Kobelt Steering System
6300-0100 Controller & 6300-0200 Station

Owner's Operation, Installation & Maintenance Manual

Ocotber 2023 (rev B)

NOTES:

RECORD DATA BEFORE INSTALLATION FOR FUTURE REFERENCE	
Model #:	
Serial #:	
Date of Purchase:	
Date of Installation:	

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1 INTRODUCTION

1.1 CONTACT

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This document is intended to clearly present comprehensive product data and provide technical information to assist the end user in design applications. Kobelt reserves the right, without notice, to change the design, or construction, of any products and to discontinue or limit distribution of any products. Kobelt also reserves the right to change, or update, without notice, any technical information contained within this document.

Kobelt recommends that customers visit our website to check for updates to this Manual. Once a product has been selected for use, it should be tested by the user to ensure proper function in all possible applications. For further instructions, please contact our distributors or visit our website.

1.2 COMPLIANT USE

This device is only intended for use by persons trained in operating marine systems.

The installer shall:

- Only use non-defective products.
- Check the safety of operation and the condition of the device before each use.
- Verify that the product is operational at all times and keep it in good working conditions.

Only Kobelt Manufacturing Co. Ltd. Authorized Dealers or Authorized Technicians are to repair Kobelt products.

1.3

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2 SAFETY

2.1 SAFETY ALERTS

Throughout this manual, the following symbols are used to alert the user to special instructions concerning a service or operation that may be hazardous if performed incorrectly or carelessly. The associated risk levels are stated below.

⚠ DANGER	This symbol indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	This symbol indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	This symbol indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
NOTICE	This symbol informs the reader of events not related to personal injury but which there is a risk of damage to property or equipment.
SAFETY INSTRUCTIONS	This symbol informs the reader of safety-related instructions or procedures.

2.2 NOTICE TO INSTALLER

Disregarding the following safety measures can result in an accident, causing severe injury to personnel and damage to material assets.

- Only use the product as directed in this manual.
- Never put the product into service if there is evidence of visible damage.
- Never put the product into service before fully completing installation and commissioning.
- Do not carry out any modifications to the product.
- Only use authentic Kobelt spare parts.
- Observe all local regulations, directives, and laws during the installation of this product.
- All installation, commissioning, and maintenance work must be conducted by qualified personnel. (For the purpose of this manual, qualified personnel are people who are familiar with the assembly, installation, commissioning, and operation of the product and who have the qualifications necessary for their occupation.)
- Observe all specifications in this manual. If these guidelines are not followed and damage occurs, the warranty will be voided.

2.3 PRODUCT HAZARDS

⚠WARNING	**Equipment Starts Automatically:** The Kobelt Steering Controller valve outputs are controlled remotely and/or through a control loop. They may be driven unintentionally through improper closed loop feedback and or unintentional operator commands. Ensure all power sources are disconnected or locked out prior to performing system maintenance or repair.
⚠WARNING	**Disconnect Power:** Turn off power at distribution panel before beginning installation to protect installer from electrical hazards.
⚠WARNING	**Voltage and Power Compatibility:** Confirm that the power and voltage requirements of the system are compatible. Ensure that the voltage drops from cabling is within the specifications of the product. If voltage drops are excessive the system could fail due to low voltage conditions resulting in abnormal behavior and or loss of function.
⚠CAUTION	**Voltage and Current Compatibility:** Confirm that the power source is compatible with the maximum voltage and current ratings of is product variant. Failure to do so could result in damage or fire.

3 SCOPE

This manual covers the installation, configuration, operation, and maintenance of the Kobelt Steering system only, information on electric and hydraulics on the vessel requires knowledge not covered within this document.

Information of any Autopilot interfacing to the Kobelt Steering System is not covered within this manual.

⚠WARNING	The Kobelt Steering System is designed to connect to a correctly installed and commissioned hydro-mechanical steering gear.

4 TERMINOLOGY AND DEFINITIONS

Before proceeding with the configuration and operation of the Kobelt Steering System, is it important for the user to become familiar with the terminology and basic functions used throughout this manual.

4.1 STATIONS

Stations are physical locations around the vessel where controls are located. On each station with a Kobelt steering station, there are one or more input device(s) (Steer-by-Wire Helm, Jog Levers, etc.).

Some common station locations include:

- the Main Bridge,
- the Fly Bridge,
- a bow or aft station,
- port or starboard wing stations,
- the Engine Room.

4.1.1 Abbreviation definitions

- FFU: Full Follow Up
- NFU: Non-Follow Up
- RFU: Rudder Feedback Unit
- CAN: Controller Area Network
- SBW: Steer-by-Wire
- RAI: Rudder Angle Indicator
- ROI: Rudder Order Indicator

5 KOBELT STEERING SYSTEM OVERVIEW

5.1 SYSTEM DESCRIPTION

The Kobelt Steering System is a configurable, electro-hydraulic steering control system for marine vessels. The system is comprised of a minimum of one steering Controller and one to four steering stations. The system is interconnected by the KNet network for communications and power. The Kobelt Steering System controls one or two hydraulic solenoid steering outputs for a single rudder, or two independent rudders. The valve outputs may be configured as on-off, or proportional control. A Steering Station can interface any combination of one NFU, one FFU, and one SBW Wheel control input. Commands are accepted at the steering station in control and transmitted digitally to the steering controller to act upon. The steering controller takes the command and controls the steering gear for the desired operation. A RFU is used by the controller to determine the angle of the rudder and continually positions the desired order for full follow up operations. Non-follow up commands are acted upon without the benefit of the rudder angle in single rudder applications. Additionally, an integrated autopilot interface that takes control signals from a traditional autopilot to control the valves for the desired autopilot operation.

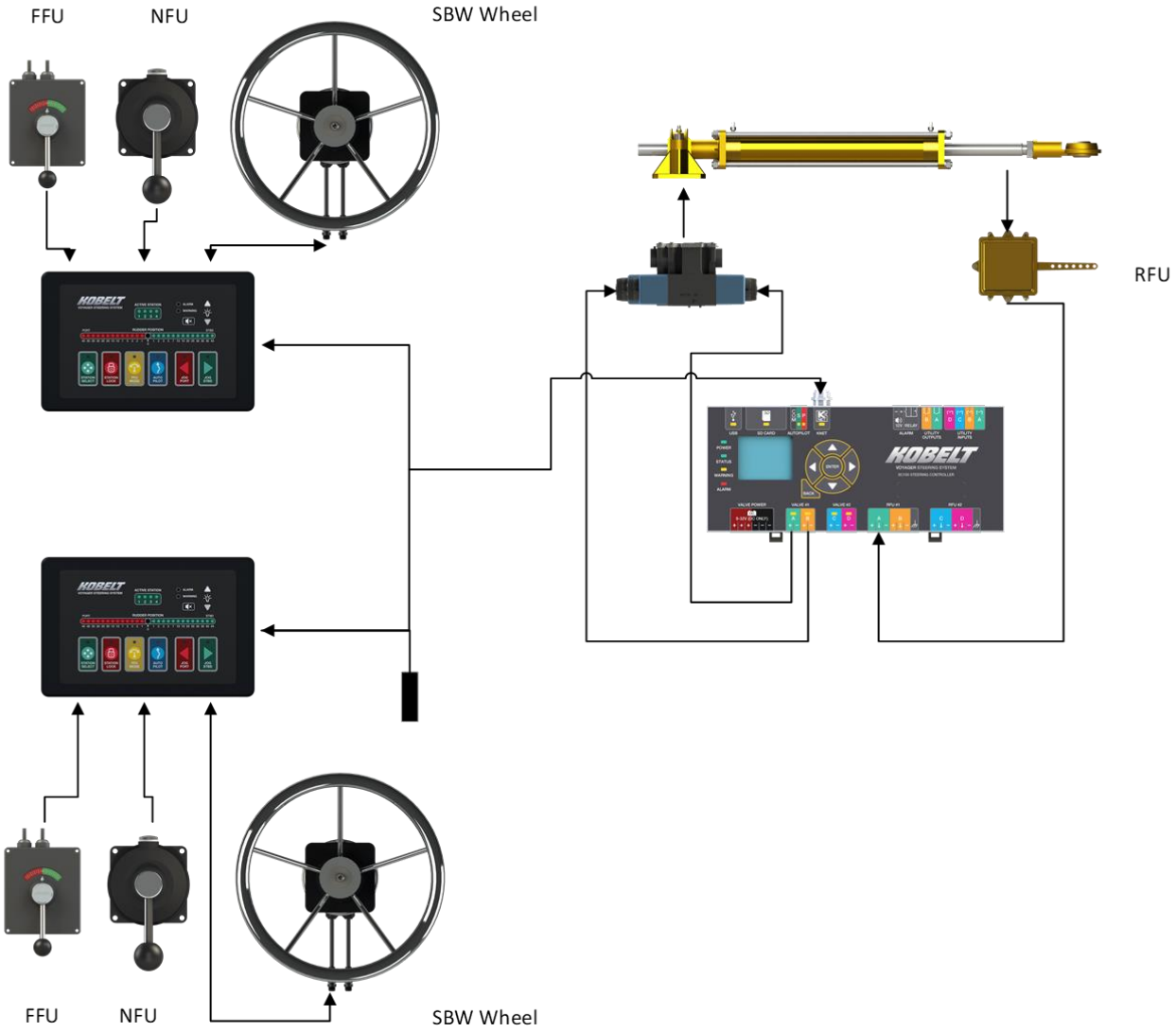


Figure 1: Single Rudder Steering System Block Diagram (Simplified)

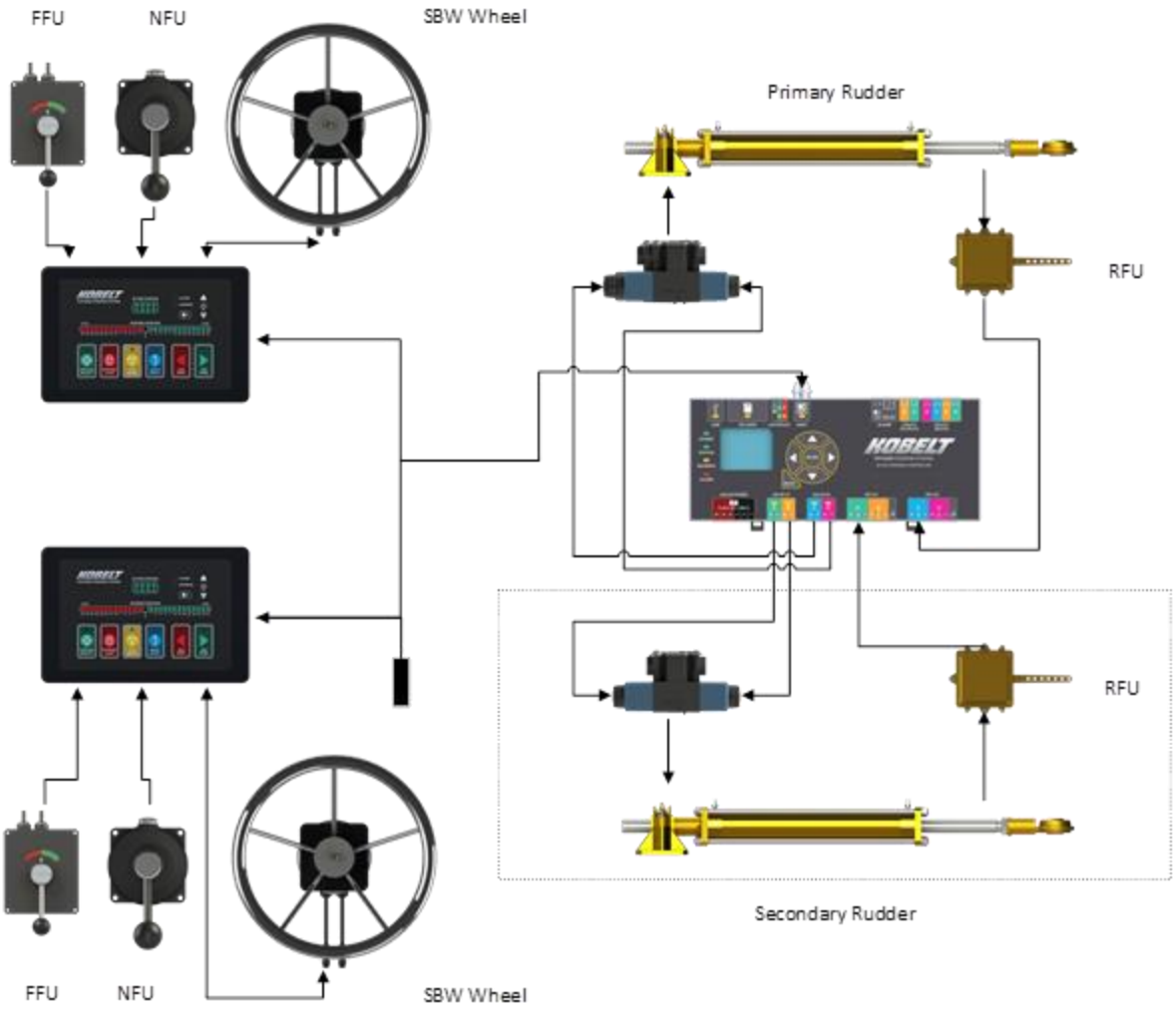


Figure 2:Dual Rudder Steering System Block Diagram (Simplified)

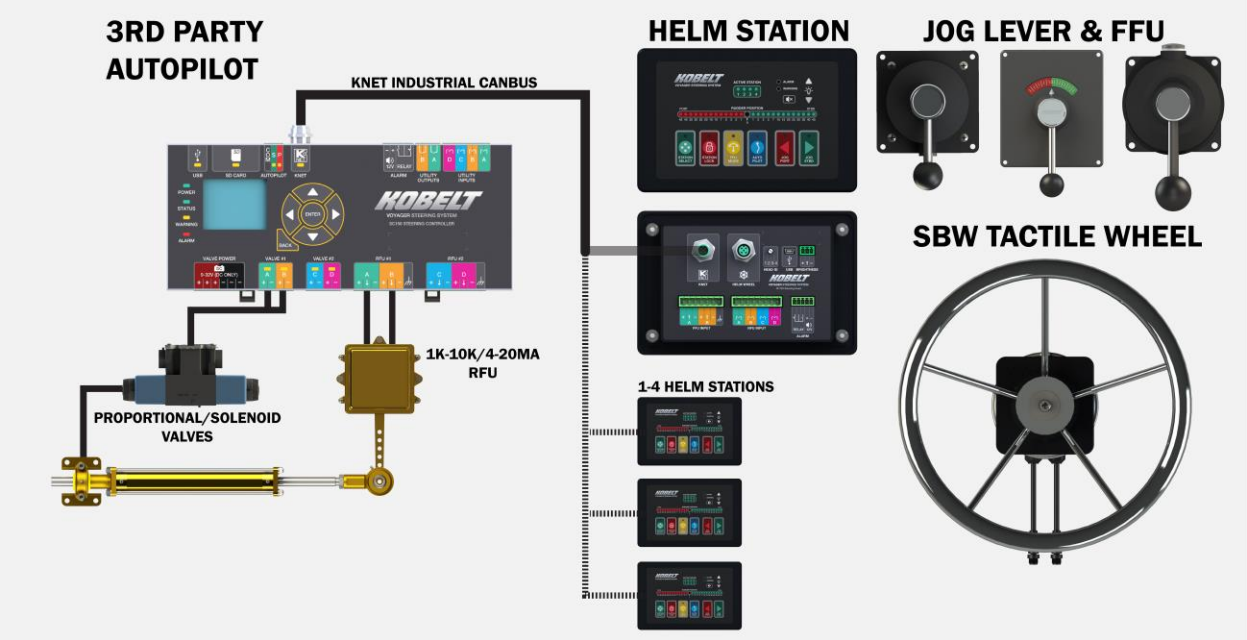


Figure 3: Steering System Block Diagram Render

5.2 System Features

- **Position and motion control of one (1) rudder or mechanically coupled rudders.**
  - Variable-speed control via proportional valve
  - Single-speed control via solenoid valve
  - Two-speed control via two solenoid valves
- **Position and motion control of two (2) rudders**
  - Variable-speed control via two proportional solenoid valves
  - Single-speed control via two on-off solenoid valves
  - Electronic tie bar capable.
- **Supports multiple types of steering input devices (Not Included with the Steering Control System):**
  - Steer-by-Wire Electronic Wheel, with Torque Feedback
  - FFU control lever, or helm wheel.
  - One or two speed NFU control lever.
- **One (1) Steering Controller unit.**
  - Graphical display for system commissioning, configuration, and diagnostics
  - Built-in on-off/Proportional Electro-Hydraulic solenoid driver
  - Integrates with legacy Kobelt RFU devices.
  - Integrates with 3rd-party autopilot systems.
- **Up to four (4) Steering Stations, each with a control panel and one or more input devices.**
  - Each steering station may have any combination of input devices: NFU jog lever, FFU control, and/or Steer-by-Wire Wheel
  - "Automatic Transfer" and "Single Station Active" are the strategies for selecting a station.
    - Single station requires the operator to activate a station before operating by pressing the station select button on the station.

        - Automatic transfer allows a jog or wheel command to transfer to a given station.
        - Optionally, use the station lock feature to prevent other stations from taking control.
    - Includes an LED-strip-style rudder angle indicator and rudder order indicator on the front panel.
- **KNet Network Communications**
    - Based on, but not compatible with, the NMEA 2000 standard. KNet uses a proprietary protocol handles the communication and power distribution for the system.

⚠WARNING	The System is not NMEA 2000 compatible and needs to be isolated from any onboard NMEA 2000 network.

5.3 CONTROLLER

5.3.1 Feature Overview

- Configurable to meet the needs of numerous installations.
- Diagnostic features to aid in problem solving.
- Up to 4 stations supported.
- One or two rudders
- On-off or proportional hydraulic solenoid support
- Autopilot output integration.
- RFU support for 1K, 10K and 4-20mA.
- OLED display for diagnostics and configuration.
- Keypad for screen and menu navigation
- SD Card for data logging and configuration storage

5.4 STEERING STATION

The steering station is the operator interface to the steering gear. The steering station takes operator control inputs and relays them to the steering controller to drive the steering gear. Steering stations should be installed at the main and auxiliary helm points.

5.4.1 Feature Overview

- Controls for selecting different control methods.
- Integrated Jog Controls
- External Jog Connector for one speed or 2 speed jog devices
- External FFU connector
- Electric wheel connector
- Integrated Rudder Order and Rudder angle indicators
- Diagnostic features to aid in problem solving.

5.5 TECHNICAL SPECIFICATIONS

Table 1: Technical Specifications Controller and Head

ELECTRICAL		
	Controller (6300-0100)	**Steering Station (6300-0200)**
OPERATING VOLTAGE	12-24Vdc	12-24Vdc
OPERATING CURRENT at 24Vdc	Max 0.2A	0.35A max (without SBW wheel)1.35A (max with SBW wheel)
VALVE OPERATING VOLTAGE	12-32VDC	
VALVE OPERATING CURRENT	0-3.0A (Per Terminal)	
REVERSE POLARITY PROTECTION	Yes.	Yes.
Compass Safe Distance	N/A	1.5 cm
CONNECTORS	1x KNET (NMEA Micro-C) 2x Analog Input Banks, 2 Channels/Bank 1x Digital Input Banks, 4 Channels/Bank 1x Digital Output Bank, 2 Channels 1x Autopilot input bank 2x Valve control outputs, Solenoid/Proportional	1x KNET (NMEA Micro-C) 2x Analog Input Banks, 2 Channels/Bank 1x Digital Input Banks, 4 Channels/Bank 1x potentiometer input for brightness control 1x Electronic CANBUS wheel connection
MECHANICAL		
PHYSICAL DIMENSIONS (L x W x H)	212.5 mm x 111.5 mm x 32.2 mm [8.37” x 4.39” x 1.27”]	184.2 mm x 120.7 mm x 52.7 mm [7.25” x 4.75” x 2.08”]
MOUNTING DIMENSIONS (L x W)	DIN rail mounted (minimum 152 mm [6”])	146 mm x 91 mm [5.75” x 4.13”]
PRODUCT WEIGHT	0.3 kg [0.68 lbs]	0.65 kg [1.44 lbs]
SHIPPING DIMENSIONS (L x W x H)	275 mm x 170 mm x 100 mm [10 7/8” x 7” x 3 7/8”]	275 mm x 170 mm x 100 mm [10 7/8” x 7” x 3 7/8”]
ENVIRONMENTAL		
Environmental Category	ENV2 / Class A / protected	ENV5 / Class C / exposed
OPERATING TEMPERATURE	-25°C to 55C [-13°F to 131°F]	-25°C to 55°C [-13°F to 131°F]
STORAGE TEMPERATURE	-30°C to 70°C [-22°F to 158°F]	-30°C to 70°C [-22°F to 158°F]
OPERATING HUMIDITY	95 % (Non-Condensing) 95% Max.	95 % (Non-Condensing) 95% Max.
STORAGE HUMIDITY	98 % (Non-Condensing) 95% Max.	98 % (Non-Condensing) 95% Max.
IP RATING	IP20	IP56 – Above console IP20 – Below console

6 INSTALLATION

6.1 LOCATION REQUIREMENTS

The location of the controller unit should be within 10m(32.7 ft) to the solenoid valves to reduce voltage drop. If a voltage RFU is used, the location of the controller should be within 18m(58.87ft) of the RFU to reduce electrical noise induced on the signal wires. 4-20mA RFUs' are less susceptible to noise.

⚠WARNING	Station 1 can override station lock at another station. It is recommended that this station should be in the main bridge or the machine room depending on emergency procedures.

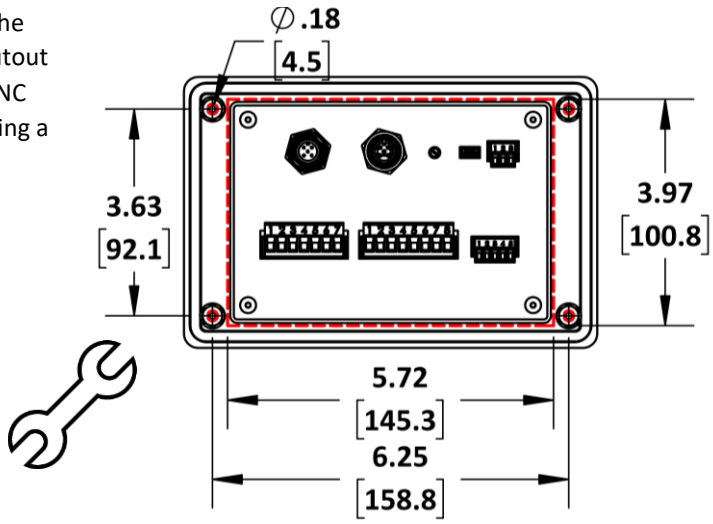
6.2 MECHANICAL

The Controller needs to be installed in an IP44 enclosure(minimum) for machinery rooms, or IP56 enclosure in exposed locations.

The controller is rail mounted on 35mm DIN rail.

The steering station is rated IP56 and can be mounted to any flat console or dashboard.

The mounting surface must be prepared as per the diagram at right (Refer to Appendix B: Station Cutout Template). Secure the panel with the four #8 UNC studs supplied. Apply Loctite 243 and tighten using a 11/32" wrench.



6.3 ADDITIONAL COMPONENTS

The controller and stations are supplied with standard 5 pin – M12 connectors. It is a system design decision for the cabling. It is possible to use Mini sized wiring with Mini to Micro/Mid reducers at the devices. This will allow a better power distribution.

Standard Micro/Mid connectors are specified for smaller wire gauge than is specified for the backbone cable. Running larger gauge wire will reduce total impedance. This is an important consideration when running backbone cables.

Contact Kobelt sales for connector components.

⚠WARNING	It is required that each system is designed with the ability to override the control system with a local backup. This can be accomplished by switching out the control system valve output with an NFU jog connected directly to the solenoid giving manual control over the valves.

NOTICE	Redundant power for the steering system is recommended.

NOTICE	For resilient systems a redundant KNet cabling is recommended in case of cable damage that may occur.

6.4 COMPASS SAFE DISTANCE

The compass safe distance for the steering station is tested to be 1.5cm.

6.5 EMC INSTALLATION GUIDELINES

6.5.1 Power Line Filter

To conform to EMC Standards in IEC60945, a power Line filter must be installed on to the main power supply line of the system as well as to the main power supply line of the valve. Kobelt recommends Schaffner EMC power line filters. The size of filter must be selected based on the expected maximum current draw of the system. The FN2010 series have rated currents ranging from 1A to 60A. Some recommended part numbers are listed in the table below.

Table 2: Power Line Filters

Schaffner Part Number	Maximum current Draw (A)
FN2010-1-06	1
FN2010-3-06	3
FN2010-6-06	6
FN2010-10-06	10
FN2010-12-06	12
FN2010-16-06	16
FN2010-20-06	20
FN2010-30-08	30
FN2010-60-24	60

The installation of the power line filter shall be placed in-between the main power supply line and the system load. The “Line” terminals shall be connected to the main power supply line and the “Load” terminals shall be connected to system load, the “PE” terminal shall be connected to the bonding of the ship as indicated in Figure 4 below. The same topology will also be followed for connecting the valve power supply.

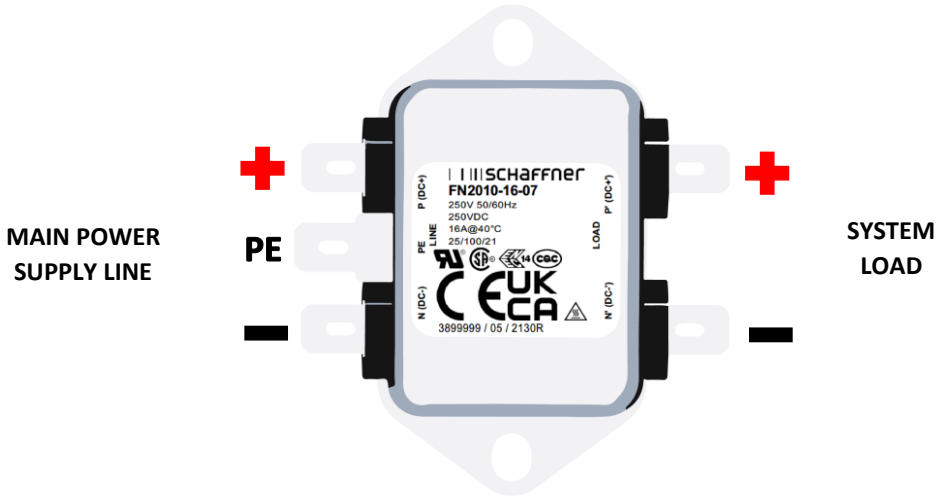


Figure 4: Schaffner Powe Liner Filter

6.5.2 Shielded cable and grounding methods

Shielded cables shall be utilized when connecting to the Kobelt Steering Controller and steering head. The shield of the cables shall be grounded at the controller to ensure proper EMC compliance, the shield can then be terminated to the bonding of the ship.

NOTICE	The user is responsible for implementing the above recommendations. Failure to do so will result in the system not meeting IEC 60945 EMC Compliance.

6.6 ELECTRICAL CONSIDERATIONS FOR INSTALLATION

6.6.1 Cable Routing

In areas of extreme EMC interference care should be taken in arranging the cabling of the Kobelt Steering system to maintain proper system performance.

To achieve adequate system performance from the rudder feedback readings, the cable lengths should be kept to a minimum. RFU cable lengths should not exceed 100ft and it is recommended to keep them below 50ft. In areas of high EMC interference care should be taken to ensure the RFU cable is less susceptible to interference. This means routing the cable further away from the potential noise source and making sure the proper shielded cable is used. Please ensure that the rudder feedback readings are stable with a maximum oscillation of +-2 degrees on the Controllers angle readout. If the rudder at a stopped position has an angle oscillating by greater than 4 degrees it is recommended to switch to 4-20mA feedback unit to ensure proper system performance.

6.6.2 KNET Cabling requirements

6.6.2.1 Wire specification

Table 3: KNet Cable Properties

	Light Cable (Micro/Drop)	Mid(Backbone)	Heavy Cable (Mini)
Signal Wire Gauge	24 AWG	20 AWG	18 AWG
Power Wire Gauge	22 AWG	16 AWG	15 AWG
Power Wire Resistance	5.7 Ohms/100m (328 ft)	1.7 Ohms/100m (328 ft)	1.6 Ohms/100m (328 ft)
Maximum Current	6 Amps	14 Amps	14-16 Amps

NOTICE	Do not use Light Cable (Micro) for back bone connections. The resistance of the wire is too high for all but minimal installations.

6.6.2.2 KNet Network Characteristics

Table 4: KNet Network Properties

Network Characteristic Summary	
Network Architecture	• Bus wiring configuration using 4-conductor twisted-pair wire to carry power to operate the interface and data signals. • Linear Network with end terminations and multiple short length drop cables connecting the backbone cable to individual nodes.
Network Operation	• Network access: Carrier Sense/Multiple Access/Collision Arbitration using CAN (Controller Are Network) • Multi-master network operation (No central control node) • Self-Configuring • Special Network tools, desirable for diagnostic purposes, are not necessary for operation
Network Size	• Physical nodes: Up to 7 devices • Length: Up to 100m(328ft) for mid-cabling, and 250m(820ft) for mini cabling. • Total drop length maximum 14m(46ft) • The network is grounded at a single location and isolated from the hull of the vessel.

6.6.2.3 Knet Wiring Rules

- The network backbone needs to be in line. i.e., No Star Topologies.
- The maximum drop or off-line connection length is 6m(19.8ft)
- Vessels larger than 40m(130ft) should use Mini, instead of micro, cabling. Alternatively, use power drops closer to the stations. Doing this reduces the voltage drop on the power lines.
- Terminations need to be at each end of the backbone run.

6.6.2.4 System Wiring guidelines.

The network design is dependent upon the voltage supplied at each station. With the voltage drop along the backbone wiring it can take several calculations to design the network properly.

⚠CAUTION	If the main power source is 24Vdc, and with sufficient voltage drop in the network it is possible for the steering station to drop below its operating voltage and experience a station brown out.

For the best power distribution, over long networks, it is recommended to use isolated power drops at each individual station, this will ensure the correct operating voltage is available at each station and guarantee that any station will not lose power due to voltage drops during periods of large current draw.

NOTICE	For 12Vd.c., any station with a SBW wheel will require an isolated power drop

Refer to the current requirements of the steering stations with and without an electric steering wheel, and the wiring specifications.

6.7 Controller Field Wiring Connections

The top and bottom sides of the Controller contain the electrical connections for wiring of the system and should be allotted extra space for ease of wiring within the enclosure.

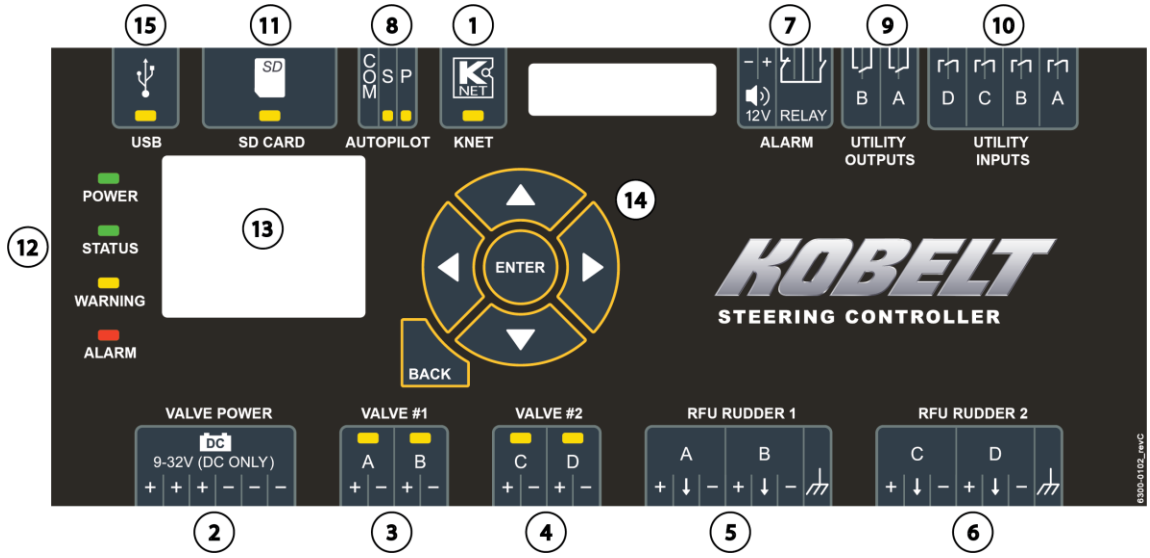


Figure 5 Controller Picture Overview

Table 5 Controller Overview Table

#	Name	Type	Description
1	KNet Interface	Input/Output	CANBUS based communication network
2	Valve Power	Input	Power input for valve drivers
3	Valve #1	Output	Connection point valve #1 – on-off or proportional solenoid
4	Valve #2	Output	Connection point valve #2 – on-off or proportional solenoid
5	RFU #1	Input	Connection point for RFU for valve 1 – 1k,10k or 4..20mA
6	RFU #2	Input	Connection point for RFU for valve 2 – 1k,10k or 4..20mA
7	Alarm	Output	Connection point for external buzzer and alarm panel
8	Autopilot	Input	Connection for autopilot input valve commands
9	Utility Outputs	Output	Additional output ports for future functionality

10	Utility Input	Input	Additional input ports for future functionality
11	SD Card	Input/Output	SD Card for steering system logs
12	Status Indicators	Output	Indicators for system status information
13	Graphical Display	Output	Graphical interface for setup, installation and monitoring
14	Membrane Keypad	Input	Membrane buttons to interface with GUI
15	USB	Input/Output	USB connection for command line interface

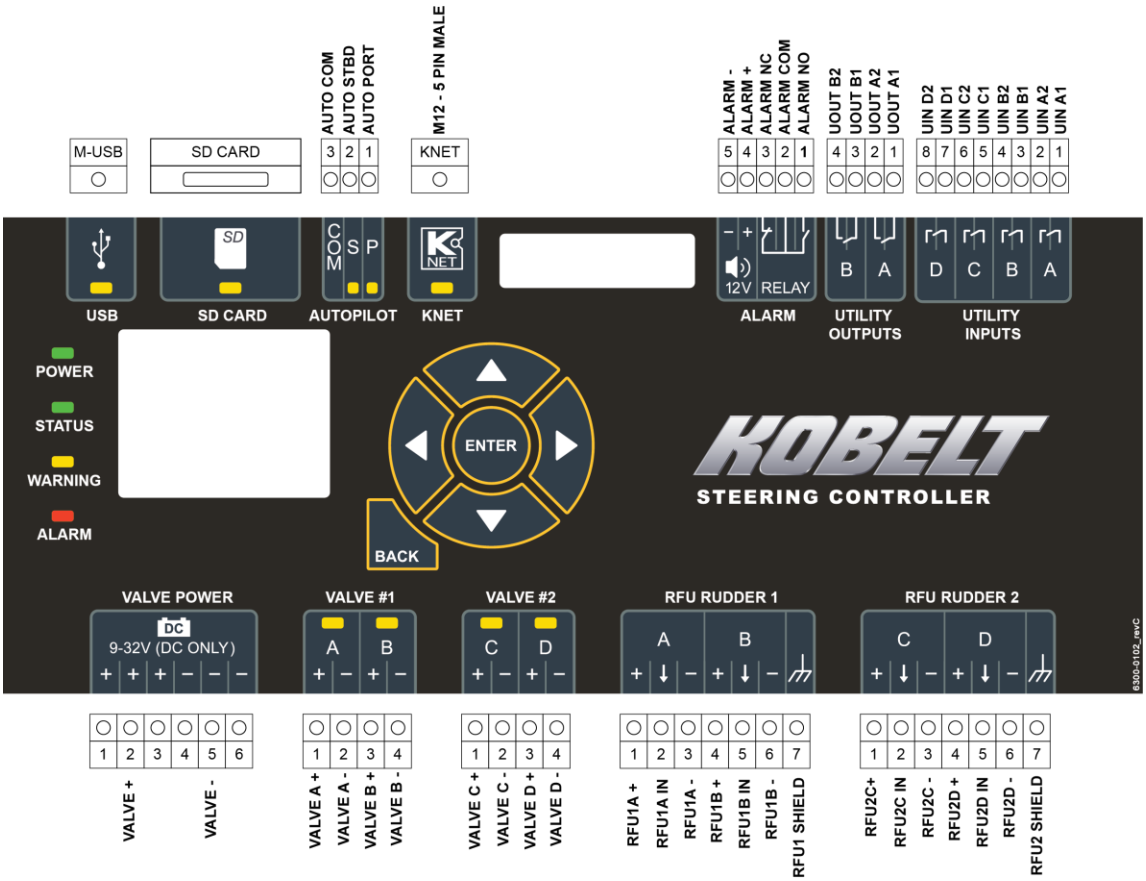


Figure 6: The Controller Wiring

6.7.1 Valve Connection

6.7.1.1 Valve Power Connector

Connector Type: 6-pin 5mm Pluggable Terminal Block

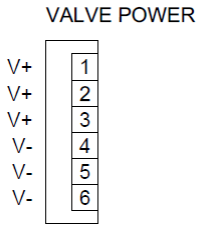


Figure 7: Electrical Connector for Valve Power

- Power supply input for all four coil drivers (Valve #1 and #2)
- Power can come from any supply suitable for driving the solenoid valves.
    - Valve power is isolated from KNet power supply, and they do not need to share a ground
    - Valve supply voltage may be different than the KNet supply voltage, to a maximum of 24Vd.c.
    - The valve power supply voltage is governed by the steering valve coil voltage.
- Only two of the pins are required for connection to the power source.
    - The remaining four pins provide convenient, redundant, and reliable termination points when wiring 3-wire valves with common return wires.

NOTICE	To meet IEC 60945 EMC regulations, the valve power connector needs to be routed through the provided ferrite clamp. Failure to clamp the cable may result in radio frequencies to be generated by the system.

Table 6: Valve Power Connector

Pin #	Pin Name	Membrane Symbol	Pin Type	Function
1	VALVE+	+	Power	Valve Power Supply Positive, 12VDC or 24VDC nominal
2	VALVE+	+	Power	
3	VALVE+	+	Power	
4	VALVE-	-	Power	Valve Power Supply Negative
5	VALVE-	-	Power	
6	VALVE-	-	Power	

6.7.1.2 Valve #1 Connector

Connector Type: 4-pin 5mm Pluggable Terminal Block

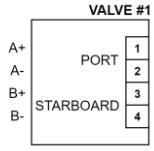


Figure 8: Electrical Connector for Valve #1 (Channels A/B)

Table 7: Valve #1 Connector

Pin #	Pin Designator	Membrane Symbol	Pin Type	Function
1	Coil A+	+	Output	Valve #1, CHA, Positive Output
2	Coil A-	-	Output	Valve #1, CHA, Negative Output
3	Coil B+	+	Output	Valve #1, CHB, Positive Output
4	Coil B-	-	Output	Valve #1, CHB, Negative Output

6.7.1.3 Valve #2 Connector

Connector Type: 4-pin 5mm Pluggable Terminal Block

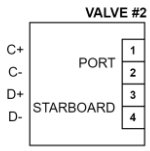


Figure 9: Electrical Connector for Valve #2 (Channels C/D)

Table 8: Valve #2 Connector

Pin #	Pin Designator	Membrane Symbol	Pin Type	Function
1	Coil C+	+	Output	Valve #2, CHC, Positive Output
2	Coil C-	-	Output	Valve #2, CHC, Negative Output
3	Coil +	+	Output	Valve #2, CHD, Positive Output
4	Coil D-	-	Output	Valve #2, CHD, Negative Output

6.7.1.4 Example of Connections

Valve 2 is only used in:

- Dual Rudder single speed or proportional control.
- or single rudder 2 speed On-off Valve configurations.

NOTICE	When using a mechanical tie bar in two rudder application the steering system treats this as a single rudder when configuring the valve outputs.

When using the two-solenoid with single rudder configuration, the first solenoid is used for low-speed operation, and both solenoids are used for high-speed operation. 'Low speed' turns on Valve 1 to in the desired direction. 'high speed' turns on both valves in the desired direction.

Variable speed proportional valve signals would use one valve per rudder for dual rudder operation.

This configuration uses a bi-directional solenoid valve controlled by 2 or 4 valve signals.

Valve 1, ChA	Valve 1, ChB	Valve 2, ChC	Valve 2, ChD
Port Solenoid Valve Signal	Starboard Solenoid Valve Signal	Port Solenoid Valve Signal	Starboard Solenoid Valve Signal

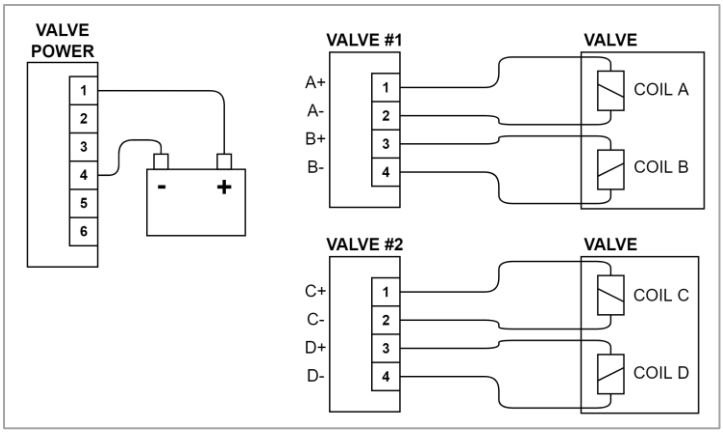


Figure 10: Valve Wiring for Solenoid Valves (4-Wire)

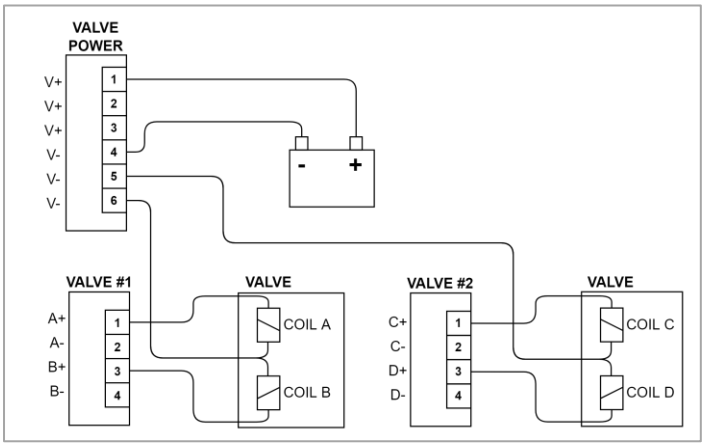


Figure 11: Valve Wiring for Solenoid Valves (Common Negative)

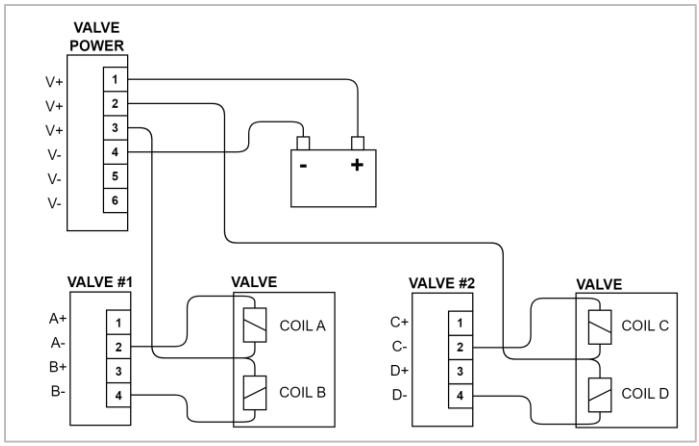


Figure 12: Valve Wiring for Solenoid Valves (Common Positive)

6.7.2 RFU Connections

A single-rudder vessel (or a multiple-rudder vessel with mechanical tie-bars) requires just one Rudder Feedback Unit. A dual rudder vessel requires 2 Rudder Feedback Units.

- Two (2) connectors for interfacing with Rudder Feedback Units (RFUs):
    - Labelled "**RFU #1**" and "**RFU #2**".
    - Each connector has two (2) input channels to read both a primary sensor and backup sensor.
    - Collectively, these are referred to as Channels A, B, C and D.

The System RFU sensor

- The RFU can be configured to interface with:
    - Potentiometer Voltage Divider (Legacy Kobelt RFU).
        - 1K Pot
        - 10K Pot
    - 4-20 mA Current Output (DEIF).
- When configured as 1K or 10K PT, each connector supplies regulated VDC+ and GND to power a potentiometer voltage divider RFU.
    - The voltage supplied to each RFU connector is independently monitored.
    - Channel B and Channel D are not used
- Use of a 4-20 mA RFU requires an external voltage supply of > 18V d.c

6.7.2.1 RFU #1 Connector (Channels A/B)

Connector Type: 7-pin 5mm Pluggable Terminal Block

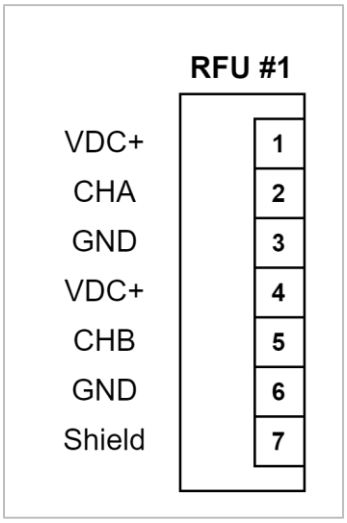


Figure 13: Electrical Connector for RFU #1

Table 9: RFU #1 Connector

Pin #	Pin Designator	Membrane Symbol	Pin Type	Function
1	RFU1A+	+	Power	Voltage power for CHA
2	RFU1A_IN	↓	Input	Voltage/current input for CHA
3	RFU1A-	-	Power	GND for CHA
4	RFU1B+	+	Power	Voltage power for CHB
5	RFU1B_IN	↓	Input	Not used (future support)
6	RFU1B-	-	Power	GND for CHA
7	RFU1_SHLD	⏚	Power	Shield

6.7.2.2 RFU #2 Connector (Channels C/D)

Connector Type: 7-pin 5mm Pluggable Terminal Block

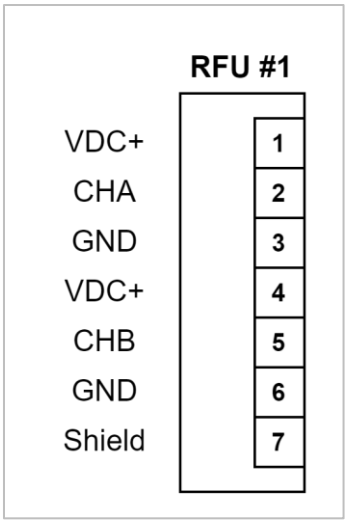


Figure 14: Electrical Connector for RFU #2

Table 10: RFU #2 Connector

Pin #	Pin Designator	Membrane Symbol	Pin Type	Function
1	RFU2C+	+	Power	Voltage power for CHC
2	RFU2C_IN	↓	Input	Voltage/current input for CHC
3	RFU2C-	-	Power	GND for CHC
4	RFU2D+	+	Power	Voltage power for CHD
5	RFU2D_IN	↓	Input	Not used (future support)
6	RFU2D-	-	Power	GND for CHD
7	RFU2_SHLD	⏚	Power	Shield

6.7.2.3 Example of RFU Connections

RFU Potentiometer (Voltage) Support

- Supports all legacy Kobelt RFU products (7163, 7168 or 7174) without modification:
  - These models contain a 1k, 5k or 10k potentiometer connected to a shaft through a gear mechanism.
  - Even if the RFU contains more than one pot (like many 7174 variants), only one is connected to the Controller in this configuration.
- VDC+ and GND applied across the pot, and the wiper voltage is measured on RFU Channel A.
- Calibration is required to convert the measured voltage into the Rudder Angle. Refer to the commissioning section.
- WIRE BREAK DETECTION

Single Rudder with 1 Potentiometer

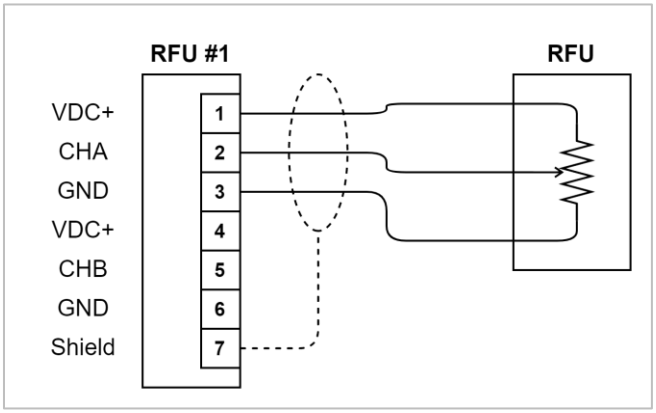


Figure 15: RFU Wiring for 1 Rudder with 1 Potentiometer Sensor

RFU 1, ChA	RFU 1, ChB	RFU 2, ChC	RFU 2, ChD
Voltage Mode	*Not used*	*Not used*	*Not used*

Dual Rudder with 2 Potentiometers

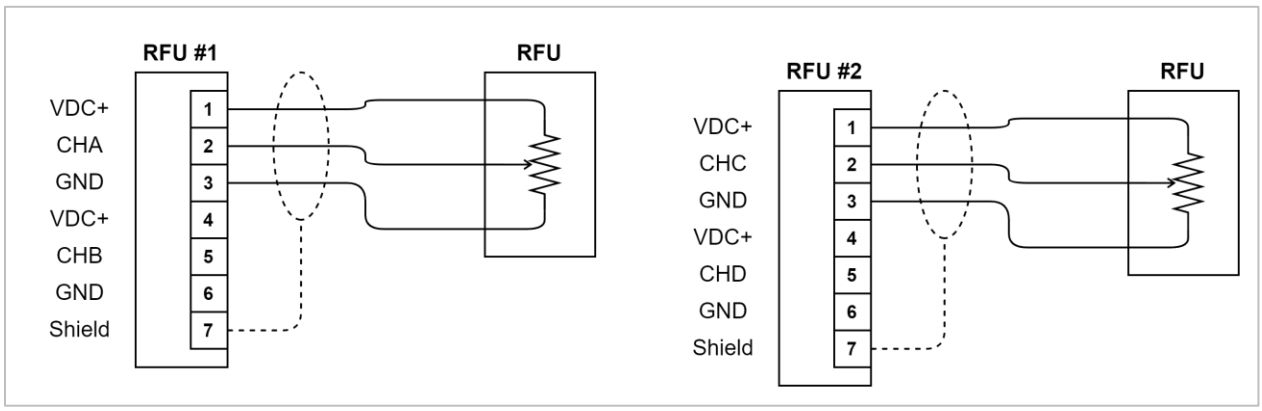


Figure 16: RFU Wiring for 2 Rudders with 2 Potentiometer Sensors

RFU 1, ChA	RFU 1, ChB	RFU 2, ChC	RFU 2, ChD
Voltage Mode	*Not used*	*Voltage Mode*	*Not used*

RFU Current Loop Support

- Supports any RFU that outputs a standard 4-20 mA signal:
  - Supports DEIF RTA-602 with an external power 24V power supply
  - Normal operating range: 4.0 mA to 20.0 mA
  - Sensor failure / wire break range: <3.8 mA or >20.2 mA
- A 3-point calibration routine converts the measured current into a Rudder Angle (regardless of the type of RFU). Refer to commissioning section.
- Note: The DEIF RTA 602 unit has built-in calibration, a zeroing feature and polarity switch, using various combinations of additional "Setup" wires. This Calibration should be done before the Controller's calibration. The DEIF's default configuration should be acceptable in nearly every case.

Single Rudder with 1 Current Sensor

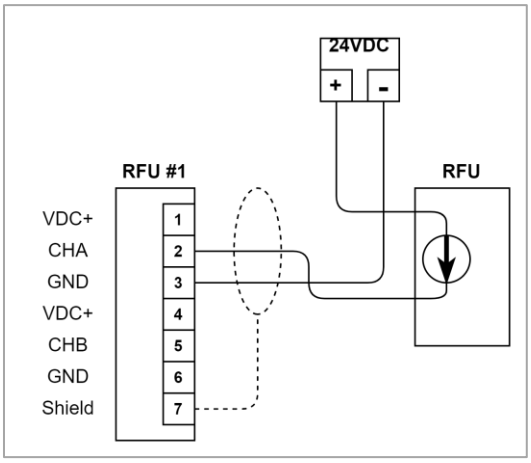


Figure 17: RFU Wiring for 1 Rudder with 1 Current Sensor

RFU 1, ChA	**RFU 1, ChB**	**RFU 2, ChC**	**RFU 2, ChD**
Current Mode	*Not used*	*Not used*	*Not used*

Dual Rudder with 2 Current Sensors

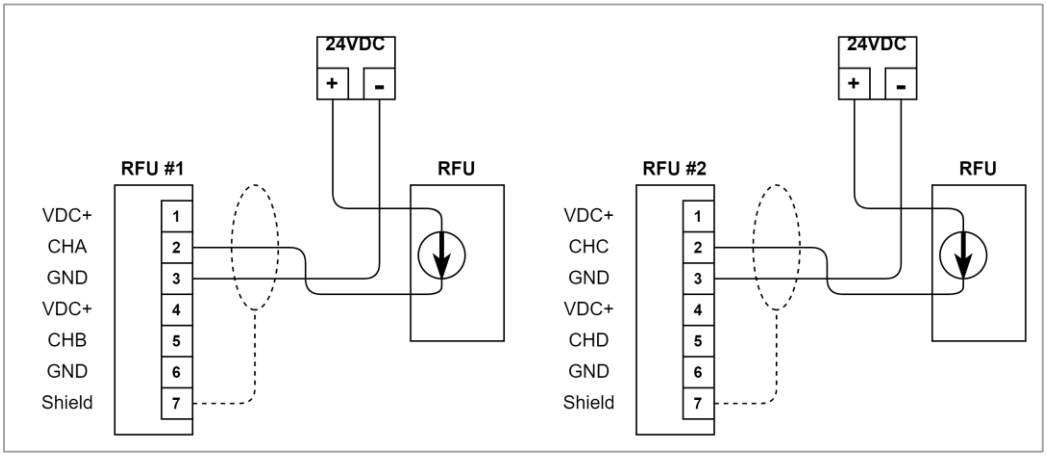


Figure 18: RFU Wiring for 2 Rudders with 2 Current Sensors

RFU 1, ChA	RFU 1, ChB	RFU 2, ChC	RFU 2, ChD
Current Mode	*Not used*	Current Mode	*Not used*

6.7.3 Autopilot Connection

- The Kobelt steering system routes autopilot signals through it to permit an integrated dodge function from a either a jog lever or SBW wheel on the steering station.
- Autopilots typically output a pair of on-off signals to command “port rudder” or “starboard rudder” movement.
- It is typically connected directly to a solenoid valve or a hydraulic reversing pump to effect rudder movement

6.7.3.1 Autopilot Connector

Connector Type: 3-pin 3.5mm Pluggable Terminal Block (Phoenix Contact)

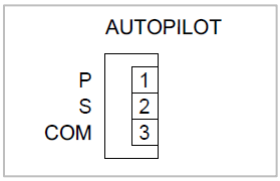


Figure 19: Electrical Connector for Autopilot Interface

Table 11: Autopilot Connector

Pin #	Pin Designator	Membrane Symbol	Pin Type	Function
1	AUTO_P	P	Input	Autopilot port input
2	AUTO_S	S	Input	Autopilot starboard input
3	AUTO_COM	COM	Power	Autopilot input common

6.7.3.2 Example Connections

1) I autopilot Outputs

a) Sourcing type: the COM terminal is connected to V- or 0Vdc, or

b) Sinking type: the COM terminal is connected to V+. i.e. VBAT or 24Vdc

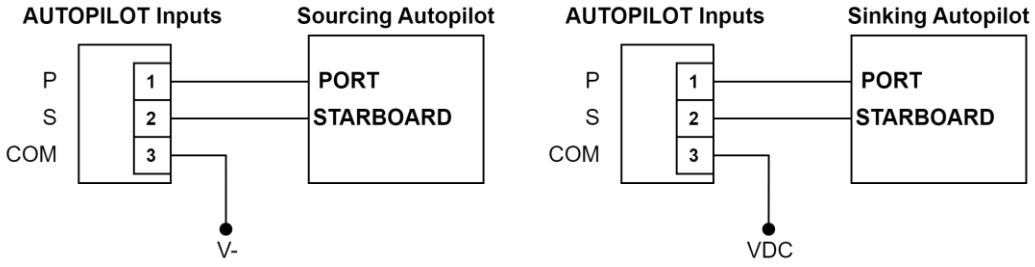


Figure 20: Autopilot Wiring for Autopilot with Solenoid Valve Outputs (Sinking or Sourcing outputs)

2) Autopilot with Reversing Pump Outputs

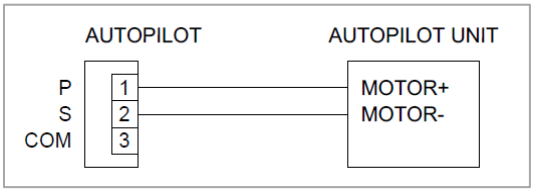


Figure 21: Autopilot Wiring for Autopilot with Reversing Pump Outputs

6.7.4 KNet Connection

Connector Type: 5-pin M12, A-Keyed, Male

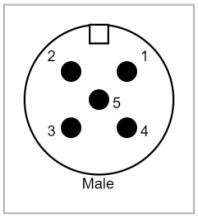


Figure 22: KNet Male Connector Pinout for The Controller

Table 12: KNet Network Connector

Pin #	Pin Designator	Pin Type	Function
1	KNET_SHLD	Power	KNet Shield Pin
2	KNET+	Power	KNet Power Supply Positive, 12VDC or 24VDC nominal
3	KNET-	Power	KNet Power Supply Common, COM
4	KNET-H	I/O	KNet CAN High Signal
5	KNET-L	I/O	KNet CAN Low Signal

6.7.5 Alarm Output Connection

Alarm Buzzer

- A standard 12VDC External Alarm Buzzer can be connected to the system.

Alarm Relay

Table 13: List of Alarm Dry Contact States

Alarm Condition	COM to NO[1]	COM to NC[1]
No Alarm (or Warning-only)	Open	Closed
Active Alarm	Closed	Open
No Power to Controller	Closed	Open

Note 1: terminal label refers to powered and healthy condition.

- Alarm Dry Contact is a SPDT (Form C) Relay use the NO connection to the external alarm.
- Alarm Buzzer
  - B+ and B- supply regulated 12 VDC to the external alarm buzzer.
  - The current is internally limited to 100mA.
- Alarm Dry Contact
  - NO, COM and NC are dry contacts suitable for connection to an alarm monitoring system.

NOTICE	Connect the relay output to external system through the NO-COM on the alarm connector.

6.7.5.1 Alarm Output Connector

Connector Type: 5-pin 3.5mm Pluggable Terminal Block

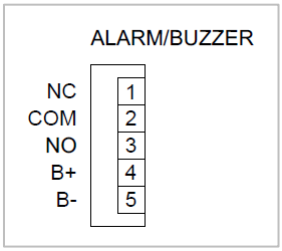


Figure 23: Electrical Connector for External Alarm Buzzer & Alarm Dry Contact

Table 14: Alarm Output Connector

Pin #	Pin Name	Pin Type	Function
1	ALRM_NC	Output	Dry contact normally closed (connected to COM in normal operation)
2	ALRM_COM	--	Dry contact common
3	ALRM_NO	Output	Dry contact normally open (Connected to COM in alarm state)
4	ALRM_B+	Output	Buzzer output positive
5	ALRM_B-	Power	Buzzer output negative

6.7.5.2 Example Connections

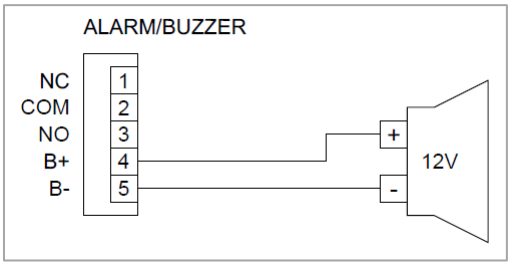


Figure 24: Wiring of External Buzzer

6.7.6 Utility Input and Output Connection

Input Connector Type: 8-pin 3.5mm Pluggable Terminal Block. The inputs are sourcing connections and are activated by shorting each pair of pins. Inputs must be controlled by dry contacts devices.

Input B is assigned for local control indication and/or when the autopilot is routed to bypass the steering system.

Inputs A, C and D are reserved for future use.

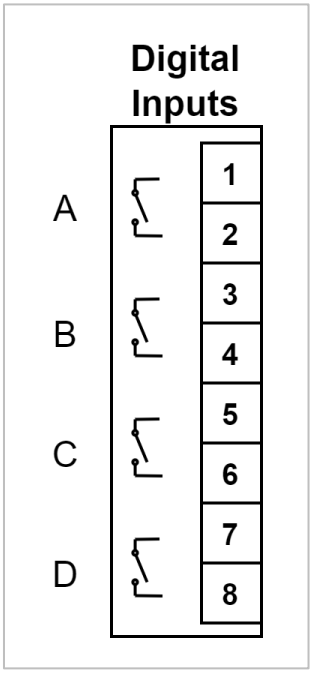


Figure 25: Utility digital inputs

Output Connector Type: 4-pin 3.5mm Pluggable Terminal Block. These are general purpose Relay outputs that are reserved for future use.

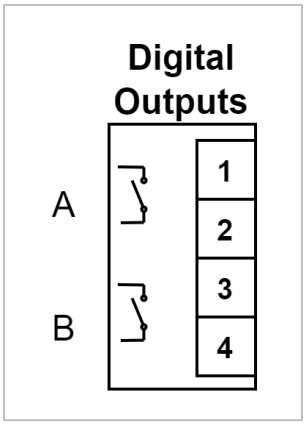


Figure 26: Utility Digital Outputs

6.8 Steering Station Field Wiring Connections

Figure 27: Head Input/Output Connections

Table 15: Station Back Connections

1	KNet Connector
2	SBW Wheel Connector
3	FFU Connector
4	Brightness adjust
5	NFU Jog Connector
6	Alarm Connector
7	Station ID Selector
8	USB mini B Connector

6.8.1 KNet Connection

- Connector Type: 5-pin M12, A-Keyed, Male

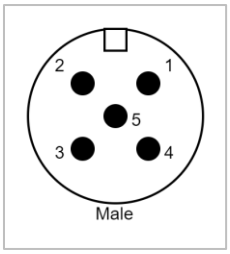


Figure 28: KNet Male Connector Pinout for the Station

Table 16: KNet Network Connector

Pin #	Pin Designator	Pin Type	Function
1	Shield	Power	KNet shield pin
2	NET-S	Power	KNet power supply positive 24VDC nominal
3	NET-C	Power	KNet power supply common, COM
4	NET-H	I/O	KNet CAN high signal
5	NET-L	I/O	KNet CAN low signal

6.8.2 SBW Wheel Connection

- Connector Type: 5-pin M12, A-Keyed, Female

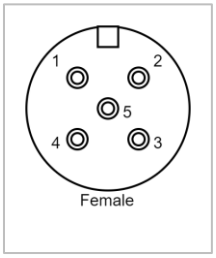


Figure 29: SBW Wheel Female Connector Pinout.

Table 17: SBW Wheel Connector

Pin #	Pin Designator	Pin Type	Function
1	Shield	Power	SBW wheel network shield pin
2	NET-S	Power	SBW wheel network power supply positive 24VDC nominal
3	NET-C	Power	SBW wheel network power supply common, COM
4	NET-H	I/O	SBW wheel network CAN high signal
5	NET-L	I/O	SBW wheel network CAN low signal

6.8.3 FFU Connection

- One (1) connector for interface with Full-Follow Up inputs (FFUs):
    - Labelled "**FFU INPUT**".

- The connector has two (2) input channels to read both a primary sensor and secondary
- These are referred to as Channels A and B.
- Only channel A is used.

NOTICE	Channel B is reserved for future use.

- Each channel measures potentiometer voltage only.

- Each channel can be configured to interface with the following type of electrical signals from FFUs:
  - Potentiometer voltage divider (Legacy Kobelt FFU).
- Each connector supplies a protected, and regulated, voltage and GND to power the FFUs:
  - The voltage supplied to both channels of the FFU connector is monitored. Faults are triggered if this voltage drops too low (indicating excessive load or a short).

NOTICE	The Kobelt Steering System is designed to work with 1k, 5k and 10k Ohm potentiometers. If the resistance becomes too low through a short, partial short or incorrect value the FFU will not function correctly

6.8.3.1 FFU Connector

Connector Type: 7-pin 5mm Pluggable Terminal Block

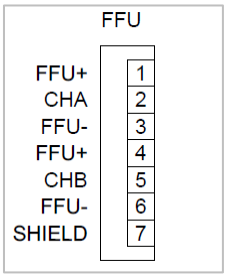


Figure 30: Electrical Connector for FFU Input Device

Table 18: FFU Connector

Pin #	Pin Designator	Membrane Symbol	Pin Type	Function
1	FFU+	+	Power	Voltage power for CHA
2	CHA	↓	Input	Pot wiper input for CHA
3	FFU-	-	Power	GND for CHA
4	FFU+	+	Power	Voltage power for CHB
5	CHB	↓	Input	Not used (future support)
6	FFU-	-	Power	GND for CHB
7	SHIELD	⏚	Power	Shield

6.8.3.2 Example Connections

Single FFU with 1 Potentiometer

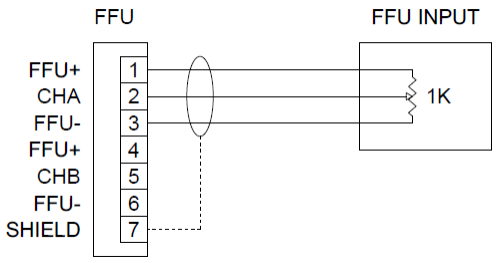


Figure 31: FFU Wiring with 1 Potentiometer Sensor

FFU, ChA	FFU, ChB
Voltage	*Not used*

- Supports all legacy Kobelt FFU products (7165, 7166, 7171, 7172 and 7197) without modification:
  - These models contain a potentiometer connected to a shaft through a gear mechanism.
  - Even if the FFU contains more than one pot (like many 7171 variants), only one is connected to the Head in this configuration.
- FFU+ and GND applied across the pot, and the wiper voltage is measured on FFU Channel A.
- Calibration is required to convert the measured voltage into the Rudder Order Angle. Refer to the commissioning section.

6.8.4 NFU Connection

- One (1) connector for interface with Non-Follow Up inputs (NFUs):
  - Labelled "**NFU INPUT**".
  - The connector has four (4) input channels to read single or two speed Kobelt jog levers.
  - These are referred to as Channels A, B, C and D.
  - Each channel is Active Low (GND input signal to activate).
  - Each channel is matched with a "B" pin that is GND for simple connection.

6.8.4.1 NFU Connector

Connector Type: 8-pin 5mm Pluggable Terminal Block

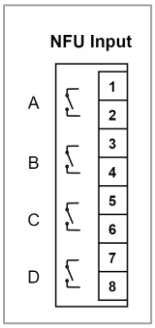


Figure 32: Electrical Connector for NFU Interface

Table 19: NFU Connector

Pin #	Pin Designator	Pin Type	Function
1	A1	Input	Switch input for CHA - Port Slow
2	A2	Power	Source A
3	B1	Input	Switch input for CHB - STBD Slow
4	B2	Power	Source B
5	C1	Input	Switch input for CHC - Port Fast
6	C2	Power	Source C
7	D1	Input	Switch input for CHD - STBD Fast
8	D2	Power	Source D

6.8.4.2 Example Connections

Single-Speed Jog Lever

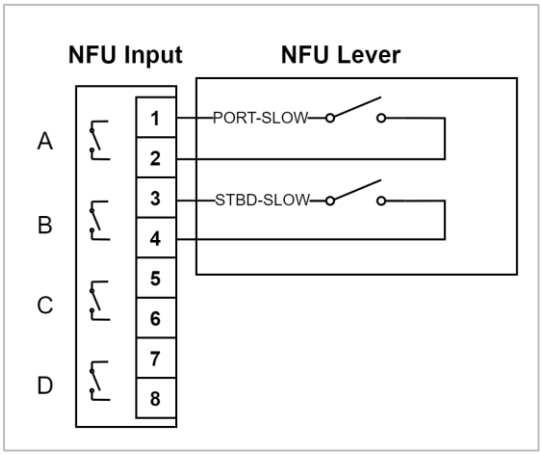


Figure 33: NFU Wiring for 1-Speed Jog Lever (Common Negative)

NFU, ChA	NFU, ChB	NFU, ChC	NFU, ChD
Port, NO	Stbd, NO	*Not used*	*Not used*

- For use with a standard Single-Speed Jog Lever, like the Kobelt 7170

Dual-Speed Jog Lever

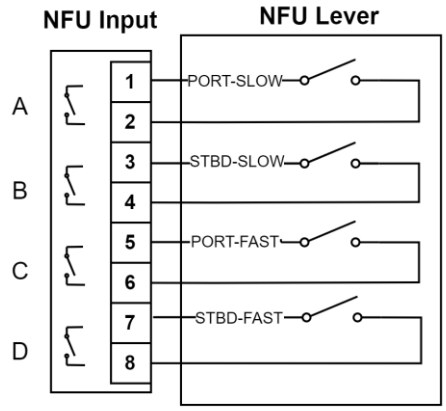


Figure 34: NFU Wiring for Two-Speed Jog Lever (8-Wire)

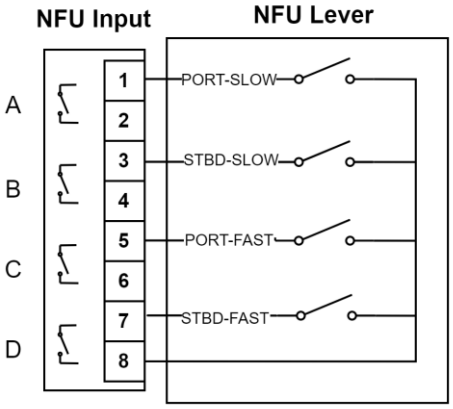


Figure 35: NFU Wiring for Two-Speed Jog Lever (Common Negative)

NFU, ChA	**NFU, ChB**	**NFU, ChC**	**NFU, ChD**
Port Slow, NO	Stbd Slow, NO	Port Fast, NO	Stbd Fast, NO

- For use with a standard 2-Speed Jog Lever, like the Kobelt 7196

6.8.5 External LED brightness adjustment connection

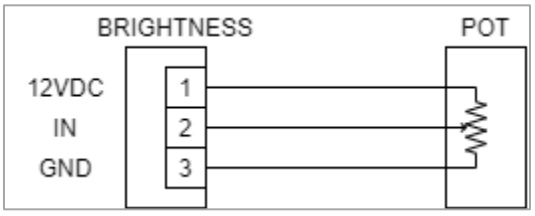


Figure 36: Brightness Wiring for Dimming potentiometer

6.8.6 Alarm Output Connection

Alarm Buzzer

- A standard 12VDC external alarm buzzer can be connected to the system.

Alarm Relay

Table 20: List of Alarm Dry Contact States

Alarm Condition	COM to NO[1]	COM to NC[1]
No Alarm (or Warning-only)	Open	Closed
Active Alarm	Closed	Open
No Power to Controller	Closed	Open

Note 1: terminal label refers to powered and healthy condition.

- Alarm Dry Contact is a SPDT (Form C) Relay use the NO connection to the external alarm.
- Alarm Buzzer
  - B+ and B- supply regulated 12 VDC to the external alarm buzzer.
  - The current is internally limited to 100mA.
- Alarm Dry Contact
  - NO, COM and NC are dry contacts suitable for connection to an alarm monitoring system.

NOTICE	Connect the relay output to external system through the NO-COM on the alarm connector.

6.8.6.1 Alarm Output Connector

Connector type: 5-pin 3.5mm pluggable terminal block

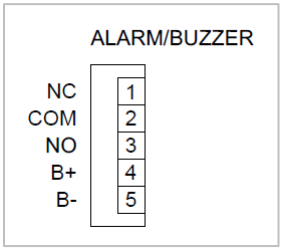


Figure 37: Electrical Connector for External Alarm Buzzer & Alarm Dry Contact

Table 21: Alarm Output Connector

Pin #	Pin Designator	Pin Type	Function
1	ALARM_NC	Output	Dry contact normally closed. Connected to COM in normal operation. Disconnected from COM when powered down or an alarm condition.
2	ALARM_COM	--	Dry contact common
3	ALARM_NO	Output	Dry contact normally open Disconnected from COM in normal operation Connected to COM when powered down or an alarm condition
4	ALARM_B+	Output	Buzzer output positive
5	ALARM_B-	Power	Buzzer output negative

6.8.6.2 *External Buzzer Example Connections*

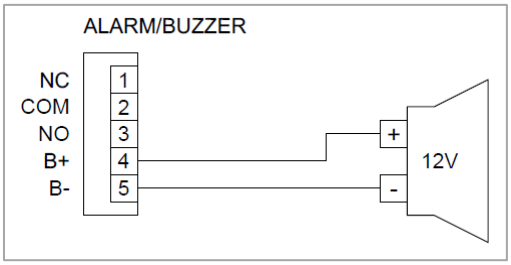


Figure 38: Wiring of External BuzzerConfiguration

Configuration of the system should be performed while the vessel is docked and once all wiring has been confirmed.

⚠WARNING	Improper configuration of the system could result in death or serious injury. Please ensure the vessel is docked and all wiring is complete and validated by qualified personnel.

⚠ DANGER	Do not access the configuration menu while underway, as the steering system is disabled while in configuration.

6.9 CONFIGURATION CHECKLIST

6.9.1 Single Rudder Configuration

Controller			Note
Steering System			
Type of Autopilot	Disabled Auto-Disengage Manual Disengage Always Active		
Dual Rudder	Disable		Must be disabled for Single rudder or mechanically tied dual rudder
Valve Type	Single On-Off Dual On-Off Proportional		
Type of RFU	1kOhm Pot 10kOhm Pot 4-20mA		
External Alarm	Disable Enable		
Number Of Stations	1 to 4		
Station Activation	Single Station Auto-Transfer		

Jog Control	Jog Speed Jog Fast Speed Jog Ramp Rate Hold for Fast Jog Jog Fault Time		Some parameters are only available for proportional valves
Setup Rudder(s)			
Rudder Endstop Band			
Rudder #1 Port Endstop			
Rudder #1 Stbd Endstop			

6.9.2 Dual Rudder Configuration

Controller			**Note**
Steering System			
Type of Autopilot	Disabled Auto-Disengage Manual Disengage Always Active		
Dual Rudder	Enable		Must be enabled for, independent, dual rudder installations
Valve Type	Single On-Off Proportional		Dual on off is not available for dual rudder configurations
Type of RFU	1kOhm Pot 10kOhm Pot 4-20mA		
External Alarm	Disable Enable		
Number Of Stations	1 to 4		
Station Activation	Single Station Auto-Transfer		
Jog Control	Jog Speed Jog Fast Speed Jog Ramp Rate Hold for Fast Jog Jog Fault Time		
Setup Rudder(s)			
Rudder Endstop Band			This is the same for both rudders
Rudder #1 Port Endstop			
Rudder #1 Stbd Endstop			

Rudder #2 Port Endstop			Dual Rudder is enabled
Rudder #2 Stbd Endstop			Dual Rudder is enabled

6.9.3 Steering Stations

Component		Station 1	Station 2	Station 3	Station 4	
Selected		Yes	Yes/No	Yes/No	Yes/No	If installed
Location On-Board						Where is the station installed
NFU	1. Disabled 2. 1 Speed 3. 2 Speed					Type of NFU
FFU	1. Disabled 2. 1K Pot 3. 5K Pot 4. 10K Pot					Type of FFU
SBW	1. Disabled 2. Kobelt TFD Type					LORD TFD SBW installed

6.10 Menu Structure Overview

6.10.1 Navigating the controller screens

NOTICE	The screen will go dark after 5 minutes of non-use. To wake up the screen press the BACK button.

Use the Keypad on the controller to navigate through the Controller HMI.

The ENTER and BACK keys are used to traverse into and out of the menu structure. The UP and DOWN arrows are used to move up and down through specific MENUS options, the highlighted option is the current selection. When the option has been located press ENTER to either enter that SUBMENU or select the item.

Below is a diagram displaying the layout of the Controller internal menu choices available.
Navigation through the menus is accomplished by pressing the arrow, the BACK and ENTER buttons.

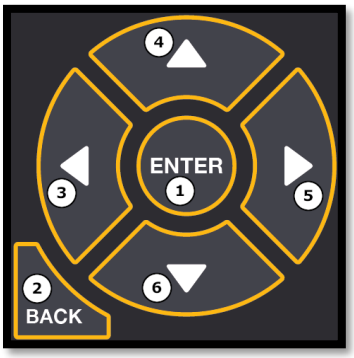


Figure 39: Controller buttons for navigation and configuration

Table 22 HMI Keypad Overview

#	Name	Type	Description
1	ENTER	Input	Used to accept a setting or to enter the password screen
2	BACK	Input	Go to the previous screen
3	LEFT ARROW	Input	Go to the previous status screen
4	UP ARROW	Input	Up one menu item or increase value
5	RIGHT ARROW	Input	Go to the next status screen
6	DOWN ARROW	Input	Down one menu item or decrease value

When editing a numeric parameter, the ARROW keys can be used to adjust the value. UP ARROW will increase the parameter value. DOWN ARROW will reduce the parameter value. LEFT ARROW while editing a parameter will decrease the parameter by a larger step size. RIGHT ARROW will increase the parameter value at a larger step size

There is a series of monitoring screens that provide information on various components in the system and are accessed by pressing the right and left keys on the navigating buttons.

A number of configuration screens that allow configuration and calibration of this system and components can be accessed through a password screen.

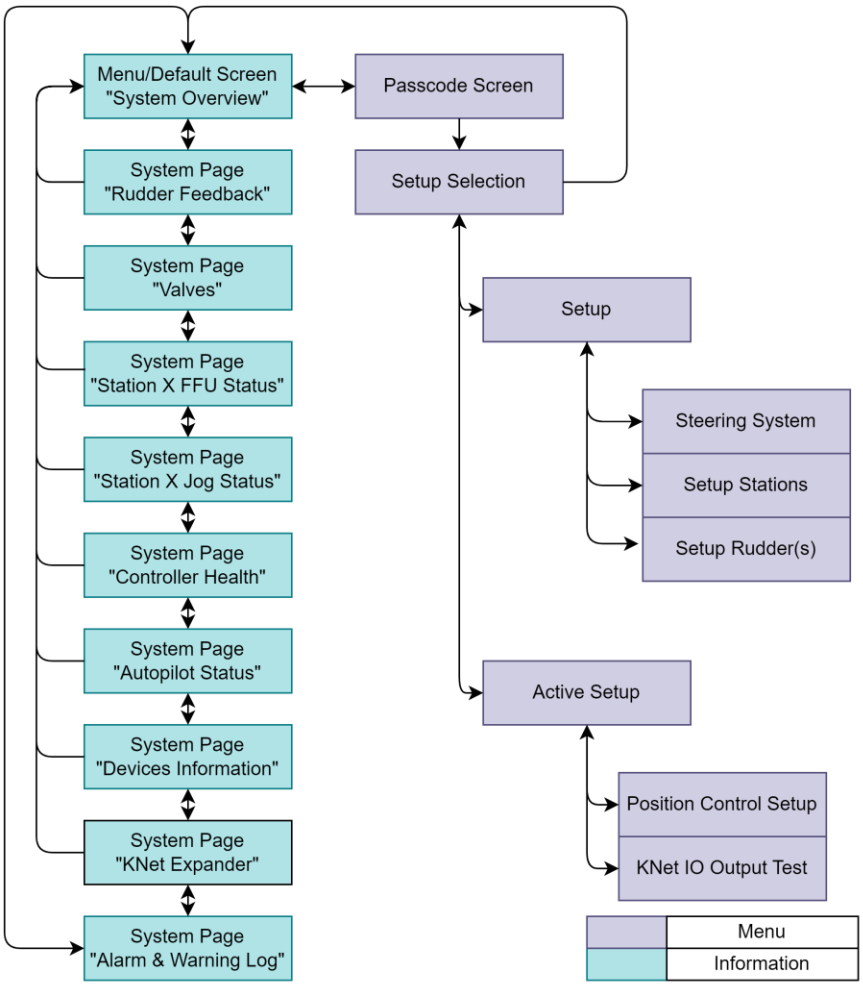


Figure 40: Root Menu Structure

The ARROW keys can be used when configuring a parameters value. UP ARROW will increase the parameter value. DOWN ARROW will reduce the parameter value. LEFT ARROW while editing a parameter will decrease the parameter by a larger step size. RIGHT ARROW will increase the parameter value at a larger step size.

6.10.2 Passcode

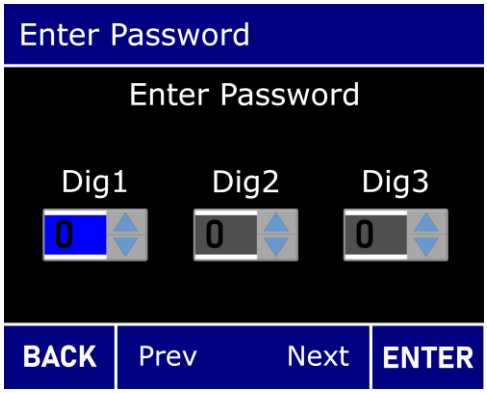


Figure 41: Password Select Screen

The first screen accessed is the Main Monitoring Screen. Pressing the Right or Left key causes the system to enter the Passcode screen. Use the Up and Down key to change the number combination, and then press the Enter button to go to the next digit.

If the input passcode is “3-2-1” as the sequence from the left to right, then the system will go to the Setup and Active Setup selection screen.

The code is a fixed value. The purpose of the code is to protect the system configuration from accidental changes. Inputting a wrong passcode, which is not “3-2-1”, the system will jump out from the Passcode screen and go to the Main Monitoring screen.

6.10.3 Steering system menu overview

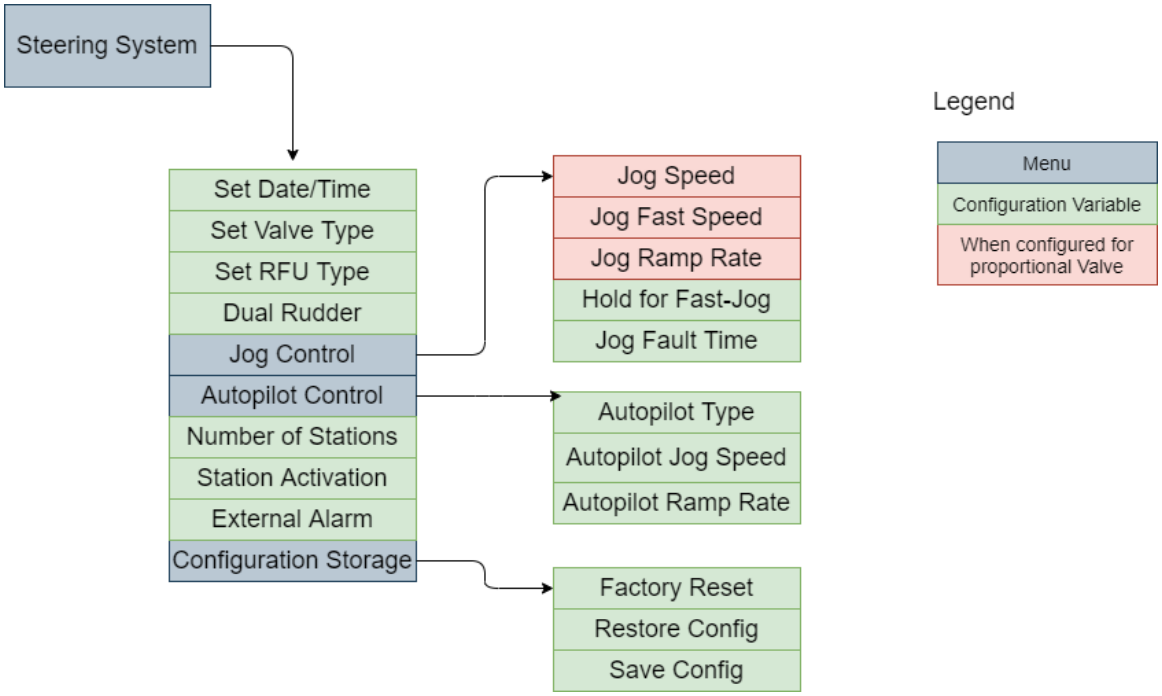


Figure 42: Steering System Configuration Menu Overview

6.10.3.1 Steering System Setup

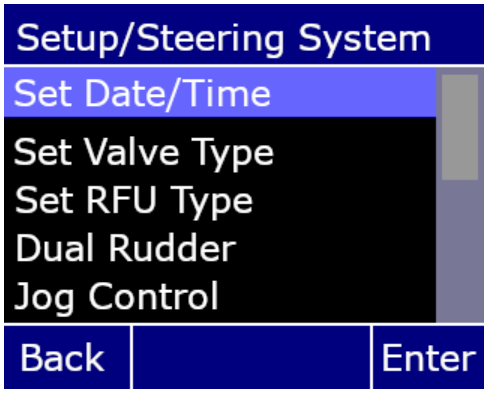


Figure 43: Steering System Setup

- 6.10.3.3 below: Set the date and time of the system used for the alarms, warnings and logs.
- 6.10.3.4: Set the valve type used for the system
  - Proportional
  - One Speed Solenoid.
  - Two Speed Solenoid
- 6.10.3.5: Set the RFU type used for the system
  - Voltage 1k Pot

    - Voltage 10k Pot
    - Current(4-20mA).
- Dual Rudder: Enable/Disable Electronically tied Dual Rudder support
- 6.10.3.6: Set the jog speed, jog fast speed, the jog ramp rate and hold for fast jog settings.
- 6.10.3.7:
    - Autopilot Type
        - Auto Disengage
        - Manual Disengage
        - Always On
    - Autopilot Jog Speed: 10-100% for proportional valves
    - Autopilot Ramp Rate: For Proportional valves, the relative rate that the command changes from off to on, or on to off.
        - Intermediate
        - Very Fast
        - Fast
        - Medium
        - Slow
        - Very Slow
    - Autopilot Input Inversion – For Autopilots that provide sinking or sourcing outputs. Inversion is required to work with autopilot outputs that are open collector/sinking sources.
        - Normal
        - Inverted
- 6.10.3.9: Set the number of stations attached to the system(1,2,3, or 4).
- 6.10.3.10:
    - Single Station
    - Automatic Station Transfer.
- External Alarm System – (Enable or Disabled).

6.10.3.2 Configuration Storage

Save, restore or reset the configuration of the steering system.

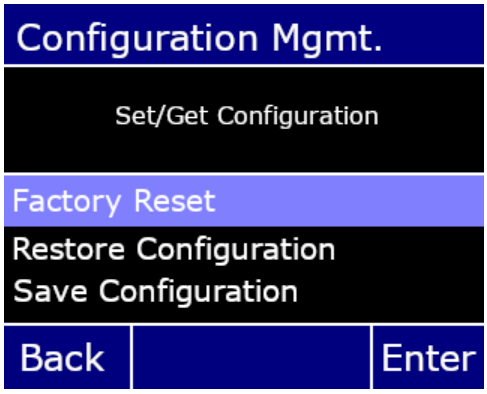


Figure 44: Configuration Management Screen

⚠WARNING	When making any changes to the configuration through a Factory Reset or Restore Configuration. The system should be validated while at dock to ensure that the loaded parameters function correctly with the installed system.

6.10.3.2.1 Factory Reset

The Factory Reset allows a reset of the Kobelt Steering System parameters to the factory defaults. After pressing the Enter button, there are two layers of confirmation screens before resetting is allowed, because previous configuration values will be lost.

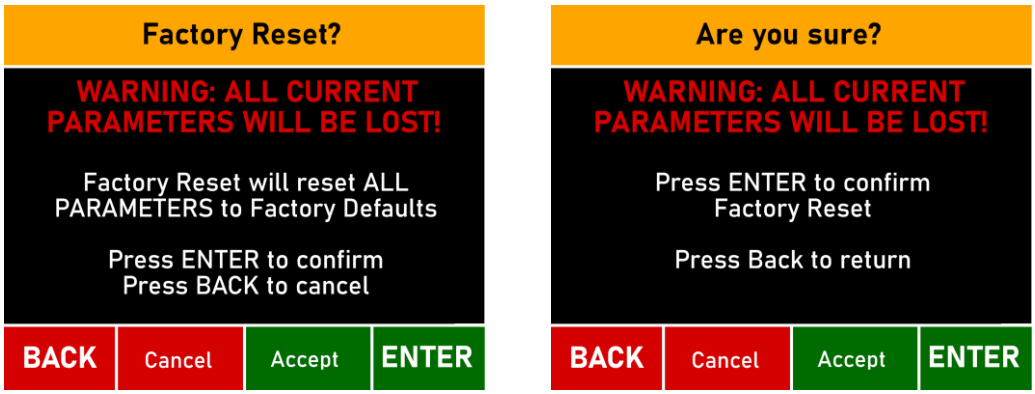


Figure 45: Factory Reset Confirmation Screen

6.10.3.2.2 Restore Configuration

The Restore Configuration allows system parameters to be loaded from a configuration file on the SD card. Before restoring the configuration, please make sure the SD card is inserted properly

After selecting the Restore Configuration and pressing the Enter button, there is one layer of confirmation screen before restoring the configuration.

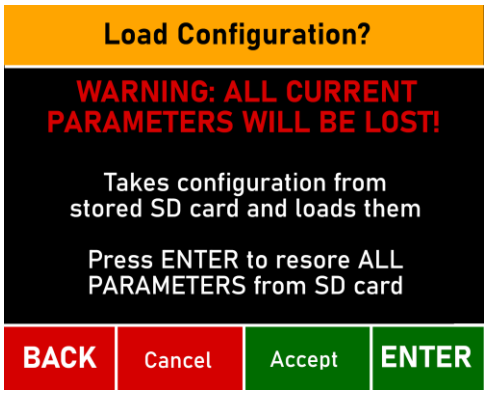


Figure 46: Restore Configuration Confirmation Screen

6.10.3.2.3 Save Configuration

The Save Configuration allows for the saving of system parameters into a configuration file on a SD card. Before saving the configuration, please make sure the SD card is inserted properly.

After selecting the Save Configuration and pressing the Enter button, there is one layer of confirmation screen before saving the configuration.

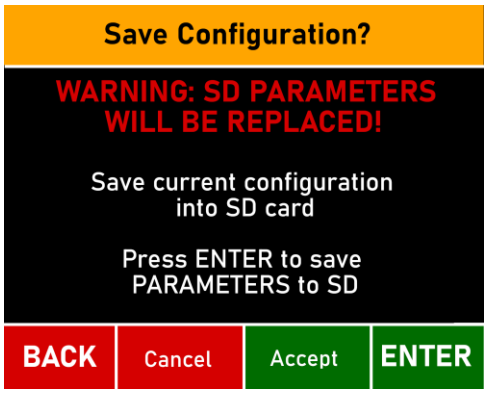


Figure 47: Save Configuration Confirmation Screen

6.10.3.2.4 Success or Failure Screen

After Factory Reset, Restore Configuration, or Save Configuration, a screen will show if the operation is successful or a failure. If failure occurs, make sure that the SD card is fully inserted and that there is a valid configuration file for the firmware version of the system.

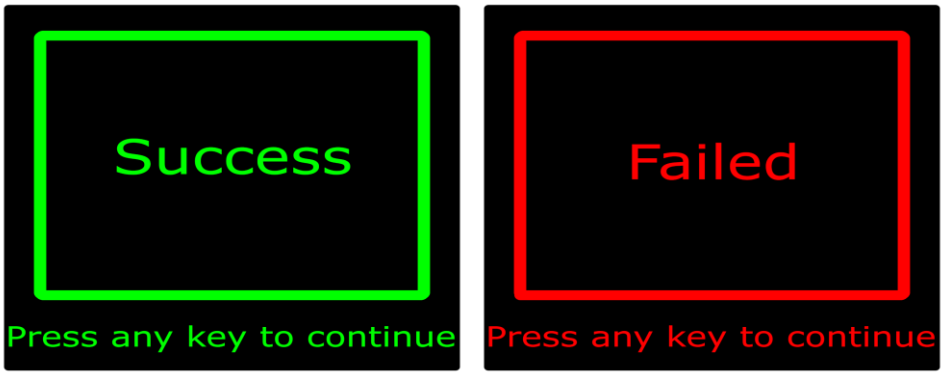


Figure 48: Success or Failed Screen

6.10.3.3 Set Date and Time

Set the date and time of the controller used for the alarms, warnings and logs. Use the Up and Down buttons to change the numbers, Enter button to confirm the change for each digit and go to the next digit, or Back button to go back to the previous digit. The date and time is used by the alarm system and the logging system, the date and time should be checked periodically to ensure that the time is relatively accurate.

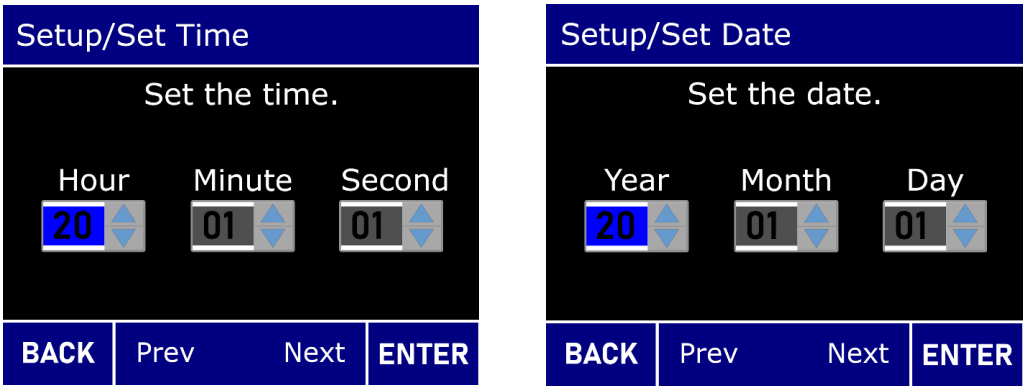


Figure 49: Set Date/Time Screen

6.10.3.4 Set Valve Type

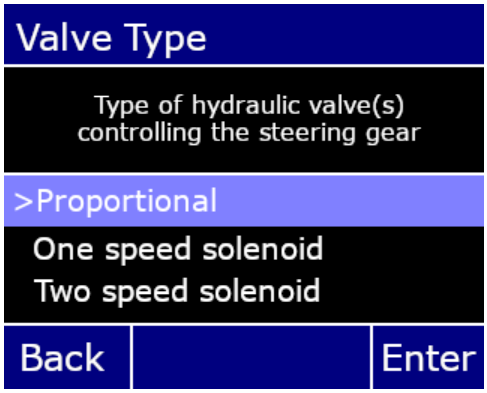


Figure 50: Set Valve Type Screen

- Proportional: Selects the valve type as proportional. This enables/shows menu items that pertain to proportional settings.
  - Ramp settings.
  - Deadband settings
  - PID settings
- One Speed Solenoid: Sets the valve type to solenoid.
- Two Speed Solenoid: Sets the valve type to dual solenoids. Allows two speed jog settings.

NOTICE	The One/ Two Speed Solenoid options will cause some system parameters to be hidden that are not relevant to these valve configurations.

6.10.3.5 Set RFU Type

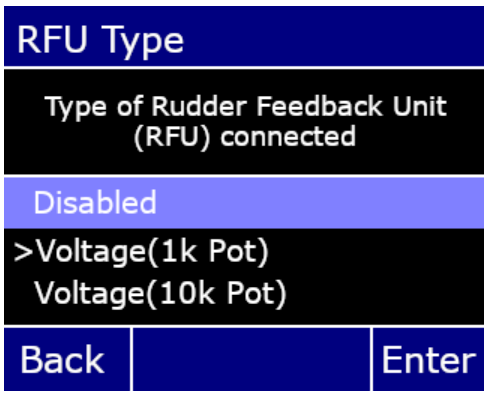


Figure 51: Set FRU Type Screen

- Disabled: no RFU is installed.
- Voltage (1k Pot): RFU readings and calibration expect a voltage reading from a 1k Pot.
- Voltage (10k Pot): RFU readings and calibration expect a voltage reading from a 10k Pot.

- 4-20mA – RFU readings and calibration expect a current reading driven by a 4-20mA transmitter.

6.10.3.6 Jog Control

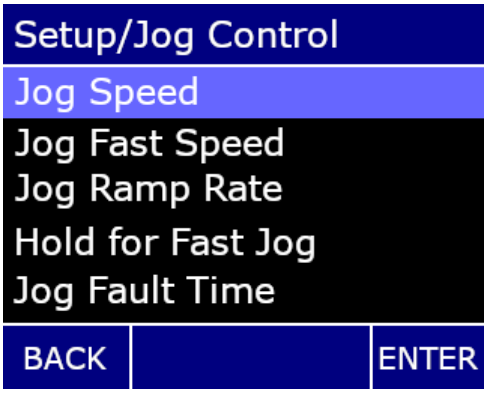


Figure 52: Setup Jog Control Screen

- Jog Speed: The proportional output setting that determines the final percentage the valve is set when an NFU jog input or a Jog button is pressed. This setting must be less than the **Jog Fast Speed**. If a high **Jog Speed** is required first raise the **Jog Fast Speed** higher to allow jog speed to reach the desired speed.
- Jog Fast Speed: The proportional output setting that determines the final percentage the valve is set when an NFU fast jog input or, when set, the hold for fast jog criteria is met. This setting must be greater than the **Jog Speed** parameter. If a lower **Jog Fast Speed** is required first lower **Jog Speed** to ensure **Jog Fast Speed** can reach the desired level.
- Jog Ramp Rate: Preset values for increasing the proportional valve output to meet the desired input for both jog and fast jog commands.
    - Intermediate
    - Very Fast
    - Fast
    - Medium
    - Slow
    - Very Slow
- Hold for Fast Jog: A preset values that determine the time that an NFU jog commands;

    1) Increase the proportional output to the Jog Fast Speed or
    2) Turn on Valve #2 when Two On-off valves configured

    - Disabled
    - Hold for 1.0 Seconds
    - Hold for 1.5 Seconds
    - Hold for 2.0 Seconds
    - Hold for 2.5 Seconds
    - Hold for 3.0 Seconds
    - Hold for 4.0 Seconds
    - Hold for 5.0 Seconds

- Jog Fault Time: A value in milliseconds that a fault is detected on any of the Jog inputs. If a jog input is detected constantly for this period, the input is disabled until it is acknowledged and release.
    - Default 30000(30 seconds)

6.10.3.7 Autopilot Control

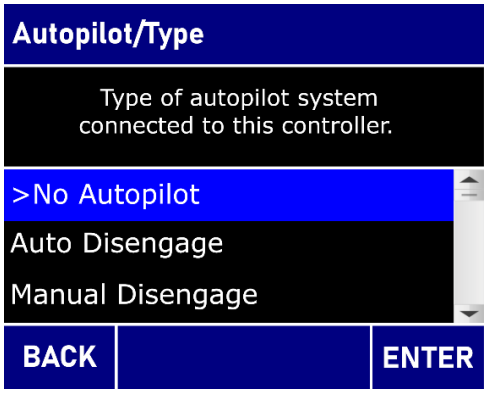


Figure 53: Autopilot Type Settings

6.10.3.8 Autopilot Setup

On systems with an autopilot. The autopilot outputs can be put through the system to use Jog, and Wheel inputs for dodge functions. Pressing the Autopilot button will allow signals from the autopilot to be sent to the solenoids based on the Autopilot Speed setting for proportional valves, or solenoid 1 for one or two speed valve setup.

- Autopilot Type
  - Disabled
    - Used when no autopilot is used or,
    - if the autopilot controls the steering gear directly. In this case Digital input B should be closed with a dry contact to eliminate any faults generated on the Kobelt steering system.
  - Auto Disengage
    - Jog or rotating of wheel will cause the Autopilot to disengage bringing control exclusively back to the Kobelt steering system
    - The user must press the Autopilot button to allow autopilot signals to send to the solenoids again
  - Manual Disengage
    - Only signals from the Autopilot inputs will be routed to the steering gear
    - All controls from the Kobelt steering system are disabled until the Autopilot button is pressed again.
    - The user must press Autopilot to disable signals from the Autopilot to be routed to the solenoids
  - Always live
    - Jog or rotating of wheel will cause the Autopilot signals to be temporarily (3 seconds) be disabled to allow steering control from the Kobelt steering system. During this time the Autopilot LED will flash approximately once every 2 seconds
    - The user must press Autopilot to disable signals from the Autopilot to be routed to the solenoids

- Autopilot Speed: This is configured when system uses proportional valves and is programmed with the amount of flow when an autopilot command is received

- Autopilot Ramp Rate: This is configured when system uses proportional valves and is programmed with the relative amount of flow rate to the maximum 'Autopilot Speed' is reached when an autopilot command is received

6.10.3.9 Number of Stations

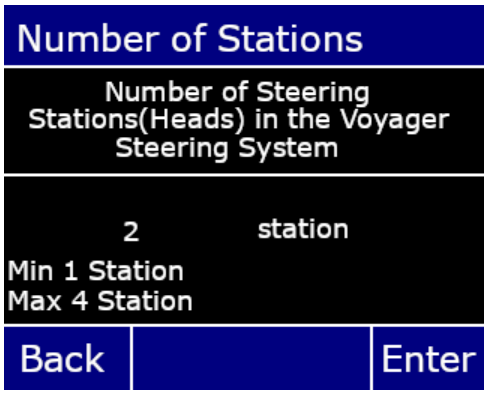


Figure 54: Number of Stations Screen

- Select between 1 and 4 stations within the system by pressing the Up or Down button.

6.10.3.10 Station Activation

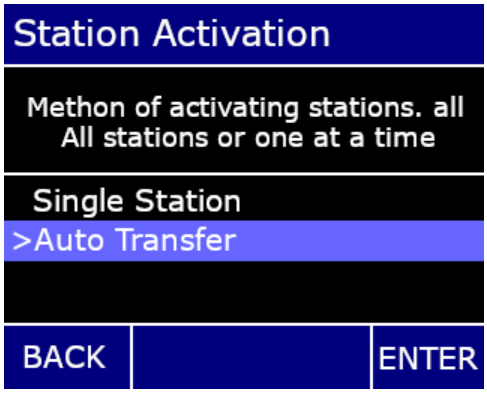


Figure 55: Station Activation Screen

- Single Station: Require pressing the Station Select button when transferring the control from one station to another.
- Auto Transfer: When using Jog commands from the NFU, the Station Jog buttons, or the Wheel the station being used will take control, or automatically transfer. When in FFU mode the transfer mechanism is the same as the **Single Station Mode** stated in the above bullet point.

6.10.4 Station Setup

6.10.4.1 Steering station menu

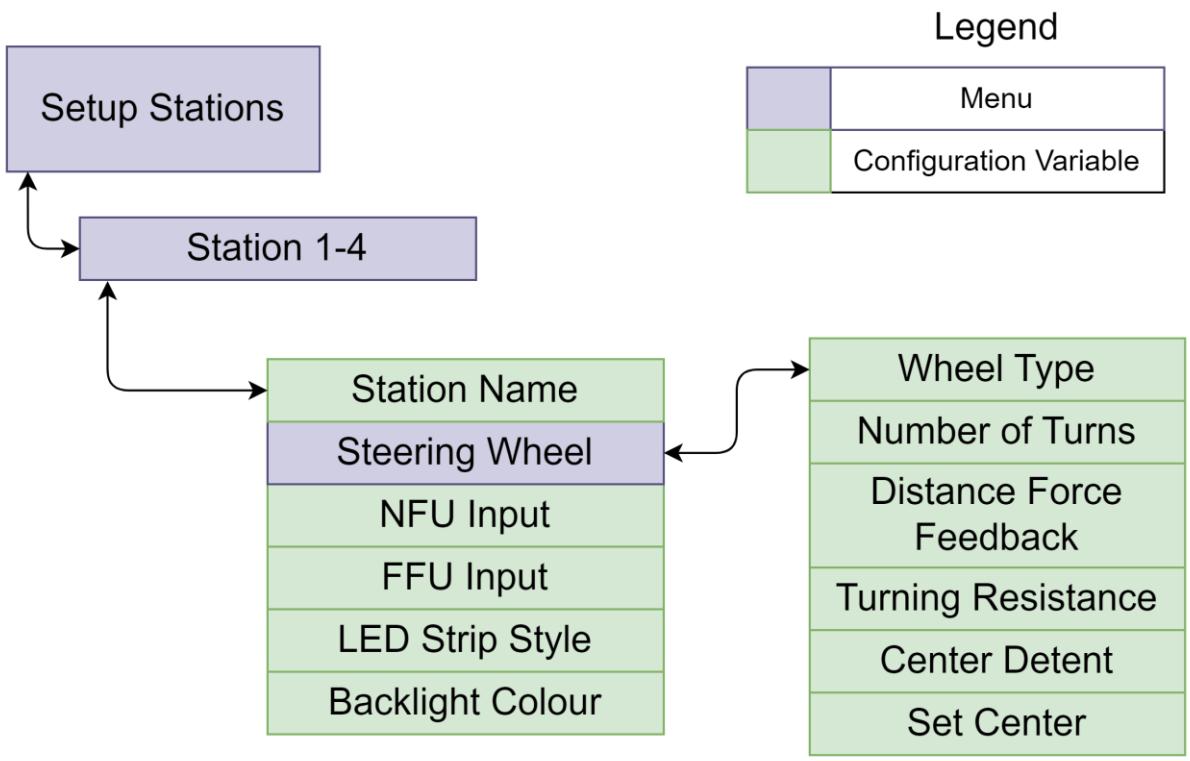


Figure 56: Steering Station Configuration Menu Overview

6.10.4.2 Select Station to configure.

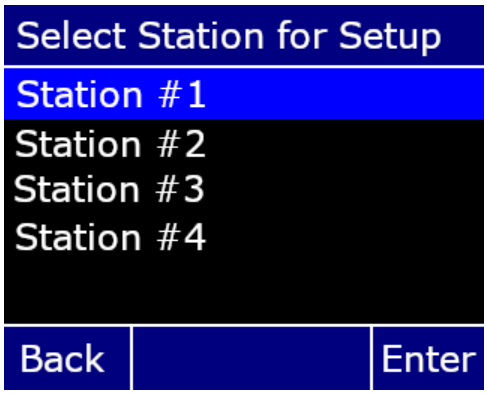


Figure 57: Station Select Screen

- Station #1-#4 – Depending on the number of stations configured the option of which station to configure is done on this Screen.

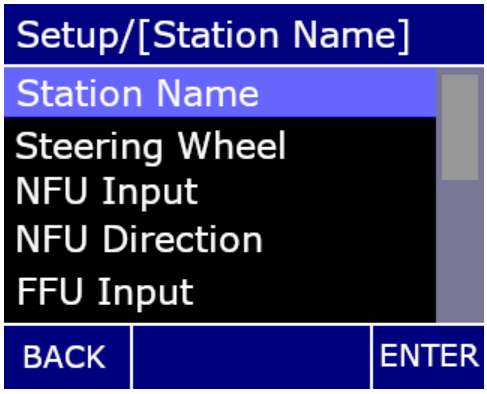


Figure 58: Station Setup Screen

- 6.10.4.3: Change the station name representation in menu and monitoring screens.
- 6.10.4.4: Enable/Disable the electronic steering wheel and configure its operating parameters.
- 6.10.4.5: Set the NFU type of the selected station.
- 6.10.4.6: select the FFU input as disabled, 1k, 5k or 10k potentiometer.
- 6.10.4.7: Set the Led strip on the head to either RAI as the bright led or the ROI as the bright LED
- 6.10.4.8: Select the backlight colour as disabled, white, or red. This is the color that the outlines of the station will glow in low light levels.

6.10.4.3 Set Station Name

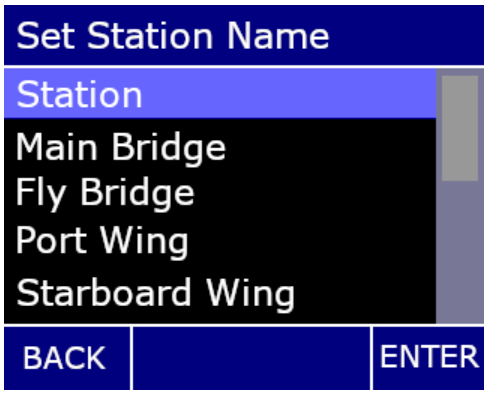


Figure 59: Set Station Name Screen

In this screen, you can select the name for each station, based on where the station locates on the boat. It has below selections and the default value is “Station”.

⚠WARNING	The station selected as station 1 should always be placed at the main bridge or main helm station. This is because this station is provided with overriding features compared to other stations.

- Station
- Main Bridge
- Fly Bridge
- Port Wing
- Starboard Wing
- Port Aft
- Starboard Aft
- Auxiliary1
- Auxiliary2

6.10.4.4 *Electronic Steering Wheel*

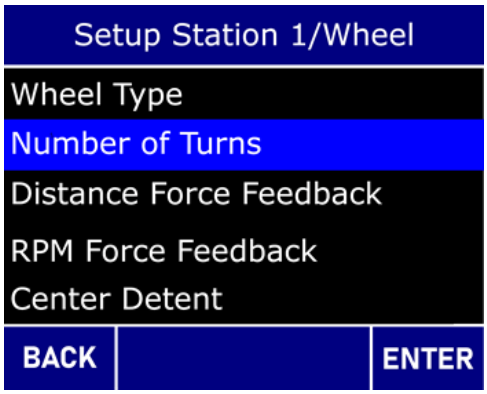


Figure 60: Steering Wheel Setup Screen

NOTICE	On a system with multiple stations, switching to a station with a wheel may come with an offset. This offset will decrease so that the zero position will become the center in a short period of time.

SAFETY INSTRUCTIONS	Before the setup the wheel and or center it, please make sure that the wheel is correctly connected to the Head/Station. Try to rotate the wheel and make sure rudder order moves within the wheel rotation

- Wheel Type:
  - No Wheel
  - Kobelt TFD Wheel

  Currently the Kobelt Steering System only supports a TFD wheel through the secondary CAN bus connector.

- Number of Turns:
  - 1 turn to 8 turns

  Changing this setting will allow the user to specify the number of turns required to go from the virtual port end-stop to the virtual starboard end-stop. The range of this setting is from 1 turn to 8 turns.

  For example, if the port and starboard virtual end-stops are -40 to 40 degrees and the user wants 1 wheel turn to translate into 10 degrees of rudder order, then the required wheel turns would be 8 to achieve this. This would mean to travel 80 degrees of rudder movement would require 8 turns.

- Distance Force Feedback:

- 0.0 to 10 when

This setting allows the user to determine the force feedback of the wheel. The turning resistance the wheel generates is a function of angular distance between the rudder order and rudder angle.

The wheel force feedback parameter is a multiplier on braking resistance based on angular distance between rudder order and rudder angle. This means that if the rudder order is currently 25 degrees and the rudder angle is 20 degrees then the brake force will be 5 degrees multiplied by the distance break force in the configuration. For example if the distance is 5 degrees and the braking force parameter is set to 5 then an additional 25% braking force will be applied to the wheel on top of the regular turning resistance. The braking force maxes out at 60% to avoid confusing end-stops and large differences in rudder angle and rudder order.

- Turning Resistance:
  - 0.0 to 30

  Turning resistance is the base resistance that the wheel will apply. A setting of 0 will mean there is no turning resistance applied electromagnetically from the wheel. A turning resistance of 30 would mean 30% of the electromagnetic resistance generated by the wheel is always applied. Users with power consumption concerns may opt for lower Turning Resistance as this will reduce the power consumption of the wheel.

- Center Detent:
  - Disabled
  - Soft
  - Medium
  - Hard

  The wheel can provide a center detent as the rudder order crosses the zero angle. The rudder order angle is aligned with the wheels internal absolute position. The user can change this center detent position with the Set Center menu option which will change the wheels absolute zero position. Please note that the wheel's center detent can momentarily change due to multiple wheels operating in the system. This effect will only be momentary as the wheel will synchronize back into alignment and maintain its absolute position.

- Set Center:

  If the wheel center detent does not match with the desired position. It can be configured for a different center position through the setup menu.

  First align the wheel with the desired center position and then enter the setup configuration menu and navigate to the correct head/station submenu and wheel submenu.

  Locate the list item "Set Center", it is highlighted upon selection.

  By pressing the "ENTER" keypad button, this will tell the system to re-center the wheel at the current location.

  Please allow, approximately, one second for this action to complete. The wheel centering will take effect upon leaving configuration mode.

  If the wheel is still not at the correct center position, please attempt again.

6.10.4.5 *NFU Input Type*

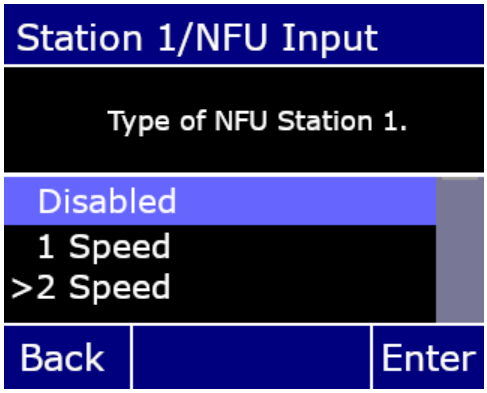


Figure 61: NFU Input Type Screen

- Disabled: No NFU device is installed on this station.
- 1 Speed: A single action Jog lever is installed on this station.
- 2 Speed: A dual action Jog level is installed on this station.

⚠WARNING	The calibrated end-stops will be ignored by NFU (Jog Commands). The system should use limit switches in addition to the virtual end-stops to ensure the rudder does not hit the hard stops.

.

6.10.4.6 *FFU Input*

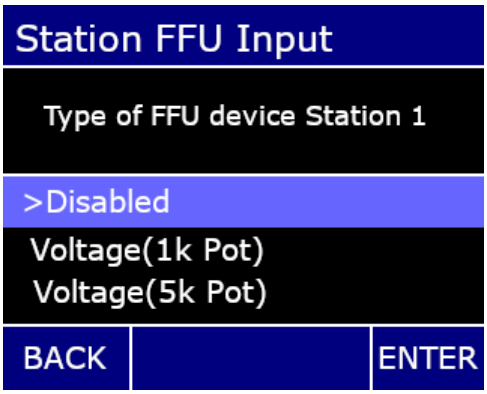


Figure 62: FFU Input Screen

- Disabled: An FFU is not installed on this station.
- 1k Pot: A 1K ohm pot FFU is installed on this station.
- 5k Pot: A 5k ohm pot FFU is installed on this station.
- 10k Pot: A 10k ohm pot FFU is installed on this station.

6.10.4.7 *LED Strip Style*

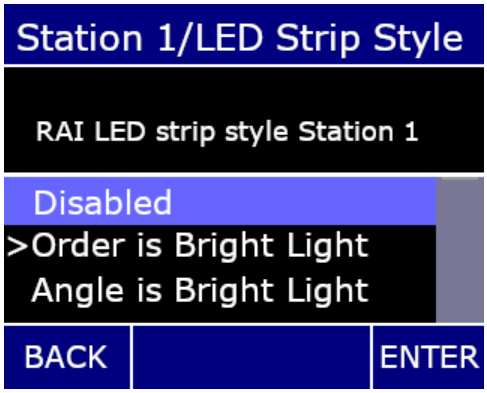


Figure 63: LED Strip Style Screen

- Disabled: No **Rudder Order** and **Rudder Angle**, only the center White LED (0°) is solid ON
- Order is Bright Light: **Rudder Order** is indicated by a single bright LED, and **Rudder Angle** is indicated as strip of dimmer LEDs extending out from centre
- Angle is Bright Light: **Rudder Angle** is indicated by a single bright LED, and **Rudder Order** is indicated as strip of dimmer LEDs extending out from centre

6.10.4.8 *Station Backlight Colour*

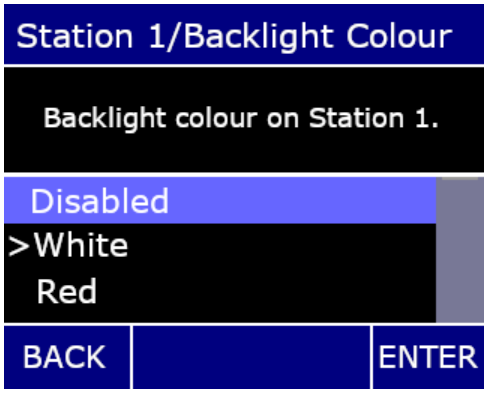


Figure 64: Station Backlight Colour Screen

- Disabled: LED backlight turned off
- White: Backlight colour is white
- Red: Backlight colour is red

6.10.5 Rudder Setup

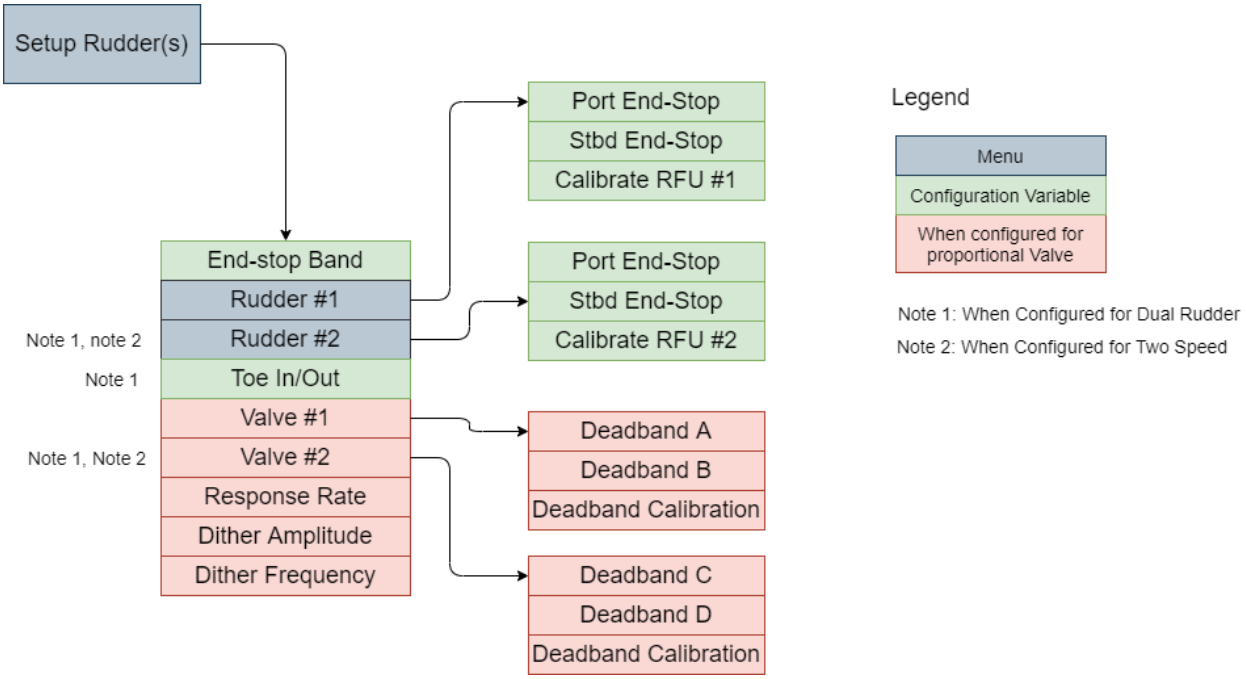


Figure 65: Setup Rudder(s)

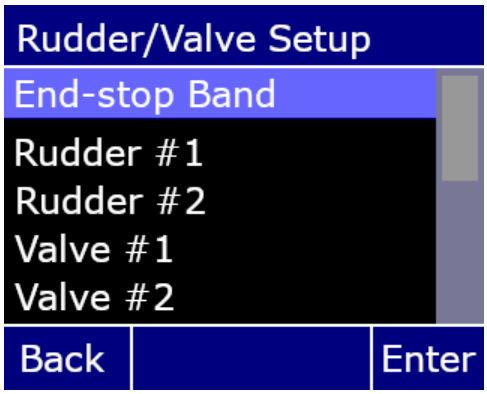


Figure 66: Rudder/Valve Setup Screen

- End-stop Band: This is the acceptable angle to stop driving the second solenoid in a 1 rudder, 2 valve on-off system, when approaching the configured end-stop.
- Rudder #1: unique settings for Rudder #1
  - Port End-stop
  - Stbd End-stop
  - Calibrate RFU #1

NOTICE	Rudder #2, Valve #2 and Toe In/Out are only available when Dual Rudder is enabled.

NOTICE	Valve #1, Valve #2, Response Rate, Dither Amplitude and Dither Frequency are only available when the Valve Type is set to Proportional

NOTICE	Ensure that the dead-band is set to a level that does not cause the system to cycle, or hunt after reaching the correct position. Default is 0.5 degrees and a maximum of 5 degrees is possible.

- Rudder #2: unique settings for Rudder #2 –
  - Port End-stop
  - Stbd End-stop
  - Calibrate RFU #2
- Toe In/Out: Offset angle between the two rudders when the order is 0 degrees.
  -

NOTICE	Toe out angles are positive. Toe in angles are negative.

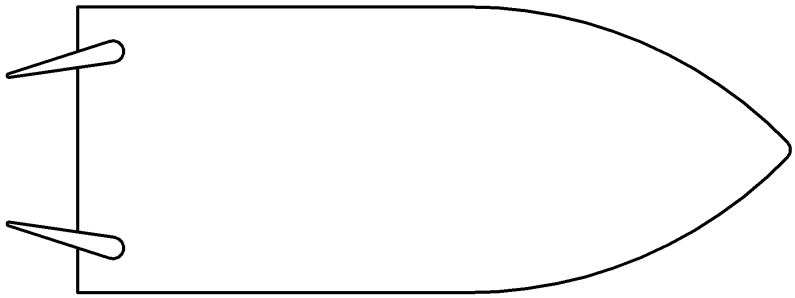


Figure 67: Toe in configuration

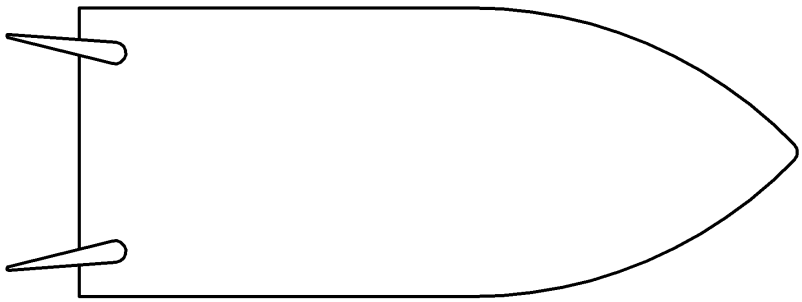


Figure 68: Toe out configuration

- Valve #1: unique settings for Valve #1
  - Dead-band A: Percentage of drive at solenoid A, that is required to start rudder movement in a given direction.
  - Dead-band B
  - Calibrate Dead-band: automatic calibration of dead bands. (For details see 7.3.1.2.1)

- Valve #2: unique settings for Valve #2 –
    - Dead-band C - Percentage of drive at solenoid C that is required to start rudder valve movement in a given direction.
    - Dead-band D
    - Calibrate Dead-band automatic calibration of dead bands. (For details see 7.3.1.2.1)
- Response Rate: delay to get to a given command
- Dither Amplitude: 0 – 10%, oscillation added to the proportional valve command in percent.
- Dither Frequency: 0 – 200 Hz, the frequency of the dither amplitude added to the proportional valve command.

6.11 Configuration Parameters

⚠WARNING	System configuration must be completed prior to commissioning of the vessel and calibration. If reference menu pictures do not match, please download the latest manual version at www.kobelt.com.

The system should be configured to match the physical hardware attached to the Voyager System. Refer Appendix C for the detail.

6.12 Default Configuration

Refer Appendix A for the detail.

7 COMMISSIONING

7.1 COMMISSIONING CHECKLIST

7.1.1 DUAL RUDDER STEERING SYSTEM COMMISSIONING CHECKLIST

Activity	Setting	Completed
Set valve solenoid type (Proportional, On/Off)		
Dual Rudder (must be Enabled)		
Set Rudder 1 Endstop Port		
Set Rudder 1 Endstop Starboard		
Set Rudder 2 Endstop Port		
Set Rudder 2 Endstop Starboard		
Set RFU Type		
Calibrate RFU 1		
Calibrate RFU 2		
Set System Time		
Set number of stations		
Set Station Activation Type		
Set External Alarm Interface		

7.1.2 SINGLE RUDDER STEERING SYSTEM COMMISSIONING CHECKLIST

Activity	Setting	Completed
Set valve solenoid type (Proportional, On/Off)		
Dual Rudder (must be Disabled)		
Set Rudder 1 Endstop Port		
Set Rudder 1 Endstop Starboard		
Set RFU Type		
Calibrate RFU 1		
Set System Time		
Set number of stations		
Set Station Activation Type		
Set External Alarm Interface		
Set Autopilot Type		
Set autopilot speed if proportional solenoids are used		

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STEERING SYSTEM Stations COMMISSIONING CHECKLIST

Activity	Setting	Completed
Set Station 1 input devices		
FFU (Disabled, 1K, 5K, 10K)		
NFU (Disabled, 1 speed, 2 Speed)		
SBW Wheel (No Wheel, Kobelt TFD Wheel)		
Set Station 2		
FFU (Disabled, 1K, 5K, 10K)		
NFU (Disabled, 1 speed, 2 Speed)		
SBW Wheel (No Wheel, Kobelt TFD Wheel)		
Set Station 3		
FFU (Disabled, 1K, 5K, 10K)		
NFU (Disabled, 1 speed, 2 Speed)		
SBW Wheel (No Wheel, Kobelt TFD Wheel)		
Set Station 4		
FFU (Disabled, 1K, 5K, 10K)		
NFU (Disabled, 1 speed, 2 Speed)		
SBW Wheel (No Wheel, Kobelt TFD Wheel)		
Configure Station 1 SBW Wheel if needed		
Configure station 2 SBW Wheel if needed		

Configure station 3 SBW Wheel if needed		
Configure station 4 SBW Wheel if needed		
Calibrate station 1 FFU if needed		
Calibrate station 2 FFU if needed		
Calibrate station 3 FFU if needed		
Calibrate station 4 FFU if needed		

7.2 STEERING STATION ID SELECTOR INTERFACE

Each steering station is assigned a unique ID number to identify it to the rest of the system.

- Sets the station ID of the Head
- Sets the station ID of the Head.
- Small rotary switch on the rear side of the Head, near the electrical connectors.
    - Requires small screwdriver to turn.
- Four positions numbered 1, 2, 3, 4, corresponding to stations 1-4.

Figure 69: Station ID Selector location

⚠WARNING	Station 1 can override station lock at another station. It is recommended that this station should be in the main bridge or the machine room depending on emergency procedures.

7.3 CALIBRATION AND ADJUSTMENT

⚠WARNING	Calibration of the system should be performed while dockside. Upon completion of calibration all systems should be tested to ensure function. Calibration at sea should only be performed in the event of an emergency or by trained personnel.
⚠CAUTION	Calibration and Adjustment should only be performed once wiring of the system has been validated.

After wiring has been checked and validated, please power on the system and run through all the applicable calibration items.

7.3.1 Valve Calibration

NOTICE	The valve configuration parameters are in two separate locations, one to set valve type and then the other to change valve settings.

7.3.1.1 Set Valve Type

The system requires the correct valve type to be selected. The system supports 3 different types.

- Type1 is a proportional valve.
- Type2 is a single speed on/off solenoid.
- Type 3 is a two-on/off solenoid in a two-speed configuration.

Please navigate to the “Set Valve Type” option located in the “Steering System” menu and select the correct valve for the intended system.

7.3.1.2 Specific Valve Settings

Please navigate to the “Valve #1” or “Valve #2” option located in the “Setup Rudder(s)” menu and configure parameters below for the intended system.

7.3.1.2.1 Automatic Valve Dead-band Calibration

Navigate to the valve dead-band calibration menu and select automatic calibration. The automatic calibration takes 30-60 seconds, and the valve LED indicates which valve is being driven to find the dead-band. The system will adjust the output to each of the coils gradually until it detects a movement in the rudder from the RFU reading.
It is recommended after automatic calibration confirm the valve dead-band values.

7.3.1.2.2 Dead-band A-B-C-D

This setting allows applying a specific dead-band to each valve output denoted by the letters A-B-C-D. This setting adjusts the minimum valve output required to start moving the.

To determine this setting manually;

- Set the deadband for all coils to 0
- Set the jog parameter (Jog Settings Screen)to 10 percent in the Jog Settings menu
- Move the rudder with the Jog buttons on the station port and starboard
- If the rudder does not move, then the value is higher.
- If it moves, then decrease it until operating the jog buttons does not move the rudder.

- This can be done coarsely at starting at 10% and adding 10 percent until movement of the rudder us detected
- When rudder movement is detected, decrease it by 5%.
- If the rudder still moves, decrease it by 2%, or if the rudder does not move, increase it by 3%.
- The value for port or starboard movement can be different.
- Record these numbers for input into the Deadband settings

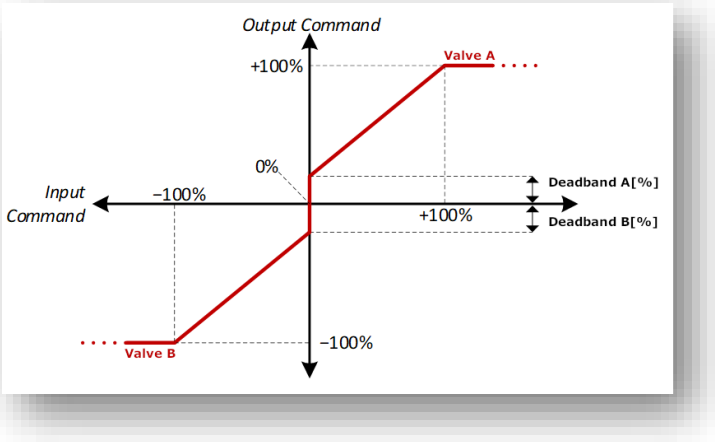


Figure 70:Valve Dead-band Graph

NOTICE	Poor dead-band calibration can result in poor system performance.

7.3.1.2.3 Response Rate

The response/slew rate of the valve determines the speed at which the output responds to a new command. The options ranges are:

- Immediate: 1000 percent/sec
- Very Fast 100 percent/sec
- Fast 50 percent/sec
- Medium 25 percent/sec
- Slow 10 percent/sec
- Very Slow 2.5 percent/sec

7.3.1.2.4 Dither Amplitude

NOTICE	Dither is a superimposed frequency on the valve output signal. This can help smooth out valve motion by reducing the valve sticking. If the rudder appears to get stuck or have jittery motion, try implementing dither.

Dither amplitude is the magnitude of the superimposed signal. If a dither amplitude of 5% is selected, then the super imposed signal will oscillate around the main valve output signal by a max of 2.5%.

7.3.1.2.5 Dither Frequency

Dither frequency is the frequency at which the imposed dither signal will oscillate. The default value is 0hz, which means no dither is applied to the output signal. Dither should be added to optimize valve responsiveness. For example, the dither frequency to 10hz and dither amplitude is 5% and the valve driver is at 50% duty cycle, then valve will oscillate between 45% and 55% at 10 times a second. The average signal will be 50% but the dither will keep the valve in constant motion reducing the chance of sticking.

7.3.2 RFU Calibration

NOTICE	The Port and Starboard endstops should be wired and tested before RFU calibration is performed.

NOTICE	The RFU Calibration is from configured Port End-stop to configured Starboard end-stop. Any error in configuring the end-stops, or in this calibration will cause an error in the steering system controls.

The RFU (rudder feedback unit) should be calibrated before operation of the vessel. The RFU requires a three-point calibration, one at the port end-stop, another at dead center and the last at the starboard end-stop. Navigate to the “Calibrate RFU” as the below sequence:

- Main Monitoring Screen -> Passcode -> Setup Selection Screen -> Setup -> Setup Rudder (s) -> Rudder #1

Following the instructions given from the top of the Calibrate RFU screen, you need to press the Left or Right button on the Controller to move the rudder to the required angle, Up or Down button to change the speed of rudder moving, Enter button to confirm the angle, and Back button to back to the previous screen.

Step One: Move the rudder to virtual Port End-stop (angle dependent on the configuration (**Port End-stop**), then press the ENTER button to accept the position.
Step Two: Move the rudder to center position, 0 degree, then press the ENTER button to accept the position.
Step Three: Move the rudder to the virtual Stbd End-stop (angle dependent on the configuration (**Starboard End-stop**), then press the ENTER button to finish the RFU calibration.

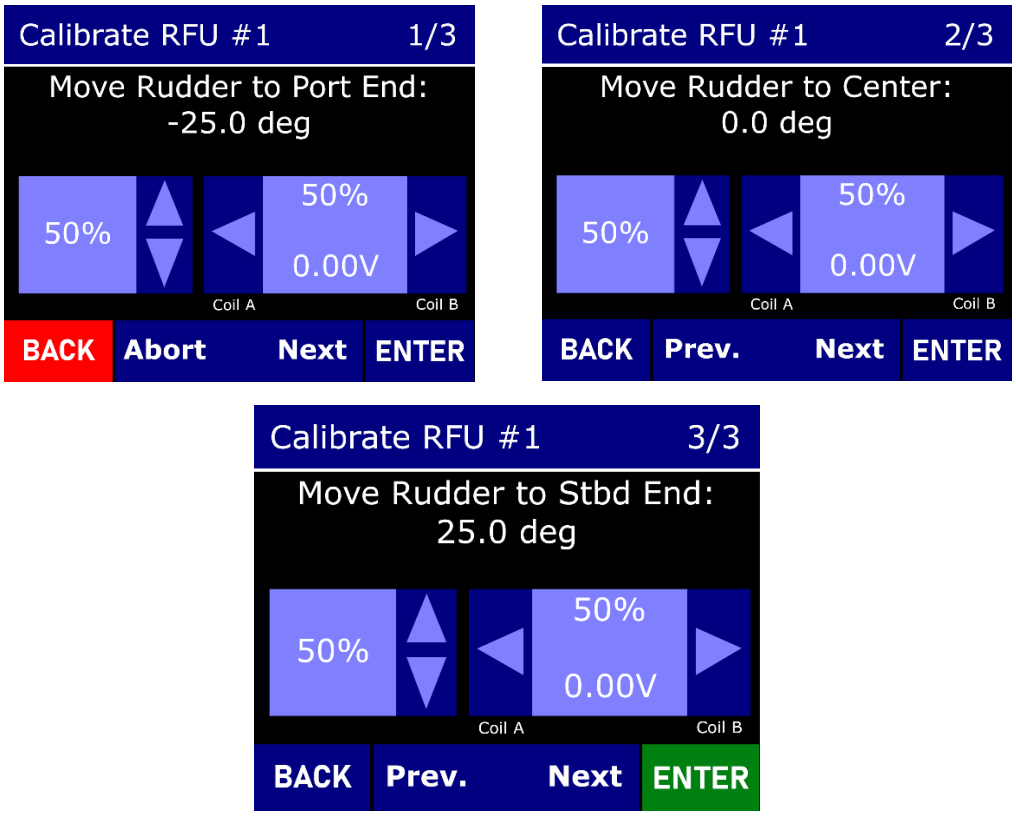


Figure 71: RFU Calibration Screens

- Pressing the BACK button at any time will take you to the previous calibration step or in the case of port calibration screen, it will take you back to the Setup RFU #1 screen.
- Pressing the BACK button for 5 seconds any time during calibration takes you out of the RFU calibration entirely.
- The RFU can be re-calibrated by repeating the above steps. If the BACK key is pressed while calibrating a new position will be stored on pressing ENTER again.

⚠WARNING	After completion of RFU calibration, the calibration should be verified by moving the rudder through the full range of motion with a FFU, (after FFU Calibration procedure), or a SBW wheel. Ensure that the device does not go outside the bounds of the desired virtual end-stops.

7.3.3 FFU Calibration

NOTICE	The FFU Calibration is from configured Port End-stop to configured Starboard end-stop. Any error in configuring the end-stops, or in this calibration will cause an error in the steering system controls.

All **FFU Input Device** on each Head should be calibrated before operation of the vessel. A three-point calibration process is required.

1. Enter the Setup Menu on the Controller.
2. On the Head, press and hold the **Brightness Up Button** and the **FFU Mode Button** simultaneously for 3 seconds to start the FFU Calibration.
    a. If there is any fault with the Head, the system will not allow the calibration to start, the internal buzzer and Station Select LED will flash/beep 3 times.
3. The 35° Port LED on the RAI Strip and the FFU LED begin flashing.
4. Move the **FFU Input Device** to extreme Port.

NOTICE	Not moving the device to extreme port will cause an error in calibration and the resolution of the FFU lever will not be correct.

5. Press the **Jog Starboard Button** to proceed to the next calibration step.
6. The 35° Port LED stops flashing, and centre (0°) LED on the RAI strip begins flashing.
7. Move the **FFU Input Device** to the centre position (0°).

NOTICE	If the 0 position is not calibrated correctly errors will be present when using the FFU position.

8. Press the **Jog Starboard Button** to proceed to the next calibration step.
9. The 0° Centre LED stops flashing, and 35° Starboard LED on the RAI strip begins flashing.
10. Move the **FFU Input Device** to Extreme Starboard.

NOTICE	Not moving the device to extreme port will cause an error in calibration and the resolution of the FFU lever will not be correct.

11. Press the **Jog Starboard Button** to finish the calibration, the 35° Starboard LED will stop flashing, and the centre LED on the RAI strip will begin flashing, followed by a head buzzer beep, upon completion of a successful calibration

If the **Jog Starboard Button** is not pressed within 10 seconds, or the **FFU Mode Button** is pressed at any point during the calibration, the calibration is aborted, and the internal buzzer of the Head will beep to notify that the calibration has failed.

7.3.4 Active Setup

The Active Setup gives the user access to a set of parameters necessary for fine tuning the behaviour of the control system while the controls are live

To navigate menus, see section 6.10.1

To enter the password, see section 6.10.2

Before allowing access to this menu, a caution message is displayed, acknowledge the inherent risk when modifying Parameters:

⚠WARNING	System tuning should only be performed by qualified personnel. Contact an installation representative to assist as required.

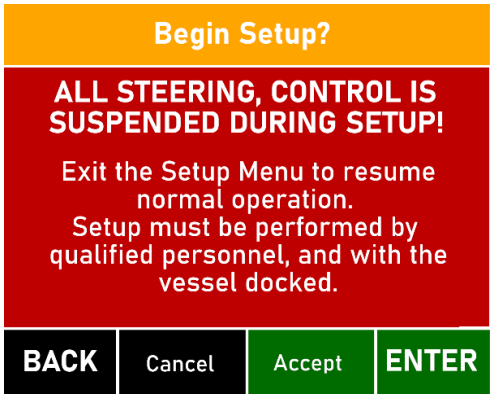


Figure 72: Entering Active Menu

7.3.4.1 Active Menu Overview

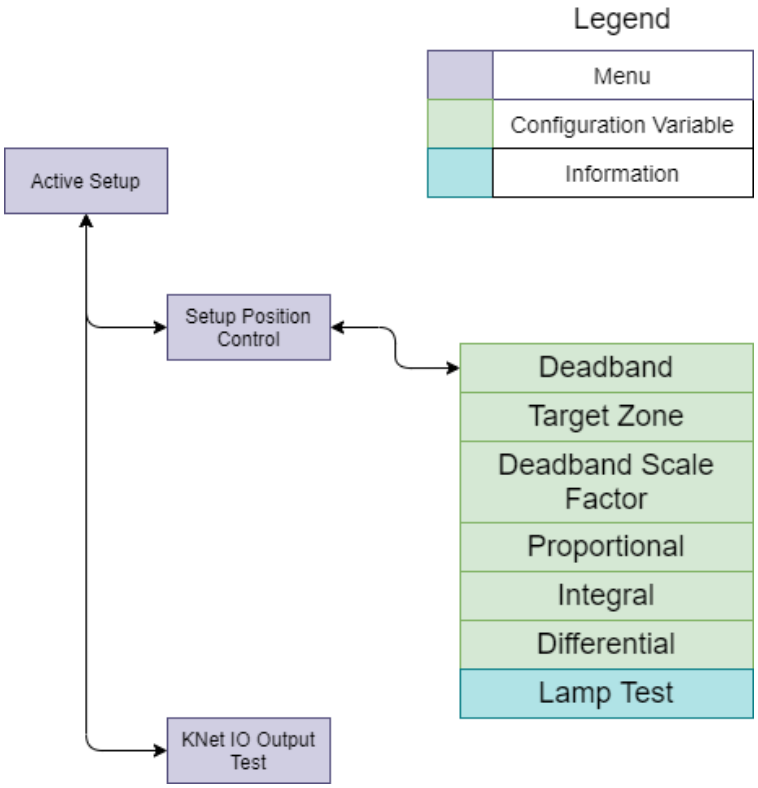


Figure 73: Active Menu Overview

Once in the Active Setup Menu, the operator can edit the parameters needed to tune the control of the vessel such as Position Control Setup.

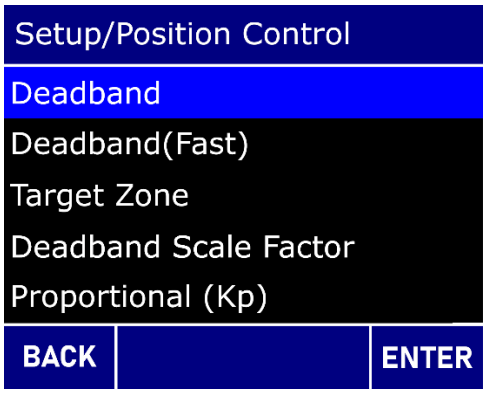


Figure 74: Position Control Menu Screen

- Dead-band
- Fast Dead-band
- Target Zone
- Dead-band Scale Factor
- Proportional (Kp)
- Integral (Ki)
- Derivative (Kd)

NOTICE	For more detailed information and information on calibration of these parameters check the calibration section.

7.3.4.2 Dead-band Configuration

Dead-band is the angle the system will allow the rudder measurement to oscillate before a rudder order will take place. For example, if the rudder is set for 2 degrees of dead-band and the current rudder order is 0 degrees and the measured rudder angle is 1 degree, the position controller will not drive the valves. The position controller will only drive the valves when the rudder angle gets 2 degrees away from the rudder order.

For optimal system performance the dead-band should be set as low as possible while not introducing unwanted oscillation about the requested rudder position. This oscillation can be observed by the valves A-B oscillating between on and off consistently around the desired position order.

7.3.4.3 Fast Dead-band Configuration

NOTICE	Fast dead-band parameter only applies to systems that have a two-speed solenoid setup.

Fast dead-band is the angle that the second solenoid will turn on. For example, if the system has been configured within a 2 degree dead-band and a 5 degree fast dead-band, the second solenoid will only turn on when the rudder order is 5 degrees or greater from the rudder angle. This value should be tuned to achieve the desired system response of the operator.

7.3.4.4 Target Zone

The target zone is the desired angular positional accuracy of the system when given a new rudder order. For example, if the Target zone is 1 degree and the current rudder order is 25 degrees and the operator changes it to 20 degrees. The position controller will drive the rudder until it gets within 1 degree of the desired position. The position controller will re-issue a valve command when the rudder order changes by 1 degree

7.3.5 PID and Position Control Settings

Fast dead-band is the angle that the second solenoid will turn on. For example, if the system has been configured within a 2 degree dead-band and a 5 degree fast dead-band, the second solenoid will only turn on when the rudder order is 5 degrees or greater from the rudder angle. This value should be tuned to achieve the desired system response of the operator.

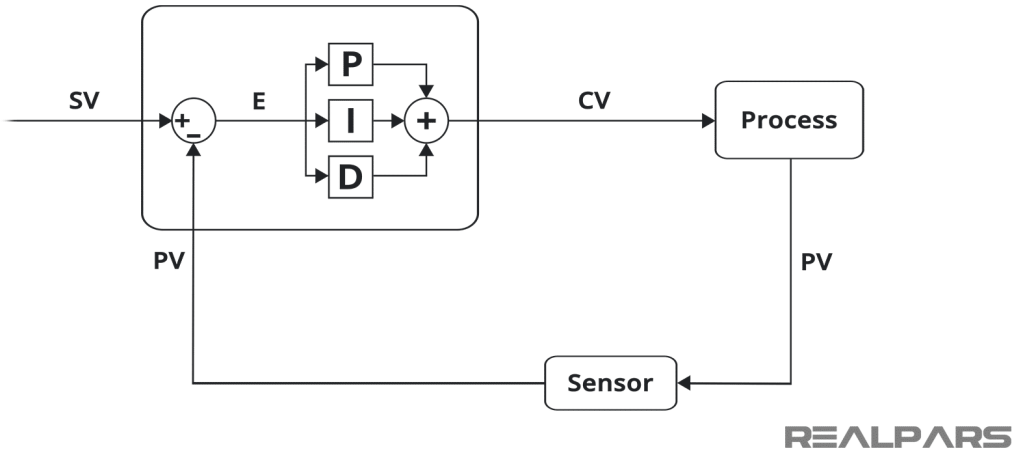
7.3.5.1 Target Zone

The target zone is the desired angular positional accuracy of the system when given a new rudder order. For example, if the Target zone is 1 degree and the current rudder order is 25 degrees and the operator changes it to 20 degrees. The position controller will drive the rudder until it gets within 1 degree of the desired position. The position controller will re-issue a valve command when the rudder order changes by 1 degree.

NOTICE	A value too small will cause the system to be unstable. This is dependent on the system design. A maximum of 2 degrees is but must be less than the dead band.

7.3.5.2 Valve driving using the PID concept

PID stands for proportion, integral and differential. Each of these work in conjunction to compute a drive value to the valve and is limited in change by the slew rate, and mechanical slew of the system.



7.3.5.3 Proportional Gain

This is the gain used to compute the valve command and direction. It multiplies the accumulated steering error by the stored gain. A valve response that is too big for the system may cause the system to steer past the target. A value that is too small will be slow to reach its target.

7.3.5.4 Integral Gain

This is the gain used to compute the valve command and direction. It takes the previous integral value and adds the proportional error and multiplies it by this gain. This is used to remove steady state errors. A slight reading outside of the target or deadband zones will accumulate and cause the valve to move the steering gear into the correct position. A value too big will cause the system to oscillate around the target zone. A value too small will not move to the correct position and the steady state error will remain.

7.3.5.5 Derivative Gain

This is the gain used to compute the valve command and direction. It takes rate of change of the error and allows a quicker resolution on very fast systems. Practically, for most systems this is not necessary and is set to 0.

7.3.5.6 Slew Rate

This configuration parameter is in the Valve setup menu when configured as a proportional valve. This is the maximum rate change for the valve control. Fast is almost immediate, and slow is about 1 second from 0 to 100%.

7.4 FUNCTIONAL TEST

7.4.1 Jog Controller

7.4.1.1 One Speed Jog Configuration

- At an active station
  - Press the Jog STBD button
  - Verify that the Rudder moves to Starboard.
- At an active station
  - Press the Jog Port button
  - Verify that the Rudder moves to Port.
- At each Steering station equipped with an NFU Jog lever
  - Make the station active
    - Move the NFU Jog lever to starboard
    - Verify the rudder moves to starboard
    - Move the NFU Jog lever to port
    - Verify the rudder moves to port

7.4.1.2 Two Speed Jog Configuration

- At an active station
  - Press the Jog STBD button
  - Verify that the Rudder moves to Starboard.
- If the system is configured ‘Hold for Fast Jog’
  - Hold the button for the time configured in the ‘Hold for Fast Jog’ setting

    - Verify that the rudder speed increases
- At an active station
    - Press the Jog Port button
    - Verify that the Rudder moves to Port.
- If the system is configured for Hold for Fast Jog
    - Hold the button for the time configured in the 'Hold for Fast Jog' setting
    - Verify that the rudder speed increases

7.4.1.2.1 One Speed Jog Lever

- At each Steering station equipped with a one speed NFU Jog lever
- Make the station active
    - Move the NFU Jog lever to starboard
        - Verify the rudder moves to starboard
    - If the system is configured for Hold for Fast Jog
        - Hold the button for the time configured in the 'Hold for Fast Jog' setting
        - Verify that the rudder speed increases
    - Move the NFU Jog lever to port
        - Verify the rudder moves to port
    - If the system is configured for 'Hold for Fast Jog'
        - Hold the button for the time configured in the 'Hold for Fast Jog' setting
        - Verify that the rudder speed increases

7.4.1.2.2 Two Speed Jog Lever

- At each Steering station equipped with a one speed NFU Jog lever
- Make the station active
    - Unlock station in control if needed
    - Press Station select on the station under test
- Move the NFU Jog lever to starboard
    - Verify the rudder moves to starboard
- Move the NFU Jog lever to starboard fast
    - Verify the rudder moves to starboard fast
- Move the NFU Jog lever to port
    - Verify the rudder moves to port
- Move the NFU Jog lever to port fast
    - Verify the rudder moves to port fast

7.4.2 FFU Controller

- At each Steering station equipped with an FFU Jog lever which must be calibrated on commissioning
- Make the station active
    - Unlock station in control if needed
    - Press Station Select on the station under test
- Press the FFU Button and align the FFU Lever to the current rudder angle
    - Move the FFU Jog lever to maximum starboard
        - Verify the rudder moves to starboard angle desired
    - Move the FFU Jog lever to maximum port
        - Verify the rudder moves to port desired angle
    - Move the FFU Lever to center
        - Verify the desired angle

⚠WARNING	The Function Test should be carried out while the vessel is still at dock and before it is taken out to sea and after installation has been completed.

7.4.3 Autopilot

7.4.3.1 Auto Disengage

On an active station

- Press Autopilot Button
  - Verify Autopilot LED flashes – System is waiting for the Autopilot to take control of the rudder
- Enable the Vessels Autopilot and cause the autopilot to command the rudder
  - Verify the Autopilot LED is on – Autopilot is in command of the rudder
- Jog the rudder with one of the jog buttons or the NFU jog lever on the active station
  - Verify the Autopilot LED is off – Autopilot commands are no longer accepted by the system to command the rudder

7.4.3.2 Manual Disengage

On an active station

- Press Autopilot Button
  - Verify Autopilot LED flashes – System is waiting for the Autopilot to take control of the rudder
- Enable the Vessels Autopilot and cause the autopilot to command the rudder
  - Verify the Autopilot LED is on – Autopilot is in command of the rudder
- Jog the rudder with one of the jog buttons or the NFU jog lever on the active station
  - Verify the rudder does not jog by the jog button
  - Verify the LED is solid on

7.4.3.3 Always Live

On an active station

- Press Autopilot Button
  - Verify Autopilot LED flashes – System is waiting for the Autopilot to take control of the rudder
- Enable the Vessels Autopilot and cause the autopilot to command the rudder
  - Verify the Autopilot LED is on – Autopilot is in command of the rudder
- Jog the rudder with one of the jog buttons or the NFU jog lever on the active station
  - Verify the rudder moves by the jog button
  - Verify the LED is flashing
- Cause the autopilot to command the rudder
  - Verify the Autopilot LED is on – Autopilot is in command of the rudder

8 OPERATION

The Voyager Steering System has three modes of operation – Normal, FFU and Autopilot.

8.1 STATION TRANSFER MODE

The Active Station is the station that is presently able to control the rudder position. The system is configurable in one of two modes for selecting the Active Station:

- **Station Select Mode** - Only a single station is enabled. Input devices on all other stations are ignored. To transfer the control, pressing the Station Select button is required. An additional step can be added by utilizing the 'station lock' to lock out other stations until it is desired by the controlling station to release control before a station transfer can occur.
- **Automatic Station Transfer Mode** - Only a single station is enabled, but Controls can be transferred between different stations automatically by operating a NFU Jog Lever or a SBW Helm wheel on any station.

NOTICE	Automatic Station Transfer Mode feature is not available when 'Station Lock' is engaged.

8.2 STATION CONTROL

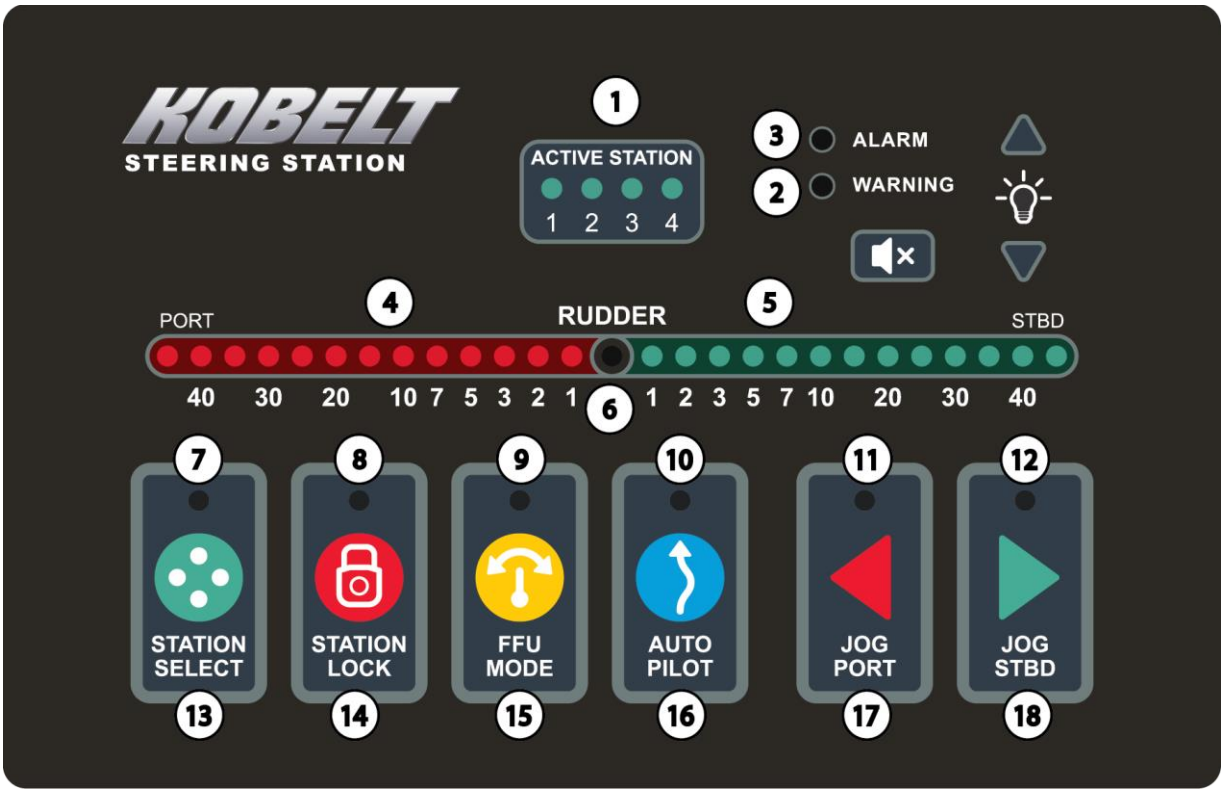


Figure 75 Head Picture Overview

Table 23 Head Overview Table

#	Name	Colour	Label	Brightness	Description
1	Active Stations [1,2,3,4]	Green	“1”, “2”, “3”, “4”	Adjustable	LED will be ON to show the station is active
2	Warning	Amber	“WARNING”	Adjustable	Solid ON or flashing if there is a warning or caution
3	Alarm	Red	“ALARM”	Adjustable	Solid ON or flashing if there is an alarm
4	Rudder angle indicators [port side, x13]	Red	Degrees	Adjustable	LED strip shows the rudder angle and order.
5	Rudder angle indicators [starboard side, x13]	Green	Degrees	Adjustable	LED strip shows the rudder angle and order.
6	Rudder angle indicator [Center]	White	“0”	Adjustable	Two styles for the strip: - Order is bright light - Angle is bright light Also, can be disabled.

7	Station select	Green	None, positioned by station select button	Adjustable	Solid ON if the head is selected
8	Station lock	Red	None, positioned by station lock button	Adjustable	Solid ON if the head is locked
9	FFU mode	Amber	None, positioned by FFU mode button	Adjustable	Solid ON if the system is FFU mode, or flashing in the FFU alignment process
10	Autopilot mode	Amber	None, positioned by autopilot button	Adjustable	Solid ON if the system is autopilot mode
11	Jog Port	Amber	None, positioned by Jog Port Button	Adjustable	ON if there is jog port command regardless that it comes from the jog lever or the button
12	Jog Starboard	Amber	None, positioned by Jog Starboard Button	Adjustable	ON if there is Jog Starboard command regardless that it comes from the jog lever or the button
13	Station Select Button		Station Select		The station select button used to activate the designated station as in control
14	Station Lock Button		Station Lock		The station lock button locks out all other stations from taking control with the station select button
15	FFU Mode Button		FFU Mode		FFU mode changes the control scheme to follow the heads Full Follow up device
16	Auto pilot Button		Auto pilot		Auto pilot button engages the autopilot mode if an autopilot is configured
17	Jog Port Button		Jog Port		Jog Port will jog the system to port as an NFU
18	Jog Stbd Button		Jog Stbd		Jog Stbd will jog the system to starboard as an NFU
19	Alarm Acknowledge Button				
20	Brightness Adjust buttons				

8.2.1 Station Select Button

Station Select Function:

- By pressing the **Station Select** button, active Station transfers between the stations. After the station is active, the Station Select LED will be solid ON.
- If the station transfer fails, an HMI behavior, internal buzzer beeping and Station Select LED flashing 3 times, will inform you for this.

Station Lock Emergency Override Function:(Station #1 only)

- At Station #1 (which should be the main bridge), holding **Station Select** button for 3 seconds to deactivate station lock and then transfer the Active Station to Station #1.
- This strategy allows the main bridge to take control in an emergency, even when another station is active and has station lock.

8.2.2 Station Lock Button

Station Lock Function:

- By pressing the **Station Lock** button from the active Station, the system control would be locked at this single station and does not allow other stations to transfer control. After station lock is enabled, the Station Lock LED will be solid ON from all the online stations.
- Button disabled when Head is not an Active Station. If pressing this button from the non-active station, an HMI behavior, internal buzzer beeping and Station Select LED flashing 3 times, will inform you for this.
- If the Station is already locked, pressing the Station Lock button will unlock the Station.

Station Lock Emergency Override Function:(Station #1 only)

- At Station #1 (which should be the main bridge), holding **Station Lock** button for 3 seconds to deactivate station lock. But be aware that this action will not trigger the active station transferring, only disable the station lock.
- This strategy allows for any other station in the system to take control without having to first transfer control back to the Primary Station.

8.2.3 Jog Buttons

Jog Control Function:

- By pressing the **Jog Port** or **Jog Stbd** button in the Normal mode from an active Station, system will start the jog control and move the rudder following the Jog Speed, which is saved in the configuration. The Jog Port or Jog Stbd LED will be ON when the button is pressing and be OFF after released.
- Holding the button for some seconds, the jog speed will change to Fast-jog Speed, if the Hold For Fast is enabled in the configuration. Both Hold for Fast Jog and Jog Fast-Speed are configurable values in the system, refer the Appendix A in the section 12 for the detail.
- In the Single Station mode, if pressing a jog button from a non-active station, an HMI behavior, internal buzzer beeping and Station Select LED flashing 3 times, will inform you this station is unavailable.

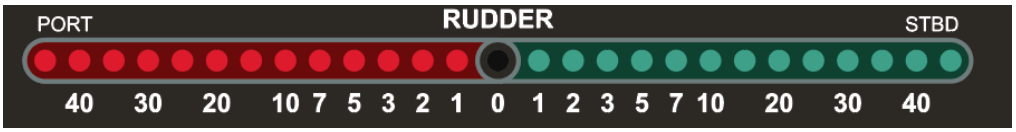
Station Transfer Function:

- In the Automatic Station Transfer mode, by pressing the jog button, the active station will transfer to the station where the jog button is pressed.

8.2.4 Station ID Selector Switch

- Sets the Station ID of the Head.
- Small rotary switch on the rear side of the Head, near the electrical connectors.
  - Flush with back of case, to avoid accidental bumping it while installing connectors.
  - Requires small screwdriver to turn.
- Four positions numbered 1, 2, 3, 4, corresponding to Stations 1-4.
- There is a maximum of **ONE** Steering Head per Station. Multiple Heads assigned to the same ID will trigger a Warning.

8.2.5 Rudder Angle Indicators



- A horizontal strip of LED indicators is used to indicate Rudder Angle and Rudder Order.
- Total of 27 LEDs in the strip
  - 1 White LED in the centre position
  - 13 Red LEDs on the left side of center
  - 13 Green LEDs on the right side of center
- Three configuration options for the showing styles:
  - **[Disabled]**: Only the White LED in the center position is solid ON, for applications that have another RAI system and do not want to confuse the operator with multiple displays.
  - **[Rudder Angle/Order (Style 1)]**: Rudder Order is indicated by a single bright LED, Rudder Angle is indicated as strip of dimmer LEDs extending out from center.

- **[Rudder Angle/Order (Style 2)]**: Rudder Angle is indicated by a single bright LED, Rudder Order is indicated as strip of dimmer LEDs extending out from center.

- Modes of operation:
  - **[Normal Operation]**: Normal operation, shows the Rudder Order and Rudder Angle
  - **[FFU Alignment Mode]**: Refer section 8.4.2.2.
  - **[FFU Calibration Mode]**: Refer section 7.3.3.

8.2.6 Active Station Indicators

- Four LED indicators on the Front Panel of Head
- Each indicator is numbered 1-4, corresponding to a Station:
  - Station 1, Station 2, Station 3, or Station 4
- An indicator is lit when the corresponding Station is active.
- Indicators can temporarily flash as part of a specific user interface response.

8.3 STEERING CONTROL

The Head provides controls on the Front Panel to switch between Normal Mode and FFU Mode.

8.4 STEERING MODES

The Steering System operates in one of the following Steering Modes:

Table 24: List of Steering Modes

Steering Mode	Mode Overview
Normal Mode	• Default operating mode, unless otherwise specified. • One- and two-speed NFU Jog levers on an active station have immediate effect and move the rudder at fixed rates port or starboard. • A Steer-by-Wire electronic wheel on an active station also has immediate effect and moves the rudder port or starboard at a rate proportional to the speed the wheel is turned. • FFU and Autopilot input signals are ignored.
FFU Mode	• Only one station can be an active station while in FFU mode (auto transfer is suspended if enabled). • The rudder is actively controlled to the current position of the FFU Lever attached to the active station. • NFU jog lever, Steer-by-Wire and autopilot input signals are ignored.
Autopilot Mode	• The rudder is commanded by an external autopilot. • Can be overridden by Jog or Wheel in certain configurations.

8.4.1 Jog Control

The general operation of Jog Control in the Voyager System is very simple. The system accepts commands from the operator or the autopilot to move the rudder to port or starboard at a fixed speed governed by the steering system's hydraulics. The System then sets the valve(s) to control the rudder in the appropriate direction. Once that input is removed, the valves are closed to stop the rudder and hold it in place.

If the rudder angle changes for some external reason, the System will not attempt to maintain the position. The valves are only opened, and thus the rudder is only moved, on direct command from the operator/autopilot.

8.4.1.1 Jog Command

Depending on the input devices attached and the system configuration, the **Jog Command** may be one of the following:

- **[Hold]**: No operation
- **[Jog Port]:** Turn the jog lever to port, or press the Jog Port button from the Head
- **[Jog Starboard]:** Turn the jog lever to starboard, or press the Jog Stbd button from the Head
- **[Jog Port, Fast]:**
  - Turn the single-speed jog lever to port and hold if the Hold for Fast-Jog is enabled.
  - Press the Jog Port button from the Head and hold if the Hold for Fast-Jog is enabled.
  - Turn the two-speed jog lever to port high-speed.
- **[Jog Starboard, Fast]**
  - Turn the single-speed jog lever to starboard and hold if the Hold for Fast-Jog is enabled.
  - Press the Jog Stbd button from the Head and hold if the Hold for Fast-Jog is enabled.
  - Turn the two-speed jog lever to starboard high-speed.

8.4.1.2 Jog Speed

If the vessel has proportional valve control, you can set the flow intensity for the Jog Speed. This value is between 0 and 100% flow rate and must be less than the Jog Fast Speed.

8.4.1.3 Jog Fast Speed

If the vessel has proportional valve control, you can set the flow intensity for the Jog Fast Speed. This value is between the Jog Speed setting and 100%

8.4.1.4 Single-Speed Operation

Single-speed operation occurs when the user operates the jog input devices attached to the system controlling the rudder in the direction corresponding to the jog input at a fixed maximum speed.

- The system uses a single **On/Off Directional Valve**
  - Only single-speed operation is possible.
    - The valve will fully turn on or fully turn off in the corresponding direction at a single fixed speed.
- The system uses a single **Proportional Directional Valve,** and the **Jog Fast-Speed** has been configured to match the **Jog speed**
  - Single-speed operation occurs because of this configuration.
  - The valve will ramp up to the full command percentage in the corresponding direction when commanded **[Jog Port]**, **[Jog Port, Fast]**, **[Jog Starboard]**, or **[Jog Starboard, Fast]**.
    - The maximum rudder speed is a single fixed speed

8.4.1.5 Two-speed Operation

Two-speed operation occurs when the user operates the jog input devices attached to the system controlling the rudder in the direction corresponding to the jog input at a fixed maximum speed.

- The system uses a single **On/Off Directional Valve**
  - Only single-speed operation is possible.
    - The valve will fully turn on or fully turn off in the corresponding direction at a single fixed speed.
- The System uses dual On-Off Directional Valves.
  - Dual Rudder
    - Only single-speed operation is possible.
  - Single Rudder
    - Two-speed operation occurs because of this configuration.
    - Valve 1 will become active when any Jog Port, Jog Port Fast, Jog Starboard, or Jog Starboard Fast command occurs.
    - Valve 2 will become active when any Jog Port Fast, or Jog Starboard Fast command occurs.
- The system uses a single **Proportional Directional Valve,** and the **Jog Fast-Speed** has been configured to match the **Jog speed**
  - Two-speed operation occurs because of this configuration.
  - The valve will ramp up to the full command percentage in the corresponding direction when commanded **[Jog Port]**, **[Jog Port, Fast]**, **[Jog Starboard]**, or **[Jog Starboard, Fast]**.
    - The maximum rudder speed is set by Jog Fast Speed.
- The system uses dual **Proportional Directional Valves,** and the **Jog Fast-Speed** has been configured to a larger value than the **Jog speed**
  - Two-speed operation occurs because of this configuration.
  - The valves will ramp up to the full command percentage in the corresponding direction when commanded **[Jog Port]**, **[Jog Port, Fast]**, **[Jog Starboard]**, or **[Jog Starboard, Fast]**.
    - The maximum rudder speed is set by Jog Fast Speed.

8.4.1.6 Hold for Fast Jog

If the vessel is equipped with Proportional Valve(s) Control, it is possible to get a single speed jog lever to move the rudder(s) faster by holding it for the configured period. The time is configured with this setting.

Single rudder only- If the vessels is equipped with 2 On-Off solenoids, and piped in parallel to get more hydraulic flow, it is possible to get a single speed jog lever to move the rudder faster by holding for a period. The time is set with this setting. After this period both Valve outputs are active.

8.4.2 Full Follow-Up

8.4.2.1 FFU Mode Button

FFU Mode Function:

- By pressing the **FFU Mode** button in the Normal Mode from the active station, the FFU Alignment process will start, refer the section 8.4.2.2 for the detail.
- If not possible, for example, the Station is non-active, FFU device is not configured for the Station, or the system is under Autopilot control, this Head performs the Error Responses to notify the operator.
- If the system mode is FFU mode, pressing the FFU Mode button will make system exit from the FFU mode and enter the Normal Mode, the FFU Mode Indicator will turn OFF.

8.4.2.2 FFU Alignment Mode

When in Normal Mode, if the **FFU mode** button is pressed from the active station, the FFU Lever must be set close to the current Rudder Angle. Or when in FFU Mode, and switching from one Station to another, the FFU Lever at the new Station must be set close to the current Rudder Angle before the station switch can occur. If the levers are not aligned when switching stations, the Rudder Order will suddenly change by a large amount when the Station is transferred.

When FFU Alignment Mode is active, the Head temporarily behaves differently:

- The FFU Mode and Station Select Indicators start flashing.
- The RAI strip switches to a special mode:
  - One bright, flashing light shows Rudder Angle (flashes in sync with FFU Mode Indicator)
  - Three dimmer lights showing the current Rudder Order from this Head's FFU Input Device
- The operator moves this Head's FFU Input Device so that it matches the current Rudder Angle:
  - The three lights move in real-time (with respect to the FFU Input Device position)
- When the three lights move to and "capture" the single flashing light, the FFU Input Device is correctly aligned:
  - Alignment Mode ends with a positive result (allowing the event that started Alignment Mode to proceed)
- If the two are **NOT** aligned within **10 seconds**:
  - Alignment Mode ends with a negative result (preventing the triggering event from proceeding)

After completing the mode, successfully or not, the Head interface returns to normal behavior.

8.5 Local Emergency Backup Control

If the steering control system needs to be bypassed due to some condition. A secondary system of local emergency backup control needs to be switched in. A dedicated input (Input B) on the controller is used to notify the controller to disable certain fault conditions. Energizing this input eliminates false conditions while in emergency backup.

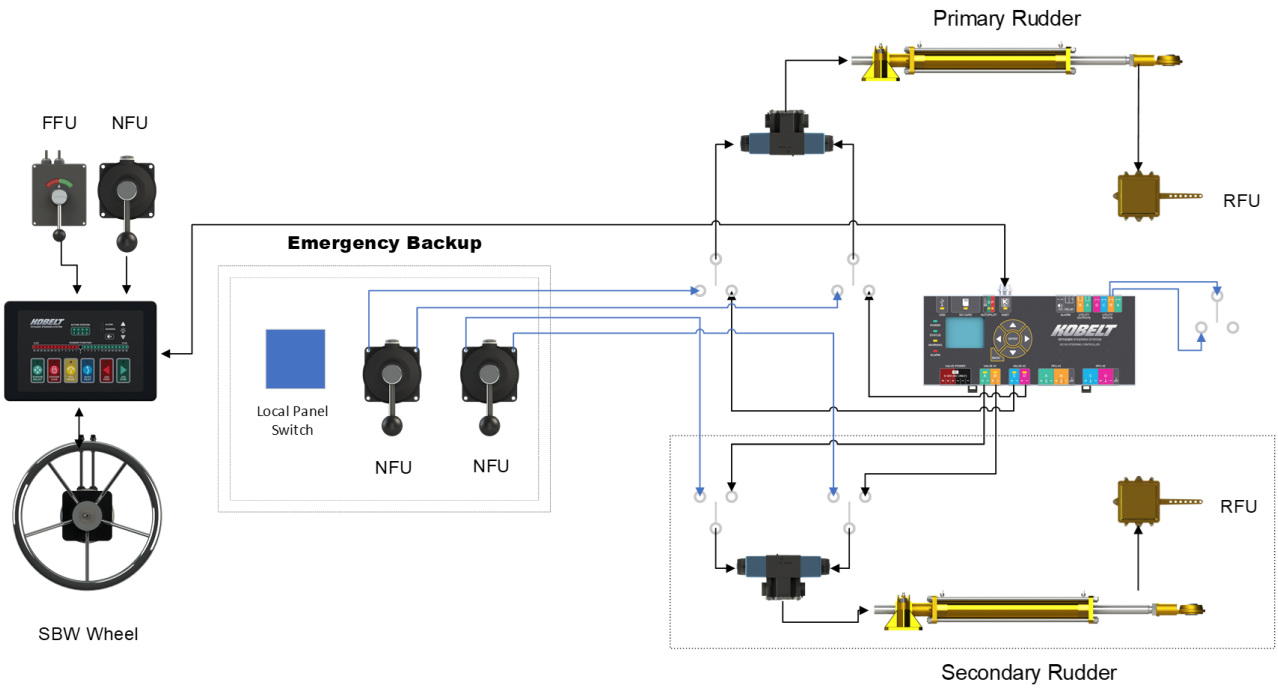


Figure 76: System with Local Emergency Backup Control

8.6 AUTOPILOT CONTROL

⚠ **CAUTION**	The system cannot detect if an autopilot faults or goes offline. It is important to detect this and report to the operator that the autopilot has released control of steering the vessel.

The Head provides a button to activate/deactivate Autopilot control (Autopilot Mode), and an indicator to indicate when the Autopilot is in control or standby.

- Autopilot Button toggles Autopilot Mode on/off
- Autopilot Mode can also be turned off by actuating an Input Device.
- Autopilot Indicator shows current state of Autopilot Mode
- Autopilot Mode persists when switching stations

8.6.1 Autopilot Button

Autopilot Mode Function (when Pressed and Released):

- By pressing the Autopilot Button in the Normal Mode from the active station, Autopilot mode enters in the Standby state. In the Standby state, the Autopilot Indicator will flash to inform the operator that the Voyager system is waiting for the Autopilot command.
- If Autopilot Mode is already Enabled or in the Standby state, pressing the Autopilot button will make the Autopilot Mode disabled.
- If not possible, for example, the System Mode is not Normal Mode, pressing the Autopilot button is from a non-active station, or Autopilot is disabled in the configuration, or Autopilot Interface is faulty, this Head performs the Error Responses to notify the operator.

8.6.2 Autopilot Indicator

Autopilot Indicator shows the current Autopilot Mode status. The state is received from the Controller as part of regular network data.

- Indicator On = Autopilot Mode is active
- Indicator Flashing = Autopilot Mode is standby
- Indicator Off = Autopilot Mode is NOT active

8.7 AUTOPILOT SETTINGS

8.7.1 Autopilot Auto Disengage

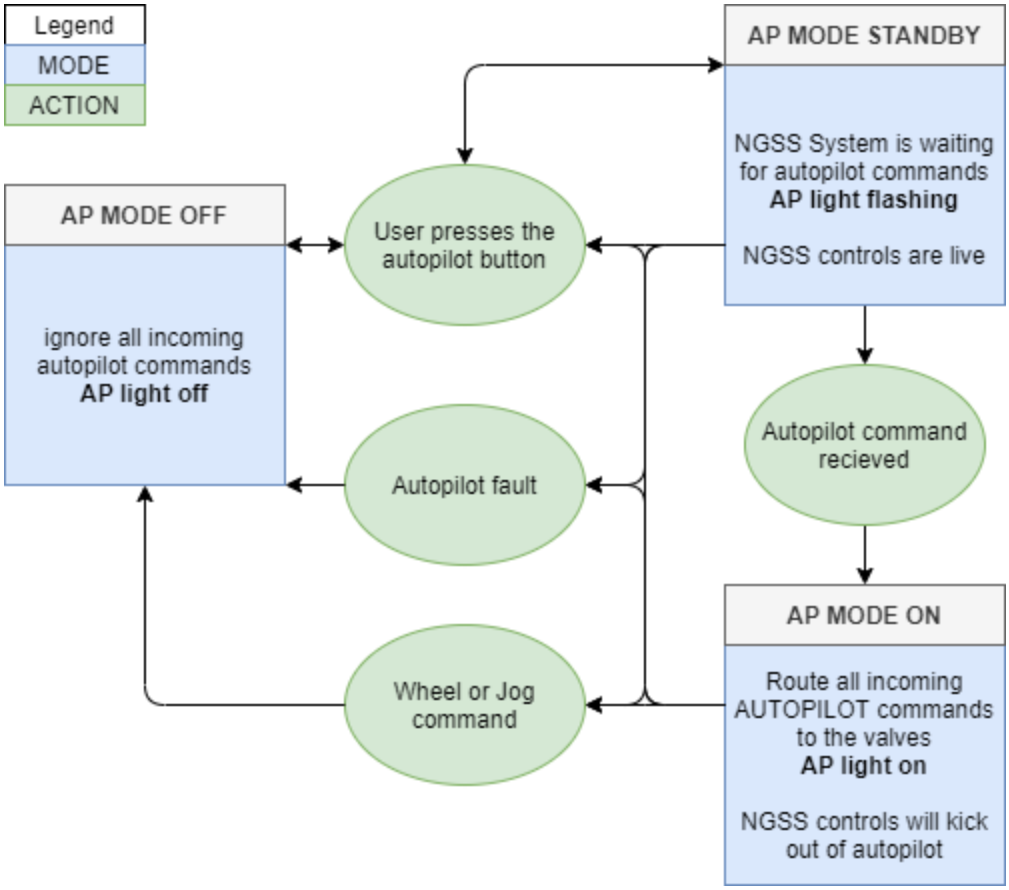


Figure 77: Autopilot Automatic Disengage State Diagram

The autopilot setting “Auto Disengage” means the autopilot mode exits when a steering command is read from the wheel or jog lever. This means that if a user is in Autopilot Mode and starts steering with the wheel or jog lever the system will exit Autopilot Mode and enter the Normal Mode. To re-enter Autopilot Mode the user is required to press the Autopilot button.

⚠WARNING	While using “Auto Disengage” type, pushing a jog lever, or the wheel shifting slightly in rough seas will cause system to exit the Autopilot Mode. The user may not be aware that the system has exited Autopilot Mode and decides to leave the helm for whatever reason. Their autopilot device should alarm in this situation notifying them of the issue. If they do not have an alarm this could be an issue.

8.7.2 Autopilot Manual Disengage

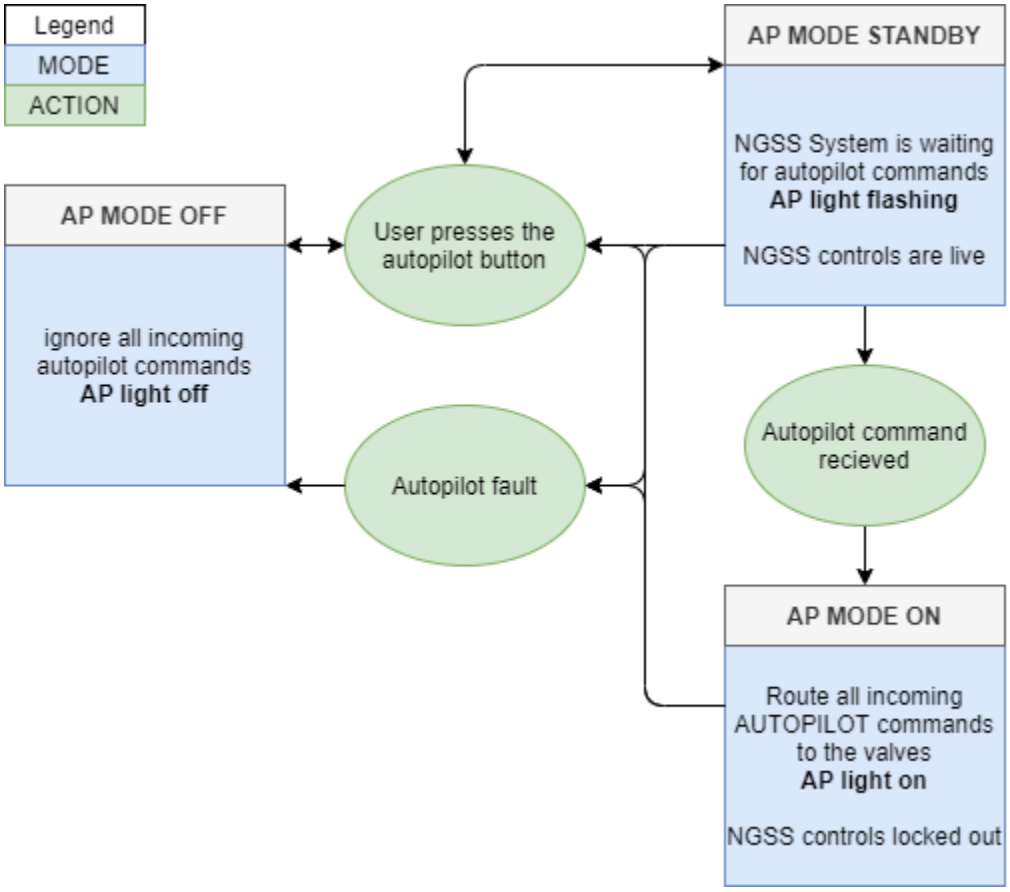


Figure 78: Autopilot Manual Disengage State Diagram

The autopilot setting “Manual Disengage” means the Autopilot Mode exits only when the Autopilot button is pressed on the active Head. The system gives full control of the valves to the autopilot input commands. While in Autopilot Mode the steering controls are not active and will only become active when Autopilot Mode is exited.

⚠WARNING	While using “Manual Disengage” type the systems controls will **NOT** be active until autopilot mode is exited, so strongly recommended having a dodge input device associating with the autopilot device, that the user can still dodge through the autopilot system with the Voyager System steering inputs.

8.7.3 Autopilot Always Live

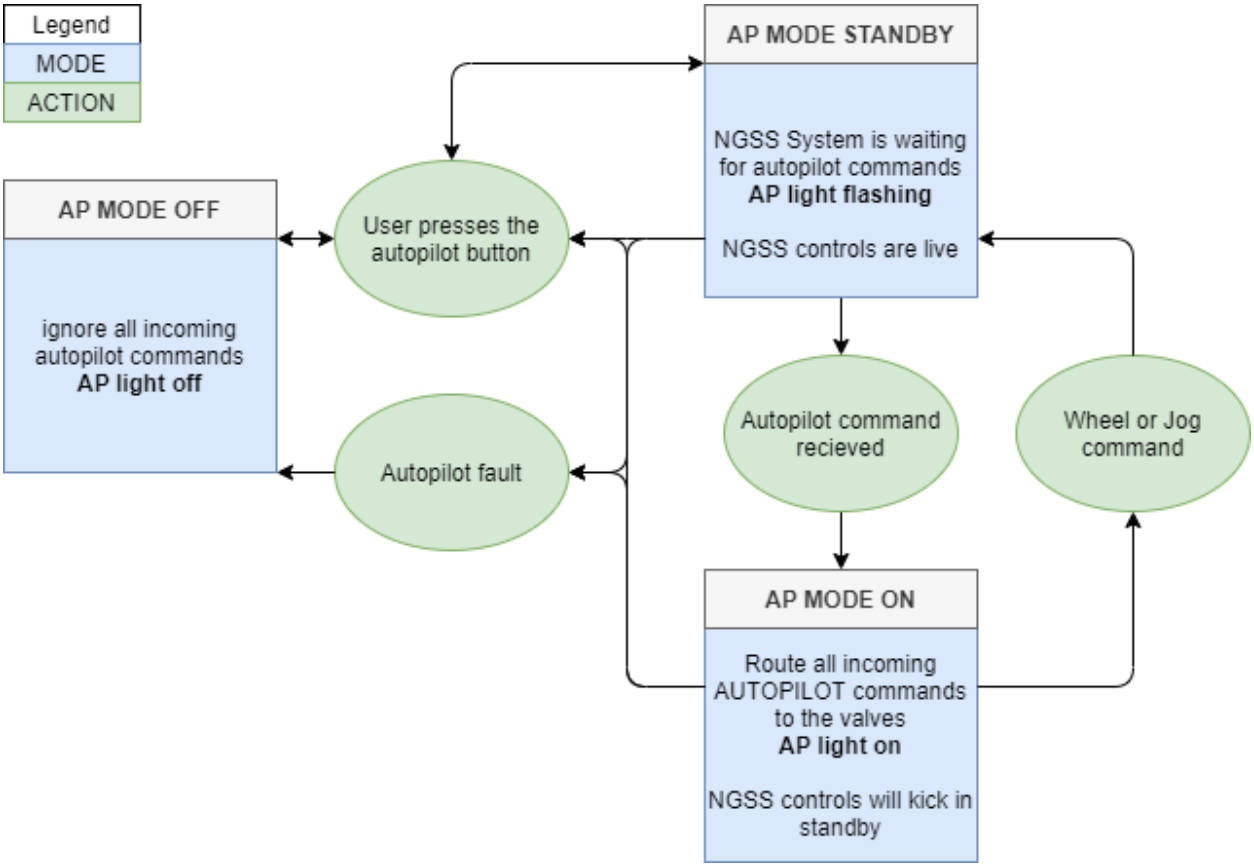


Figure 79: Autopilot Always Live State Diagram

The autopilot setting “Always Live” means the autopilot will not exit when the user inputs new steering commands. Instead, the system will temporarily go into an Autopilot Standby state, indicated by flashing the Autopilot Indicator. This state means the Voyager System is currently waiting for autopilot steering commands. When the steering commands are received the system will automatically jump into Autopilot Mode. To exit Autopilot Mode the user must press the Autopilot button. Autopilot Mode being disabled will be indicated by the Autopilot Indicator turning off.

NOTICE	It is recommended that any required service work on a Kobelt product be performed by a factory authorized service representative. Please contact the nearest Kobelt authorized distributor for assistance.

8.8 VIRTUAL END-STOP

Notification: The gap between Virtual end-stop and physical end-stop should be as small as practical, and not larger than 5 degrees

The system has configurable virtual end-stops that will stop the valve from being driven when the system's feedback input reaches the configured end-stop angle. These end-stops are intended for use with the Position

Control Rudder orders from the FFU or the SBW Wheel. The Jog commands will ignore the virtual end-stops and continue to drive the valve. The system should be installed with physical limit switch end-stops to cut off the jogs before hitting the hard stop.

8.9 ALARMS

8.9.1 Active alarm

When not configured for External Alarm System

During normal operation of the vessel, there are three types of faults in the system, including Alarm, Warning and Caution, which will be indicated by the flashing Alarm or Warning Indicators combined with the internal buzzer and/or an external buzzer if installed. Refer to section 6.7.5 for the connection with the external buzzer.

To acknowledge the fault, press the Acknowledge button. If the Alarm or Warning Indicator turns solid red or yellow after pressing the Acknowledge button, this indicates that the fault has been acknowledged but the fault condition persists. If the Alarm or Warning Indicator turns off this means that the fault condition is no longer present.

Figure 80 - Acknowledge Alarm Button

8.9.2 Fault Information

If the fault persists the user can determine the source and timing information of the fault through the Controller screen, “Alarm & Warning Log” page, refer section 10.1.10 and 10.1.11. The top item on the list is the most current alarm. Navigate to the alarm of interest and press enter for more detailed information.

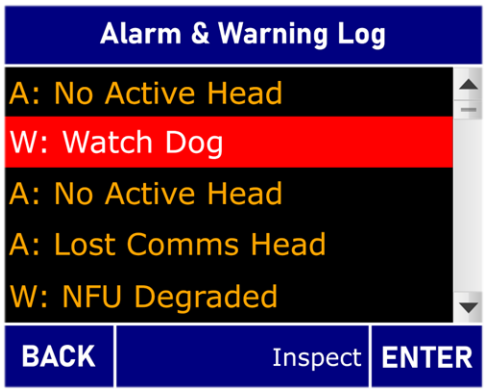


Figure 81 - Alarm & Warning Log page

8.10 SD CARD

The SD Card is used to store configuration parameters, this feature should be used when the operator and or installer is making changes to ensure that they have an operational return point.

The SD Card will also log system data time stamped to the internal clock time. This feature is intended for helping the operator pinpoint potential errors in configuration or setup.

NOTICE	The SD Card will log data time stamped based on the real time clock. The clock should be periodically checked for drift to ensure the time stamp is still within desired tolerance levels.
NOTICE	Supports SDHC/XC cards and up to 64 GB (Requires Special Formatting), these can be purchased from Kobelt. Off the shelf 32GB cards with FAT32 formatting will work without special formatting
NOTICE	Inserting an SD card during operation requires the system to be power cycled to successfully mount the card. This means that the logging, saving, and restoring configuration features won't work when a new card is inserted until the system is re-booted.

9 MAINTENANCE

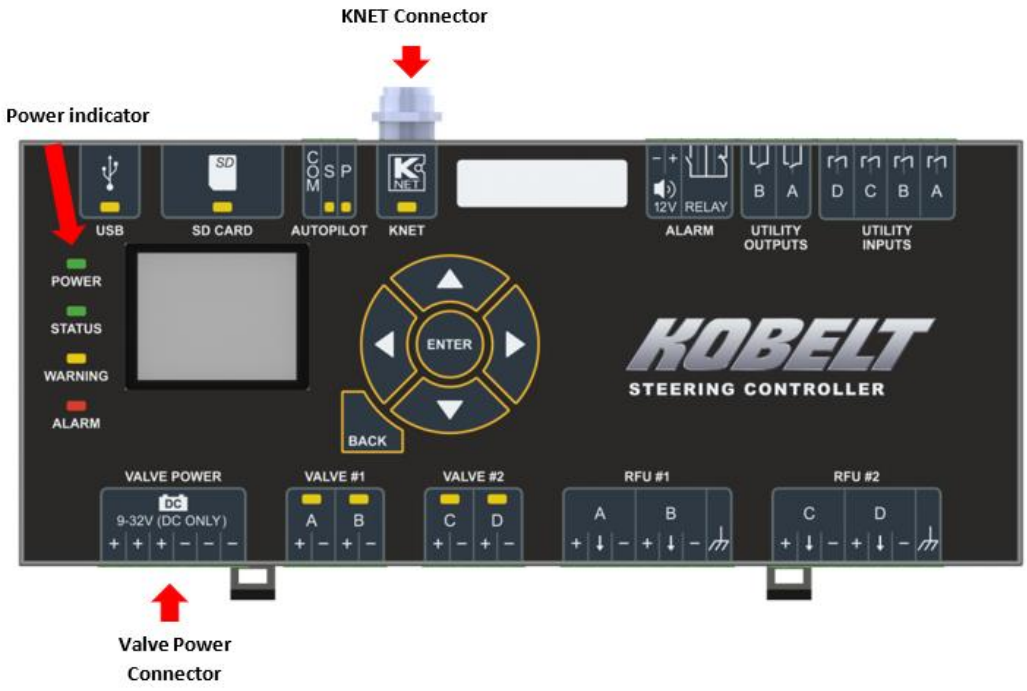
9.1 BATTERY REPLACEMENT

This section will provide a detailed guide on replacing the battery on the NGSS Controller.

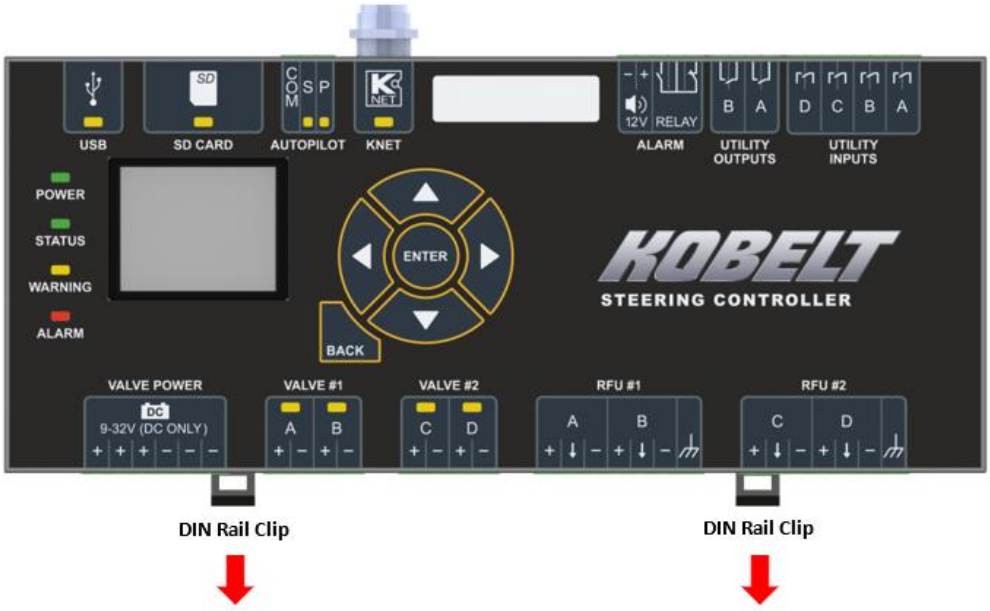
The NGSS Controller has an internal battery on the device (CR2032). This battery is needed for the real time clock to function correctly. Periodically the battery will require replacement(yearly). The NGSS Controller will issue a caution when the battery is low and then issue a warning when the battery needs to be replaced to maintain the real time clock functionality. The system will still operate at 100% steering functionality should the battery fail, however the logged alarms and data will lose its timing information.

Follow the following steps to replace the battery:

1. Turn of the power of the system. If this is not possible remove the connector labeled “KNET” (NMEA2000 Micro-C) and then remove the “VALVE POWER” connectors.
2. Check to ensure that the system is no longer powered, indicated by the “POWER” led indicator.

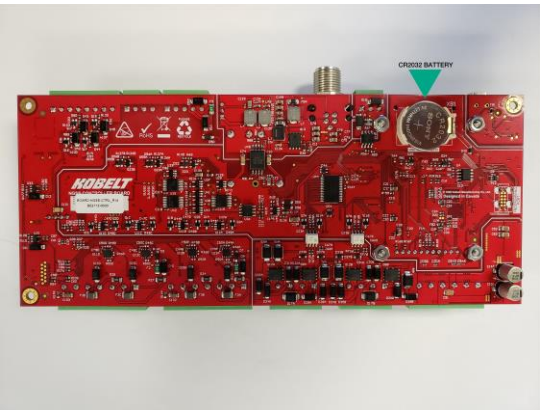


3. Remove all the connectors on the device.
4. Unclip the din rail mounts from the controller and remove it from the din rail. Pull the clips downward to release the device from the din rail.



5. Remove the din rail clips from the housing
6. Ensure that you are properly ground at this point to guarantee no unwanted Electrostatic discharge onto the device.
7. Open the controller box backing making sure to start with the side with the “KNET” Connector and labeled “TOP” on the housing. making sure to pull the back plate off slowly trying to keep both top and bottom as level as possible.

8. Once the back plate is off and the PCB board is exposed, electrically ground yourself and then simply replace the battery with a new CR2032. Removal of the low battery can be done by levering one end of the battery.



9. Ensure that the four LCD screen nuts are still securely fastened.
10. Put the backplate of the enclosure back onto the device slowly and maintaining a consistent level between both clipped sides when putting it back on.
11. Re-insert the din rail clips onto the device.
12. Mount the controller back into its intended position on the din rail
13. Put the connectors back onto the device leaving the power connectors last.
14. Plug in the power connectors “KNET” and “VALVE POWER” and turn on the device.
15. Navigate to the lock setup screen and re-enter the current date and time of the device.
16. Upon completion of replacing the battery the battery the system should perform a functional test of the steering, to ensure no failures have occurred during the battery replacement procedure.

9.2 Real Time Clock

The Kobelt Steering Controller has a real time clock that will continuously run from an additional internal battery. In the event the battery is discharged and is replaced the real time clock needs to be re-set to the current date and time.

The real time clock is not a perfect measurement of time and may drift over time. The real time clock is used for date stamping alarms and logging data. Maintaining a relatively accurate time will aid in the event system analysis is required.

9.3 Preventative Maintenance

- Every Sailing
  - Functionally test any NFU Jog Lever.
  - Functionally test any FFU lever.
- Once per year
  - Replace internal CR2032 Battery then set the current time.

9.4 RECOMMENDED SPARE PARTS

As a minimum Kobelt recommends the following spare parts are on-hand:

Table 25: Recommended Spares

RECOMMENDED SPARES		
QTY	**ITEM**	**KOBELT PART #**
1	Male Network Terminator	6015-1011
1	Female Network Terminator	6015-1012
1	CR2032 Coin Battery	9870-0001

To purchase spare parts Contact Kobelt for list of parts numbers available

10 TROUBLESHOOTING

In the event of an abnormal operation, check the error message against this section of the manual and try to rectify the problem as specified in the error message or in this section of the manual.

If it is not possible to locate or eliminate the problem using this section, or if the fault is still present, switch off the device and contact Kobelt Manufacturing Co. Ltd. technical support department.

⚠WARNING	The user must not attempt to repair the unit themselves. It is strongly recommended that any required service work on a Kobelt unit be performed by a factory authorized service representative. Please contact the nearest Kobelt authorized distributor for assistance. Any repairs performed by 3rd party may null and void any warranty or type approvals

10.1 CONTROLLER INFORMATION SCREENS

10.1.1 Main Monitoring Screen

This is the root monitor screen and first screen after system power ON and Splash screen.

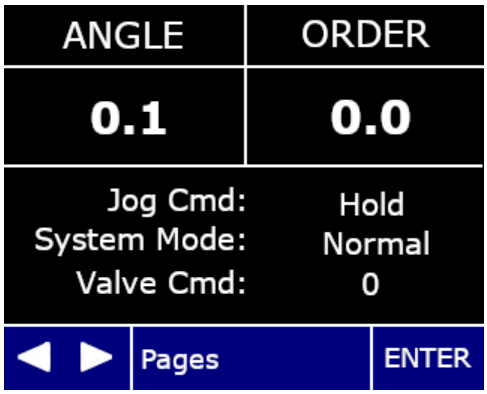


Figure 82: Single Rudder Main Monitoring Screen

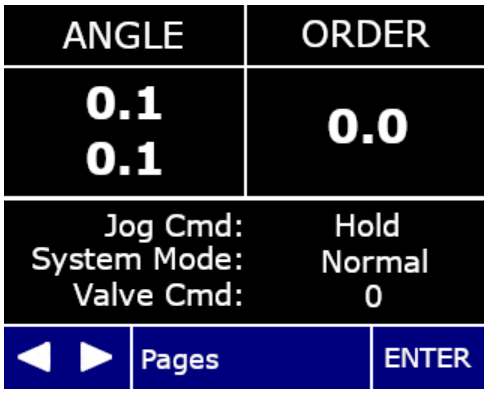


Figure 83: Dual Rudder Main Monitoring Screen

- Angle – Angle reading from the RFU source.
  - This will show a " – " if there is a fault with the RFU reading
- Order – Order from the FFU or wheel input. This will be blank when the system does not have an order.
  - This is blank if the system is not in positioning mode of operation. Positioning mode of operation is entered when using an FFU or Wheel to command the steering gear
- Jog Cmd – What jog command is determined by the controller:
  - Hold
  - Port
  - Starboard
  - Port Fast
  - Stbd Fast
- System Mode
  - Normal
  - FFU
- Valve Cmd – Percentage driving the valves. One number indicates one proportional or one solenoid. Two numbers for two valve operation.
  - A negative value is driving port and a positive number is driving starboard.

10.1.2 Rudder Feedback Screen

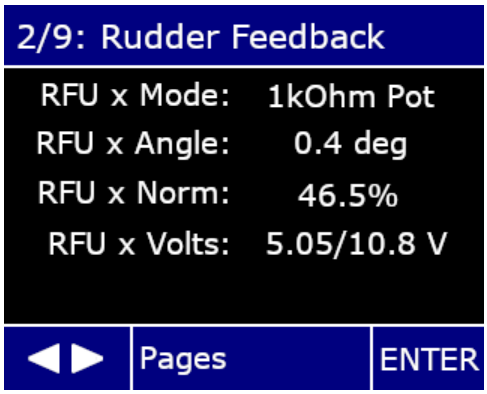


Figure 84: Rudder Feedback Screen

- RFU x Type – what type of RFU is configured with the system:
  - 1kOhm Pot
  - 10kOhm Pot
  - 4-20mA
- RFU x Angle – The determined angle from the input after computing.
- RFU x Norm – The normalized angle from Port to Starboard Endstops, value is from 0 – 100 %.
- RFU x Volts/Amps – The raw value from the RFU device in Volts or Amps. The end voltage is the voltage supply read by the system that supplies the RFU.
- If there is more than 1 RFU, pressing the up or down buttons on the controller will cycle through the rudder feedback units

10.1.3 Valves Screen

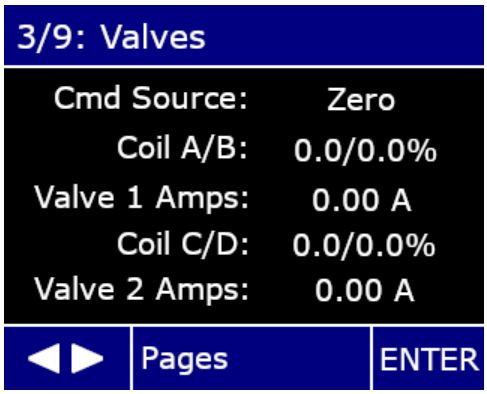


Figure 85:Valves Status Screen

- Cmd Source –Method commanding the solenoid output.
  - Zero – the valves are not driven
  - Jog – the valves are driven by the NFU, Jog buttons, or the third-party autopilot.
  - Position – the valves are driven by the FFU or the Electric wheel.
- Coil A/B – The percentage of the valve A/B driven duty between dead-band and maximum 100%.
- Valve 1 Amps – The measured current driving the on/off or proportional solenoid.
- Coil C/D – The percentage of the valve C/D driven duty between dead-band and maximum 100%.

- Valve 2 Amps – The measured current driving the on/off or proportional solenoid.

10.1.4 FFU Status Screen

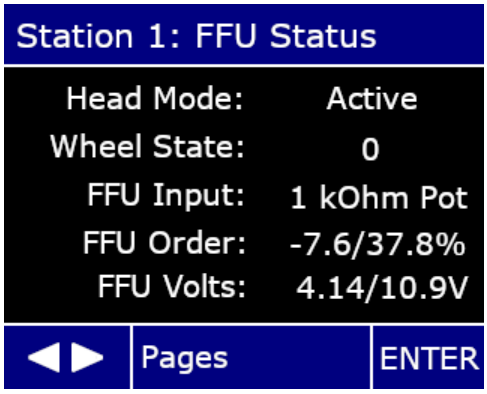


Figure 86: FFU Status Screen

- Head Mode – The state of the head that is being displayed.
- Wheel state – A numeric indication of the Wheel state for diagnostics.
- FFU Input – The type of FFU that was configured on the Station that is being displayed.
- FFU Order – Computed FFU angle/(0-100%) as computed from the calibration values.
- FFU Volts – Voltage reading from the FFU and the Supply voltage to the FFU on the station being displayed.
- Note: This is a Station diagnostic and does not indicate FFU Mode, only the current status and reading on each individual station

10.1.5 Jog Status Screen

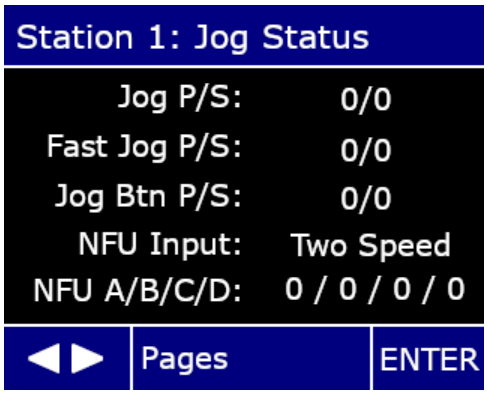


Figure 87: Jog Status Screen

- Jog P/S – The jog drive signals for port and starboard from the displayed station.

- Fast Jog P/S – The fast jog drive signals for port and starboard from the displayed station.
- Jog Btn P/S – Jog port and jog starboard buttons drive signals from the displayed station.
- NFU Input – The NFU programmed for the station being displayed, non-active stations display offline.
- NFU A/B/C/D – Individual input signals from the digital input port.

10.1.6 Controller Health Screen

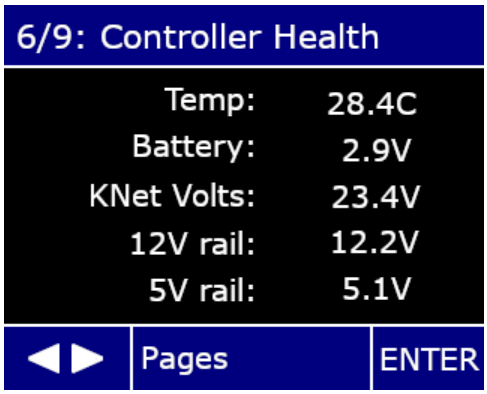


Figure 88: Controller Health Screen

- Temp – Temperature reading on the Voyager controller of the ambient temperature inside the case.
- Battery – The RTC (real time clock) battery voltage level.
- KNet Volts – The voltage reading of KNET connector voltage level.
- 12V rail – The voltage generated for the internal 12V rail on the circuit board.
- 5V rail – The voltage generated for the internal 5V rail on the circuit board.

10.1.7 Autopilot Status Screen

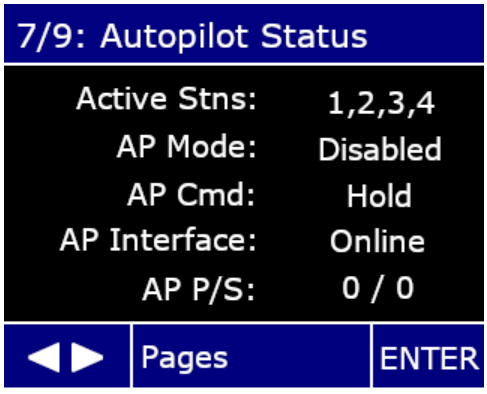


Figure 89: Autopilot Status Screen

- Active Stations – The stations that are currently online.
- AP Mode – If Autopilot Mode is Enabled, Disabled or Standby.
- AP Cmd – The current Autopilot command.

- AP Interface – The configured autopilot interface mode
  - Always live.
- AP P/S – The direction of Autopilot command, port or starboard.

10.1.8 Controller and Stations Version Screen

- Controller – Firmware/Hardware information
  - H/W: The hardware version of the Controller, “0” as the initial version.
  - F/W: The firmware version of the Controller and time that the F/W was compiled.
  - UID: The unique ID of the micro-controller on the device.
- Head – Firmware/Hardware information
  - Wheel F/W: The firmware version of the SBW wheel connecting to this Head.
  - H/W: The hardware version of this Head, “0” as the initial version.
  - F/W: The firmware version of this Head and time that the F/W was compiled.
  - UID: The unique ID of the micro-controller on the device.

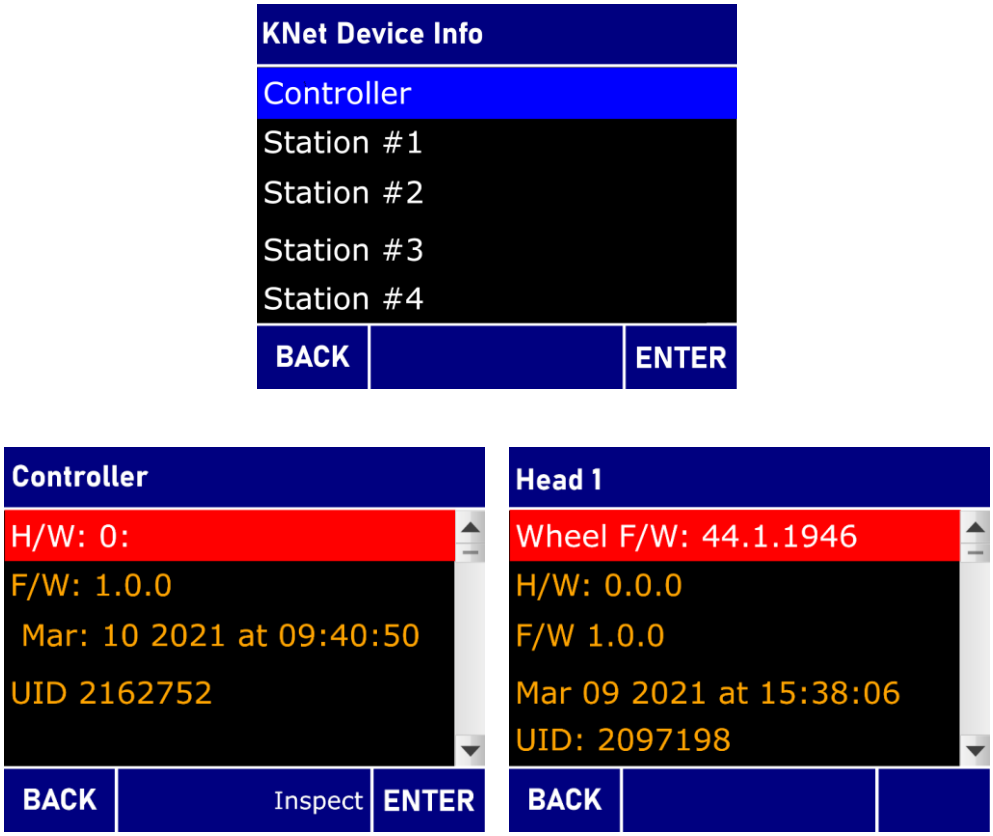


Figure 90: Controller and Head Version Screen

10.1.9 KNet IO Status Screen

- This screen is available when the External Alarm int the configuration is enabled.
- It shows the status of the KNet IO Expander, used for indicating to an external alarm system a fault.
  - Output 1 – Deviation Fault. The rudder is moving slow or not at all to a given order
  - Output 2 – Loop Fault.

        - RFU fault
        - NFU Fault
        - SBW Wheel
        - Valve Current Fault
    - Output 3 – Control System Fault
        - Over Temperature
        - Internal Voltage fault
        - KNet Power Fault
        - Flash or configuration fault
    - Output 4 - Communications Fault
        - There is a communications fault with any configured station.
    - Output 5 - Hydraulic Lock - Input 1 and 2, or 3 and 4, are energized at the same time
        - Input 1 and 2 should be connected to Pressure Switches on Valve 1
        - Input 3 and 4 should be connected to Pressure Switches on Valve 2

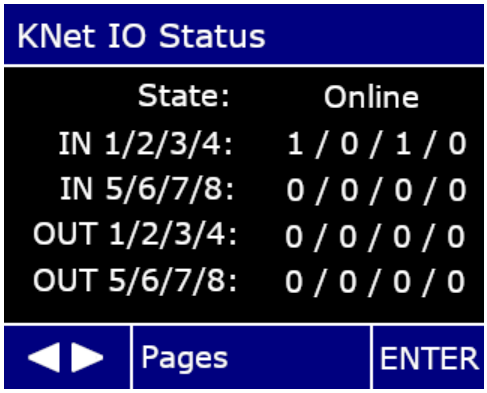


Figure 91: KNet IO Status Screen

10.1.10 Alarm and Warning Log List

- The Alarm & Warning Log Screen is a list of faults that have been detected recently. It displays any alarm that occurs, even if the fault condition has already been removed.
- Scrollable list up to **30** of the most recent Alarms and or Warnings
- Gives an overview of the alarm, warning or caution, with alarm name/type
- Sorted in reverse chronological order (newest first)
- Each row of the list shows a single Fault, with the following elements:
    - A letter to indicate the severity:
        - A for Alarms
        - W for Warnings
        - C for Cautions
- Upon entering the screen, the first entry in the log (if any) is selected
    - Up/Down Arrow Keys moves the active selection up and down the list
    - Enter Key – Switches to Fault Inspector Screen to view timing details about selected list entry, see detail in the next section
    - Back Key – Return to Main Menu Screen

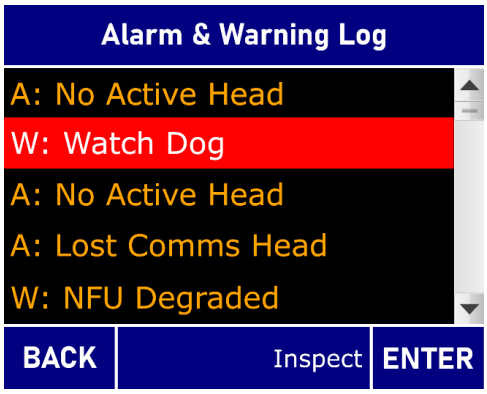


Figure 92: Fault Log Screen

10.1.11 Fault Inspection Screens

The Fault Inspector Screen shows details about alarms and warnings that have occurred. It is accessed by pressing the Enter button to select a fault in the Fault Log Screen.

- The title of the screen will state Warning/Alarm/Caution Information, and the order 1/30, 2/30, 3/30…30/30.
- The details for the alarm or warning, is given on this screen:
  - Date and time that the alarm or fault occurred, first row.
  - Date and time that the alarm was acknowledged, second row.
  - Date and time that the fault cleared, third row. This may have occurred on power up.
- A letter to indicate the severity:
  - 'W' for Warnings
  - 'C' for Cautions
  - 'A' for Alarms
- The Right and Left arrows will go to the next or previous Fault.
- Back key will take the user back to the Fault Log screen.
- Enter key will take the user to acknowledge the Fault.

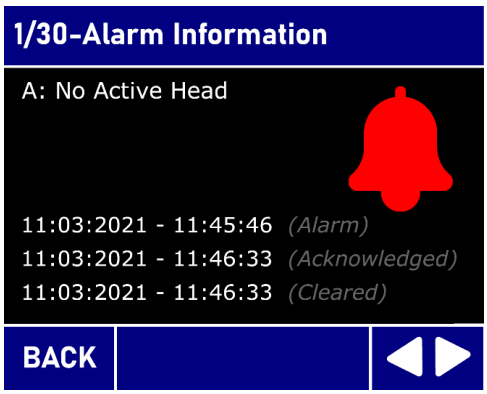


Figure 93: Fault Inspector Screen

10.2 ALARMS, WARNINGS, AND CAUTIONS CORRECTIVE ACTIONS

Table 26: Common Troubleshooting Problems

Problem (Issue Encountered)	Cause (What it Means)	Corrective Action (What to Do)
Product does not turn on	Blown fuse or circuit breaker Wiring is not correct	1. Replace external fuse. Replace internal fuse. Reset circuit breaker. 2. Check wiring diagram and ensure that all connections are correct.
Alarms		
No Active Head (Communication Fault)	No Head is in control of the system.	1. Check wiring diagram for KNET and ensure that all connections are correct. 2. Press the Station Select button from any station.
Valve Failure (Loop Failure)	1. Valve is open-circuit. 2. Valve current is too high.	Check wiring diagram for the valve(s) and ensure that all connections are correct.
Hydraulic Lock	Pressure on both sides of the Valve.	
Rudder Deviation Alarm	The Rudder Deviation fault is a critical alarm that alerts the operator that the system is not controlling the rudder adequately (or cannot verify that it is controlling the rudder)	When the actual position of the rudder differs by more than 5 degrees from the rudder position ordered by the follow-up control systems for more than: 30 seconds for ordered rudder position changes of 70 degrees; 6.5 seconds for ordered rudder position changes of 5 degrees; and The time period calculated by the following formula for ordered rudder positions changes between 5 degrees and 70 degrees: $t = (R/2.76) + 4.64$ where: t = maximum time delay in seconds R = ordered rudder change in degrees
RFU Failure (Loop Fault)	1. RFU supply voltage is shorted. 2. RFU supply voltage is wire break.	Check wiring diagram for the RFU and ensure that all connections are correct.
Controller Internal Failure (Control System Failure)	The Steering Controller has an internal fault. High temperature or voltage failure	Examine Controller health screen to identify what condition is present. Voltage issues may be due to a low voltage at the device. Temperature problems could be due wrong environmental conditions. To close to heat generating devices. Consider different location, or provide some ventilation at the device.

Head x SBW wheel Input Failure (Loop Failure)	The communication problem between the Head and SBW wheel	Check Wheel connection between the station and the wheel. Replace drop cable or Y connector.
Head x FFU Input Failure (Loop Failure)	1. The FFU lever is wire break. 2. The supply of the FFU lever is shorted.	Check wiring diagram for the FFU lever and ensure that all connections are correct.
Head x NFU Input Failure (Loop Failure)	The supply of the NFU lever is shorted.	Check wiring diagram for the NFU lever and ensure that all connections are correct.
Controller Comms to Head x Lost (Communication Failure)	Controller cannot communicate with the Head.	Check wiring diagram for KNET and ensure that all connections are correct.
Warnings		
Head x Internal Failure	The Steering Station has internal fault. Temperature High or internal voltage has failed	Check voltage at the station. Make sure the temperature at the station is not above 50 degreec C, 122 degrees F
Head x Station ID Conflict	Two Heads set as the same ID x.	Check each Station ID Selector Switch and ensure the switches are set as the different ID.
Invalid Autopilot Input	The Voyager system receives the autopilot command port and starboard at the same time.	
Battery Failure	The battery voltage on the Controller is too low.	Replace CR2032 battery.
Cautions		
Controller Degraded	Internal voltages or temperature not in acceptable tolerance	
Head x Degraded	Internal voltages or temperature not in acceptable tolerance	
RFU Input Degraded	RFU Voltage supply reading is too low.	Check the connections on the RFU
Head x FFU Input Degraded	FFU Voltage supply is too low	Check the connections of the FFU.
Head x NFU Input Degraded	Supply voltage for the NFU switches are too low.	Possible short Check connections to the NFU Jog Lever

Table 27: Alarm Indicator Error Codes

Fault Report ID	Indication Pattern				Meaning of Fault
	Alarm Indicator	*Internal & External Buzzers*	*Warning Indicator*	*Fault Relay*	
External Alarm configured or Acknowledged Alarm *All Alarms once acknowledged*	1 ON	0 OFF	0 OFF	1 ON	An Alarm occurred and the fault condition is still present.
External Alarm configured or Acknowledged Warning or Caution *All Warnings or caution*	0 OFF	0 OFF	1 ON	0 OFF	A Warning or Caution occurred and the fault condition is still present.
	Alarm Indicator	*Internal & External Buzzers*	*Warning Indicator*	*Fault Relay*	*Internal and External buzzers are not activated with the External Alarm Enabled.*
Alarm	••… Non-stop rapid beeps	••… flash approx. once every 2 seconds	0 OFF	1 ON	An alarm is a high priority of an alert. Condition requiring immediate attention and action, to maintain the safe navigation and operation of the ship.
Warning	0 OFF	••… Non-stop rapid beeps	••… flash approx. once every 2 seconds	0 OFF	Condition requiring no immediate attention or action. Warnings are presented for precautionary reasons to bring awareness of changed conditions which are not immediately hazardous, but may become so if no action is taken.
Caution	0 OFF	0 OFF	1 ON	0 OFF	Lowest priority of an alert. Awareness of a condition which does not warrant an alarm or warning condition, but still requires attention out of the ordinary consideration of the situation

10.3 SERIAL NUMBER

- Assembly Serial Number
    - The final product, as assembled by Kobelt has a serial number.

- Printed on a label on the front face of the Kobelt Steering Controller, or the back face of the Kobelt Steering Station

10.4 USB INTERFACE

10.4.1 USB Port

Connector Type: Mini USB Female B

Qualified Technician use only.

Figure 94: Mini USB Female B Connector

11 WARRANTY

Kobelt Manufacturing Co. Ltd. (“Kobelt”) warrants the Products and Parts manufactured by Kobelt to be free from defects in workmanship or material and that said products are designed mechanically and functionally to perform to specifications.

This warranty is effective providing:

- The equipment is used within the intended operating conditions and in accordance with Kobelt recommendations
- The equipment is installed according to equipment diagrams, specifications, and recommendations which Kobelt has provided

This warranty becomes invalid if the factory supplied serial number has been removed or altered on the product. This warranty does not cover cosmetic damage or damage caused by an act of God, accident, misuse, abuse, negligence, or modification of any part of the product. This warranty does not cover damage due to improper operation or maintenance, connection to inappropriate equipment or attempted repair by anyone other than an authorized Kobelt representative.

Upon identification of a potential issue or defect with a Kobelt Product or Part, the Warranty Applicant (“Applicant”) must immediately contact Kobelt and describe the issue in writing, by letter, fax, email or other electronic conveyance. Kobelt will then assess the cause of the defect and determine warranty applicability and appropriate remediation.

If any part is found to be defective, Kobelt will replace said part FOB the Kobelt factory provided that any such defective part is returned by the Buyer with freight and applicable forwarding charges prepaid by the Buyer. Kobelt’s sole obligation to the Applicant will be to repair or replace the defective part with same or similar product, to a maximum value of the list price of the product or part. The Kobelt warranty does not cover labour charges, travel, or any other associated expenses.

All Products and Parts manufactured by Kobelt, are subject to a warranty against manufacturer’s defects in materials or workmanship for a period of two (2) years from the date of purchase.

Kobelt will be responsible for all Products or Parts sold by Kobelt but manufactured by 3rd party manufacturing companies. However, these products and parts are subject to applicable 3rd party warranties and may not be the same as the Kobelt warranty.

12 APPENDIX A: CONFIGURATION PARAMETERS

ID	Parameter	Explanation	Range	Step	Unit	Default
1	**Number of Stations**	Number of Steering Stations (Heads) in the Voyager System.	1…4	1	stations	1
2	**Station Control Strategy**	Set the Station Control Strategy. **Options:** [1] Single Station Mode [2] Automatic Station Transfer Mode				[1]
3	**Set Date/Time**	Set the UTC time for the battery backed clock.	HH:MM:SS YY/MM/DD			00:00:00 00/00/00
4	**Station Name**	Set the Name for each Station. **Options:** [1] Station [2] Main Bridge [3] Fly Bridge [4] Port Wing [5] Starboard Wing [6] Port Aft [7] Starboard Aft [8] Auxiliary 1 [9] Auxiliary 2				[1]
5	**Wheel Type**	Configure the **SBW Wheel** type. **Options:** [1] No Wheel [2] Kobelt SBW Wheel				[1]
6	**Number of Turns**	Number of turns from Lock to Lock (Hard-Over to Hard-Over) on the **SBW Wheel**.	1.0…8	0.25	turns	4
7	**Distance Force Feedback**	Braking intensity of the **SBW Wheel**.	0.0…10.0	0.5		2.0
8	**Turning Resistance**	Base turning resistance of the **SBW Wheel**.	0.0…30.0	1	%	16.0
9	**Centre Detent**	Select the Centre Detent intensity Configurable options. **Option** / **Value** [1] Disabled — 0.0 [2] Soft — 1.0 [3] Medium — 15.0 [4] Hard — 30.0				[1]

10	**NFU Input**	Configure the NFU Input type. **Options:** [1] Disabled [2] 1 Speed [3] 2 Speed				[2]
11	**FFU Input**	Configure the FFU Input type. **Options:** [1] Disabled [2] 1k Pot [3] 5k Pot [4] 10k Pot				[1]
12	**LED Strip Style**	Configure the RAI/ROI LED strip style. **Options:** [1] Disabled [2] Order is Bright Light [3] Angle is Bright Light				[2]
13	**Backlight Color**	**Options:** [1] Disabled [2] White [3] Red				[2]
14	**Port Endstop**	Software endstop for the port direction.	-180.0…0.0	0.5	°	-25.0
15	**Starboard Endstop**	Software endstop for the starboard direction.	0.0...180.0	0.5	°	25.0
16	**Endstop Band**	Width of the endstop band where the rudder decelerates to a stop.	0.0…5.0	0.5	°	2.0
17	**Jam Fault Timer**	Time that a persistent Jog command causes a fault.	5000…60000	500	ms	30000
18	**RFU #1 Type**	Configure the FFU Input type. **Options:** [1] Disabled [2] Voltage (1k Pot) [3] Current (4-20mA) [4] Voltage (10k Pot)				1k Pot
19	**Valve Type**	Configure the Valve type. **Options:** [1] Proportional (Valve 1) [2] One-Speed (Valve 1) [3] Two-Speed (Valve 1+2)				[1]
20	**External Alarm**	Configure the availability of an External Alarm System **Options:** [1] Disable [2] Enable				[1]

21	**Valve #1 Deadband A**	Change the deadband compensation used for Valve #1 for direction A. The deadband is the range of spool commands that is not great enough to overcome spool friction and doesn't move the spool (the spool is "dead"). This is only shown when the Valve Type is configured as **Proportional Valve** control.	0.0…75.0	0.5	%	25.0
22	**Valve #1 Deadband B**	Change the deadband compensation used for Valve #1 for direction B. This is only shown when the Valve Type is configured as **Proportional Valve** control.	0.0…75.0	0.5	%	25.0
23	**Valve #1 Response Rate**	Set how quickly Valve #1 opens and closes in response to valve commands. This is the slew rate. Limiting it will reduce hydraulic hammering caused by the shock of instantly opening or closing the valve. Setting this slower reduces the maximum movement speed of the spool. Slowest = 100%/s -> 1000 millisecond opening Fastest = 10000%/s -> 10 millisecond opening Default = 250%/s -> 400 millisecond opening	100.0…10000.0		%/s	[5]

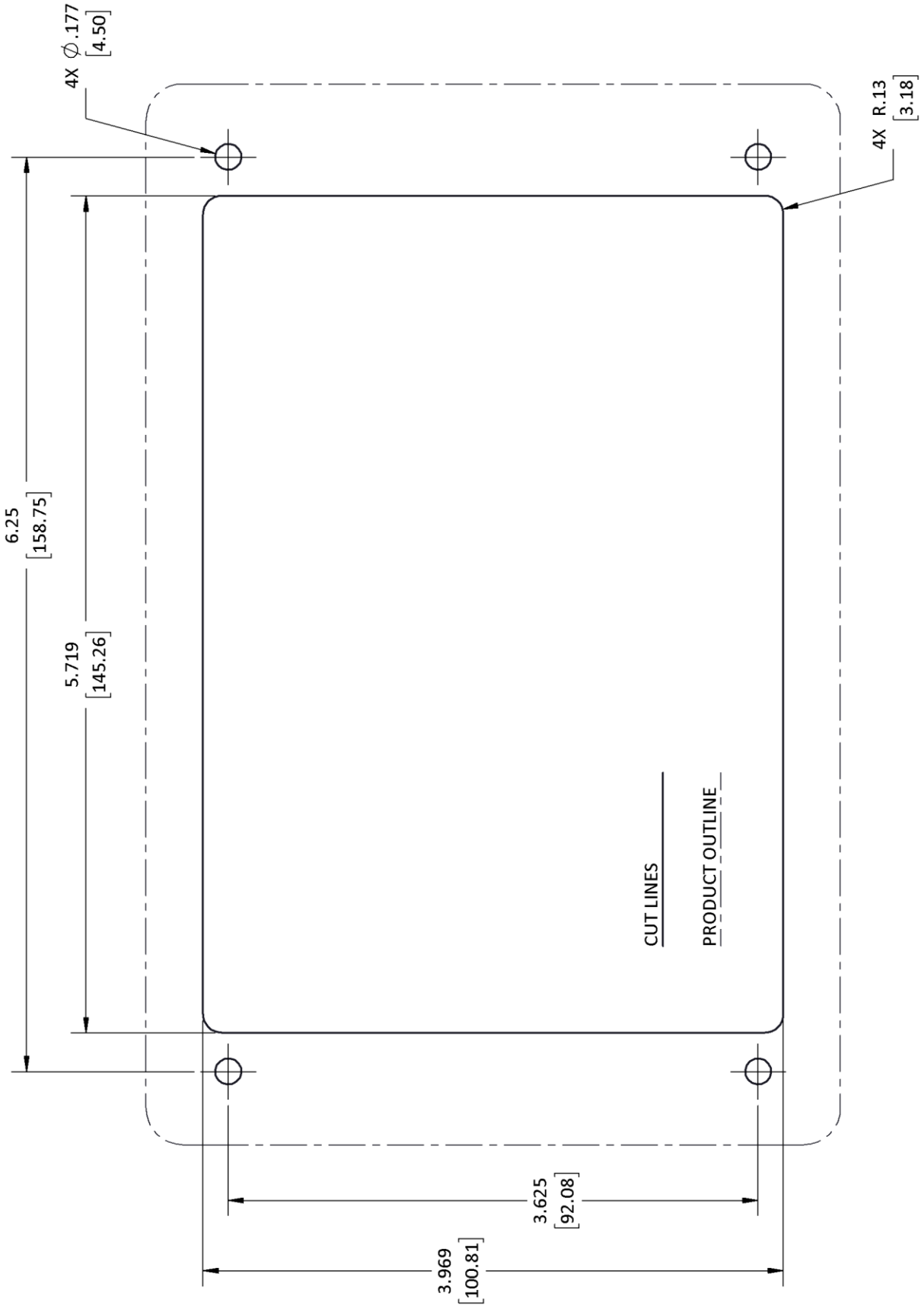
Option	Value
[1] Immediate	1000.0
[2] Very Fast	750.0
[3] Fast	600.0
[4] Medium	400.0
[5] Slow	250.0

	[6] Very Slow	100.0				
24 **Valve #2 Deadband C**	Change the deadband compensation used for Valve #2 for direction C. The deadband is the range of spool commands that is not great enough to overcome spool friction and doesn't move the spool (the spool is "dead"). This is only shown when the Valve Type is configured as **Proportional Valve** control.		0.0…75.0	0.5	%	25.0
25 **Valve #2 Deadband D**	Change the deadband compensation used for Valve #2 for direction D. This is only shown when the Valve Type is configured as **Proportional Valve** control.		0.0…75.0	0.5	%	25.0
26 **Rudder Lock Tolerance**	This is used for the Rudder Lock Fault now, If the rudder is outside this angular distance for longer than the Lock-to-Lock time it will result in a rudder lock fault.		2.0…7.0	0.1	°	2.0
27 **Autopilot Type**	Configure the type of Autopilot. **Options:** [1] No Autopilot [2] Auto Disengage [3] Manual Disengage [4] Always Live					[1]
28 **Autopilot Jog Speed**	Rudder speed when commanded by autopilot.		1.0…100.0	5	%	10.0
29 **Autopilot Ramp Rate**	Acceleration rate from stopped to Autopilot Jog Speed.		1.0…10000.0		%/s	[5]
	Option	**Value**				
	[1] Immediate	10.0				
	[2] Very Fast	20.0				
	[3] Fast	30.0				
	[4] Medium	40.0				
	[5] Slow	50.0				
	[6] Very Slow	60.0				
30 **Jog Speed**	Rudder speed for normal-speed jogging.		0.0…**[Jog Fast-Speed]**	1	%	40.0

	This is only shown when the Valve Type is configured as **Proportional Valve** control.				
31 Jog Fast-Speed	Rudder speed for fast-speed jogging. This is only shown when the Valve Type is configured as **Proportional Valve** control.	**[Jog Speed]** …100.0	1	%	70.0
32 Jog Ramp Rate	Acceleration rate for the Jog Command Same for both Off->Low-speed and Low-Speed->Fast-Speed ramping. Slowest = 50%/s -> 2 seconds to full command Fastest = 1000%/s -> 100 milliseconds to full command Default = 100%/s -> 1 second to full command This is only shown when the Valve Type is configured as **Proportional Valve** control.	1.0…10000.0		%/s	[4]
	Option	**Value**			
	[1] Immediate	10000.0			
	[2] Very Fast	500.0			
	[3] Fast	250.0			
	[4] Medium	100.0			
	[5] Slow	75.0			
	[6] Very Slow	50.0			
33 Hold for Fast-Jog	Set the time that the operator must hold the NFU input for before the system starts to fast-jog. Holding any normal-speed jog input or button for specified duration to will cause the ramp to fast-jog. This is shown when the Valve Type is configured as **Proportional Valve** or **Two-speed Solenoid Valve** control.				[1]
	Option				
	[1] Disabled				

	[2] Hold for 1.0 seconds				
	[3] Hold for 1.5 seconds				
	[4] Hold for 2.0 seconds				
	[5] Hold for 2.5 seconds				
	[6] Hold for 3.0 seconds				
	[7] Hold for 4.0 seconds				
	[8] Hold for 5.0 seconds				
34 Dither Amplitude	This is only shown when the Valve Type is configured as **Proportional Valve** control. This parameter affects the distance the dither travels from the original command. If the dither amplitude is set to 5% and the command is 20% the command will oscillate from 15% to 25%	0-5	0.1	%	0.0%
35 Dither Frequency	This is only shown when the Valve Type is configured as **Proportional Valve** control. This parameter affects the frequency of the dither oscillation. This changes how fast the signal will oscillate around the pwm output command. If the dither frequency is 200hz it will oscillate 200 times a second around the valve PWM command with a range of the Dither Amplitude	0-200	1	Hz	0Hz

13 APPENDIX B: STATION CUTOUT TEMPLATE


4X ∅.177 [4.50]
4X R.13 [3.18]
6.25 [158.75]
5.719 [145.26]
CUT LINES
PRODUCT OUTLINE
3.625 [92.08]
3.969 [100.81]