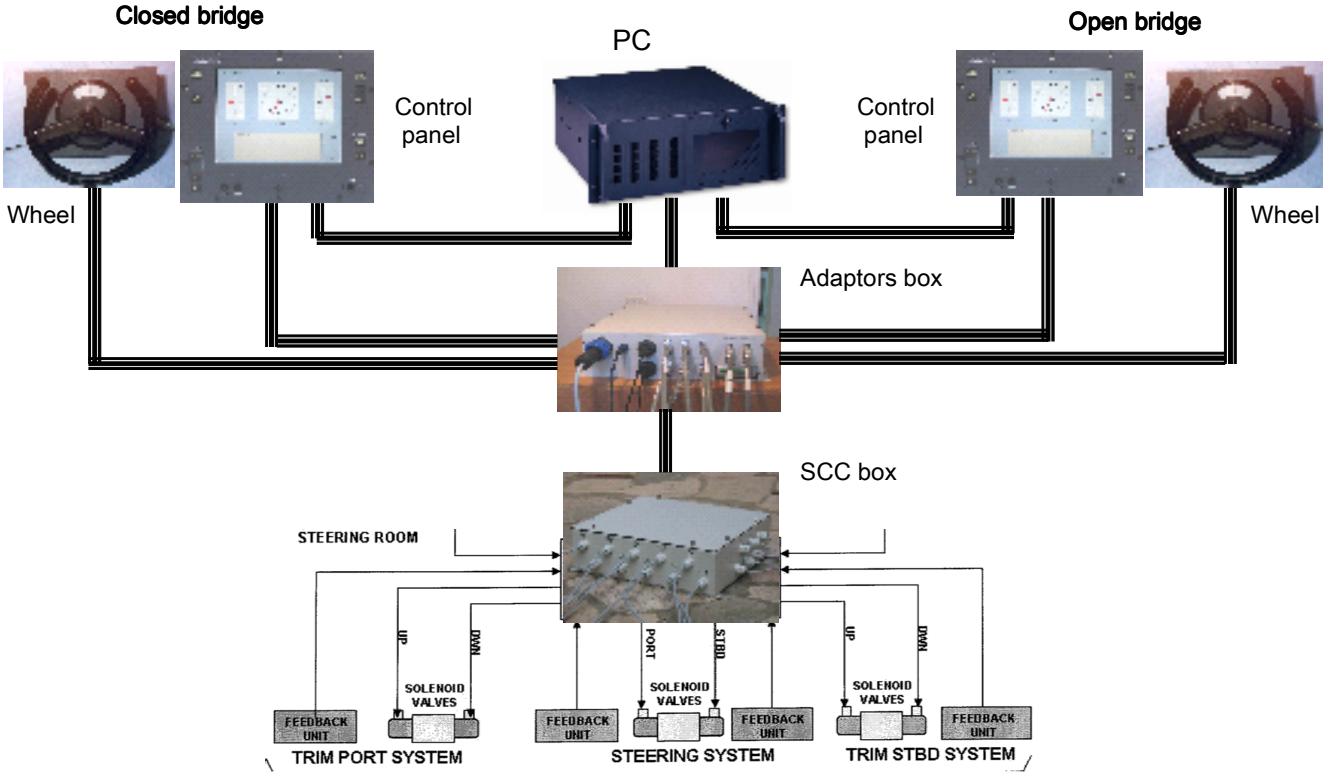
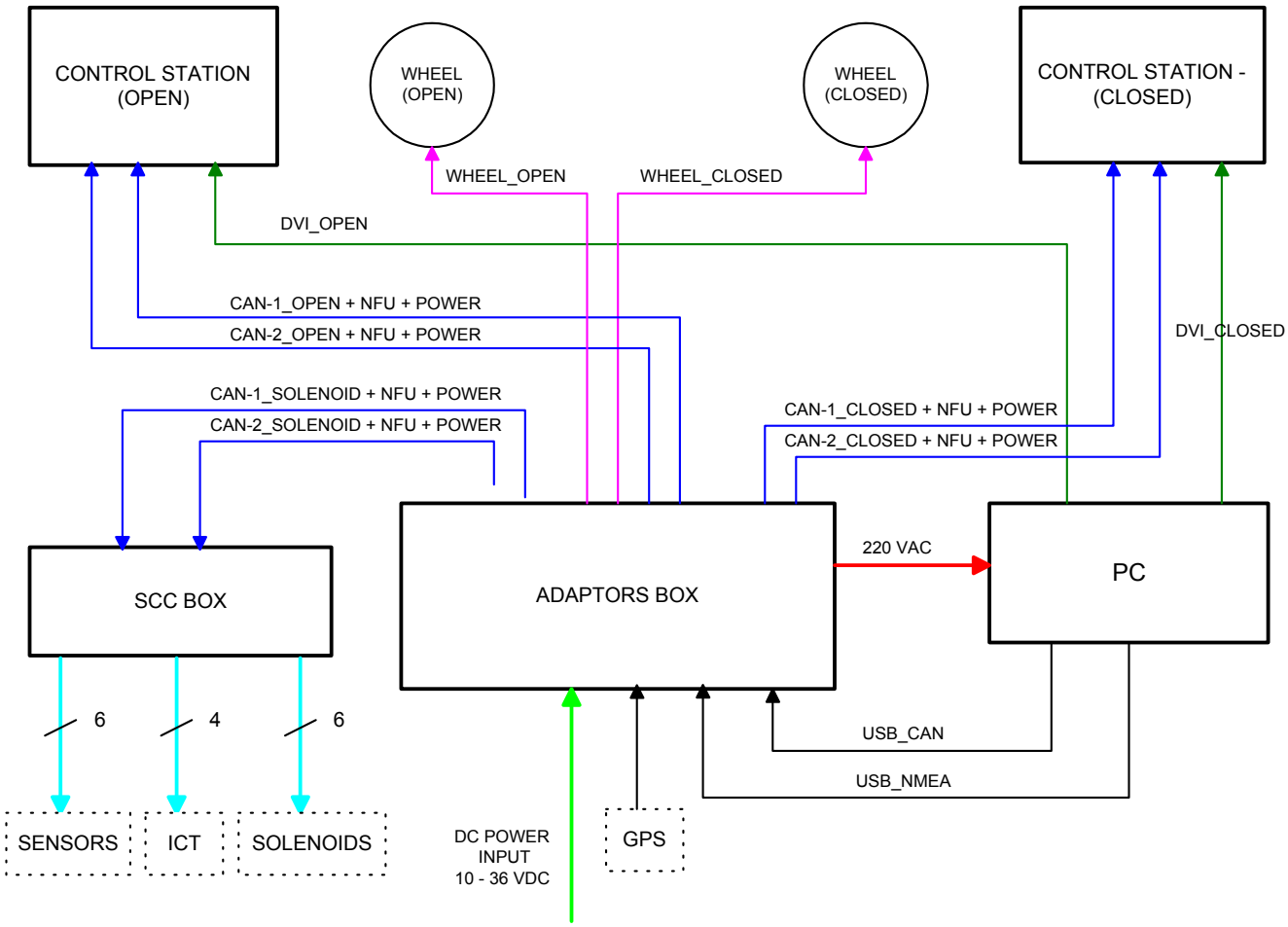


Figure 2: ***ACS System Block Diagram***



1.3.1. ACS block diagram description

The PC – The PC is the main controller of the ACS. This is a rugged industrial PC. It communicates with the ACS devices (two control panels and two SCC cards) through a CAN bus and controls the control panels displays through DVI. There are two CAN channels for redundancy.
The PC is located inside the closed bridge niche.

Control Panels – two identical control panels, one in the open bridge and another one in the closed bridge. The control panel displays the steering and trim angles and the error messages. It has function keys for controlling the ACS.
Only one control panel is active at any time. The default active panel upon power-up is the open-bridge panel.

Steering Wheels - two identical steering wheels, side by side to the two control panels. Only one wheel is active at any time. The default active wheel upon power-up is the open bridge wheel.

Adaptors box – this box is a junction box that connects almost all the ACS parts, but it also includes communication adaptors, power converters and steering wheels sensing card. It is located inside the closed bridge niche.

SCC box - this is a Solenoids Control Card box. It includes only a single electronics board which drives and control the hydraulic proportional valves system. It is located in the steering room.

Solenoids, ICTs and Hydraulic sensors – the ACS uses the solenoids to control the propellers movenent. It uses the In-Cylinder Transducers to sense the propellers status feedback and it uses the discrete sensors to test the hydraulic oil parameters. All these are located in the steering room.

1.4. Features

- Steering & Trim control
- Max. Steering and Trim angles can be limited
- Independent Trim Port and Trim Starboard control allows maintaining a constant offset between the two sides.
- Follow-Up (FU) and Non Follow-Up (NFU) control capability
- PID control algorithm
- Craft control can be done either from the Open Bridge or the Closed Bridge.
- Two identical control panels – one for the Open Bridge and the other for the Closed Bridge.
- Two CAN communication channels from the PC to the ACS devices for redundancy.
- NMEA0183 and RS485 communications.
- PWM current drive to the proportional solenoids
- Robust BIT – Tests the ICT feedbacks, the wheel signal, the PWM drive, the CAN communication and the hydraulic sensors.
- Rugged system – Designed to sustain the harsh marine environment.

1.5. Characteristics

Table 1*: System Characteristics*

Max. Steering Angle available:	± 30 °
Max. Trim Angle available:	± 10 °
Trim Control Accuracy:	± 0.1 °
Number of CAN Communication Channels:	2
Number of NMEA Comm. Channels:	4
Number of RS485 Comm. Channels:	2
Number of USB Comm. Channels:	8 (6 free)
Number of Solenoids PWM Drive Channels:	6
Number of Wheel Lamps PWM Drive Channels:	2
Number of ICT Sensing Channels:	4
Number of Wheel Sensing Channels	2
Number of Hydraulic System Sensing Channels:	6
CAN Comm. Baud Rate:	100 Kb/S
Power Consumption:	250W nom. 500W peak
Power Circuit Breaker Switch (fuse):	25A
Operating Voltage:	10 : 36 VDC
Operating Temperature:	-15 : +60 °C
Storage Temperature:	-20 : +80 °C
Humidity:	95% non condencing
Shock & Vibrations:	10 G

Table 2: ***Control Panel Characteristics***

LCD Type	TFT
LCD Size	12" (246x184mm)
Resolution:	1024x768 pix.
Brightness:	1000 nit
Contrast	700 : 1
Viewable Angles:	-60+60 (H) -75+45 (V)
Antireflective and Antiglare	Yes
Brightness Control:	0 – 100 %
Optical Bonded Protective Glass Thickness	3 mm
Display Control Interface:	DVI
Communication:	CAN Bus x 2
Outer Dimensions:	380x300 mm
Power Consumption:	30W
Water and Dust Resist:	IP56

Table 3: *PC Characteristics*

CPU:	Core-2 Duo 2.67GHz
Memory:	2GB 800Mhz
Disk:	32GB , SSD
Operating System:	WIN-XP Professional
Free USB Ports:	6
Ethernet Ports:	1
PS2 Port:	2
OnBoard DVI Display ports:	1 DVI and 1 VGA
Dedicated DIV Ports on PCIexp Graphics card:	2
RS485 Ports on PCI card:	2
Free PCIexpX1 Slots:	3
Free PCI Slots:	2
D-Sub and DVI Connectors:	Water Proof IP67
Power Consumption:	230VAC/ 150W
Dimensions:	483x450x177 mm
Weight:	25 Kg

Table 4: ***Adaptors Box Characteristics***

Military D-Sub Connectors:	MIL-C-24308
EMI Filter:	For DC Inlet Voltage
DC/DC Converter:	250 W
DC/AC Inverter:	250 W
USB to CAN Adaptor:	Two CAN channels
USB to NMEA0183 Adaptor:	Four NMEA channels
Steering SCC Card:	Two Wheel Feedbacks 0.5-4.5 V Two Wheel Backlights Drive - PWM
Dimensions:	430x450x133 mm
Weight:	7 Kg

Table 5: Steering-Wheel Characteristics

On-axis Potentiometer	20K
Wheel angle meter backlight	24V/50ma lamp 0–100 % brightness control

Table 6: ***SCC Box Characteristics***

Military D-Sub Connectors:	MIL-C-24308
Other Connections:	Cable glands
Fuse:	10A, 20x5, Fast
Solenoids Control Card:	
Two CAN channels:	100 Kbs
Six Solenoid Drive Channels:	2.5A – FU (PWM) 2.5A - NFU Steering 4A - NFU Trim
Four ICT Feedback Sensing:	0.5 – 4.5 VDC
Six Hydraulic Discrete Sensing:	Closed ('0') – OK Open ('1') – Fail
Dimensions:	350x300x102 mm
Weight:	3.5 Kg

Table 7: ***Solenoids Characteristics***

Connectors:	Rectangle - CNE
Valves per Solenoid:	2
Coil resistance:	Steering - 10Ω Trim - 6Ω
Max. Coil Current:	Steering – 2.5A Trim – 4A

Table 8: ***EICT Characteristics***

Connectors:	Cable glands
Input Signal from Propeller Piston:	LVDT
Output Signal to SCC card:	0.5 – 4.5 VDC
Power from SCC card:	10-36 VDC
Offset and Gain Potentiometers:	2
Output Voltage Polarity:	Jumper A/B

2. Hardware Description

2.1. Scope

This chapter provides description of the ACS structure and subassemblies.

2.2. Control Panels

The main tasks of the two control panels are:

- To control the craft trim and steering using NFU switches.
- To control the craft trim using FU function keys (push buttons).
- To display the steering and trim angles.
- To display the error messages.
- To display the craft speed.

2.2.1. Front Side Description

Figure 3: ***Control Panel Front Side View***

The Control Panel front side includes the following:

Rudder Angle meter – this meter indicates the actual propellers steering angle. The accurate angle value is shown also digitally near to the analog meter.

Trim Angles meters – these two meters have two arrows each. The red arrows indicate the actual propellers trim angles (port and starboard) and the black arrows indicates the desired trim angles. The accurate angle values are shown also digitally near to the analog meters.

Messages window – displays the error messages of the system Built-In-Tests (BIT).

Steering NFU switch – a Port/Stb switch for manual adjustment (Non-Follow-Up) of the propellers steering angle.

Trim NFU switches - two Up/Down switches for manually tune (Non-Follow-Up) the propellers trim port and trim starboard angles independently.

Trim FU arrows buttons – two arrows buttons for automatic (Follow-Up) trim control.

Trim FU/NFU button – toggle button selects between trim follow-up and non-follow-up modes of operation.

Steering FU/NFU button – toggle button selects between steering follow-up and non-follow-up modes of operation.

TAKE CMND button - initiates Take Command procedure for control delivery from the active control panel to the non-active one.

Steering PORT/STB button - this button selects one of the two In-Cylinder Transducers to be the valid sensor for the steering control.

The default valid sensor upon power-up is the PORT sensor. In the case of Port ICT malfunction the Starboard ICT will be selected automatically by the software, but

this will be done only if the two trim angles are smaller than ±2.5°. In case of wider angle the user should do that manually by pressing the PORT/STB button.

Buzzer - it turns-on by the ACS software in correspondence to an error message appearance on the screen, or 'take command' activation. It buzzes in disruptive way.

ALARM ACK button – to turn-off the buzzer. Pressing this button will also stop the error message blinking.

Please note that the buzzer can be turns-off also by the ACS software.

MAN/AUTO button – this is a provision-fore button (not active) – it will select between manual and automatic cruise if an appropriate software will be written.

DIM+ and DIM- arrow buttons – to tune the display backlight brightness. Pressing these buttons will also dim automatically the relevant wheel meter backlight – the open-bridge control panel will dim the open-bridge wheel and the closed-bridge control panel will dim the closed-bridge wheel.

SPEED indication - indicates the craft speed in Knots. The system reads the speed value continuously from the GPS .

2.2.2. Rear Side Description

Figure 4: ***Control Panel Back Side View***

The Control Panel back side includes the followings (see Figure 3):

- **CAN1 & CAN2 connectors –** Two identical 15pin male D-Sub connectors. Each connector includes the same pinout and the same signals (except the CAN signals) for redundancy.
  The CAN cables are connected to the Adaptors box.

Table 9: ***Control Panels CAN Connectors Pinout***

Pin no'	Signal
1	CAN1-H (for CAN-1), CAN2-H (for CAN-2)
2	CAN1-L (for CAN-1), CAN2-L (for CAN-2)
3	N.C
4	NFU_TRIM PORT– UP
5	NFU_TRIM PORT – DOWN
6	NFU_TRIM STB – UP
7	NFU_TRIM STB – DOWN
8	NFU_STEERING PORT
9	NFU_STEERING STB
10	GND
11	DISPLAY-ID
12	GND
13	N.C
14	POWER
15	N.C

CAN1-H and CAN1-L are the CAN Channel-1 communication signals that exist only on CAN1 connector, while CAN2-H and CAN2-L are the CAN Channel-2 communication signals that exist only on CAN2 connector.
The control panels have no termination resistor for the CAN bus internally, but this 120Ω resistor is implemented inside the CAN cables mating

connectors (connected between the H and L signals) and only for the open-bridge cables.

NFU signals – these are the NFU wires. They are connected internally only to the NFU switches. They bypass the control panel electronics and even the main fuse.

This is because the NFU functions should be active also in emergency case that may be no power to the control panel – as long as the NFU wires are still connected to the craft batteries they can still be useful.

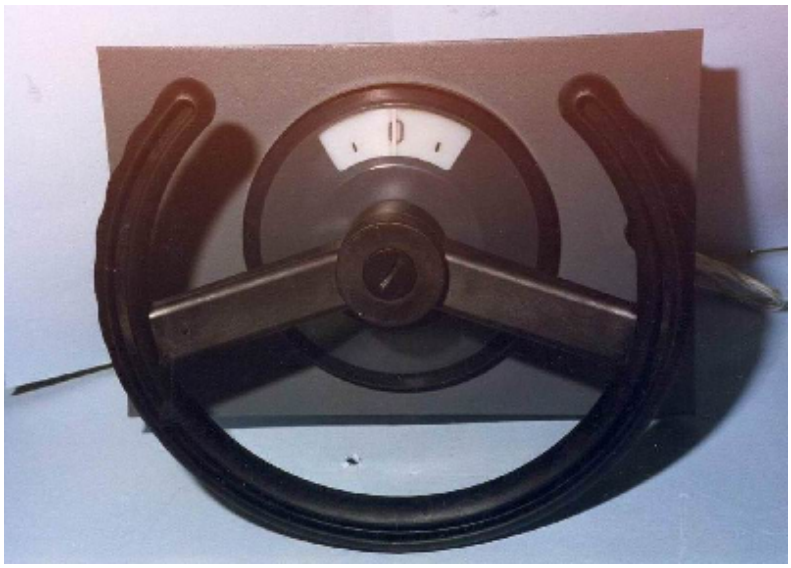
DISPLAY-ID pin – this pin is internally connected to a Pullup resistor and sensed by the internal microcontroller. The control panel uses it for own identification. Because the two control panels are identical and replaceable we need some mean for the ACS system to distinguish between the two – this pin is shorted to GND inside the tow Closed Bridge CAN cables mating connectors and left open inside the tow Open Bridge CAN cables mating connectors. This means that the Closed Bridge control panel reads a '0' logic from the DISPLAY-ID pin and recognize itself as 'Closed' and the Open Bridge read '1' logic and recognize itself as 'Open'.

POWER pin – for inlet 10-36 VDC power.

- **DVI connector** – a standard DVI-D connector for the display.
- **5A fuse** - 20x5 type 5A Fast Acting fuse.

2.3. Steering Wheels

Figure 5: ***Steering Wheel View***



The steering-wheel include the following items:

Potentiometer – 20KΩ potentiometer which is mounted on the wheel axis. Rotating the wheel rotates also the potentiometer. One of the potentiometer end terminals is connected to a bias voltage, coming from the SCC-Steering card, and the other end terminal is connected to ground. The center terminal voltage value is variable and proportional to the wheel position. This voltage is sampled by the SCC-Steering card

Wheel Angle Meter - indicates the wheel position.

Each wheel angle meter backlight is controlled by the ACS in a way that its brightness changes simultaneously in accordance to the nearby control panel dimming – the closed bridge wheel brightness is synchronized with the closed bridge control panel dimming and the open bridge wheel brightness is synchronized with the open bridge control panel dimming.
The dimming dynamic range is 0 – 100 %.
Connector Pinout – 9pin male D-Sub connector. It includes the following signals:

Table 10: ***Wheel Connector Pinout***

Pin no'	Signal
1	WHEEL BIAS VOLTAGE (5 VDC)
2	CLOSED/OPEN WHEEL SIGNAL
3	GND
4	CLOSED/OPEN LAMP VOLTAGE
5	CLOSED/OPEN LAMP DIM
6	N.C
7	N.C
8	N.C
9	N.C

2.4. The PC

Warnings:

- Never turn-off the power to the system during start-up.

- After turning the power OFF, wait at least 5 seconds before you turn it ON again.

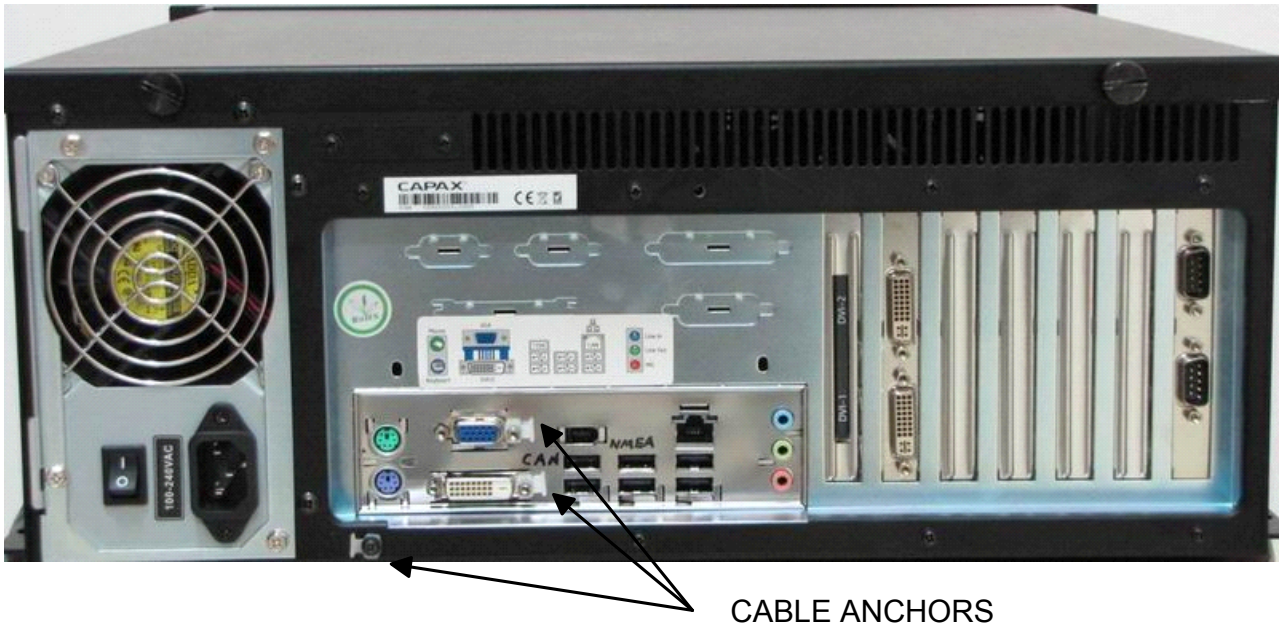
- Never use the system PC for any purpose other than the ACS application.

The main tasks of the PC are:

- To run the ACS application software, calibration software and debug software.
- Supports the two control panels displays.
- To control all the ACS devices through a CAN bus.

Figure 6: ***PC General View***

Figure 7: ***PC Rear Side View***



2.4.1. Rear Side Description

The PC rear panel is standard but only the following items are in use in the ACS system:

Two USB ports – one for the USB to CAN adaptor and the other for the USB to NMEA0183 adaptor, that are located inside the Adaptors box.

Two DVI ports on an add-in card - the DVI-1 is dedicated to the Closed bridge control panel and the DVI-2 is dedicated to the Open bridge control panel.

Note that on-board DVI and VGA ports are not in use.

Two PS2 ports – for keyboard and mouse.

Two RS485 (COM) ports on an add-in card – these are provisional-for. Not in use at this time.

Power – 230VAC inlet power from the Adaptors box.

2.5. Adaptors Box

The main tasks of the Adaptors box are:

- Junction box - collects and distributes the most of the ACS connecting cables.
- Contains the SCC-Steering card and various types of adaptors/converters boxes.

Figure 8 : ***Adaptors Box General View***

2.5.1. Internal Content and Functional Description

Figure 9: ***Adaptors Box Top View***

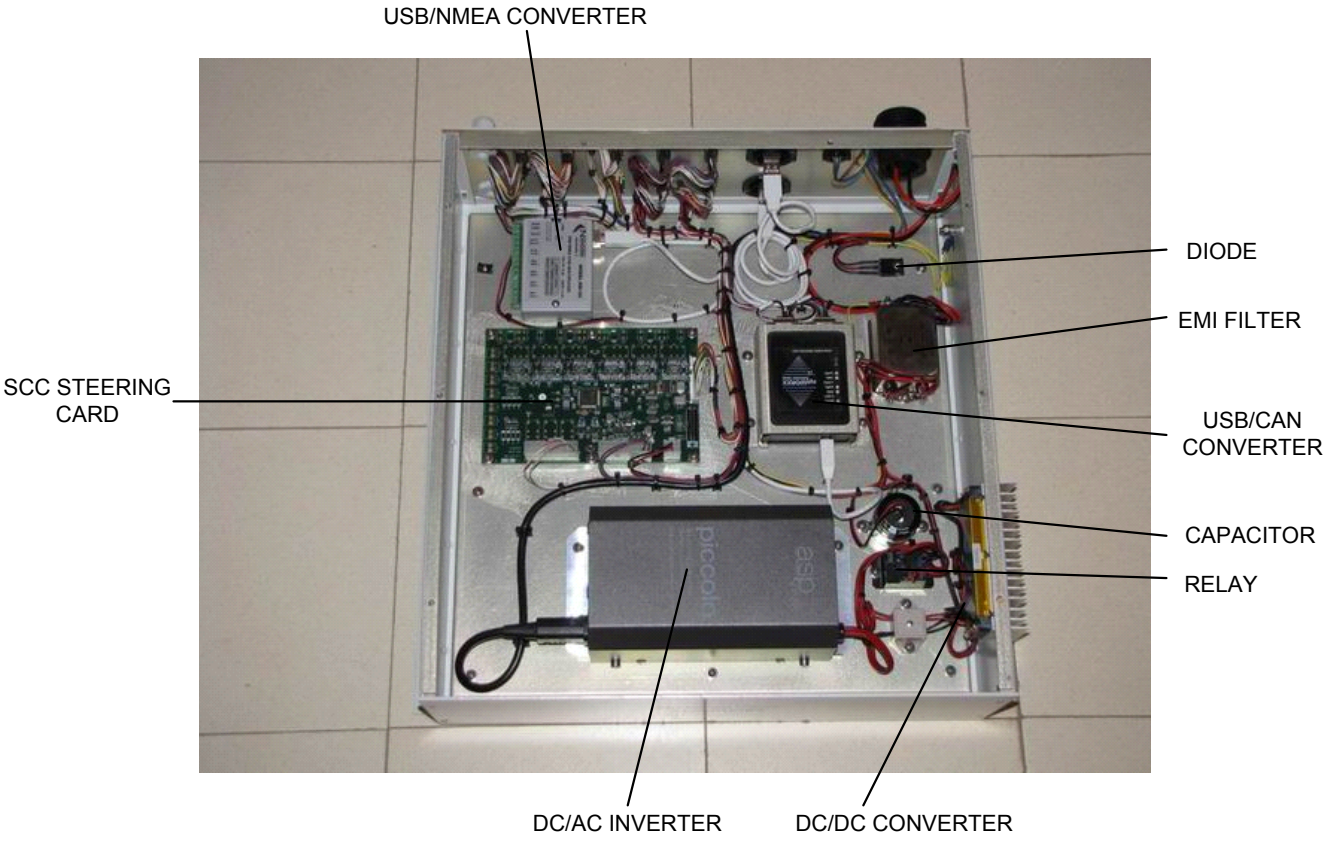
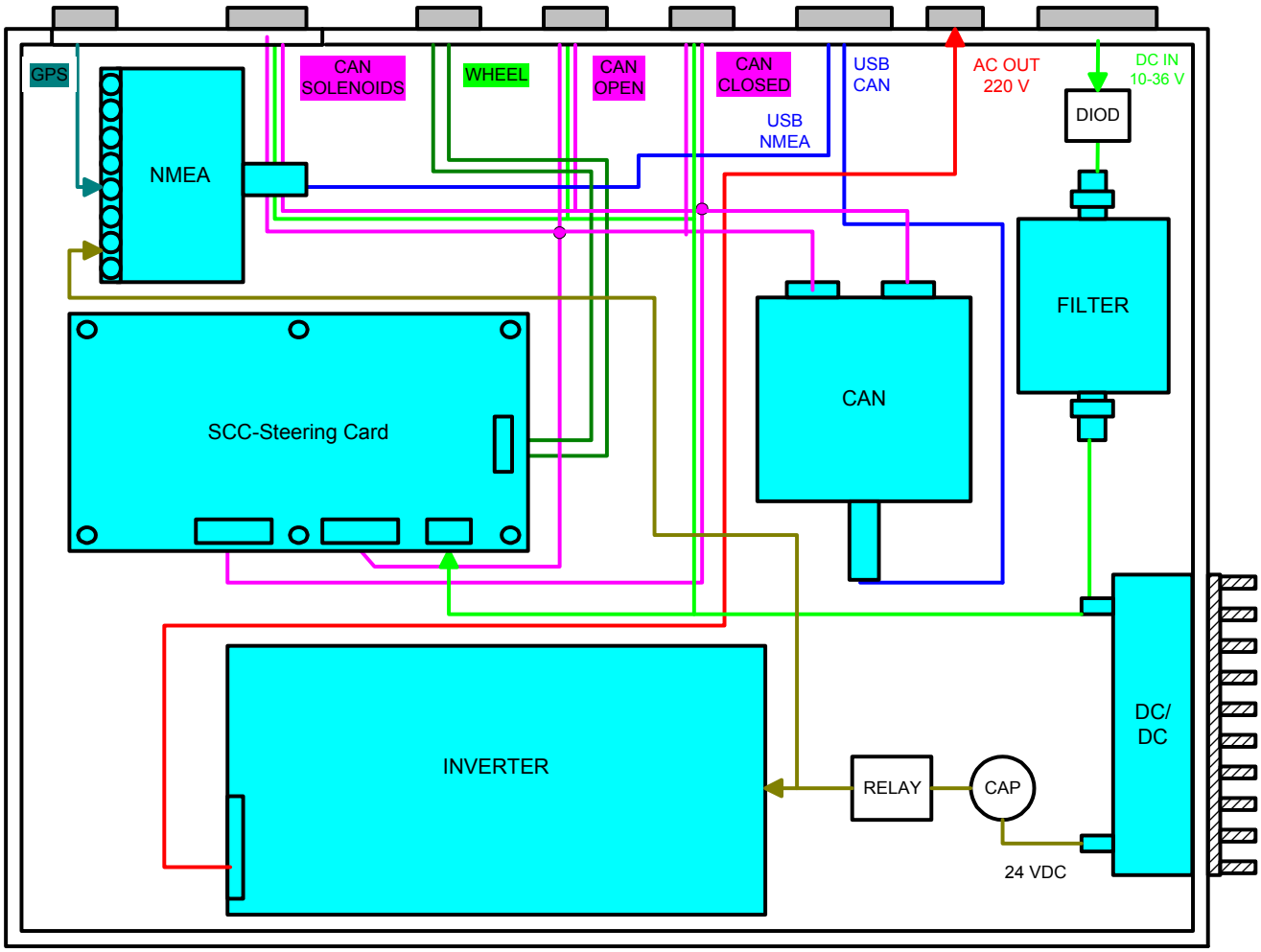


Figure 10 : ***Adaptors Box Block Diagram***



The adaptors box contains the followings:

USB/CAN adaptor box - converts simultaneously two CAN communication channels to USB channel for the PC.

USB/NMEA adaptor box - converts simultaneously four NMEA0183 communication channels to USB channel for the PC.

The first channel used by the GPS to transmit the craft speed data to the PC. The others channels are provision for future use.

DC/DC Converter – converts the inlet 10 to 36 VDC power from the craft batteries to a constant 24VDC power for the DC/AC Inverter.

DC/AC Inverter - converts the 24VDC power from the DC/DC to 230VAC power for the PC.

SCC Steering Card – this is a functional reduced SCC card that samples the steering wheels status signals (from the potentiometers) and controls the wheels meters backlight dimming. It communicates with the PC through the CAN bus but there is no need for termination resistors here.

EMI Filter – this is a line filter that accepts directly the inlet DC power of the craft and distributes it to the whole ACS system. It filters the conducted emission noise from the ACS to the batteries and vice versa.

Protection Diode – protects the system against inverse polarity of the inlet voltage.

Relay & Capacitor – they serves as inrush current compensation circuit at the Inverter input power – only after the capacitor charged by the DC/DC, the relay connect it, and the DC/DC output, to the inverter input.

2.5.2. Rear Panel Description

Figure 11: ***Adaptors Box Rear Panel View***

The rear panel contains almost all the ACS interface connectors:

a) **24VDC IN Connector** – ACS system inlet power.

10-36 VDC (24V nominal).

Table 11: ***24VDC IN Connector Pinout***

Pin no'	Signal
L	POWER
N	RETURN
E	N.C

b) **220VAC OUT Connector** – AC output power to the PC.

Table 12: ***220VAC OUT Connector Pinout***

Pin no'	Signal
L	PHASE
N	NEUTRAL
E	ERTH

c) **CAN1 OPEN connector –** 15pin female D-Sub connector.

The CAN1 OPEN cable goes to the Open bridge control panel.

Table 13: ***CAN1 OPEN Connector Pinout***

Pin no'	Signal
1	CAN1-H
2	CAN1-L
3	N.C
4	NFU_TRIM PORT– UP- OPEN
5	NFU_TRIM PORT – DOWN- OPEN
6	NFU_TRIM STB – UP-OPEN
7	NFU_TRIM STB – DOWN- OPEN
8	NFU_STEERING PORT- OPEN
9	NFU_STEERING STB- OPEN
10	N.C
11	N.C
12	GND
13	N.C
14	POWER
15	N.C

CAN1-H and CAN1-L – these are the CAN Channel-1 signals.

NFU wires – this is the NFU group of wires to the Open bridge.

POWER – outputs the 10-36VDC power to the control panel.

d) **CAN2 OPEN connector** – 15pin female D-Sub connector..

The CAN2 OPEN cable goes to the Open bridge control panel.

Table 14: ***CAN2 OPEN Connector Pinout***

Pin no'	Signal
1	CAN2-H
2	CAN2-L
3	N.C
4	NFU_TRIM PORT– UP- OPEN
5	NFU_TRIM PORT – DOWN- OPEN
6	NFU_TRIM STB – UP-OPEN
7	NFU_TRIM STB – DOWN- OPEN
8	NFU_STEERING PORT- OPEN
9	NFU_STEERING STB- OPEN
10	N.C
11	N.C
12	GND
13	N.C
14	POWER
15	N.C

CAN2-H and CAN2-L - these are the CAN Channel-2 signals.

NFU wires – this is the NFU group of wires to the Open bridge.

POWER – outputs the 10-36VDC power to the control panel.

e) **CAN1 CLOSED connector –** 15pin female D-Sub connector..

The CAN1 CLOSED cable goes to the Closed bridge control panel.

Table 15: ***CAN1 CLOSED Connector Pinout***

Pin no'	Signal
1	CAN1-H
2	CAN1-L
3	N.C
4	NFU_TRIM PORT– UP- CLOSED
5	NFU_TRIM PORT – DOWN- CLOSED
6	NFU_TRIM STB – UP- CLOSED
7	NFU_TRIM STB – DOWN- CLOSED
8	NFU_STEERING PORT- CLOSED
9	NFU_STEERING STB- CLOSED
10	N.C
11	N.C
12	GND
13	N.C
14	POWER
15	N.C

CAN1-H and CAN1-L are the CAN Channel-1 signals.

NFU wires – this is the NFU group of wires to the Closed bridge.

POWER – outputs the 10-36VDC power to the control panel.

f) **CAN2 CLOSED connector –** 15pin female D-Sub connector..

The CAN2 CLOSED cable goes to the Closed bridge control panel.

Table 16: ***CAN2 CLOSED Connector Pinout***

Pin no'	Signal
1	CAN2-H
2	CAN2-L
3	N.C
4	NFU_TRIM PORT– UP- CLOSED
5	NFU_TRIM PORT – DOWN- CLOSED
6	NFU_TRIM STB – UP- CLOSED
7	NFU_TRIM STB – DOWN- CLOSED
8	NFU_STEERING PORT- CLOSED
9	NFU_STEERING STB- CLOSED
10	N.C
11	N.C
12	GND
13	N.C
14	POWER
15	N.C

CAN2-H and CAN2-L are the CAN Channel-2 signals.

NFU wires – this is the NFU group of wires to the Closed bridge.

POWER – outputs the 10-36VDC power to the control panel.

g) **CAN1 SOLENOIDS connector –** 25pin female D-Sub connector..

The CAN1 SOLENOIDS cable goes to the SCC box.

Table 17: ***CAN1 SOLENOIDS Connector Pinout***

Pin no'	Signal
1	CAN1-H
2	CAN1-L
3	N.C
4	NFU_TRIM PORT– UP- OPEN
5	NFU_TRIM PORT – DOWN- OPEN
6	NFU_TRIM STB – UP-OPEN
7	NFU_TRIM STB – DOWN- OPEN
8	NFU_STEERING PORT- OPEN
9	NFU_STEERING STB- OPEN
10	N.C
11	NFU_TRIM PORT– UP- CLOSED
12	NFU_TRIM PORT – DOWN- CLOSED
13	NFU_TRIM STB – UP- CLOSED
14	NFU_TRIM STB – DOWN- CLOSED
15	NFU_STEERING PORT- CLOSED
16	NFU_STEERING STB- CLOSED
17	N.C
18	GND

19	POWER
20	POWER
21	N.C
22	N.C
23	N.C
24	N.C
25	N.C

CAN1-H and CAN1-L are the CAN Channel-1 signals.

NFU wires – these are the two NFU groups of wires (Open and Closed) to the SCC box.

POWER – outputs the 10-36VDC power to the SCC box.

h) **CAN2 SOLENOIDS connector –** 25pin female D-Sub connector..

The CAN2 SOLENOIDS cable goes to the SCC box.

Table 18: ***CAN2 SOLENOIDS Connector Pinout***

Pin no'	Signal
1	CAN2-H
2	CAN2-L
3	N.C
4	NFU_TRIM PORT– UP- OPEN
5	NFU_TRIM PORT – DOWN- OPEN
6	NFU_TRIM STB – UP-OPEN

7	NFU_TRIM STB – DOWN- OPEN
8	NFU_STEERING PORT- OPEN
9	NFU_STEERING STB- OPEN
10	N.C
11	NFU_TRIM PORT– UP- CLOSED
12	NFU_TRIM PORT – DOWN- CLOSED
13	NFU_TRIM STB – UP- CLOSED
14	NFU_TRIM STB – DOWN- CLOSED
15	NFU_STEERING PORT- CLOSED
16	NFU_STEERING STB- CLOSED
17	N.C
18	GND
19	POWER
20	POWER
21	N.C
22	N.C
23	N.C
24	N.C
25	N.C

CAN2-H and CAN2-L are the CAN Channel-2 signals.

NFU wires – these are the two NFU groups of wires (Open and Closed) to the SCC box.

POWER – outputs the 10-36VDC power to the SCC box.

i) **WHEEL OPEN connector –** 9pin female D-Sub connector..

The WHEEL OPEN cable goes to the Open bridge wheel.

Table 19: ***WHEEL OPEN Connector Pinout***

Pin no'	Signal
1	WHEEL BIAS
2	OPEN WHEEL SIGNAL
3	GND
4	OPEN LAMP VOLTAGE
5	OPEN LAMP DIM
6	N.C
7	N.C
8	N.C
9	N.C

WHEEL BIAS - outputs 5V voltage to the wheel potentiometer, port 3.

OPEN WHEEL SIGNAL – input signal from the Open bridge wheel potentiometer, port 2.

GND – ground signal, connected to the potentiometer port 1.

OPEN LAMP VOLTAGE – outputs 24V voltage to the Open bridge wheel meter backlight.

OPEN LAMP DIM – return wire from the Open bridge wheel meter backlight to the Steering SCC card dimming control circuit.

j) **WHEEL CLOSED connector –** 9pin female D-Sub connector.

The WHEEL CLOSED cable goes to the Closed bridge wheel.

Table 20: ***WHEEL CLOSED Connector Pinout***

Pin no'	Signal
1	WHEEL BIAS
2	CLOSED WHEEL SIGNAL
3	GND
4	CLOSED LAMP VOLTAGE
5	CLOSED LAMP DIM
6	N.C
7	N.C
8	N.C
9	N.C

WHEEL BIAS - outputs 5V voltage to the wheel potentiometer, port 3.

CLOSED WHEEL SIGNAL – input signal from the Closed bridge wheel potentiometer, port 2.

GND – ground signal, connected to the potentiometer port 1.

CLOSED LAMP VOLTAGE – outputs 24V voltage to the Closed bridge wheel meter backlight.

CLOSED LAMP DIM – return wire from the Closed bridge wheel meter backlight to the Steering SCC card dimming control circuit.

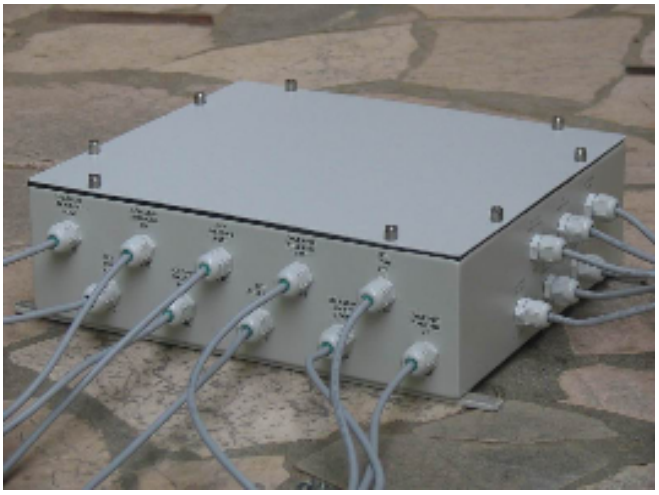
2.6. SCC Box

The main tasks of the SCC box are:

- To drive and control the solenoids while sensing the ICT signals.
- To sense the hydraulic sensors.

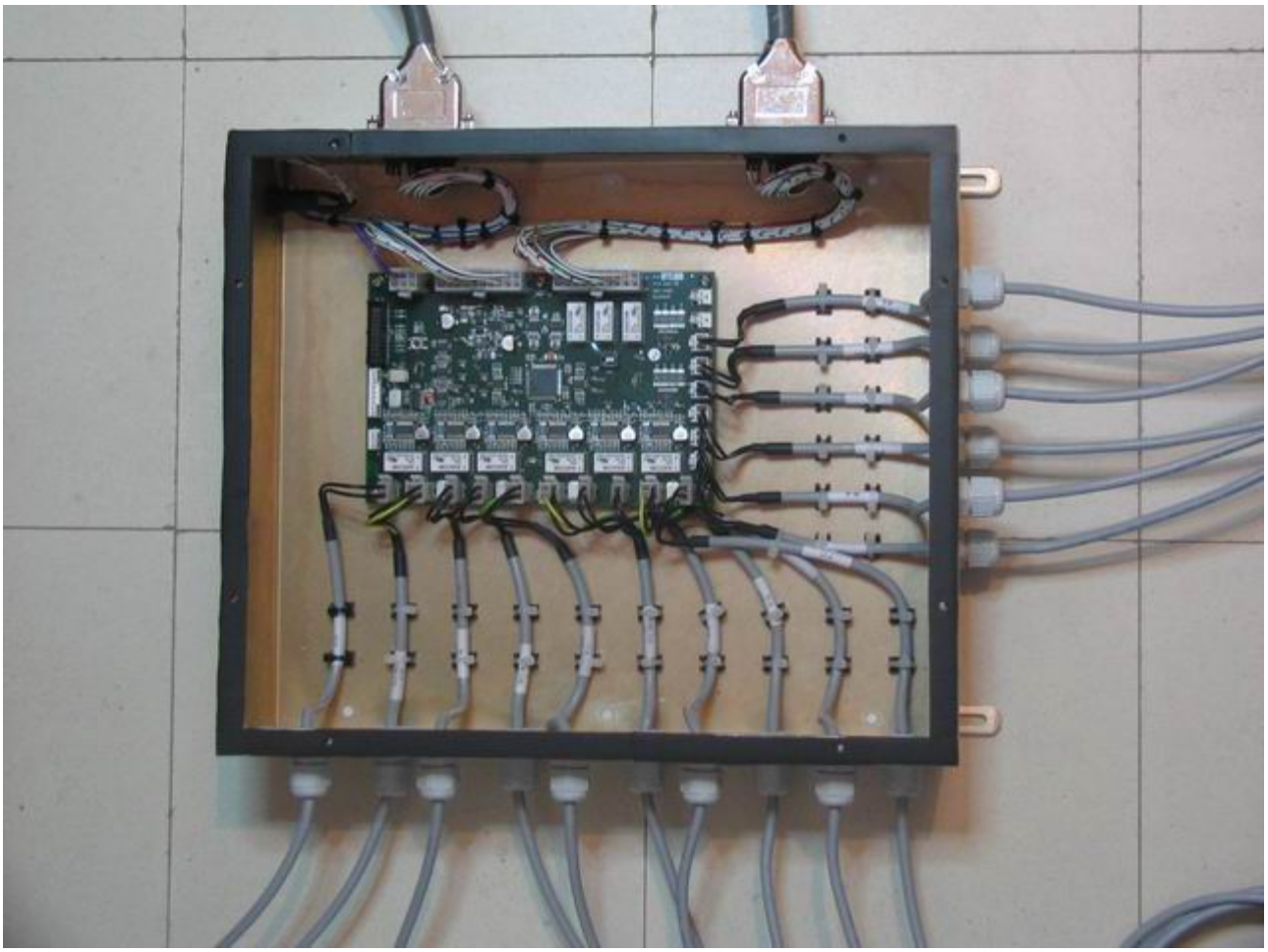
Figure 12 : ***SCC Box General View - Connectors Side***

Figure 13 : ***SCC Box General View - Glands Side***



2.6.1. Internal Content and Functional Description

Figure 14 : ***SCC Box Top View***



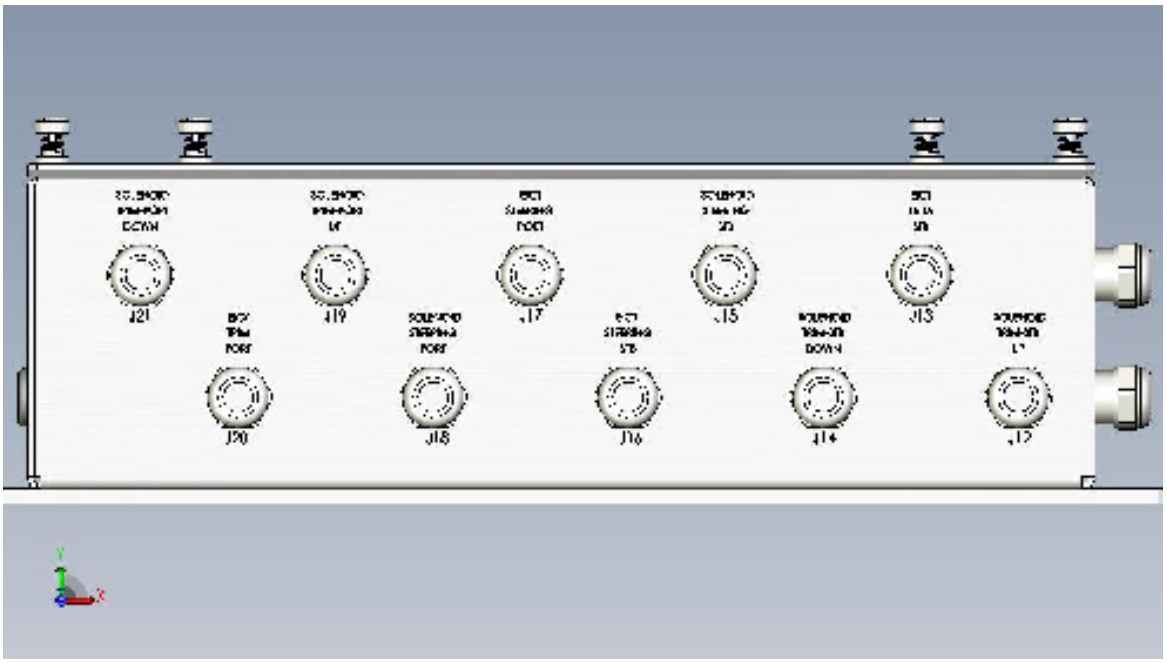
The SCC box contains only the Solenoids SCC card.

2.6.2. Panels Description

Fuse Holder – 10A, 20x5, Fast acting fuse.

CAN1 and CAN2 Connectors - The SCC card accepts the Power, CAN communication channels and NFU wires from the Adaptors box through these connectors on the top panel.
These are the other two ends of the two CAN channels, therefore we need two 120Ω termination resistors, but unlike the control panels, the resistors here are populated on the SCC card rather than inside the cables mating connectors.
The pinout of these connectors is the same as the CAN1-SOLENOIDS and CAN2-SOLENOIDS of the Adaptors box mutually.

Figure 15 : ***SCC Box Bottom Panel View***



Bottom panel glands – these glands holds the cables from the SCC card which goes directly to the solenoids and EICTs .

There are six solenoid cables as follows:

J12 – SOLENOID TRIM STB UP

J14 – SOLENOID TRIM STB DOWN

J15 – SOLENOID STEERING STB

J18 – SOLENOID STEERING PORT

J19 – SOLENOID TRIM PORT UP

J21 – SOLENOID TRIM PORT DOWN

All these cables have the same connector pinout as follows:

Table 21: ***SCC Solenoid Cables Pinout***

Pin no'	Signal
1	SOLENOID DRIVE
2	RETURN

There are four ICT cables as follows:

J13 – EICT TRIM STB

J16 – EICT STEERING STB

J17 – EICT STEERING PORT

J20 – EICT TRIM PORT

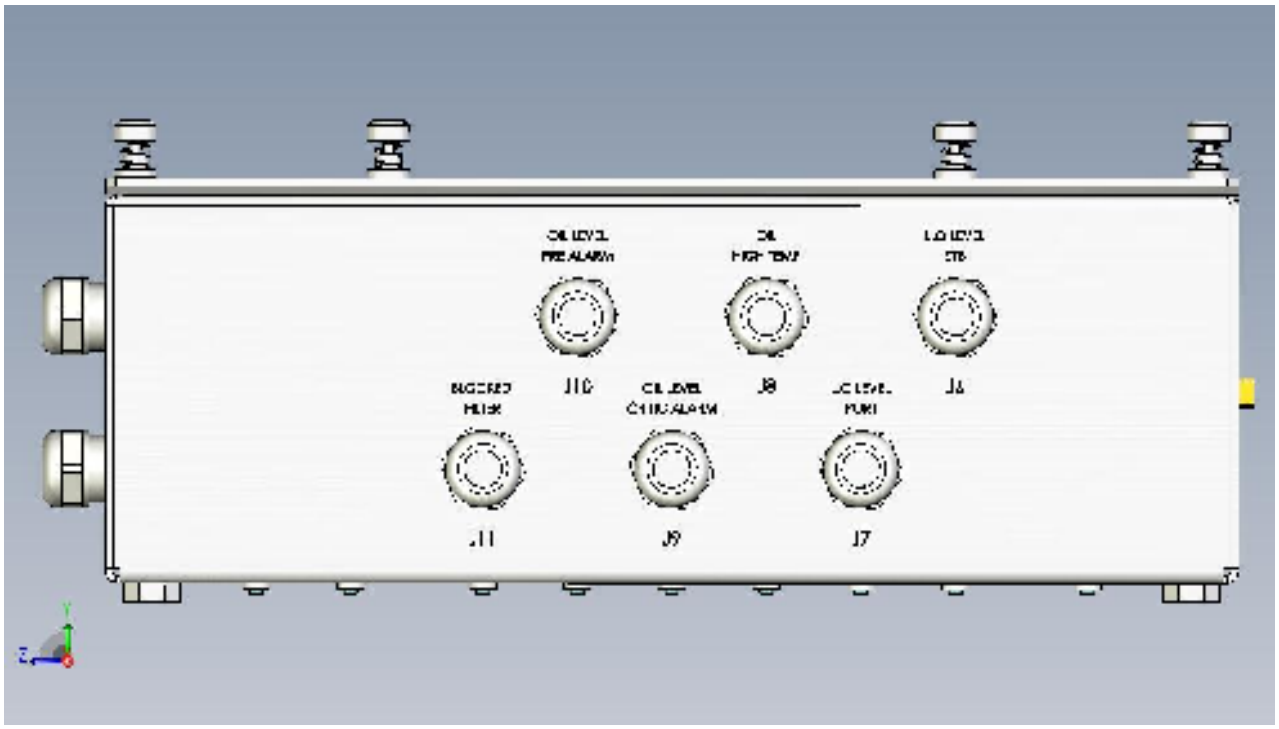
All these cables have the same connector pinout as follows:

Table 22: ***SCC EICT Cables Pinout***

Pin no'	Signal

1	POWER
2	SIGNAL
3	GND

Figure 16 : ***SCC Box Right Panel View***



Right panel glands – these glands holds the cables from the SCC card which goes directly to the hydraulic sensors.

There are six sensor cables as follows:

J6 – L.O LEVEL STB

J7 – L.O LEVEL PORT

J8 – OIL HIGH TEMP

J9 – OIL LEVEL CRITICAL ALARM

J10 – OIL LEVEL PRE ALARM

J11 – BLOCKED FILTER

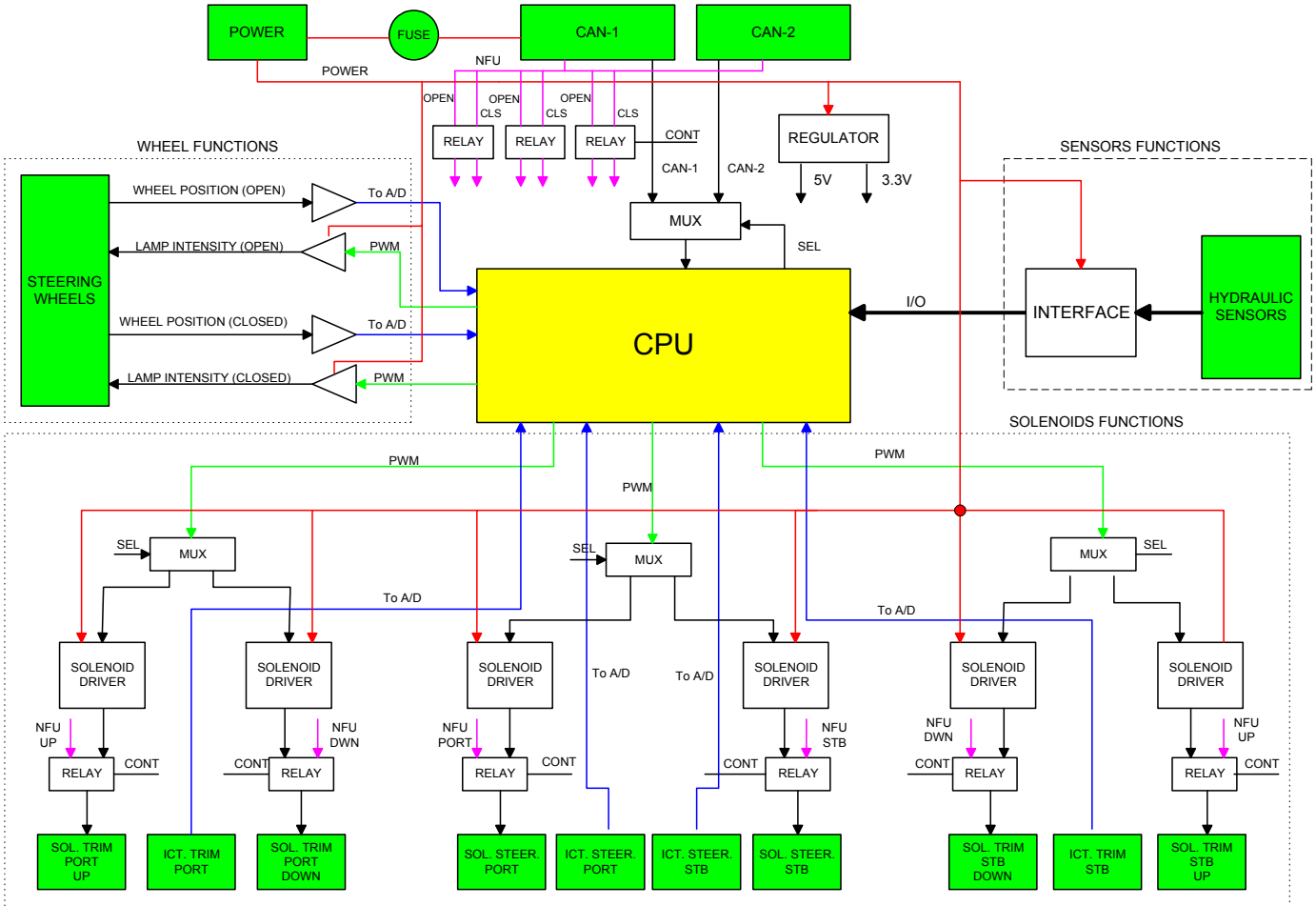
All these cables have the same connector pinout as follows:

Table 23: ***SCC Sensors Cables Pinout***

Pin no'	Signal
1	SIGNAL
2	GND

2.6.3. SCC Card Description

Figure 17 : ***SCC card Block Diagram***



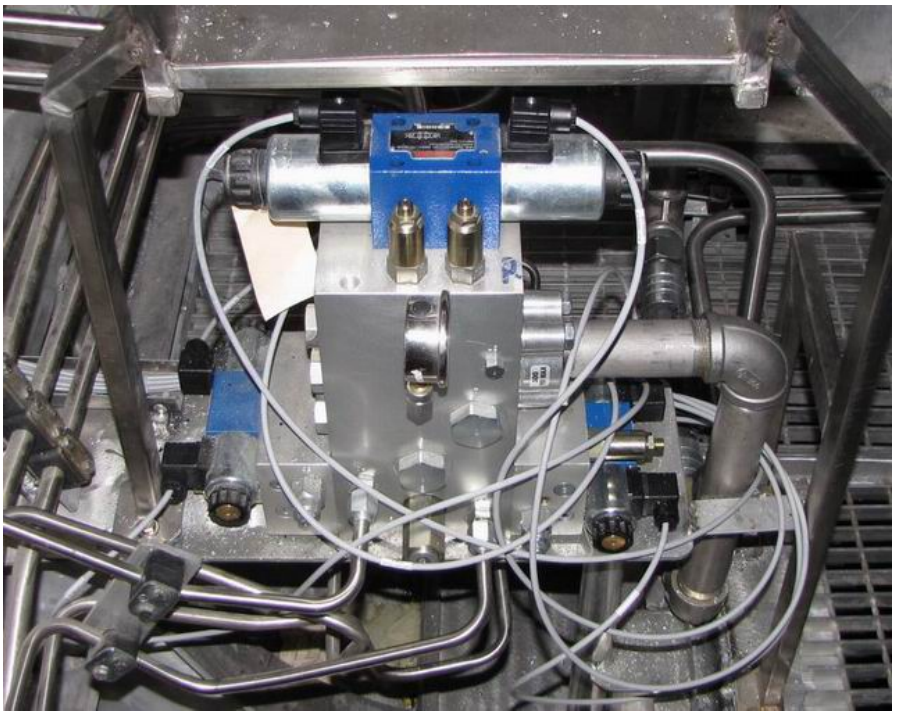
CAN interface – CAN1 and CAN2 connectors brings the battery power, the two CAN channels signals and the two NFU sources (Open bridge and Closed bridge) from the adaptors box to the SCC card.
The power wires goes to the fuse on the SCC box panel and then to the Power connector on the card.
The CPU uses a multiplexer and relays to select the desired CAN and NFU signals according to software algorithm. The power-up defaults are CAN1 for the CAN bus and the Open bridge for the NFU wires.
Solenoids functions - The CPU produces 3 digital PWM signals for the solenoids: one for the steering and two for the trim. Each signal goes to a multiplexer which directs it to one of the two analog PWM drivers (total of 6 drivers) for the relevant dual-valves solenoid. Each analog PWM drive signal goes to relay and then to the relevant solenoid-out connector.
The relays accept also the NFU wires and switch them to the solenoids, upon CPU request, instead-off the PWM. The control mode upon power-up is NFU mode.
Important note: Thanks to the unique relay property, the NFU wires will be directed to the solenoids even if there is no power to the SCC card (discharged coil). This is useful in emergency case.
The CPU also samples (A/D) the 4 ICT feedback analog signals – two from the steering pistons and two from the trim.
Sensors functions - the 6 hydraulic discrete sensors are sensed by the CPU I/O ports. These signals are buffered by optocouplers before connecting to the CPU.
Wheels functions - The CPU also samples (A/D) the feedback voltages from the two wheels and produces another two PWM signals to drive the backlight lamps of the wheels. These functions are in-use only in the Steering-SCC version.

2.7. Solenoids

The proportional solenoids task is to adjust the hydraulic oil flow to the craft propellers cylinders.

There are one dual-valve solenoid for the steering control and two dual-valve solenoids for the trim control.

Figure 18 : ***Solenoids General View***

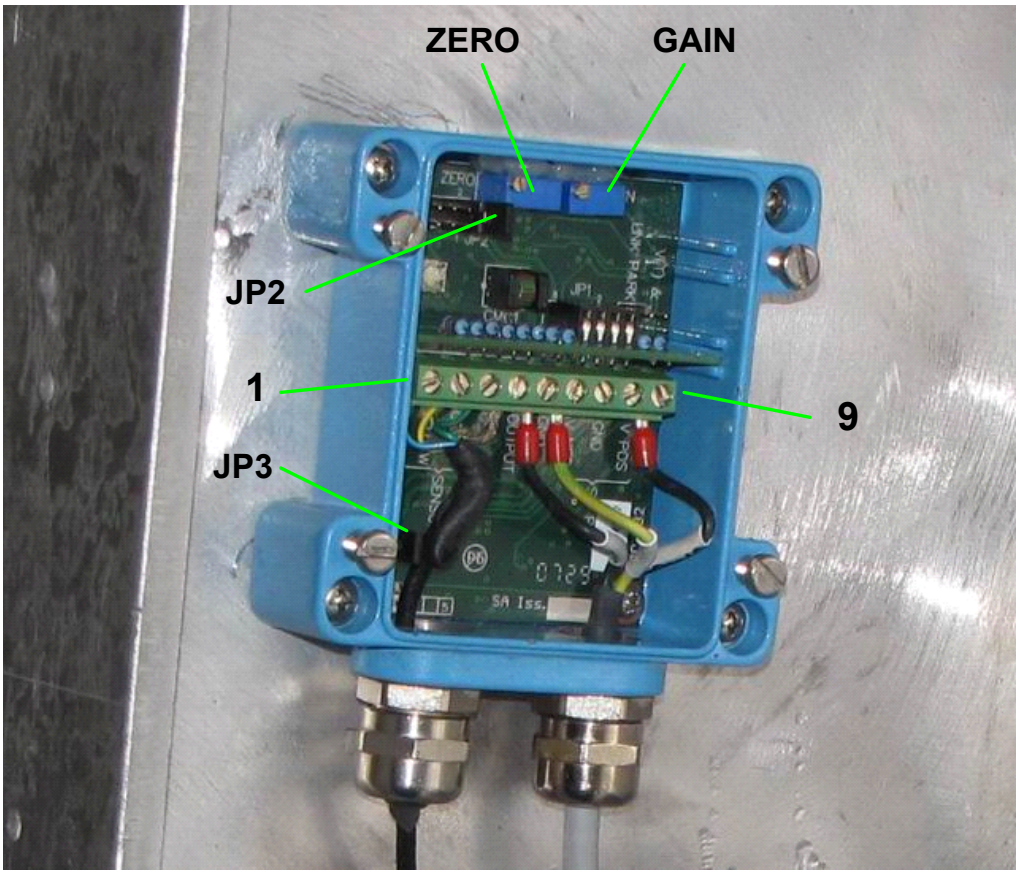


2.8. EICT – Electronics In Cylinder Transducer

The EICT task is to sense the ICT sensor, performs signal conditioning and outputs a propeller position proportional voltage to the SCC box.

The output voltage should be calibrated as a precondition to the ACS software calibration.

Figure 19 : ***EICT General View***



2.8.1. Internal Wiring Description

The EICT wiring should be connected as follows:

Table 24: ***EICT Wiring***

Terminal No'	Signal
1	ICT BLUE wire
2	ICT YELLOW wire
3	ICT GREEN wire
4	ICT SHIELD
5	OUTPUT SIGNAL to the SCC
6	N.C
7	N.C
8	GND for the SCC cable
9	V-POS POWER from the SCC

2.8.2. Potentiometers and Jumpers Description

Note: Make sure that the VM (Voltage Module) card is not fitted (there should be only one small daughter card fitted to the main EICT card).
There are two potentiometers, ZERO (OFFSET) and GAIN, on the EICT electronic board which are useful for output voltage calibration (see picture).
There are also two jumpers, JP2 and JP3, which should be connected according to the following table:

Table 25: ***EICT Jumpers***

Jumper no'	Jumper Position
JP2	Between pins 1 and 2
JP3	'A' position – For Steering Port EICT 'B' position – For Steering Stb EICT 'B' position – For Trim Port EICT 'B' position – For Trim Stb EICT

2.9. ACS Components on-ship Assembly

This chapter describes, mainly through pictures, the way that the ACS components should be assembled on the ship.

2.9.1. Control Panels Assembly

The two control panels are assembled on the closed bridge and the open bridge almost in the same way behind the steering wheel.

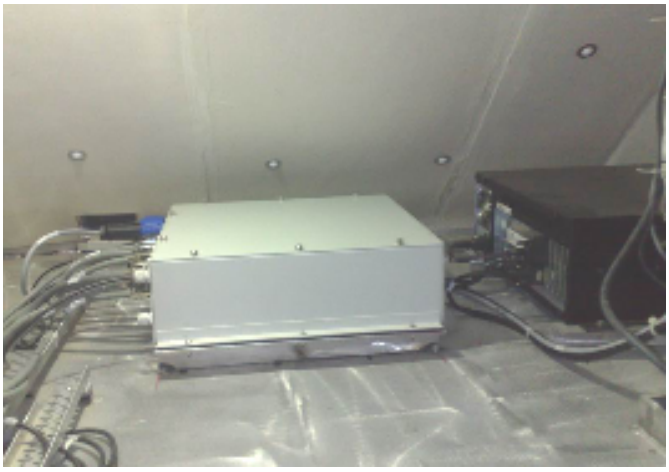
Figure 20 : ***Closed-Bridge Control Panel Assembly***

Figure 21 : ***Open-Bridge Control Panel Assembly***

2.9.2. Adaptors box and PC Assembly

The adaptors box and the PC are located side by side in the closed bridge niche.

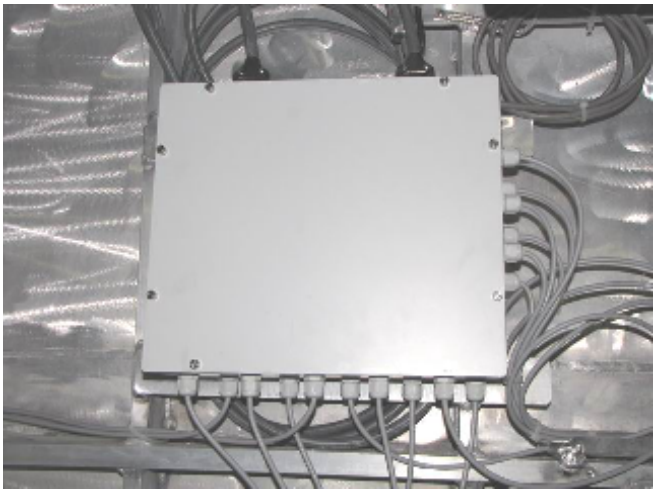
Figure 22 : ***Adaptors Box and PC Assembly***



2.9.3. SCC box Assembly

The SCC box is assembled vertically on a wall inside the steering room.

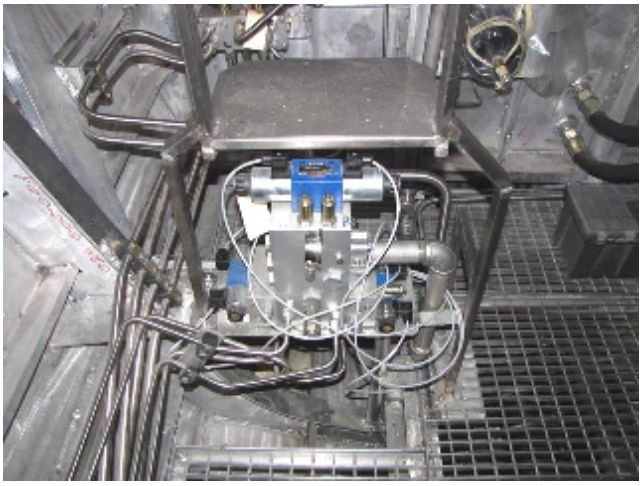
Figure 23 : ***SCC box Assembly***



2.9.4. Solenoids block Assembly

The Solenoids block is assembled in the steering room floor beneath the ladder.

Figure 24 : ***Solenoids block Assembly***



2.9.5. EICTs Assembly

The EICTs are assembled on the left and right walls corners in the steering room.

Figure 25 : ***EICTs Assembly***

3. Software Description

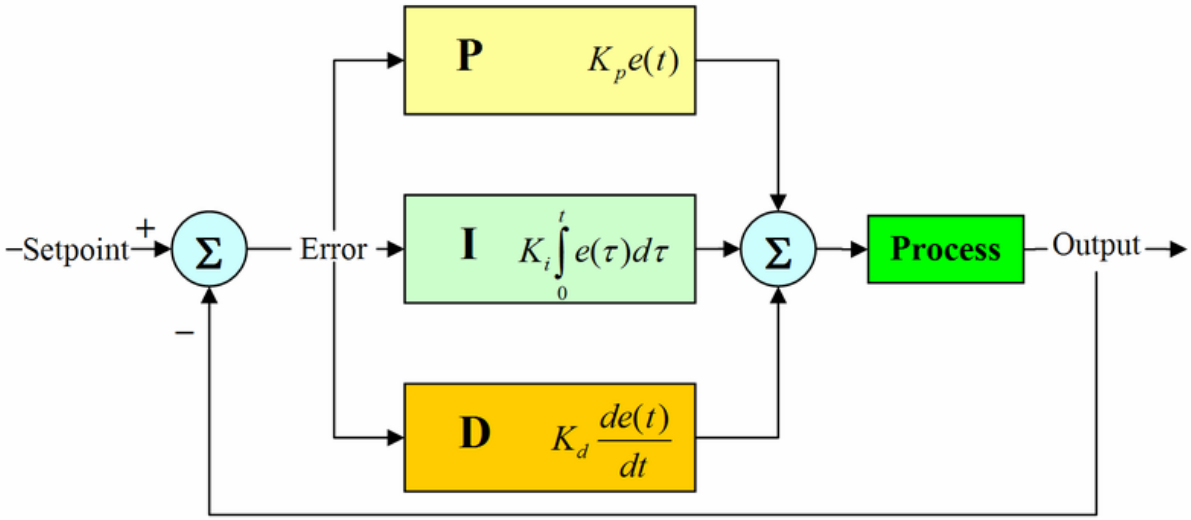
3.1. Scope

This chapter describes briefly two main software tasks implemented by the PC and the SCC-Solenoids card – the PID control algorithm and the CAN channels control algorithm.

3.2. PID Control Algorithm

This algorithm is implemented mutually by the PC and the SCC-Solenoids card in Follow-Up mode. The well known PID (Proportional Integral Differential) as described in the figure bellow is the algorithm used by the ACS to control the craft steering and trim propellers movement and position.

Figure 26 : ***PID control algorithm***

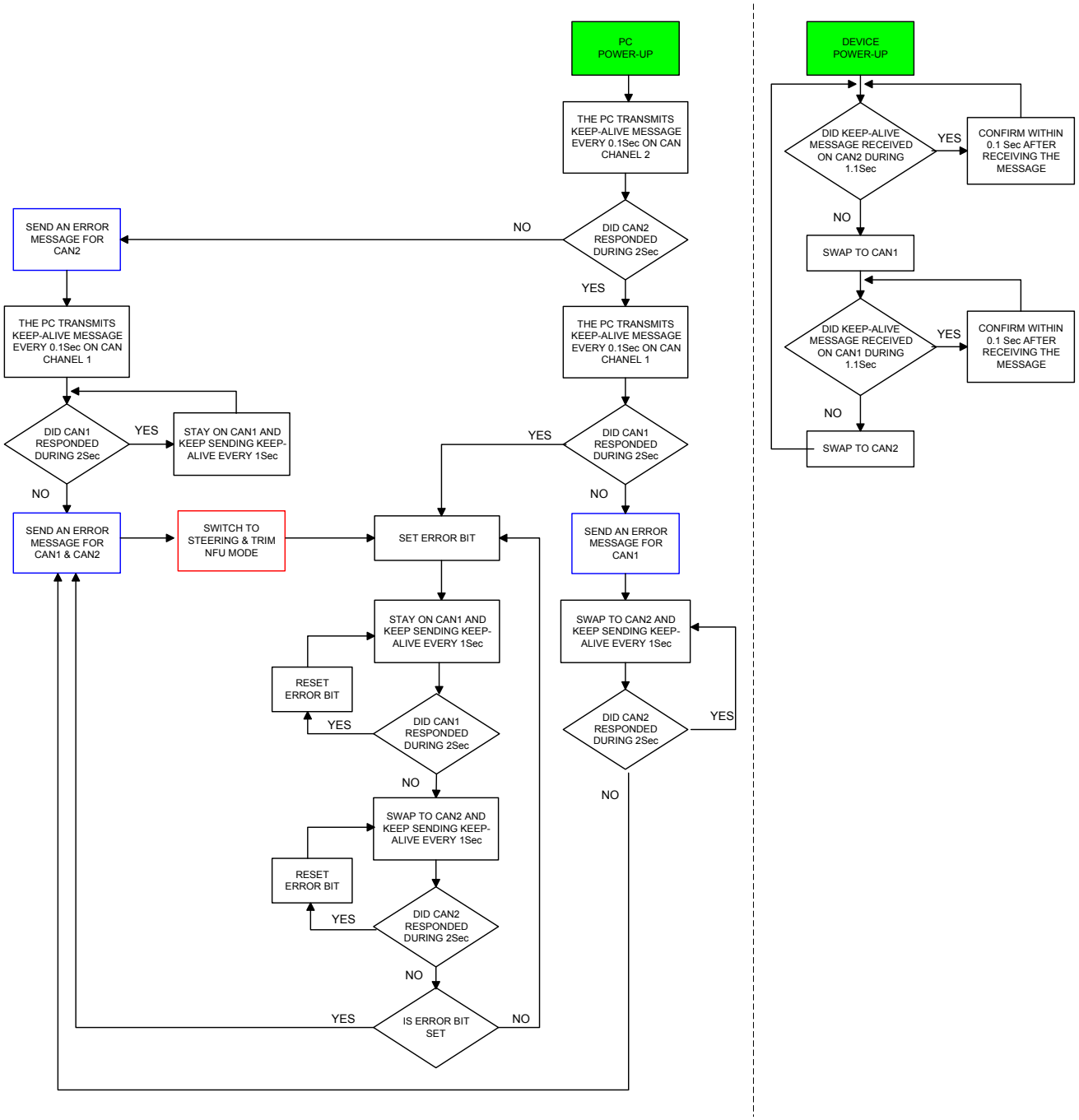


As any control algorithm, its task is to drive the system parameters (the output of the algorithm) to follow the input setpoint continuously an accurately.
The P, I and D are mathematical functions that the algorithm implements to process the fluctuations of the input signal in real time.
We actually implemented two independent PID algorithms, one for the steering control and another one for the trim control.
The input setpoints are the wheel position and the two desired trim positions (the black arrows positions on the trim meters). The outputs are the propellers steering and trim actual position feedbacks. We need off-course some means to drive the outputs to fulfill the inputs desire.
The ACS senses the status of the wheel and the trim black arrows and drives the hydraulic system, through the solenoids, such that the ICT feedback signals (indicates the propellers position) will satisfy the wheel and trim positions.

3.3. CAN Channels Control Algorithm

We need a unique mechanism to supervise and test in real time the two CAN channels. A two-parts algorithm have been developed for this purpose - the algorithm is actually separated to two parts which are running simultaneously, one part runs on the PC and the other part runs on each of the ACS devices CPU – the two control panels and two SCC cards.

Figure 27 : ***CAN channels control algorithm***



Flow chart description

On the PC:

Immediately after power-up, the PC sends, every 0.1 second, a 'Keep alive' message on CAN bus channel-2 - meaning 'Are you alive?'. Each device should confirm immediately on channel-2 with its own Keep-alive Opcode .

If there is a complete approval, then the PC swaps to channel-1 and continues to send its Keep-alive command. Again, all the devices should confirm on channel-1.

If there is complete approval then the PC stays on channel-1 and continues sending the Keep-alive, but now every 1 second.

- Power-up BIT - If any device didn't respond upon power-up during 2 seconds only on a single channel, then the PC will send an error message to the control panels display relating to this CAN channel and turns the buzzer on.
  The PC will continue to communicate on the active channel.
  If also the second channel will stop responding then the PC will send an error message for the two CAN channels and will switch automatically the control panels to NFU mode.
- On-line BIT - If upon power-up the two CAN channels were OK but later-on any device stopped responding during 2 seconds, then the PC will swap automatically to the other channel, keeping testing and swapping between the two channels continuously.
  Only if the two channels will not respond one by one during 4 seconds then the PC will send an error message and buzzer-on for the two CAN channels and will switch the control panels to NFU mode.

On the devices:

Upon power-up each device will wait for the keep-alive message from the PC on CAN2 channel during 1.1 Sec. If it will receive it, it will confirm immediately during 0.1 Sec and stays to communicate on this channel. If not, it will swap to CAN1 and waits there for 1.1 Sec before swapping again to CAN2.
The devices will do this swapping continuously every time they will lose the keep-alive signal.

3.4. Other software tasks

Other software tasks of the PC are:

- **System calibration –** to calibrate the steering wheels parameters to be match with the propellers parameters.
- **Built-In Tests (BIT) -** the system runs many internal tests upon start-up and on-line (in real time). There are up to 22 error messages available and up to 8 messages may be introduced on the control panel's display at the same time.
- **Debug tools –** two dedicated applications which are helpful in troubleshooting, named 'Debug' and 'CAN Status'.
- **'About' window –** introduces the system software and firmware versions.

All these tasks will be described in details in the following paragraphs.

4. Operation

4.1. Scope

This chapter details the procedure to follow when operating the ACS as a usual manner, assuming that the calibration procedure has already performed.
All the ACS operating tasks performs by the control panel and the steering wheel.

Warnings:

- Never turn-off the power to the system during start-up.

- After turning the power OFF, wait at least 5 seconds before you turn it ON again.

- Never use the system PC for any purpose other then the ACS application.

4.1.1. System Startup

Power-up the ACS by pulling its circuit breaker switch. Waite for a minute until the system startup will complete and verify that a message SYSTEM BIT PASSED displayed on the control panel messages window.
The system is now in Non Follow-Up (NFU) mode (manually steering and trim control) and the default active bridge is the Open bridge (only one control panel can be active at any time).

Figure 28 : The *Control Panel*

4.1.2. Using the Trim NFU control mode

Use the two Trim NFU switches to fine tune the trim port and trim starboard angles.

4.1.3. Using the Trim FU control mode

Press the Trim FU/NFU button and verify that the black arrows of the trim meters aligned automatically with the red arrows and the FU/NFU button status changed to FU.

Please note that in FU mode you can not differentiate the port and starboard trims – they move together simultaneously and maintaining the offset angle between the port and starboard.

To modify now the trim angle in FU press the trim arrows buttons – first you will see the black arrows moves, because they indicate the desired angles, and a second after you release the button the automatic trim control take place and moves the propellers until the red arrows aligned with the black arrows.

4.1.4. Using the Steering NFU control mode

While the ACS system is in Steering NFU mode use the single switch to control the steering propellers port/starboard angles manually.

4.1.5. Using the Steering FU control mode

Press the Steering FU/NFU button to change to steering FU mode. Rotating now the active bridge steering-wheel causes the propellers to follow automatically the wheel angle and the Rudder Angle meter arrow shows this angle constantly.

4.1.6. Take-Command procedure

As mentioned earlier, only one control panel is active at any time. If the skipper wants to control the craft from the non-active bridge, he should initiate the following procedure:

a) The skipper presses the TAKE CMND button on the active control panel. Pressing this button causes the IN COMMAND and NO COMMAND indications on the active panel display and the non-active display respectively, to blink, and also the non-active display buzzer turns on.

b) The receptor in the non-active bridge should now press its TAKE CMND button to confirm the message. Its buzzer will automatically turn-off after this action.

c) The receptor needs also to turn its wheel to the same angle as the steering meter within ±0.5° accuracy. At this moment its NO COMMAND red message will turn to IN COMMAND green message and stops to blink. At the same time on the other bridge the IN COMMAND green message will turn to NO COMMAND red message and also stops to blink.

The Take-Command procedure is completed now and the other-bridge control panel and wheel are the active one.

Remark: If the whole procedure will not complete within 90 seconds it will be canceled automatically.

5. Calibration

Warnings:

- You must not drive a ship that its ACS system was not calibrated yet.

- The calibration validation should be verified once in 6 months and you should recalibrate the system if necessary (if any of the ICT or wheel signals are outside of the 0.3 – 4.7 V interval).

5.1. Scope

This chapter details the procedure to follow in-order to calibrate the ACS.

ACS calibration is divided to two parts – EICTs hardware calibration and the software calibration.

You should first calibrate the EICTs before executing the software calibration.

Remark: The calibration can be done only from the closed bridge.

5.2. EICT Calibration

If the EICT cards are not calibrated, imply the following procedure to calibrate them. You need a DVM meter for this calibration.

a) Start the craft engines and turn the power-on to the ACS.

b) Use the steering room manual solenoids valves adjustment to bring the **trim port** craft propeller to its lowest end position – maximum down.

c) Measure the EICT trim port output voltage and make sure that its value is inside the range 0.1-1.5 V.

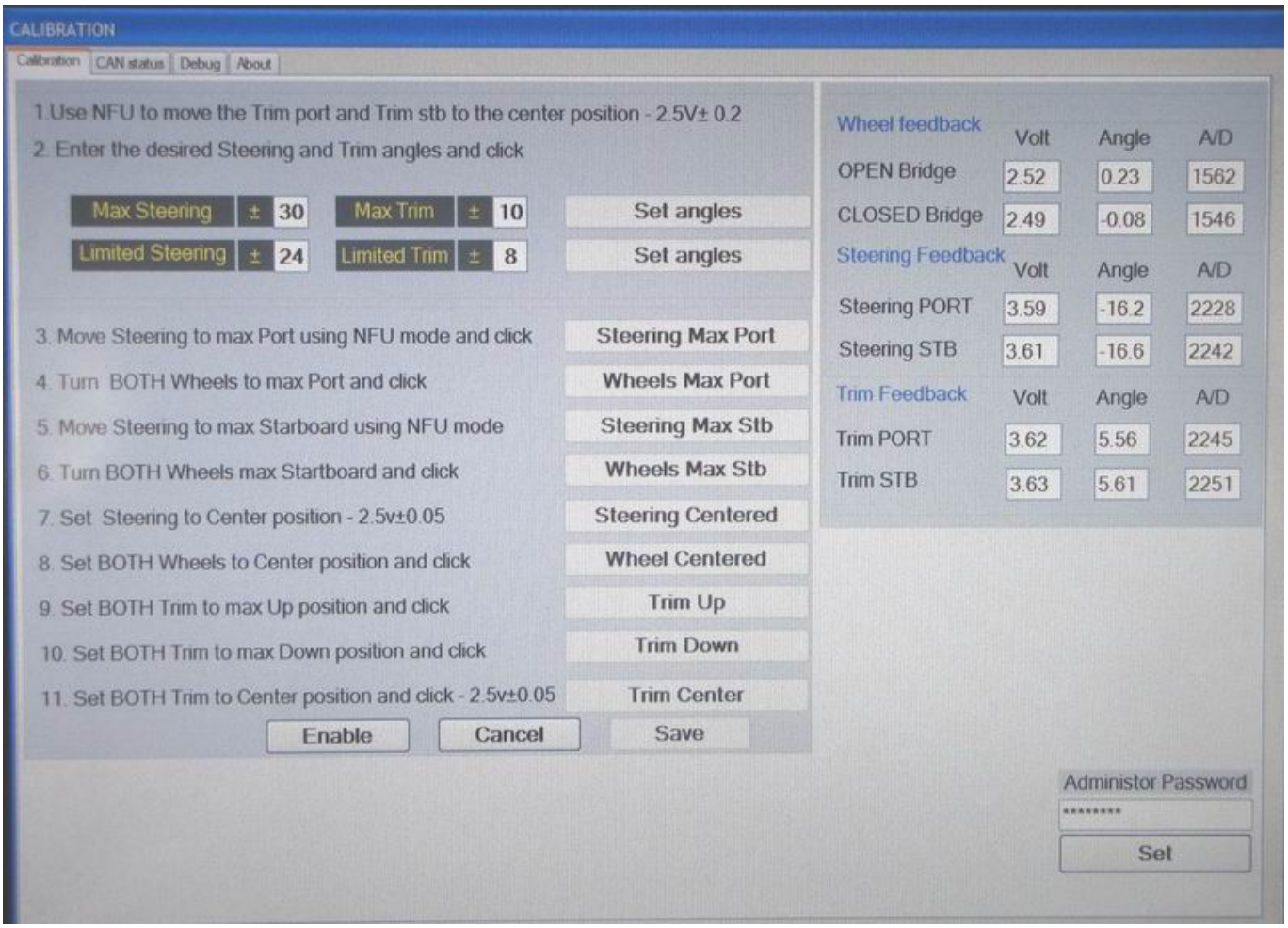
If this is not the case, bring the ZERO and GAIN potentiometers of this EICT to the center position – bring the potentiometer to the end of its scale (it can be done by carefully listening to the click sound when it reaches to the end) and rotate it back 10 full rotations.

d) Use the ZERO potentiometer to bring the output voltage to 0.5±0.05 V
e) Use the manual solenoids valves adjustment to bring the port craft propeller to its trim highest end position – maximum up.
f) Use the GAIN potentiometer to bring the output voltage to 4.5±0.05 V
g) Repeat steps **b** to **f** (you can use also the GAIN slightly for fine tuning the Max. Down voltage and you can use also the ZERO slightly for fine tuning the Max. Up voltage) again until you verify the acceptance of these voltages at the propeller ends without further trimming.
h) Bring the trim port propeller to the center position - 2.5±0.1 V
i) Repeat steps **b** to **h** for the **trim starboard** propeller.
j) Repeat steps **b** to **h** for the **steering port** EICT calibration.
k) Repeat steps **b** to **h** for the **steering starboard** EICT calibration.

5.3. Software Calibration

5.3.1. Software Calibration Preparation

Figure 29 : ***Calibration window***



a) Connect a PS2 type keyboard and mouse to the ACS system PC (use extender cables).
b) Make sure that the craft engines are operating.
c) Start-up the ACS.
d) Press the Alt+Tab keyboard keys to display the three system application icons. While holding the Alt pressed constantly, use the Tab to select the CALIBRATION application.
   The calibration window is open now and you can see the calibration instructions on the left and the ACS feedback sensors readout values (wheels, steering and trim) on the right. The sensors **Volts** represents the real-time exact voltages as they read by the SCC card. The **A/D** represents the corresponding digital values, but the **Angles** will represent the corresponding actual angles only after calibration done.
e) Click the **Enable** button. This action will not only enable the calibration procedure but it also activates the closed bridge control panel and switches it automatically to NFU mode.
f) Use the wheels and the NFU switches to verify that the steering and trim ICT sensors are already calibrated – their corresponding voltages should be according to the following table. Otherwise you should calibrate them (see the next paragraph for EICT calibration) before continue to the next ACS calibration steps:

Table 26: ***EICT Voltages truth table***

Feedback Signal	Position	Expected Voltage (V)
Wheel _Open & Closed	Max. Port Max. Stb	0.5±0.1 4.5±0.1
Steering _Port & Stb	Max. Port Max. Stb	0.5±0.1 4.5±0.1
Trim _Port & Stb	Max. Down Max. Up	0.5±0.1 4.5±0.1

5.3.2. Software Calibration Procedure

a) Execute accurately the calibration instructions, in the calibration window, one by one.

b) After executing the whole instructions click **Save** (if you made a mistake during calibration, click **Cancel** and restart from step 1).

c) Use the Alt+Tab to go back to the CLOSED bridge window.

d) Press the trim and steering FU/NFU buttons to switch to FU mode and verify that the steering and trim meters are in the center position ±0.5°.

e) Rotate the wheel to the maximum port and starboard and verify that the calibrated limited angles are accomplished within ±1°.

f) Use the trim arrow buttons to move the trim to maximum up and down and verify that the calibrated limited angles are accomplished ±0.5°.

g) Restart the system and use the open bridge to verify again the calibration success.

6. Troubleshooting

6.1. Scope

This chapter provides troubleshooting information and lists the preventing maintenance activities performed on the ACS system.

The ACS software has a robust BIT (Built In Tests) which can be very helpful in troubleshooting thanks to the 22 error messages that may introduced on the control panels screen and covers almost every aspect of the system.

The BIT performs on power-up and also on-line.

Additionally, there is special maintenance application software, divided to two windows, named **'Debug'** and **'CAN'** that helps also in troubleshooting.

Another window is the **'About'** which gives us information about the software versions and firmware versions of the system.

You can access to these applications through the Calibration window by inserting a password in the 'administrator password' field, clicking **Set** and then selecting the desired task from the task bar menu.

You need only DVM for this troubleshooting.

6.2. Debug window

Figure 30 : ***Debug window***

The Debug window allows us to test the following functions:

- **FU/NFU select -** selects between FU and NFU modes.
- **Solenoids PWM Drive -** by checking this option the system disconnect the closed loop of the PID control and allows manually control of each one of

the eight SCC card PWM hardware drivers– six for the solenoids and two for the wheels backlight. The value 999 indicates PWM duty cycle = 100%. The default value is 500 = 50% D.C.

Here is the right order to enable the manual PWM test:

a) Verify that the FU/NFU radio buttons are in NFU mode.
b) Click the **Open Loop Mode** checkmark to activate the manual PWM control (the PWM algorithm is disabled).
c) Reset all PWM ports by clicking on their **Rst** buttons.
d) Use the FU/NFU radio buttons to switch the steering and trim to FU mode (note that selecting the FU in open loop mode means that the PWM output ports are now connected to the solenoids rather than the NFU control panel switches, but the PWM drive is not controlled by the craft wheel anymore).

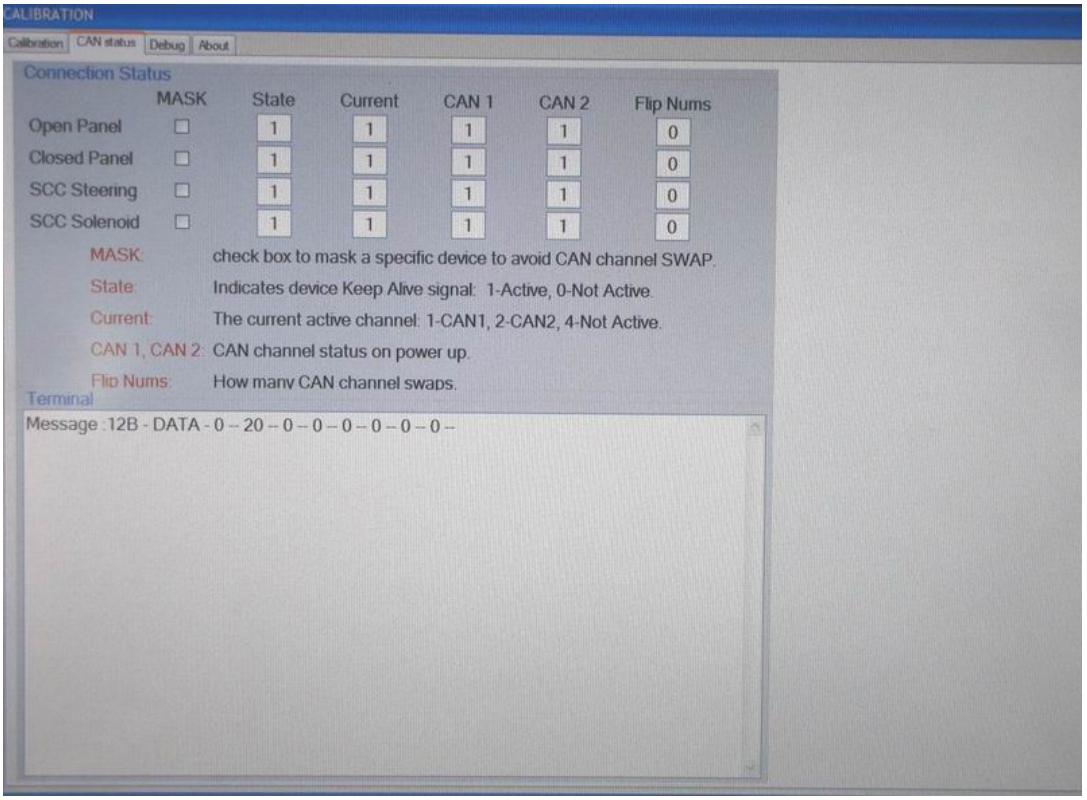
You can operate now each PWM port to 50% D.C continuously by clicking its **Set**. Use its **Rst** to stop the PWM drive.

You can use PWM D.C other then 50% by inserting the desired value in the D.C field.

- **Sensors readout** – the real time values of the ICTs, wheels and hydraulic sensors are introduced. Note that the hydraulic sensors readouts are in discrete values - '0' means OK and '1' means Not OK.

6.3. CAN Status window

Figure 31 : ***CAN window***



The CAN Status window allows us to test the CAN communication channels.

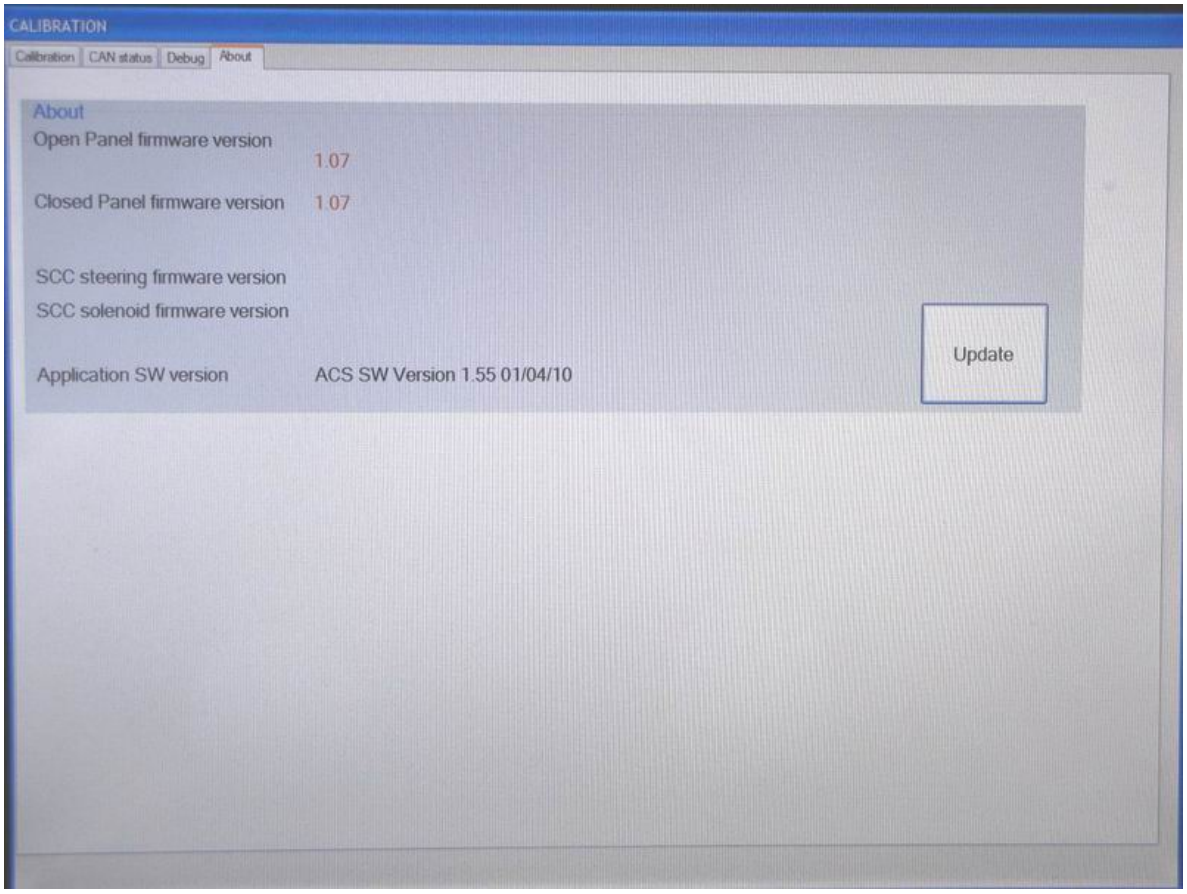
There is one master on the CAN and it is the PC (through the USB/CAN converter) and four devices - Open bridge control panel, Closed bridge control panel, SCC-Steering card and SCC-Solenoids card.

This window gives us different kinds of information about the devices as explained in the window legend.

For better understanding the CAN window information, recall the CAN channels control algorithm in paragraph 3.3 .

6.4. About window

Figure 32 : ***About window***



The About window introduces the software and firmware versions of the system. Please note that you must click the Update button to introduce the actual current versions.

6.5. BIT Error Messages list

The followings are the error messages of the BIT software:

ERROR1: BLOCKED FILTER

ERROR2: HYDRAULIC OIL LOW LEVEL PRE ALARM

ERROR3: HYDRAULIC OIL LOW LEVEL CRITICAL ALARM

ERROR4: HYDRAULIC OIL HIGH TERMPERATURE

ERROR5: LUBE OIL LOW LEVEL PORT

ERROR6: LUBE OIL LOW LEVEL STARBOARD

ERROR7: ERROR WHEEL CLOSED-BRIDGE

ERROR8: ERROR WHEEL OPEN-BRIDGE

ERROR9: ERROR FEEDBACK STEERING PORT

ERROR10: ERROR FEEDBACK STEERING STARBOARD

ERROR11: ERROR FEEDBACK TRIM PORT – TRIM FOLLOWUP IS DISABLED

ERROR12: ERROR FEEDBACK TRIM STARBOARD – TRIM FOLLOWUP IS DISABLED

ERROR13: STEERING PORT FEEDBACK IS NOT RESPONDING

ERROR14: STEERING STARBOARD FEEDBACK IS NOT RESPONDING

ERROR15: TRIM PORT FEEDBACK IS NOT RESPONDING

ERROR16: TRIM STARBOARD FEEDBACK IS NOT RESPONDING

ERROR17: NO USB COMMUNICATION WITH CAN ADAPTOR

ERROR18: CAN1 COMMUNICATION ERROR - SWITCHED TO CAN2

ERROR19: CAN2 COMMUNICATION ERROR - SWITCHED TO CAN1

ERROR20: CAN1 AND CAN2 COMMUNICATION ERROR – SWITCHED TO NFU

ERROR21: NO USB COMMUNICATION WITH NMEA0183 ADAPTOR

ERROR22: CALIBRATION ERROR – SWITCHED TO NFU

6.6. Troubleshooting of the error messages

This chapter will discuss all the error messages one by one and will suggest possible reasons and troubleshooting for each case.

ERROR1: BLOCKED FILTER

Possible reasons:

a) The Arneson hydraulic oil filter is blocked because contamination or other reason.

b) The BLOCKED FILTER sensor cable is disconnected from the Solenoids SCC card inside the SCC box or from the oil tank sensor.

c) The Solenoids SCC card is malfunctioned.

Troubleshooting:

a) Check the filter.

b) Check if the cable is disconnected from the oil tank.

c) Open the SCC box cover and check if the sensor cable is indeed connected to connector J11 on the SCC card and there is no disconnected wire.

d) Disconnect the sensor cable from the SCC card (don't use screw driver. Simply pull it out) while the ACS is operating and make a short circuit between the two pins of J11. Check if the error message disappeared. If it didn't disappear, it means that the SCC card is malfunctioned.

ERROR2: HYDRAULIC OIL LOW LEVEL PRE ALARM

Possible reasons:

a) The Arneson hydraulic oil level is about to reach to its lowest allowed limit.

b) The OIL LEVEL PRE ALARM sensor cable is disconnected from the Solenoids SCC card inside the SCC box or from the oil tank sensor.

c) The Solenoids SCC card is malfunctioned

Troubleshooting:

a) Check the oil level.

b) Check if the cable is disconnected from the oil tank.

c) Open the SCC box cover and check if the sensor cable is indeed connected to connector J10 on the SCC card and there is no disconnected wire.

d) Disconnect the sensor cable from the SCC card (don't use screw driver. Simply pull it out) while the ACS is operating and make a short circuit between the two pins of J10. Check if the error message disappeared. If it didn't disappear, it means that the SCC card is malfunctioned.

ERROR3: HYDRAULIC OIL LOW LEVEL CRITICAL ALARM

Possible reasons:

a) The Arneson hydraulic oil level is much lower than the lowest allowed limit and about to reach to a critical limit that can cause damage to the hydraulic system.

b) The OIL LEVEL CRITICAL ALARM sensor cable is disconnected from the Solenoids SCC card inside the SCC box or from the oil tank sensor.

c) The Solenoids SCC card is malfunctioned.

Troubleshooting:

a) Check the oil level.

b) Check if the cable is disconnected from the oil tank.

c) Open the SCC box cover and check if the sensor cable is indeed connected to connector J9 on the SCC card and there is no disconnected wire.

d) Disconnect the sensor cable from the SCC card (don't use screw driver. Simply pull it out) while the ACS is operating and make a short circuit between the two pins of J9. Check if the error message disappeared. If it didn't disappear, it means that the SCC card is malfunctioned.

ERROR4: HYDRAULIC OIL HIGH TERMPERATURE

Possible reasons:

a) The Arneson hydraulic oil temperature is too high.

b) The OIL HIGH TEMP sensor cable is disconnected from the Solenoids SCC card inside the SCC box or from the oil tank sensor.

c) The Solenoids SCC card is malfunctioned.

Troubleshooting:

a) Check the oil temperature.

b) Check if the cable is disconnected from the oil tank.

c) Open the SCC box cover and check if the sensor cable is indeed connected to connector J8 on the SCC card and there is no disconnected wire.

d) Disconnect the sensor cable from the SCC card (don't use screw driver. Simply pull it out) while the ACS is operating and make a short circuit between the two pins of J8. Check if the error message disappeared. If it didn't disappear, it means that the SCC card is malfunctioned.

ERROR5: LUBE OIL LOW LEVEL PORT

Possible reasons:

a) The Arneson hydraulic articulations oil level is too low in the port side tank.

b) The L.O LEVEL PORT sensor cable is disconnected from the Solenoids SCC card inside the SCC box or from the oil tank sensor.

c) The Solenoids SCC card is malfunctioned.

Troubleshooting:

a) Check the oil level in the port tank.

b) Check if the cable is disconnected from the oil tank.

c) Open the SCC box cover and check if the sensor cable is indeed connected to connector J7 on the SCC card and there is no disconnected wire.

d) Disconnect the sensor cable from the SCC card (don't use screw driver. Simply pull it out) while the ACS is operating and make a short circuit between the two pins of J7. Check if the error message disappeared. If it didn't disappear, it means that the SCC card is malfunctioned.

ERROR6: LUBE OIL LOW LEVEL STARBOARD

Possible reasons:

a) The Arneson hydraulic articulations oil level is too low in the starboard side tank.

b) The L.O LEVEL STB sensor cable is disconnected from the Solenoids SCC card inside the SCC box or from the oil tank sensor.

c) The Solenoids SCC card is malfunctioned.

Troubleshooting:

a) Check the oil level in the starboard tank.

b) Check if the cable is disconnected from the oil tank.

c) Open the SCC box cover and check if the sensor cable is indeed connected to connector J6 on the SCC card and there is no disconnected wire.

d) Disconnect the sensor cable from the SCC card (don't use screw driver. Simply pull it out) while the ACS is operating and make a short circuit between the two pins of J6. Check if the error message disappeared. If it didn't disappear, it means that the SCC card is malfunctioned.

ERROR7: ERROR WHEEL CLOSED-BRIDGE

Possible reasons:

a) The WHEEL CLOSED cable is disconnected from the Adaptors box, or from the Closed bridge wheel, or its internal wiring is disconnected.

b) Any of the WHEEL CLOSED harness wires inside the Adaptors box is disconnected.

c) Any of the Closed bridge wheel potentiometer wires is disconnected.

d) The Steering SCC card inside the Adaptors box is malfunctioned.

Troubleshooting:

a) Check if the WHEEL CLOSED cable is connected tightly to the Adaptors box and to the wheel.

b) Check the harness inside the Adaptors box from the back panel connector up to the SCC card.

c) Check the Closed bridge wheel potentiometer wiring.

d) Disconnect the cable from the Adaptors box and the wheel connectors and use DVM to check if any of the cable wires is disconnected inside.

e) Replace the Steering SCC card.

ERROR8: ERROR WHEEL OPEN-BRIDGE

Possible reasons:

a) The WHEEL OPEN cable is disconnected from the Adaptors box, or from the Open bridge wheel, or its internal wiring is disconnected.

b) Any of the WHEEL OPEN harness wires inside the Adaptors box is disconnected.

c) Any of the Closed bridge wheel potentiometer wires is disconnected.

d) The Steering SCC card inside the Adaptors box is malfunctioned.

Troubleshooting:

a) Check if the WHEEL OPEN cable is connected tightly to the Adaptors box and to the wheel.

b) Check the harness inside the Adaptors box from the back panel connector up to the SCC card.

c) Check the Open bridge wheel potentiometer wiring.

d) Disconnect the cable from the Adaptors box and the wheel connectors and use DVM to check if any of the cable wires is disconnected inside.

e) Replace the Steering SCC card.

ERROR9: ERROR FEEDBACK STEERING PORT

Possible reasons:

a) The Steering Port ICT sensor (LVDT) is malfunctioned.

b) The sensor cable EICT STEERING PORT is disconnected from the Solenoids SCC card inside the SCC box or from the EICT itself.

c) Any of this ICT sensor wires is disconnected inside the EICT box.

d) The SCC card is malfunctioned.

e) The EICT card is malfunctioned.

Troubleshooting:

Important note: this error message appears only if the two trim angles are smaller than ±2.5°.

a) Open the Debug application window and bring the propellers trim and steering to their middle range approximately (use NFU mode to do so).

- If this sensor signal voltage is around its nominal value ~2.5V, use the NFU to move its propeller to the extreme ends. If you get values inside the legal range 0.2-4.8 V but too close to the extreme values (0.2-0.3 V or 4.7-4.8 V) then you should recalibrate the relevant EICT sensor.
- If it is constantly outside the range 0.2-4.8 V or jumps randomly, then continue the troubleshooting to the next step.

b) Check the cable connections to the Solenoids SCC card connector J17, inside the SCC box, and to the EICT Steering Port box.

c) Check the ICT (LVDT) wiring connections inside the EICT.

d) If the cable and wiring are OK, do the following:

Use DVM to measure the sensor signal voltage on the SCC card connector J17, between pins 3 (GND) and 2 (signal). You need to do this measurement without disconnecting the cable (otherwise there will be no power to the EICT card and eventually no signal).

- If the signal level is inside the range 0.3 – 4.7 V, then it seems that the SCC card is malfunctioned.
- If it is outside of this range, measure also the voltage on pin 1 (output power to the EICT box). Verify that it is higher than 18V and continue to the next step. If it is lower than that, disconnect the cable from the SCC card, **wait 60 seconds** and measure again the voltage directly on the card connector pins.

  If the voltage is now above 18V it seems that we have a short circuit on the EICT card. Otherwise the SCC card is malfunctioned.

e) Measure the input operating voltage on the EICT card terminal 9 (GND on terminal 6) and verify that it is the same as measured on the SCC card, i.e. higher then 18V.

- If it is not, check again if the wires are tightened to the EICT terminal screws. After this corrective action verify that the operating voltage is OK now and measure the signal on terminal 5, hopping that it is now inside the valid range.
- If the operating voltage is OK but the signal voltage in not yet OK, disconnect this signal wire from the EICT card and measure again. If it is OK now it seems that there is a short circuit on the SCC card.
- If the signal voltage is not OK yet, then check again if the wires are tightened to the EICT screws. If it didn't help, then replace the EICT card and check again. If it is not OK yet, it seems that the ICT sensor is malfunctioned.

ERROR10: ERROR FEEDBACK STEERING STARBOARD

Possible reasons:

a) The Steering Starboard ICT sensor (LVDT) is malfunctioned.

f) The sensor cable EICT STEERING STARBOARD is disconnected from the Solenoids SCC card inside the SCC box or from the EICT itself.

g) Any of this ICT sensor wires is disconnected inside the EICT box.

h) The SCC card is malfunctioned.

i) The EICT card is malfunctioned.

Troubleshooting:

Important note: this error message appears only if the two trim angles are smaller than ±2.5°.

a) Open the Debug application window and bring the propellers trim and steering to their middle range approximately (use NFU mode to do so).
   - If this sensor signal voltage is around its nominal value ~2.5V, use the NFU to move its propeller to the extreme ends. If you get values inside the legal range 0.2-4.8 V but too close to the extreme values (0.2-0.3 V or 4.7-4.8 V) then you should recalibrate the relevant EICT sensor.
   - If it is constantly outside the range 0.2-4.8 V or even jumps randomly, then continue the troubleshooting to the next step.

b) Check the cable connections to the Solenoids SCC card connector J16, inside the SCC box, and to the EICT.

c) Check the ICT (LVDT) wiring connections inside the EICT.

d) If the cable and wiring are OK, do the following:
   Use DVM to measure the sensor signal voltage on the SCC card J16, between pins 3 (GND) and 2 (signal). You need to do this measurement without disconnecting the cable (otherwise there will be no power to the EICT card and eventually no signal).

- If the signal level is inside the range 0.3 – 4.7 V, it seems that the SCC card is malfunctioned.
- If it is outside of this range, measure also the voltage on pin 1 (output power to the EICT box). Verify that it is higher than 18V and continue to the next step. If it is lower than that, disconnect the cable from the SCC card, **wait 60 seconds** and measure again the voltage directly on the card connector pins.
  If the voltage is now above 18V it seems that we have a short circuit on the EICT card. Otherwise the SCC card is malfunctioned.

e) Measure the input operating voltage on the EICT card terminal 9 (GND on terminal 6) and verify that it is the same as measured on the SCC card, i.e. higher then 18V.
   - If it is not, check again if the wires are tightened to the EICT screws. After this corrective action verify that the operating voltage is OK now and measure the signal on terminal 5, hopping that it is now inside the valid range.
   - If the operating voltage is OK but the signal voltage in not yet OK, disconnect this signal wire from the EICT card and measure again. If it is OK now it seems that there is a short circuit on the SCC card.

- If the signal voltage is not OK yet, then check again if the wires are tightened to the EICT screws. If it didn't help, then replace the EICT card.
- Check again. If it is not OK yet, it seems that the ICT sensor is malfunctioned.

ERROR11: ERROR FEEDBACK TRIM PORT – TRIM FOLLOWUP IS DISABLED

Possible reasons:

a) The Trim Port ICT sensor (LVDT) is malfunctioned.

j) The sensor cable EICT TRIM PORT is disconnected from the Solenoids SCC card inside the SCC box or from the EICT itself.

k) Any of this ICT sensor wires is disconnected inside the EICT box.

l) The SCC card is malfunctioned.

m) The EICT card is malfunctioned.

Troubleshooting:

a) Open the Debug application window and bring the propellers trim and steering to their middle range approximately (use NFU mode to do so).

- If this sensor signal voltage is around its nominal value ~2.5V, use the NFU to move its propeller to the extreme ends. If you get values inside the legal range 0.2-4.8 V but too close to the

minimum and extreme values (0.2-0.3 V or 4.7-4.8 V) then you should recalibrate the relevant EICT sensor.

- If it is constantly outside the range 0.2-4.8 V or even jumps randomly, then continue the troubleshooting to the next step.

b) Check the cable connections to the Solenoids SCC card connector J20, inside the SCC box, and to the EICT.

c) Check the ICT (LVDT) wiring connections inside the EICT.

d) If the cable and wiring are OK, do the following:

Use DVM to measure the sensor signal voltage on the SCC card J20, between pins 3 (GND) and 2 (signal). You need to do this measurement without disconnecting the cable (otherwise there will be no power to the EICT card and eventually no signal).

- If the signal level is inside the range 0.3 – 4.7 V it seems that the SCC card is malfunctioned.
- If it is outside of this range, measure also the voltage on pin 1 (output power to the EICT box). Verify that it is higher than 18V and continue to the next step. If it is lower than that, disconnect the cable from the SCC card, **wait 60 seconds** and measure again the voltage directly on the card connector pins.

If the voltage is now above 18V then it seems that we have a short circuit on the EICT card. Otherwise the SCC card is malfunctioned.

e) Measure the input operating voltage on the EICT card terminal 9 (GND on terminal 6) and verify that it is the same as measured on the SCC card, i.e. higher then 18V.

- If it is not, check again if the wires are tightened to the EICT screws. After this corrective action verify that the operating voltage is OK now and measure the signal on terminal 5, hopping that it is now inside the valid range.
- If the operating voltage is OK but the signal voltage in not yet OK, disconnect this signal wire from the EICT card and measure again. If it is OK now it seems that there is a short circuit on the SCC card.
- If the signal voltage is not OK yet, then check again if the wires are tightened to the EICT screws. If it didn't help, then replace the EICT card.
- Check again. If it is not OK yet, it seems that the ICT sensor is malfunctioned.

ERROR12: ERROR FEEDBACK TRIM STARBOARD – TRIM FOLLOWUP IS DISABLED

Possible reasons:

a) The Trim Starboard ICT sensor (LVDT) is malfunctioned.

n) The sensor cable EICT TRIM STB is disconnected from the Solenoids SCC card inside the SCC box or from the EICT itself.

o) Any of this ICT sensor wires is disconnected inside the EICT box.

p) The SCC card is malfunctioned.

q) The EICT card is malfunctioned.

Troubleshooting:

a) Open the Debug application window and bring the propellers trim and steering to their middle range approximately (use NFU mode to do so).

- If this sensor signal voltage is around its nominal value ~2.5V, use the NFU to move its propeller to the extreme ends. If you get values inside the legal range 0.2-4.8 V but too close to the extreme values (0.2-0.3 V or 4.7-4.8 V) then you should recalibrate the relevant EICT sensor.
- If it is constantly outside the range 0.2-4.8 V or even jumps randomly, then continue the troubleshooting to the next step.

b) Check the cable connections to the Solenoids SCC card connector J13, inside the SCC box, and to the EICT.

c) Check the ICT (LVDT) wiring connections inside the EICT.

d) If the cable and wiring are OK, do the following:
Use DVM to measure the sensor signal voltage on the SCC card J13, between pins 3 (GND) and 2 (signal). You need to do this measurement without disconnecting the cable (otherwise there will be no power to the EICT card and eventually no signal).

- If the signal level is inside the range 0.3 – 4.7 V it seems that the SCC card is malfunctioned.
- If it is outside of this range, measure also the voltage on pin 1 (output power to the EICT box). Verify that it is higher than 18V and continue to the next step. If it is lower than that, disconnect the cable from the SCC card, **wait 60 seconds** and measure again the voltage directly on the card connector pins.
  If the voltage is now above 18V it seems that we have a short circuit on the EICT card. Otherwise the SCC card is malfunctioned.

e) Measure the input operating voltage on the EICT card terminal 9 (GND on terminal 6) and verify that it is the same as measured on the SCC card, i.e. higher then 18V.

- If it is not, check again if the wires are tightened to the EICT screws. After this corrective action verify that the operating

voltage is OK now and measure the signal on terminal 5, hopping that it is now inside the valid range.

- If the operating voltage is OK but the signal voltage in not yet OK, disconnect this signal wire from the EICT card and measure again. If it is OK now it seems that there is a short circuit on the SCC card.
- If the signal voltage is not OK yet, check again if the wires are tightened to the EICT screws. If it didn't help, then replace the EICT card.
- Check again. If it is not OK yet, it seems that the ICT sensor is malfunctioned.

ERROR13: STEERING PORT FEEDBACK IS NOT RESPONDING

Please note that this error message is not relating to the ICT sensor malfunctioning.

Possible reasons:

a) The hardware PWM drive to SOLENOID STEERING PORT channel on the Solenoids SCC card is malfunctioned.

b) The relay on the Solenoids SCC card concerns to this channel is malfunctioned.

c) The cable SOLENOID STEERING PORT from the SCC box to the solenoid block is malfunctioned.

d) The Steering solenoid is malfunctioned.

e) Mechanical or hydraulic malfunction concerning to this port.

Troubleshooting:

a) Open the Debug application window. Make sure that the FU/NFU selections are in NFU mode and check the 'Open loop mode' from the 'Solenoids PWM Drive' block.
Now reset all the PWM ports by clicking their **Rst** buttons and then select Steering FU mode from FU/NFU block and.
Click **Set** on **Steering Stb**, wait for two seconds and click **Set** on **Steering Port** . Check if the propeller moves not only to Starboard but also to the Port (you can see if their ICT voltages are changing or not).
If yes, it seems that the Steering Port PWM driver on the Solenoids SCC card is not working correctly.
If not, go to the next step.

b) Select Steering NFU mode and push the Steering NFU switch to the Port. Check if the propeller is responding.
If yes, you may conclude that the relay of the SOLENOID STEERING PORT channel on the Solenoids SCC card is malfunctioned (doesn’t switch the output port to FU PWM channel) or the PWM driver itself is malfunctioned.
If also the NFU is not working, go to the next step.

c) Check the SOLENOID STEERING PORT cable connections between the SCC box and solenoid.

If it is OK, you may conclude that the steering solenoid or the hydraulic system is malfunctioned. You can verify that by swapping connections between the Steering Port solenoid and any other solenoid - verify that the SCC card can drive the other channel and vice versa.

ERROR14: STEERING STARBOARD FEEDBACK IS NOT RESPONDING

Please note that this error message is not relating to the ICT sensors malfunctioning.

Possible reasons:

f) The hardware PWM drive to SOLENOID STEERING STB channel on the Solenoids SCC card is malfunctioned.
g) The relay on the Solenoids SCC card concerns to this channel is malfunctioned.
h) The cable SOLENOID STEERING STB from the SCC box to the solenoid block is malfunctioned.
i) The Steering solenoid is malfunctioned.
j) Mechanical or hydraulic malfunction concerning to this port.

Troubleshooting:

d) Open the Debug application window. Select Steering FU mode from FU/NFU block and check the 'Open loop mode' from the 'Solenoids PWM Drive' block.

Click **Set** on **Steering Port** , wait for two second then click **Set** on **Steering Stb** and check if the propeller moves not only to port but also to the starboard.

If yes, it seems that the Steering Stb PWM driver on the Solenoids SCC card is not working correctly.

If not, go to the next step.

e) Select Steering NFU mode and push the Steering NFU switch to the Port. Check if the propeller is responding.

If yes, you may conclude that the relay of the SOLENOID STEERING STB channel on the Solenoids SCC card is malfunctioned (doesn't switch the output port to FU PWM channel) or the PWM driver itself is malfunctioned.

If also the NFU is not working, go to the next step.

f) Check the SOLENOID STEERING STB cable connections between the SCC box and solenoid.

If it is OK, you may conclude that the steering solenoid or the hydraulic system is malfunctioned. You can verify that by connecting the SOLENOID STEERING STB cable to other solenoid and see if the SCC card can drive this channel or not.

ERROR15: TRIM PORT FEEDBACK IS NOT RESPONDING

Please note that this error message is not relating to the ICT sensors malfunctioning.

Possible reasons:

k) The hardware PWM drive to SOLENOID TRIM PORT channel on the Solenoids SCC card is malfunctioned.

l) The relay on the Solenoids SCC card concerns to this channel is malfunctioned.

m) The cable SOLENOID TRIM PORT from the SCC box to the solenoid block is malfunctioned.

n) The Steering solenoid is malfunctioned.

o) Mechanical or hydraulic malfunction concerning to this port.

Troubleshooting:

g) Open the Debug application window. Select Trim FU mode from FU/NFU block and check the 'Open loop mode' from the 'Solenoids PWM Drive' block.

Click **Set** on **Trim Port Up** , wait for two second then click **Set** on **Trim Port Down** and check if the propeller doesn't move to one of these directions.

If yes, it seems that one of the Trim Port PWM drivers on the Solenoids SCC card is not working correctly.

If not, go to the next step.

h) Select Trim NFU mode and push the Trim NFU Port switch to up and down. Check if the propeller is responding.
   If yes, you may conclude that one of the relays of the SOLENOID TRIM PORT channel on the Solenoids SCC card is malfunctioned (doesn't switch the output port to FU PWM channel) or the PWM driver itself is malfunctioned.
   If also the NFU is not working, go to the next step.

i) Check the SOLENOID TRIM PORT cable connections between the SCC box and solenoid.
   If it is OK, you may conclude that this solenoid or the hydraulic system is malfunctioned. You can verify that by connecting the SOLENOID TRIM PORT cable to other solenoid and see if the SCC card can drive this channel or not.

ERROR16: TRIM STARBOARD FEEDBACK IS NOT RESPONDING

Please note that this error message is not relating to the ICT sensors malfunctioning.

Possible reasons:

p) The hardware PWM drive to SOLENOID TRIM STB channel on the Solenoids SCC card is malfunctioned.

q) The relay on the Solenoids SCC card concerns to this channel is malfunctioned.

r) The cable SOLENOID TRIM STB from the SCC box to the solenoid block is malfunctioned.

s) The Steering solenoid is malfunctioned.

t) Mechanical or hydraulic malfunction concerning to this port.

Troubleshooting:

j) Open the Debug application window. Select Trim FU mode from FU/NFU block and check the 'Open loop mode' from the 'Solenoids PWM Drive' block.

Click **Set** on **Trim Stb Up** , wait for two second then click **Set** on **Trim Stb Down** and check if the propeller doesn't move to one of these directions.

If yes, it seems that one of the Trim Starboard PWM drivers on the Solenoids SCC card is not working correctly.

If not, go to the next step.

k) Select Trim NFU mode and push the Trim NFU Stb switch to up and down. Check if the propeller is responding.

If yes, you may conclude that one of the relays of the SOLENOID TRIM STB channel on the Solenoids SCC card is malfunctioned (doesn't switch the output port to FU PWM channel) or the PWM driver itself is malfunctioned.

If also the NFU is not working, go to the next step.

l) Check the SOLENOID TRIM STB cable connections between the SCC box and solenoid.
If it is OK, you may conclude that the solenoid or the hydraulic system is malfunctioned. You can verify that by connecting the SOLENOID TRIM STB cable to other solenoid and see if the SCC card can drive this channel or not.

ERROR17: NO USB COMMUNICATION WITH CAN ADAPTOR

Possible reasons:

a) External or internal USB-CAN adaptors box cable is disconnected.
b) External or internal USB-CAN adaptors box cable is malfunctioned.
c) The USB-CAN adaptor is malfunctioned.

Troubleshooting:

Remark: In-order to verify that you succeeded to solve the problem you need to restart the computer.

a) Check the USB-CAN cables connections.
b) Replace the USB-CAN cables.
c) Replace the USB-CAN adaptor.

ERROR18: CAN1 COMMUNICATION ERROR - SWITCHED TO CAN2

Possible reasons:

a) Any of the following cables connectors is not connected properly or malfunctioned:
CAN1_OPEN, CAN1_CLOSED, CAN1_SOLENOIDS.

b) Any of the CAN1 harnesses inside the Adaptors box or SCC box is malfunctioned.

c) The CAN1 port of any of the following devices is malfunctioned: USB-CAN Adaptor, Steering SCC card, Solenoids SCC card, Open Bridge Control Panel, Closed Bridge Control Panel.

Troubleshooting:

Open the CAN Status application window and check the **CAN1** status. You should see which of the CAN devices is not active on channel-1.

a) If all the four devices are not responding, check the CAN1 harness connected to the CAN adaptor inside the Adaptors box. If the harness is OK, replace the USB-CAN adaptor.

b) If any of the devices is not responding, do as follows:

- Check the CAN1 cable connection to this device.
- Check the CAN1 harness to this device.
- Replace the device itself.

ERROR19: CAN2 COMMUNICATION ERROR - SWITCHED TO CAN1

Possible reasons:

d) Any of the following cables connectors is not connected properly or malfunctioned:
CAN2_OPEN, CAN2_CLOSED, CAN2_SOLENOIDS.

e) Any of the CAN2 harnesses inside the Adaptors box or SCC box is malfunctioned.

f) The CAN2 port of any of the following devices is malfunctioned: USB-CAN Adaptor, Steering SCC card, Solenoids SCC card, Open Bridge Control Panel, Closed Bridge Control Panel.

Troubleshooting:

Open the CAN Status application window and check the **CAN**2 status. You should see which of the CAN devices is not active on channel-2.

c) If all the four devices are not responding, check the CAN2 harness connected to the CAN adaptor inside the Adaptors box. If the harness is OK, replace the USB-CAN adaptor.

d) If any of the devices is not responding, do as follows:

- Check the CAN2 cable connection to this device.
- Check the CAN2 harness to this device.
- Replace the device itself.

ERROR20: CAN1 AND CAN2 COMMUNICATION ERROR – SWITCHED TO NFU

Possible reasons:

a) Any of the following devices is malfunctioned:
   USB-CAN Adaptor, Steering SCC card, Solenoids SCC card, Open Bridge Control Panel, Closed Bridge Control Panel.

b) Any of the following cables connectors is not connected properly or malfunctioned:
   CAN1_OPEN & CAN2_OPEN, CAN1_CLOSED & CAN2_CLOSED, CAN1_SOLENOIDS & CAN2_SOLENOIDS.

c) Any of the CAN1 & CAN2 harnesses inside the Adaptors box or SCC box is malfunctioned.

Troubleshooting:

Open the CAN Status application window and check the **Current** status.

If all the four CAN devices are not active at-all, do as follows:

a) Check the CAN1 and CAN2 harnesses connections to the USB-CAN adaptor.

b) Replace the USB-CAN adaptor.

If not all the devices but only one of them is not active, do as follows:

a) Check the CAN1 and CAN2 cables connection to this device.

b) Check the fuse of this device.

c) Replace the device itself.

ERROR21: NO USB COMMUNICATION WITH NMEA0183 ADAPTOR

Possible reasons:

a) External or internal USB-NMEA adaptors box cable is disconnected.
b) External or internal USB-NMEA adaptors box cable is malfunctioned.
c) The USB-NMEA adaptor is malfunctioned.

Troubleshooting:

Remark: In-order to verify that you succeeded to solve the problem you need to restart the computer.

a) Check the internal and external USB-NMEA cables connections.
b) Replace the USB-NMEA cables.
c) Replace the USB-NMEA adaptor.

ERROR22: CALIBRATION ERROR – SWITCHED TO NFU

Possible reasons:

Calibration file corruption.

Troubleshooting:

a) Recalibrate the ACS.
b) Call the manufacturer.

6.7. More Troubleshooting

6.7.1. No Craft Speed Indication

Possible Reasons:

a) The GPS power is OFF.

b) The GPS cable is not connected to the USB-NMEA adaptor.

c) Wrong connections of the GPS cable wires to the USB-NMEA adaptor.

d) GPS cable malfunctioned.

e) 24V power is not connected to the USB-NMEA adaptor.

f) The USB-NMEA adaptor is malfunctioned.

g) The GPS is malfunctioned.

Troubleshooting:

a) Check if the GPS power is ON.

b) Use the other speed reader means in the craft to verify that the GPS is OK – can read speed.

c) Verify that the 24V power is indeed connected correctly (not swapped) from the DC/DC output terminals to the USB-NMEA adaptor POWER & GND terminals and the GPS cable is connected correctly to IN1+ and IN1- terminals:
If there is no power to the NMEA or to the GPS, the indicator lamp on the adaptor will not light. If there is power but the GPS wiring is

wrongly connected, the lamp will light in constant yellow. If there is power and also GPS signal, the lamp will light in blinking green.

If still there is no blinking green lamp:

a) Replace the GPS cable.
b) Replace the USB-NMEA adaptor.

6.7.2. No Wheel Meter Backlight Dimming

There is light but only no dimming control.

Possible reasons:

a) The relevant control panel (Closed bridge or Open Bridge) CAN channels are malfunctioning.
b) The Steering SCC card inside the Adaptors box is malfunctioned.

Troubleshooting:

a) Verify that there is no CAN1 and CAN2 error message.
b) Replace the Steering SCC card.

6.7.3. No Wheel Meter Backlight

No backlight at-all.

Possible reasons:

a) The relevant wheel cable (WHEEL CLOSED or WHEEL OPEN) is not connected properly to the Adaptors box or to the wheel or malfunctioned.
b) The relevant wheel wiring to its backlight lamp is disconnected.

c) The relevant wheel backlight lamp is burnt out.
d) The Adaptors box WHEEL harness connected to the Steering SCC card connector J23 is malfunctioned.
e) The Steering SCC card inside the Adaptors box is malfunctioned.

Troubleshooting:

a) Check if the cable is connected tightly to the Adaptors box and to the wheel.
b) Check the wheel lamp wiring.
c) Check the WHEEL harness inside the Adaptors box.
d) Replace the wheel lamp.
e) Replace the Steering SCC card.

6.7.4. Display Image is Corrupted or No Backlight

In this case the Function-keys backlight is OK.

Possible reasons:

a) The DVI cable of this Control Panel is not connected properly or malfunctioned.
b) The Control Panel is malfunctioned.
c) The PC DVI add-in card is malfunctioned.

Troubleshooting:

a) Check the relevant DVI cable connections to the control panel and to the PC.

b) Make cross of the two DVI cables at the PC graphics card – connect the DVI-1 cable to DVI-2 port and vice versa.
   If the problem remains at the same display, it means that this display is malfunctioned. If the problem is now at the other display, it means that the relevant cable or graphics port is malfunctioned.
c) In case that you came to the conclusion that the graphics card is to blame, replace the graphics card.
   Please not that you cannot use the PC motherboard DIV port instead.

6.7.5. No Control Panel Function-keys Backlight

In this case the display backlight is OK.

Possible reasons:

The Control Panel is malfunctioned.

Troubleshooting:

Replace the Control Panel.

6.7.6. No Control Panel Buzzer

Possible reasons:

a) There is **CAN1 and CAN2** communication malfunction.
b) The Control Panel is malfunctioned.

Troubleshooting:

a) Verify that there is no **CAN1 and CAN2** error message.

b) Replace the Control Panel.

6.7.7. A Function Key of the Control Panel is Not Working

Remark: This is Function-Key, not NFU switch.

Possible reasons:

No matter which function key it is, the conclusion is the same - The Control Panel is malfunctioned.

Troubleshooting:

Replace the Control Panel.

6.7.8. An NFU Switch of the Control Panel is Not Working

Possible reasons:

a) The CAN1 **and** CAN2 cables from the Control Panel to the Adaptors box and from the Adaptors box to the SCC box are not connected properly or malfunctioned.

b) Disconnected wire inside the Adaptors box or SCC box.

c) Disconnected wire inside the control panel.

d) The Solenoids SCC card is malfunctioned.

Troubleshooting:

a) Check all the CAN cables connections and verify that they are connected properly and their wiring is OK.

b) Check all the wiring related to this NFU function inside the adaptors box and SCC box.
c) Replace the Control Panel.
d) Replace the Solenoids SCC card.

6.7.9. The PC has No Electrical Power

Possible reasons:

a) The DC/AC Inverter inside the Adaptors box is not working.
b) The internal AC voltage harness inside the Adaptors box is not connected properly or malfunctioned.
c) The inlet AC power cable from the Adaptors box to the PC is not connected properly or malfunctioned.
d) The PC power supply switch on its back side is OFF.
e) The PC is malfunctioned.

Troubleshooting:

a) Open the Adaptors box cover and check if the Inverter power indicator lamp is lighting in green.
   - If it lights in orange or doesn't lights at-all, it means that it does not accept 24VDC from the DC/DC converter or it maybe malfunctioned. You should continue to check backwards all the DC voltage stages – DC power inlet to the Adaptors box, DC

out from the EMI filter to the DC/DC input, DC/DC output voltage, the capacitor, the relay.

- If it blinks, this means that its input DC voltage is not stable – check the capacitor and relay wiring or replace the capacitor.

b) Check the AC harness inside the adaptors box.

c) Check the AC cable to the PC and use DVM to measure its output voltage – should be 230VAC.

d) Check the PC power switch on its back side.

e) Turn Off and On again the power to the ACS system. If it didn't help replace the PC.

6.7.10. The PC is not working properly

In this case the PC power is OK but it doesn't power-up properly.

Possible reasons:

a) The PC software is corrupted.

b) The PC is malfunctioned.

Troubleshooting:

a) Reinstall the PC software.

b) Replace the PC.

7. Replacement Parts list

Part reference	Catalog number
CONTROL PANEL	EB12-M4HB
MARINE PC	BDG43NB
SCC-Solenoids Card	ASSY-ACS111-A
SCC-Steering Card	ASSY-ACS111-B
USB to CAN CONVERTER	3204003
DC/DC CONVERTER, 9-36 Vin, 24 Vout	BV28A24C2RRBG
INVERTER, 24 Vin, 230VAC out	PE2.5-24
USB to NMEA0183 CONVERTER	RENM42U
EMI FILTER, 30A, 230V	FN2030-30-08
DIODE, 2X40A, 45V	DSB80C45HB
CAPACITOR, 10mF/50V, ELECTROLITIC	ECOS1HA103EA
REALAY, 20A/24V, SPST, SCREW MOUNT	T9AP1D52-24
BACKSHELL, D-TYPE,15 PIN, WATERPROOF	SL7001
SCREW KIT FOR D-TYPE, PANEL (10 each)	167501-2
PINS FOR HEADER MOLEX - 7A (100 each)	08-52-0113
PINS FOR HEADER MOLEX - 12A (100 each)	39-00-0060
PINS FOR HEADER MOLEX - 4A (100 each)	08-50-0114
FUSE 10A, 20x5 mm (10 each)	0217010.P
BACKSHELL FOR D-TYPE, 9 PIN, Cable OD=10mm	5745171-5
BACKSHELL FOR D-TYPE,15 PIN, Cable OD=10mm	5745172-1
BACKSHELL FOR D-TYPE, 25 PIN, Cable OD=14mm	5745173-1
SCREW JACK FOR D-SUB	SPC14961