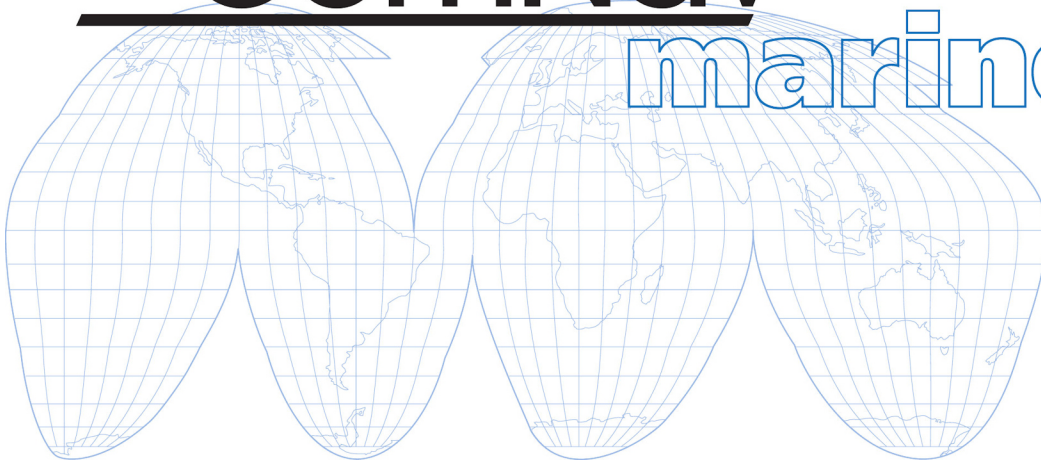


ComNav[®]

marine ltd



1420 Autopilot System

Installation & Operation Manual



ISO 9001



COMPLIES WITH
CE REGULATIONS



1420 Autopilot System

Installation & Operation Manual

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WELCOME

Congratulations on your purchase of a ComNav Marine 1420 Autopilot System Autopilot System! At ComNav, we are dedicated to reliability & quality in all our products, and proud of our prominence as a leader in the design and manufacture of marine autopilot systems. We promise to do our best to ensure your satisfaction with your new Autopilot System.

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WARRANTY NOTICE

Prior to the installation and/or operation of the equipment, ensure that you read, understand, and accept the conditions of the warranties as detailed in the **Warranty Information** section of this manual.

OPERATOR'S WARNING

The 1420 Autopilot System Autopilot System will steer your vessel, when you activate it.

However, it is only an aid to navigation. Its performance can be affected by many factors including equipment failure, environmental conditions, and improper handling or use. An autopilot system does not reduce your responsibility for the control of the vessel when underway. You must always be in a position to monitor the course, supervise the autopilot, and resume manual control if the need to do so arises.

Whenever underway, your vessel must be under the control of a qualified and alert person.

GENERAL NOTICE

This document, ComNav part number 29010012 Version 1 Revision 3, is the approved Installation and Operation Manual for use with the 1420 Autopilot System Autopilot System. Where versions of this manual exist in other languages, the English version shall be considered authoritative.

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Product Description

The ComNav 1420 Autopilot System has been designed to make the advantages of a marine autopilot available to a wide range of vessels which need accurate steering control, yet have only limited space, and require easy installation and operation.

The 1420 Autopilot System can steer the vessel on a constant Heading, or along a Course line.

To steer a constant Heading, the Autopilot compares the compass information with the Heading (Course) that the operator has selected. If the vessel is not on the correct Heading, the Autopilot calculates the rudder position which will bring the vessel onto the correct Heading.

The Autopilot uses the vessel's steering system to move the rudder (or outboard motor) to the position it calculates. The steering system may be a hydraulic system, or an electric motor, and mechanical linkage. Information from the Autopilot's Rotary Feedback (or Outboard Feedback) is used to calculate new rudder positions, and to verify that the steering system has followed the Autopilot commands.

When steering along a Course line, the 1420 Autopilot System uses information from the compass to monitor the vessel's heading. It can also use position information received in NMEA 0183 format from a GPS receiver, a chartplotter, or other device. Using both of these inputs, the Autopilot calculates the Course to Steer which will keep the vessel on the Course line.

The 1420 Autopilot contains a feature called *Ghost Rudder*. Should the Rudder Feedback ever fail, the Autopilot will use its prior knowledge of how the rudder moves to calculate new "virtual rudder" positions. While the *Ghost Rudder* will not allow the Autopilot to steer as well as it can with the Rudder Feedback, it *will* allow the Autopilot to be used until repairs can be made.

The 1420 Autopilot is protected against many mishaps, including: reverse power connection, output circuitry overload, computer failure, or program error.

The 1420 Autopilot features pushbutton steering control, course correction as small as one degree, two independent rudder response settings with 14 sensitivity settings in each, a navigation interface, and watertight construction.

The Control Head can be mounted on a panel using a supplied Clip. When removed from the Clip, it can be used as a portable unit.

Specifications

Voltage: 10 VDC - 40 VDC

Steering Outputs: 20 Amperes Maximum

Dimensions

L x W x H or D

Control Head: 3.1 x 2.5 x 0.7 inches
(7.9 x 6.4 x 1.8 cm)

Processor: 15 X 6.3 X 2.7 inches
(38.1 x 16.0 x 6.9 cm)

Compass: 5.6 x 3.0 x 4.2 inches
(14.2 x 10.7 x 7.6 cm)

Pump: 7.5 x 4.75 x 4 inches
(19.0 x 12.2 x 10.2 cm)

Before You Start

Thank you for buying the ComNav 1420 Autopilot System. It **will** make boating safer, easier and more enjoyable for you!

Please do not forget to complete and send in your warranty card.

This will give you 3 years of Warranty protection. We suggest that you do it first!

Happy boating!

Unpacking and Identification

Please make sure that you have found and identified all of the components of your Autopilot System, before you begin installation. This manual begins with a parts list, to help you identify the components of your system.

Your system will have either a Rotary Rudder Feedback or an Outboard Motor Feedback. There are separate sections about both Feedback units in this manual.

If you purchased a system without a Hydraulic Pump, you can ignore the sections of the manual dealing with Pumps, and about bleeding the hydraulic system.

Wiring diagrams for connecting to 4 and 5 wire motors and solenoid valves are in the appendixes.

Manual Conventions

In this manual, the names of the main components are capitalized.

For example: Processor

Also, the keys on the Control Head are capitalized.

For example: Speed Key

When you are required to perform an action with a key, it is underlined.

For example: Press the Red Key

When you are to look for a Control Head light to turn on, it will be underlined.

For example: light beneath the Green Key

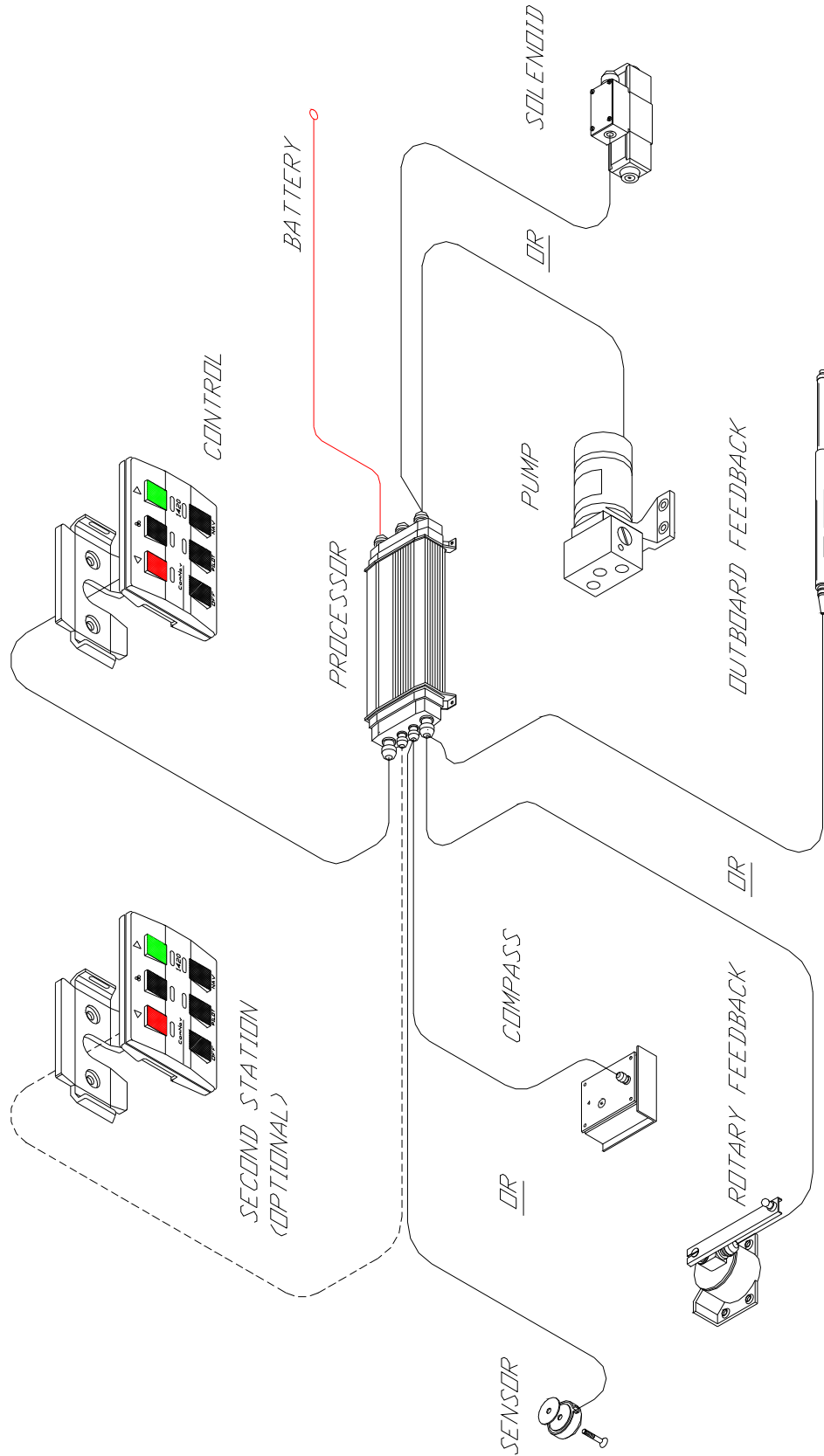
Tools Required

The general tools & other items you will need while installing the system are:

- 1) Basic Tool Kit
- 2) Screwdrivers: One Phillips, one slot-head
- 3) Wire Cutters: a pair of ordinary wire cutters suitable for general electrical work will do
- 4) Drill and a selection of Drill Bits
- 5) Small Adjustable Wrench
- 6) Any tools specific to your boat
- 7) Miscellaneous fasteners & mounting hardware, for mounting components and securing hydraulic lines (see individual "installation" sections, below, for specific suggestions)
- 8) You may also wish to have a supply of Ty-wraps (aka "zap straps") for securing electrical cables

If you purchased a 1420 with a Hydraulic Reversing Pump, a list of the tools you will require specifically for the installation of the Reversing Pump is on page 25.

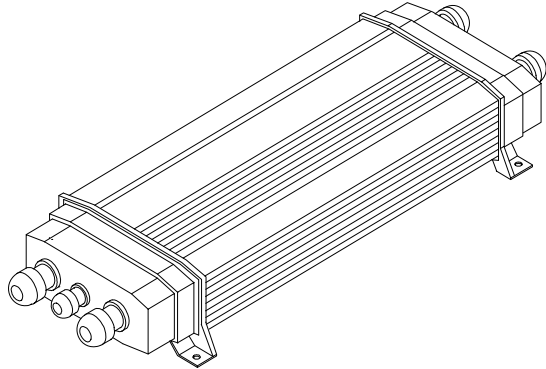
If you purchased a 1420 with a Rotary Rudder Feedback you may need one stainless steel band clamp, of a size more than large enough to fit around your vessel's rudder post. See page 16.



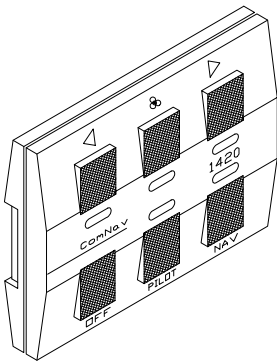
1420 System Diagram

Parts List

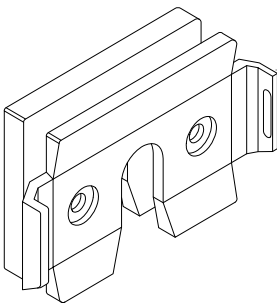
Note: Parts are not drawn to any scale.



Processor. PN 20070003

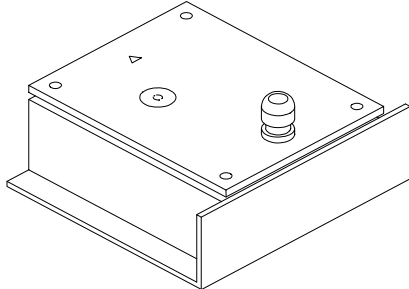


Control Head. PN 20070002. This part includes 25 feet (7.6 m) of cable wired to it.



Control Head Mounting Clip and Spacer (these are included in the Accessory Kit). PNs 65610066 & 65610067 (can also be ordered together as PN 30070002, if additional Head mounting locations are desired).

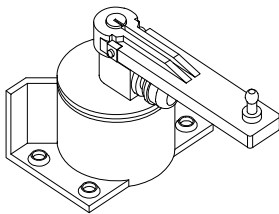
ComNav Fluxgate Compass. PN 20320003. This has 40 feet (12.2 m) of cable wired to it; the other end of the cable has stripped & tinned wires.



If you purchased a system with a Heading Rate Stabilizer, you will instead have a Fluxgate Compass PN 20320004, which has a 7-pin plug on the cable's end. The Compass plugs into the HRS.

The HRS is PN 20320009, and has 40 feet (12.2 m) of cable wired to it; the other end of the cable has stripped & tinned wires. Installation & wiring instructions for the HRS are included with it.

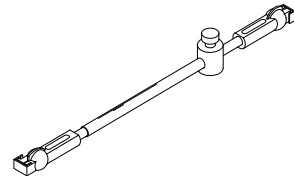
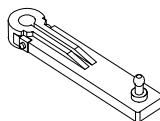
One of two different Feedback Units will be included:



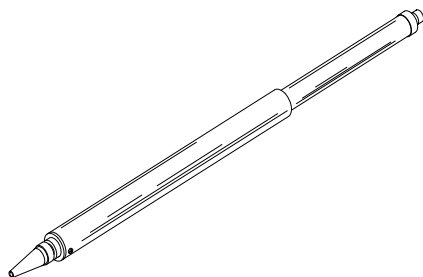
Rotary Rudder Feedback. PN 20330008. This part includes 50 feet (15.2 m) of cable wired to it.

This part always comes with:

Rotary Rudder Feedback Linkage Kit. PN 20330007.



or.

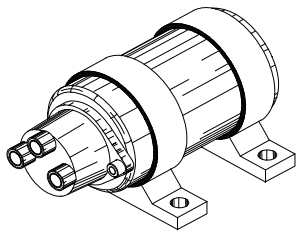


Outboard Feedback. PN 20330002. This part includes 30 feet (9.1 m) of cable wired to it.

Also included but not shown:

- Power Cable. 7.5 feet (2.3 m) of cable (labelled “5”), for connecting supply voltage to the Processor.
- Accessory Kit. PN 20070004. Contains extra terminal sockets, a cable gland and the Control Head Mounting Clip & Spacer.
- 1420 Installation & Operation Manual (this manual, PN 29010012).

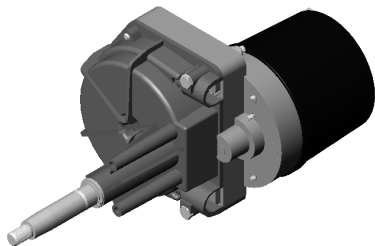
If you purchased a system with a ComNav hydraulic pump, one of two models, at one of two operating voltage ratings, will be included. All the pumps look very similar, so inspect the labels carefully.



- 18CI Reversing Pump, 12 VDC. PN 20810016
- 18CI Reversing Pump, 24 VDC. PN 20810031
- 30CI Reversing Pump, 12 VDC. PN 20810018
- 30CI Reversing Pump, 24 VDC. PN 20810035

All pumps have 20 feet (6.1 m) of cable wired to the Pump Motor.

If you purchased a system with a Cable Drive, one of several models will be included. The models vary slightly in appearance, so inspect the labels carefully.



- Type 'S' (Morse Straight Shaft – shown in the figure). PN 20910002
- Type 'MTS' (Morse Tilt Shaft). PN 20910003
- Type 'T' (Teleflex Performance Tilt). PN 20910004
- Type 'TST' (Teleflex Standard Tilt). PN 20910005
- Type 'R' (Remote). PN 20910009

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Installation Instructions

Caution

*Using ordinary electric tools near water is **VERY** dangerous! To minimize the dangers of electric shock and personal injury, we recommend using only cordless rechargeable tools, and/ or hand tools, during the installation of the system.*

1420 Autopilot System

Planning

Processor Location

In choosing a location for your ComNav 1420 Autopilot System, remember that the cable from the Control Head to the Processor (Cable #1) should not be cut or lengthened. Excess cable may be loosely coiled behind a panel.

You will want to have the Control Head near the steering station you use the most; place the Mounting Clip at this station. Also note the following, when you plan the routing of cable #1:

- Cable #1 is 25 feet (7.7 m) long, and is permanently attached to the Control Head.
- If you are intending to move the Control Head around, in order to use it in other locations, locate the Processor so that the Head's cable will also be able to reach those other locations.

Similarly, the cable from the Compass to the Processor (Cable #2), should not be cut or lengthened. Cable #2 is 40 feet (12.2 m) long (excess may be coiled up).

Allow at least a foot (30 cm) of clearance on either end of the Processor in the space where it is to be located.

Do not mount the Processor near heat sources, such as heat radiators, or over engines.

If you can, mount the Processor so that the cooling fins are vertical.

If possible, mount the Processor where you will be able to hear its internal beeper while operating your boat. Although the lights on the Control Head will tell you about the Autopilot's actions, it helps if you can hear the beeper too.

Compass Location

When choosing a location for the Compass, try to locate it as close as possible to the most stable spot on your boat. Usually this spot will be close to the water line level, in the middle of the boat and two-thirds towards the stern from the bow.

Do not install your Compass near wires or devices carrying large electric currents such as battery chargers, electric pumps and motors or televisions.

Do not mount your Compass near any iron or steel objects.

Power Connection

There is 7.5 feet (2.3 m) of power cable included with your Autopilot System. We recommend that you do not lengthen this cable.

However, if you must extend the cable:

- Use the shortest extension length possible; it must be less than 10 feet (3 m) in length.
- Use no less than #10 or 12 AWG conductors. Splice and solder the joints.
- Make the joints watertight by using heat-shrink tubing and silicon, or some other watertight covering.

Power Cable

The Power Cable is labelled with a "5". Connect the Power Cable to a breaker capable of supplying at least 20 Amperes at 12 Volts DC.

The white wire is for Battery Positive from the breaker. The black wire is Battery Negative. The green wire must be wired to the ground point (see *Grounding*, next).

Route Cable #5 to the Processor location. Keep the breaker turned off until you have connected the wires to the breaker.

Grounding

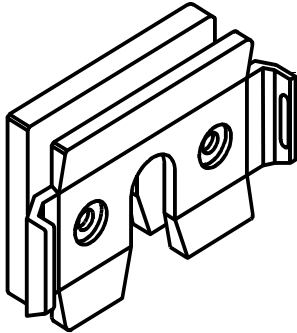
The Power Cable also contains a grounding wire. Connecting this wire to a good ground (see * *below*) may reduce static on radios and improve GPS reception.

Many different grounding methods can be used:

1. If you have a small vessel, the negative battery post can be used.
 - If you have several electronic instruments, each must be attached to the battery individually. Do not connect one instrument to another and then to the battery post.
2. If you have a ground plane for a radio on your boat, connect the ground wire to that ground plane.

** A proper ground connection point must be at the same voltage level as battery negative. Any difference in voltage between battery negative & the ground point may indicate a problem in the wiring, and so the ground-point wiring must be re-done, or replaced. Ensure that all ground connection wires are as short as possible, and that all connectors are clean.*

Installing the Mounting Clip And Spacer



Head Mounting Clip and Spacer

The Mounting Clip is used for mounting the Control Head. The design of the Clip allows two methods of placing the Control Head cable.

- Using the Clip and the Spacer, the cable can run out loose from the bottom of the clip.
- Using only the Clip, the cable can be run straight back through a hole in the mounting surface.

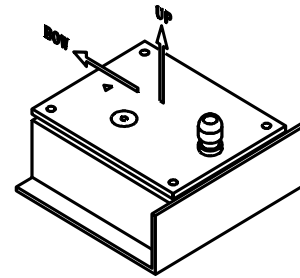
If the cable is brought through a hole in a panel, you can store the excess cable behind the panel. If you want to move the Head to another position, you can pull the cable out as needed (and you can buy additional Clips for those other locations – see page 9).

The usual mounting spot is on the dashboard within easy reach when you are steering your vessel.

The Clip is mounted using four # 10 (5 mm) fasteners (supplied by you: use a corrosion-resistant type, and a style & length suitable to the mounting surface).

Use the Clip as a template to mark the holes.

Fluxgate Compass Installation



Fluxgate Compass

The fluxgate compass must be correctly positioned or it will not work.

To correctly position the Fluxgate Compass, mount it so that the top surface (with the cable gland) is up.

On the top surface there is an arrow labelled "bow". The arrow must point in the same direction as the bow of your boat.

In cases where the compass is mounted on a side wall, the bow line arrow will be pointing to Port or Starboard. If so, remove the four screws in the top of the case, rotate the bottom part of the case ± 90 degrees, as needed so that the arrow points to the bow; then re-fasten the top to the bottom with the 4 screws.

Warning: This compass is designed to be watertight. Be careful with seals and "O" rings, if you remove the case's top to correct for a side-wall mounting.

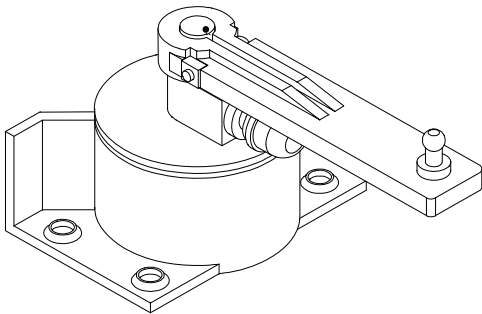
Initially, mount your Fluxgate Compass using strong adhesive tape or some other temporary, non-marking fastener. The reason for this is that it may be necessary to relocate your compass after you have done the Setup Routine.

Once the compass setup is completed, the compass's case can be securely fastened down with suitable fasteners.

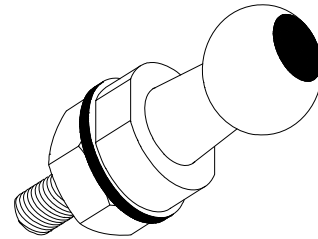
Rotary Rudder Feedback Installation

If you have a 1420 Autopilot System with an Outboard Feedback, please go to page 19.

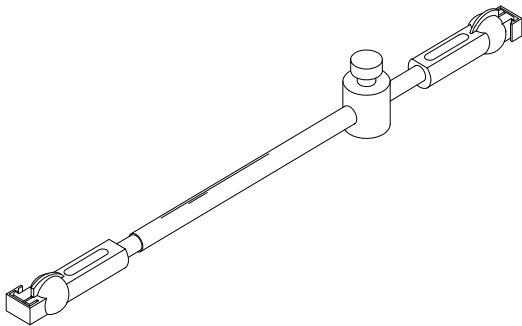
Select the following parts from the 1420 Autopilot package:



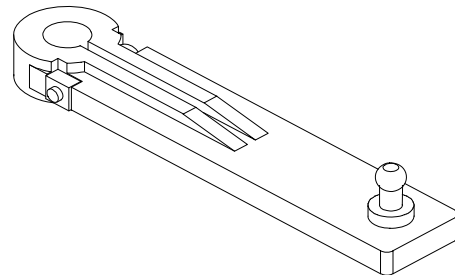
Rudder Feedback
PN 20030008



Brass Ball Joint
(Included with linkage)
PN 65520006



Linkage
PN 65520051

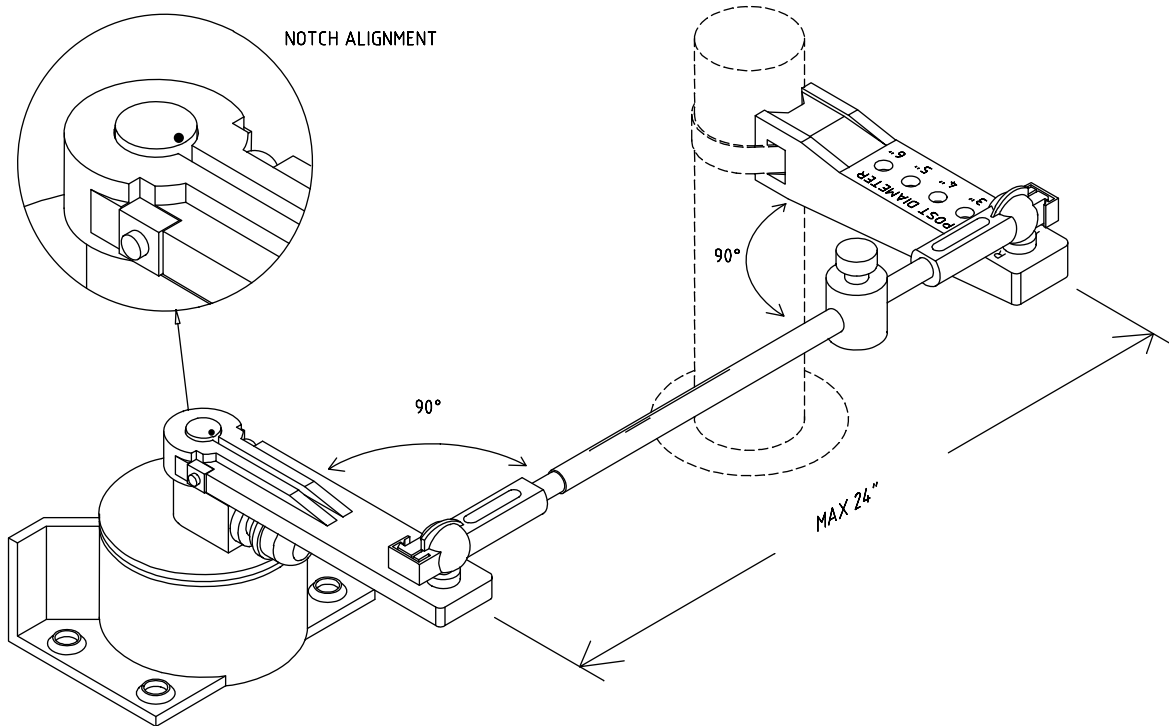


Rudder Post Arm
PN 65520004

You may also need:

- one stainless steel band clamp to hold the Rudder Arm to the rudder post
- four screws: #10 size (5 mm), suitable length, to fasten down the Rudder Feedback

Install the Rudder Feedback in the stern of the vessel, close to the rudder post. Place the Rudder Feedback so that it will be protected from objects which may shift position when your boat is moving.



Mounting the Rudder Feedback

In the diagram above notice that:

- the Rudder Feedback Arm is above the cable entry gland
- the Linkage sockets are on the top of the ball joints. *Do not mount the ball joints on the underside of the Arms, so that the Linkage would “hang” from the ball joints.*

Mount the Rudder Feedback so that the Rudder Feedback Arm and the Rudder Post Arm:

- are at the same height
- are separated by less than 24” (60.9 cm) centre to centre
- each makes an angle of 90 degrees with the Linkage

To align the Rudder Feedback Arm & the Rudder Post Arm correctly, you may need to make a mounting base for the Rudder Feedback. Such a base must be firm. It should not flex when the vessel is moving.

Use the Rudder Feedback as a template to drill holes in the mounting surface. If you must drill new holes in the flange at the back of the Rudder Feedback, drill the Rudder Feedback flange first, and then use it as a template to drill holes in the surface.

Mount the Rudder Feedback using # 10 (5 mm) screws or bolts of suitable length.

Assembling the Rudder Feedback Arm:

Measure the approximate diameter of your rudder post in inches.

The Rudder Post Arm has several holes drilled through it. The holes are marked by numbers on the top surface of the arm.

Select the hole on the Rudder Post Arm marked by a number equal to the diameter of your rudder post measured in inches. (1 cm = 0.394")

Bolt the Brass Ball Joint onto the Rudder Post Arm using the selected hole. The ball of the Brass Ball Joint must be on the same side of the Rudder Post Arm as the numbers. Tighten the nut and lock washer securely.

Attach the Rudder Post Arm to the rudder post using a stainless steel band clamp. The Brass Ball Joint must be on top. The Rudder Post Arm must be at the same height as the Rudder Follower.

The Rudder Post Arm must point straight ahead when the rudder is in the straight ahead steering position.

Attaching the Rudder Feedback Linkage:

Move the rudder so it is in the straight ahead position.

Move the Rudder Feedback Arm so that it is directly above the point where the cable enters the Rudder Feedback.

Loosen the adjustment block that keeps the two pieces of the Rudder Feedback Linkage from sliding.

Snap the Rudder Feedback Linkage onto the two Brass Balls. Make sure to close the small release clamps on each Plastic Socket.

With the Rudder Feedback Arm directly above the cable gland and the Rudder Post Arm pointing straight ahead, tighten the adjusting block.

Caution

Carefully watch the Linkage while you move the rudder through its full range of motion. The Rudder Feedback and the Rudder Feedback Linkage should move easily without binding. The moving parts must not contact any other objects. ***If there are any problems, fix them now.***

Run the Rudder Feedback Cable from the Rudder Feedback to the space where the Processor will be located. Place the Cable so that it is protected from abrasion, stretching and cutting.

You will connect these wires to the Processor when you make all the other wiring connections.

Next, turn to the section on Installing the Rudder Drive (page 23).

Outboard Feedback Installation

If you have a Rotary Rudder Feedback, please go to page 16.

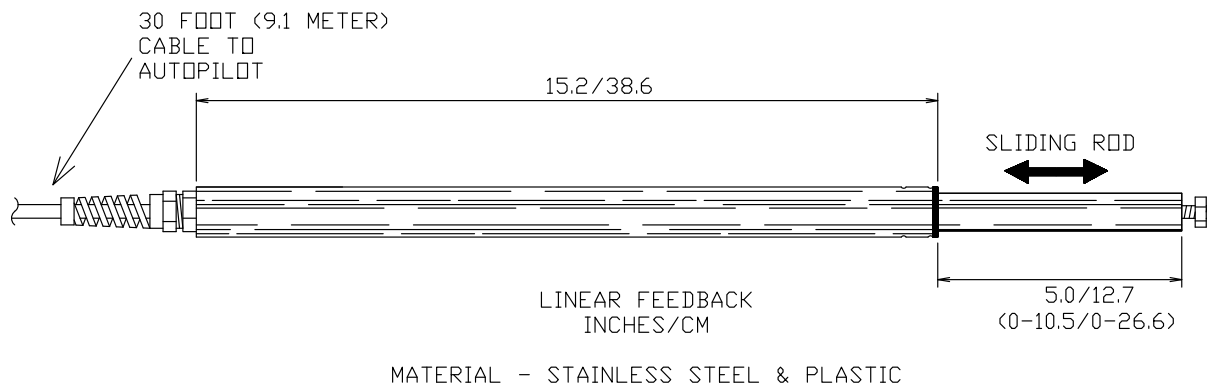
Introduction

The Outboard Feedback sends information about the rudder or propeller position to the 1420 Autopilot.

The Outboard Feedback can be attached to the hydraulic steering cylinder by using a stainless steel band clamp. A stainless steel bracket attaches one end of the Outboard Feedback to the steering cylinder rod.

The Outboard Feedback is provided with 30 feet (9.1 m) of cable.

The Outboard Feedback can be used with hydraulic cylinders from 1.25 to 2.25" (3.18 to 5.71 cm) in diameter. The cylinder stroke cannot exceed 10" (25.4 cm).

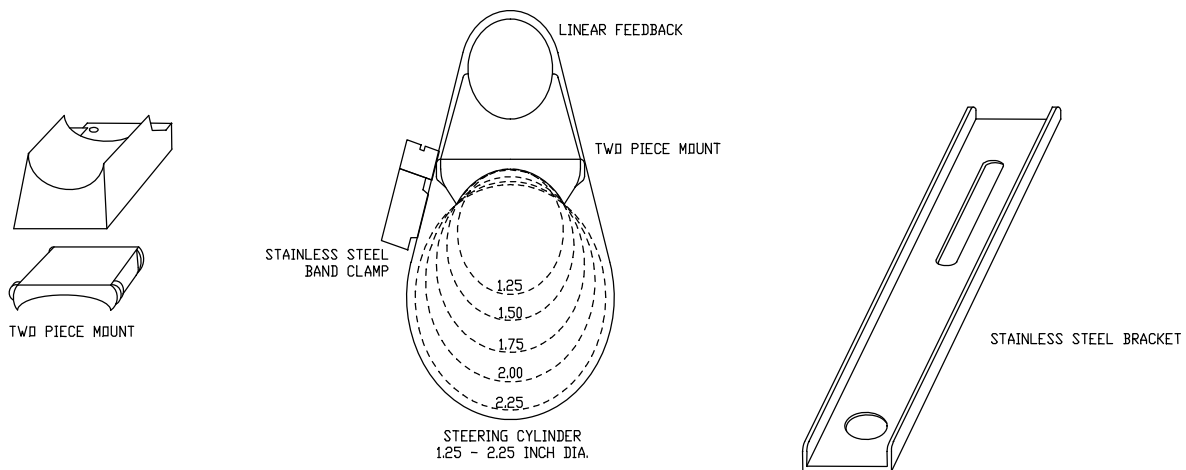


Outboard Feedback

Caution

The Outboard Feedback will be damaged if it is extended more than 10 inches. This damage will not be covered by warranty.

If necessary the extended length of the steering cylinder can be limited using corrosion resistant spacers as shown on page 22.



Mounting Hardware

Mount the Outboard Feedback so that it will not be damaged when the motor is tilted for trailering.

Mounting

The Outboard Feedback may be mounted with the sliding rod facing either left or right.

Before you install the Feedback, move the steering gear through its full range of motion from one side to the other. Measure the change in length of the hydraulic steering cylinder rod. If the rod extends or retracts more than 10" (25.4 cm), make spacers to limit the motion of the steering system as shown on page 22.

Turn the motor so that it is centred between the left and right limits of travel.

Use a tape measure or ruler to position the Outboard Feedback rod so that it projects 5.25" (13.3 cm) from the body of the Outboard Feedback.

Loosely clamp the Outboard Feedback to the tube of the hydraulic cylinder using both pieces of the Two Piece Mount and the Stainless Steel Band Clamp. The Clamp should be positioned as close as possible to the tube end where the cable exits.

Remove the nut from the end of the rod of the hydraulic cylinder. Place the Stainless Steel Bracket over the threaded end of the rod and replace the nut. Do not completely tighten at this time.

Adjust the position of the Outboard Feedback so that the end of the sliding rod is flush with the Stainless Bracket. Screw the nut onto the threaded rod at the end of the Outboard Feedback.

Adjust the position of the Outboard Feedback so that as nearly as possible it is parallel with the hydraulic cylinder both horizontally and vertically. Tighten the nuts and the stainless steel band clamp securely.

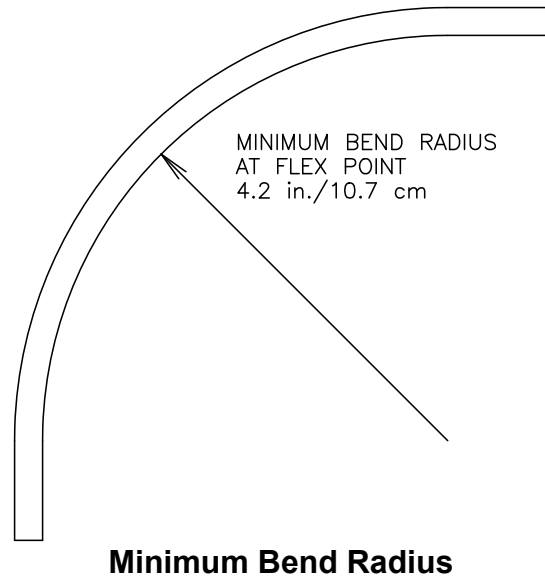
Run the cable forward to the 1420 Processor location. Choose a route for the cable so that the *minimum bend radius in the cable is at least 4.2" (10.7 cm)*. This is especially important in the motor well and other areas where vibration is present.

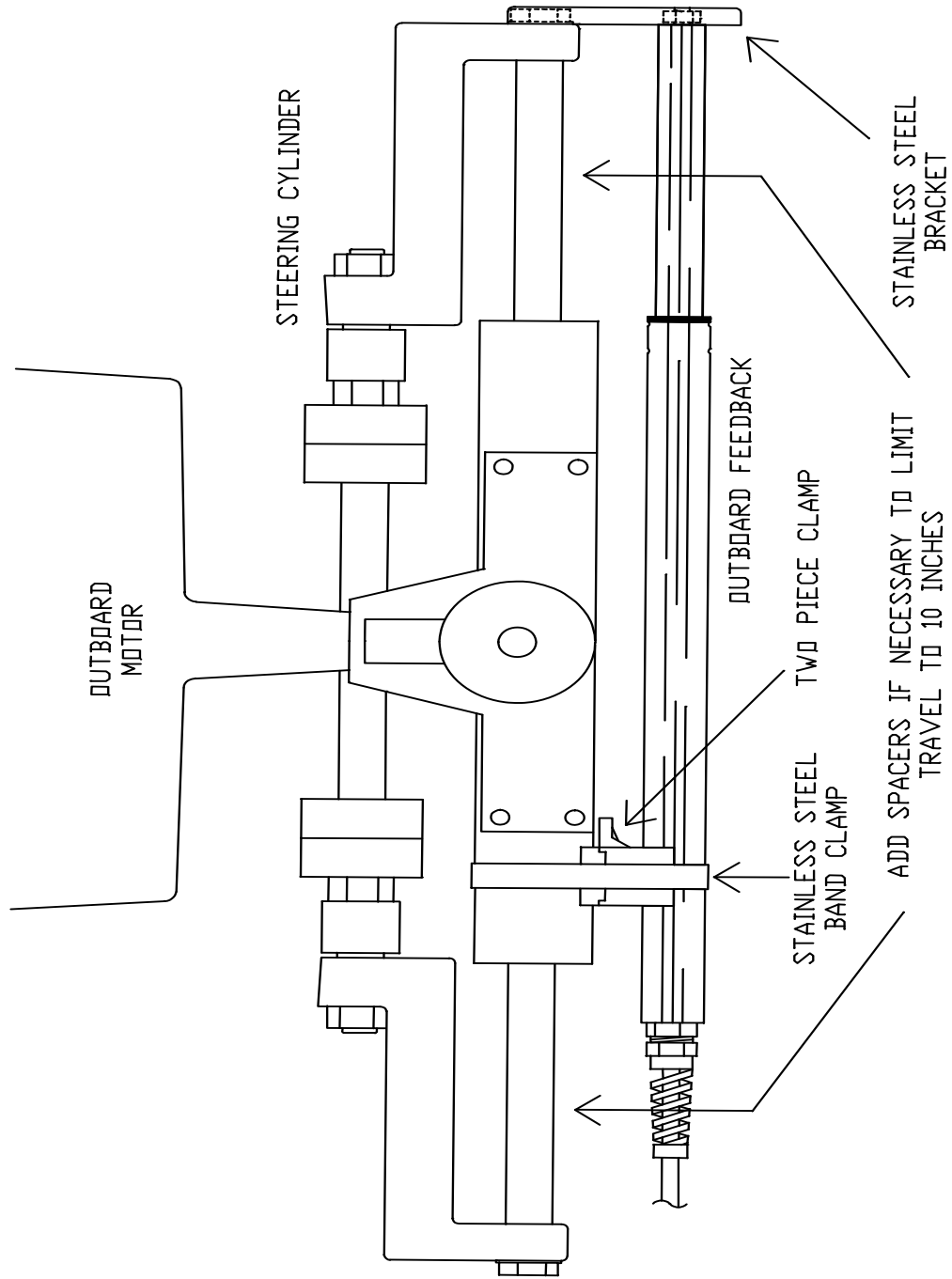
You will connect these wires to the Processor when you make all the other wiring connections.

Maintenance

Keep the sliding rod clean. Wipe it occasionally so that dirt cannot enter the Linear Feedback. Use a clean, soft rag.

*After transporting your boat on a trailer, it is **very** important to clean the sliding rod!*





Outboard Feedback Mounting to Front Mount Cylinder

Rudder Drive

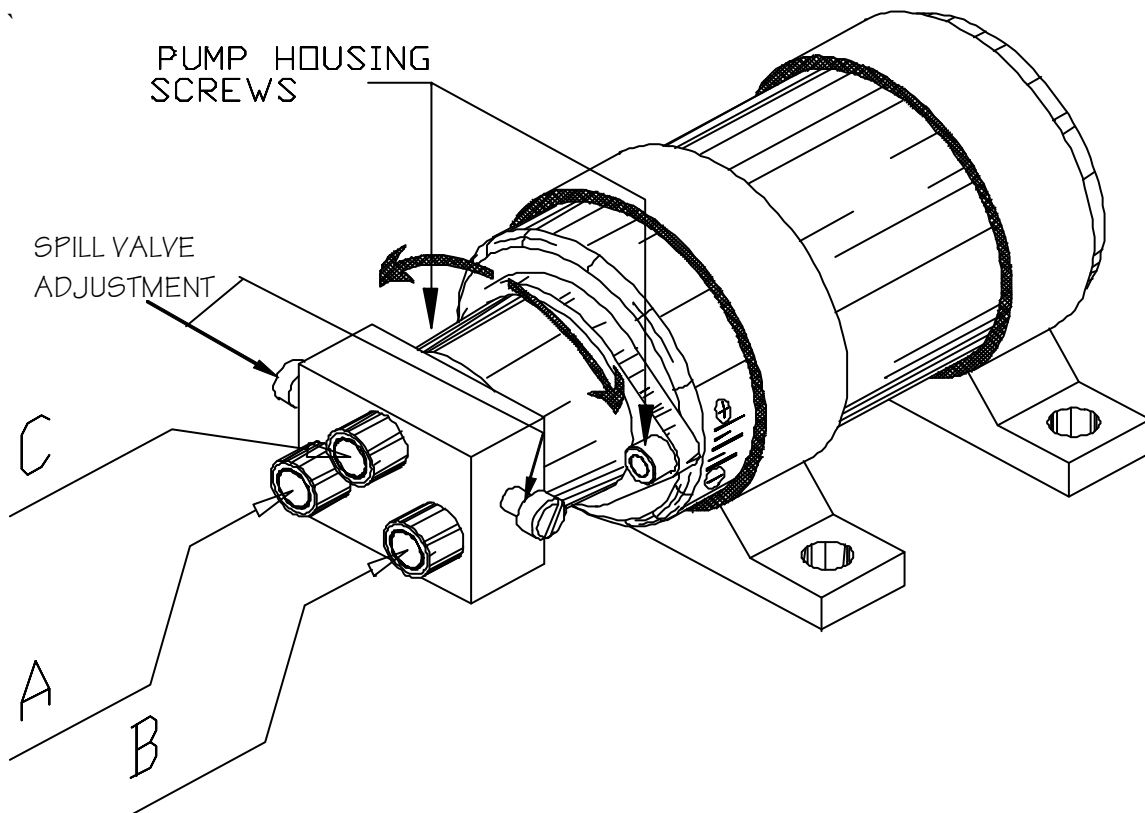
The next step is to install the Rudder Drive.

- If the system you purchased includes a Reversing-Motor Hydraulic Pump, follow the instructions in this section.
- If your system came with a Cable Drive, follow the Installation Instructions that came with that.
- If your system did not come with a Drive System, you will have to adapt the Autopilot's Drive outputs to your vessel's existing Steering System.

ComNav Reversing-Motor Hydraulic Pump

(PNs 20810016, 20810018, 20810031, 20810035)

The reversing pump consists of a hydraulic pump and a motor. The pump is a piston type, driven by the reversing permanent magnet motor. The pump is designed in such a way that it will keep oil from returning through the pump when is not running or correcting. There is also a bleed-to tank to allow the use of unbalanced cylinders. The pump is compatible with all hydraulic steering systems, including pressurized steering systems such as Hynautic.



To adjust the pump's flow rate, loosen pump housing screws and turn pump housing. Clockwise will decrease flow rate, anti-clockwise increases flow rate.

Pump Models & Specifications

There are two models of ComNav pumps, defined by the maximum size of cylinder they can be used with: 18 in³ or 30 in³. Each model also has a choice for the operating voltage of the pump's motor: 12 or 24 VDC.

1. Model 18CI pumps are suitable for cylinders from 7 in³ to 18 in³ (115 cm³ to 295 cm³) in displacement
2. Model 30CI pumps are suitable for cylinders from 15 in³ to 30 in³ (246 cm³ to 492 cm³) in displacement

Model Number:	———— 18CI ————	———— 30CI ————
Part Number:	20810016 20810031	20810018 20810035
Operating Voltage:	12VDC 24VDC	12VDC 24VDC
Current @ 200 PSI:	4.5 Amps 3.0 Amps	6.0 Amps 3.0 Amps
Min Displacement:	— 26 in ³ (600 cm ³) —	— 61 in ³ (1000 cm ³) —
Max Displacement @ 200PSI:	— 73 in ³ (1200 cm ³) —	— 122 in ³ (2000 cm ³) —
Max Pressure:	———— 800 PSI ————	———— 500 PSI ————

Specifications Common to All Pumps

Port Sizes:	3/8" compression fittings supplied
Min Stall Pressure:	1200 PSI (84.0 Bar) (8,268 kPa)
Oil Type:	Any approved hydraulic steering fluid
Operating Temperature:	0° to 50° C (32° to 122° F)
Adjustable Flow:	Yes
Lock valve:	Yes
Lock valve Leakage:	Negligible
Unbalanced Cylinder:	Yes, up to 3/4" (1.9 cm) diameter rod
Weight:	5.0 lbs (2.27 kg) including wire
Size:	10" x 3.75" x 4.75" (25.4 cm x 9.5 cm x 12.1 cm)
Shaft Seal:	100 PSI (6.89 Bar) (689 kPa) minimum

Types of Steering Systems

There are two general types of steering systems: Two Line systems, and Three Line systems. The pump connection to the steering system is different for each type. There are separate instructions below for each type (see pages 28 & 29).

If you are installing this pump on a Capilano or Syten steering system, you *probably* have a Three Line steering system. If the helm pump is a Capilano Model 250 or 275 (made by Teleflex), or there is a Uniflow valve mounted close to the steering cylinder, you *definitely* have a Three Line system.

You have a Two Line system if you do not have the above components in your system.

Tools and Material Required to Install Pump

By following the step-by-step procedure here, and using only the basic tools and materials listed below, you will find the installation easy to do.

Caution

This Pump is not waterproof and is therefore not warranted against water damage. This Pump is also not warranted against damage caused by improper installation.

- 1) Pipe Cutter
- 2) Funnel with Filter (a coffee filter will do)
- 3) Bucket large enough to hold oil drained from the steering system. A 2 gallon (9 litre) bucket is adequate for most pleasure boars.
- 4) Rags or Paper Towels
- 5) 3/8" Electric Drill
- 6) Pipe Fittings (*check with steering gear manufacturer for type & size*)¹
- 7) Tubing (*check with steering gear manufacturer for type and size*)²
- 8) Hydraulic Oil (*check with steering gear manufacturer for type*)²
- 9) Teflon based thread sealer (such as Loctite® PST)
- 10) Suitable fasteners for mounting the pump and securing lines

Caution

*Using ordinary electric tools near water is **VERY** dangerous! To minimize the dangers of electric shock and personal injury, we recommend using cordless rechargeable tools or hand tools.*

¹ Consult with your steering system manufacturer to get detailed information about factory authorized materials. Failure to do so could void your warranty.

Notes & Cautions

Before beginning to connect the pump to the steering system, review the following points:

- Cap or cover the ends of hoses with a clean rag before pushing them between bulkheads.
- Wipe copper filings off freshly cut and reamed copper tube. Do not blow the filings off.

Caution

CLEANLINESS must be maintained while making hydraulic connections!

Contamination introduced into the steering system fluid can cause steering components to malfunction, possibly resulting in a loss of steering.

- Teflon based thread sealer must be used on all male pipe threads.
 - ⇒ Do not place thread sealer on the first two threads.
 - ⇒ Do not use a tape-type thread sealer. These can shred and enter the steering system fluid.
 - ⇒ Do not place thread sealer on female pipe threads.
- When tightening fittings into the pump lock valve, hold the lock valve, not the motor. That way, the lock valve will not twist out of alignment with the rest of the pump.
- Connection of the pump lines is most easily made at existing breaks in the steering system lines. For example: at valves, Tee-joints and other fittings.

Caution

Opening your hydraulic steering system will introduce air to your steering system!

However, this air will be expelled if the steering system is bled properly.

After you refill the system and during the Autopilot Setup Routine, your autopilot can be used for bleeding any trapped air.

Ensure that you follow the Compensating Line installation instructions given below (pages 28 & 29) very carefully, as all air is expelled through this line when bleeding your system. If the Compensating Line does not prime properly and allows fluid to get to the autopilot pump, the pump will not perform properly. The Compensating Line does not have to be a high pressure hose. In fact, even a clear hose can be used, allowing for easy visual confirmation of proper Compensating Line operation.

Installing the Pump

Installation of the pump consists of:

- Finding a mounting location for the pump
- Partially draining the steering system
- Mounting and connecting the pump to the existing steering lines
- Filling and bleeding the steering system

A suitable mounting location for the pump MUST:

- Be dry
- Be lower than at least one of the helm pumps in the steering system
- Provide a solid mounting base
- Be at least 4 feet (3.1 m) from the vessel's compass

A mounting location for the pump SHOULD:

- Provide easy access to the pump
- Provide an easy connection point to the steering system
- Minimize the length of the pump hoses
- Minimize the length of the wires to the motor

A typical mounting location would be in the engine compartment or the steering console.

The pump can be mounted in any orientation except with Port C facing downward. If Port C is facing downward then air will not be able to rise out of the pump and the pump will not have a supply of oil.

There are two ways to connect the pump to the steering system. The first is to leave the system completely filled and be careful not to spill hydraulic fluid. The second is to drain the system of fluid completely before cutting or opening any lines.

If you follow the first method, remember that when you disconnect or cut the steering lines, there will be a constant slow discharge of oil due to gravity draining the system. Have a container ready to catch all excess oil. Do not reuse any oil reclaimed from your system.

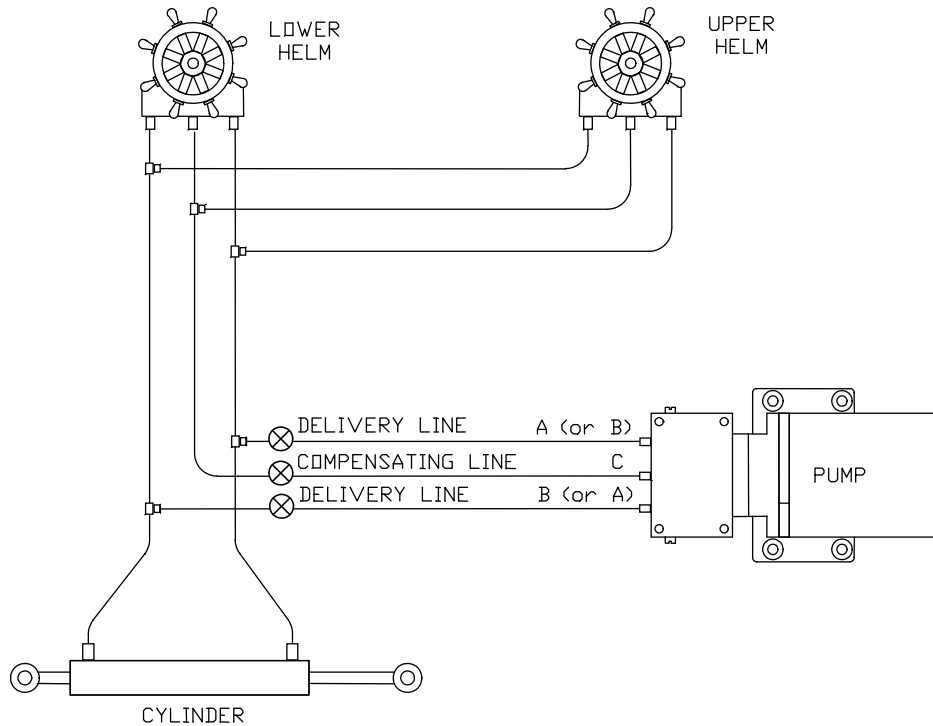
If you wish to follow the second method and drain the system, use the following simple procedure.

1. Have a large container, about 2 gallons, ready.
2. Disconnect the delivery lines at a low point, usually where the lines connect to the steering cylinder.
3. Turn the wheel of the highest helm pump in both directions until no more fluid comes out of the lines.
4. Repeat the previous step on each lower helm pump in turn.

Hydraulic Connections

Next, make the appropriate hydraulic connections, according to whether you have a Two Line or Three Line Steering System.

Hydraulic Connections for Two Line Steering Systems



2 Line Steering System Connections

Delivery Lines:

Ports A and B in the diagram above are the input/output ports of the pump and must be connected to the steering lines coming from the steering cylinder. It does not matter which pump port is connected to which steering line.

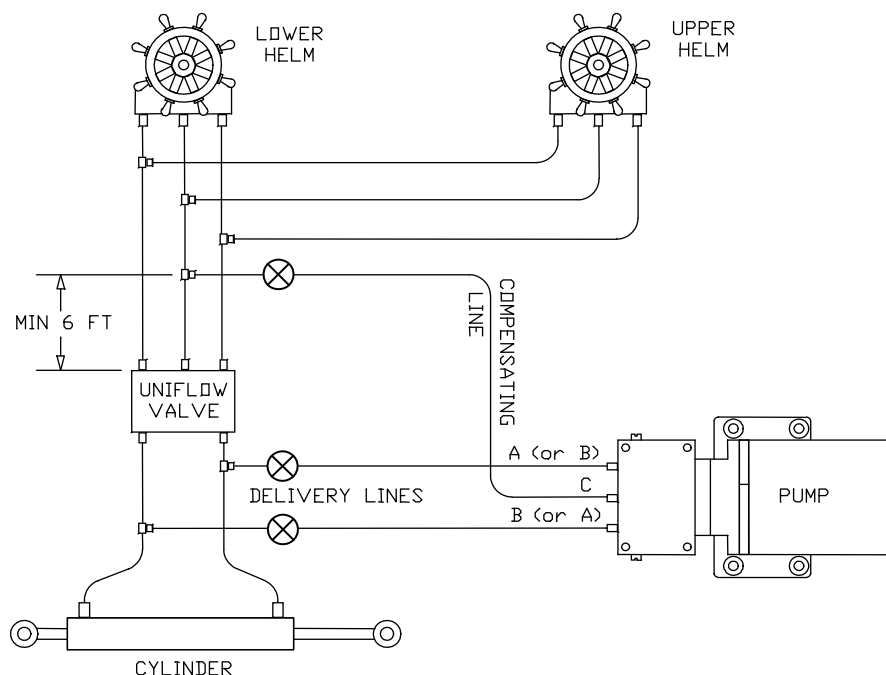
Compensating Line:

Port C is the compensating or bleed line, and must be connected to the steering system's reservoir. This connection can be made at: a helm pump, the remote reservoir (if there is one), the compensating line connecting two helm pumps, or the compensating line connecting a helm pump to the remote reservoir. If the connection is being made directly to a helm pump, ensure that the bleed line is connected to the **LOWER** helm's bleed port.

The compensating line *MUST* have a gradual rise from the pump to the connection to the steering system. This allows air to rise out of the pump, ensuring a constant supply of oil to the pump.

INSTALLATION OF SHUT-OFF VALVES IS RECOMMENDED (shown with )

Hydraulic Connections for Three Line Steering Systems



3 Line Steering System Connections

Delivery Lines:

In the above diagram, **Ports A and B** are the input/output ports of the pump, and must be connected to the steering lines between the steering cylinder and the Uniflow valve. The simplest method of doing this is to install a tee in each of the cylinder ports of the Uniflow valve itself, and connect to these tees. It does not matter which pump port is connected to which steering line.

Compensating Line:

Port C is the compensating or bleed line, and must be connected to the steering system's reservoir. This connection can be made at a helm pump, the remote reservoir (if there is one), the return line connecting two helm pumps, or the return line between a pump and the Uniflow valve. If the connection is being made directly to a helm pump, ensure that the bleed line is connected to the **LOWER** helm's bleed port.

The connection *MUST* be at least 6 feet (1.83 m) from the Uniflow valve as shown above. If the connection is too close to the Uniflow valve, the manual steering system may not work well.

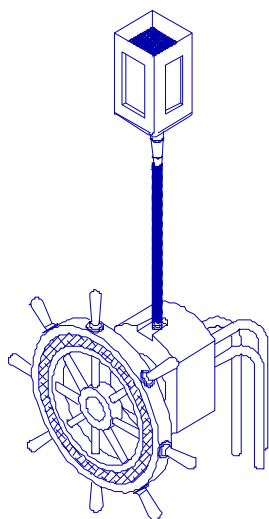
The compensating line *MUST* have a gradual rise from the pump to the connection to the steering system. This allows air to rise out of the pump, ensuring a constant supply of oil to the pump.

INSTALLATION OF SHUT-OFF VALVES IS RECOMMENDED (shown with )

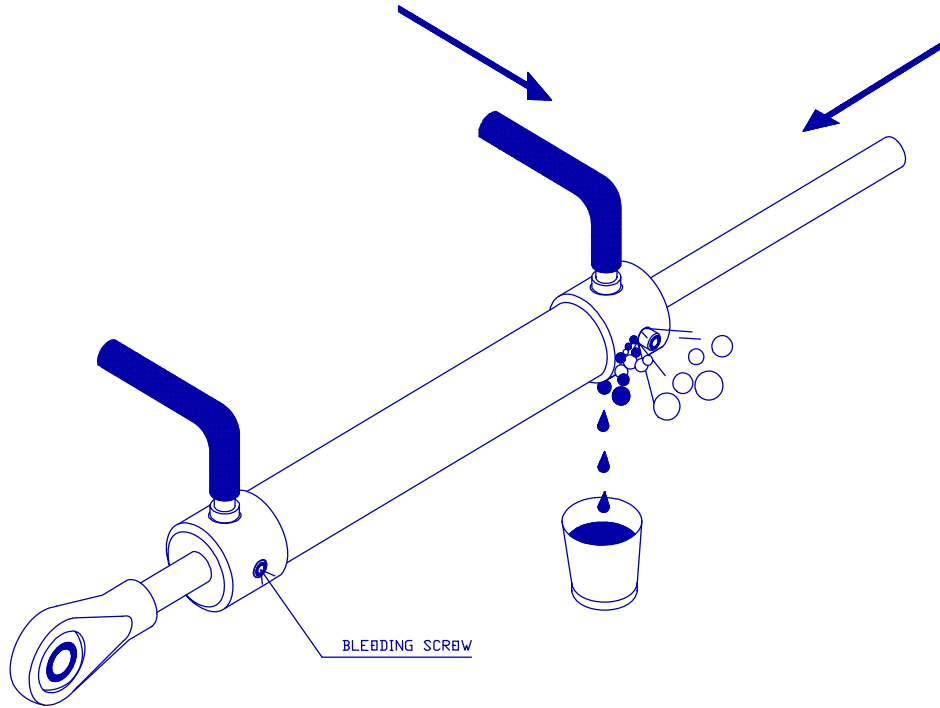
Fill And Bleed

After you have installed your Pump, fill it with hydraulic fluid, and then bleed it. The first part of this procedure can be done right away – but for the rest, the Autopilot must be installed and powered up, so you will be referred back here during Autopilot Setup.

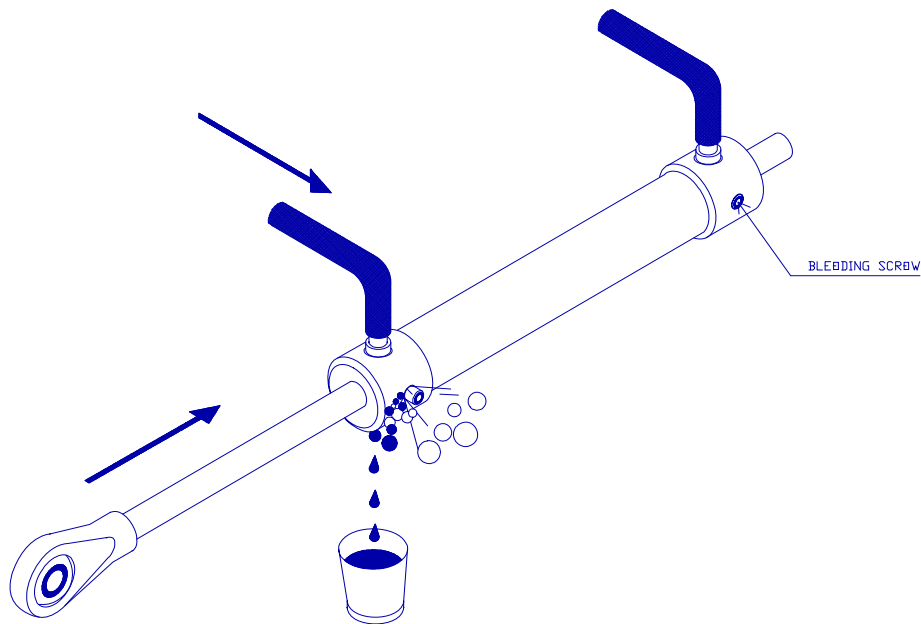
1. Bleed your manual steering system according to the manufacturer's instructions. When you have completed the bleeding, leave the equipment for the bleeding procedure attached to your hydraulic steering system.
2. Fill your highest reservoir completely. Turn the steering wheel just past the stop to press as much oil as is possible into the system.
3. If you can, use a bottle of recommended hydraulic oil and a piece of plastic tubing to add extra capacity to your highest reservoir.
⇒ *The manufacturer of your system may provide these items when you purchase a bleeding kit for your system.*
If you have a helper, have them watch the oil level in the highest reservoir and refill it when necessary.
4. If you started this bleeding procedure right after Step 8 in the Autopilot Setup Procedure (see page 42), the hydraulic cylinder rod will be fully extended in one direction. To bleed the Reversing Pump, you will be extending the cylinder rod in the other direction. Open one and close the other bleeding screw just as you did when bleeding the manual part of your system and you were extending the cylinder arm in this direction. Generally, you close the bleeding screw or nipple closest to the rod which is now retracted. Open the bleeding screw closest to the now extended rod. See the diagrams on the next page.
5. Position yourself so that you can see your hydraulic steering cylinder while operating the Control Head.
6. You will be able to move the steering cylinder rod by pressing the Red Key or the Green Key on the Control Head. When you press the key, the lights will stop blinking and the red or green light will turn on. Extend the rod as far as it will travel in the other direction.
7. If you are using a Reversing Pump, let the Autopilot drive the Reversing Pump until it nearly stops after the rod reaches the end of its travel. This will press as much oil as possible into the system. It will not damage the pump.



Adding Capacity



Bleeding cylinder, rod moving left



Bleeding cylinder, rod moving right.

8. Refill your steering system from the highest reservoir.
9. Adjust the bleeding screws so that the cylinder will be bled when the rod is extended in the original direction. Generally, you close the bleeding screw or nipple closest to the now retracted rod. Open the bleeding screw closest to the rod that is now extended.
10. Use the Control Head to fully extend the cylinder rod to the other side.
11. Refill the highest reservoir.
12. Repeat Steps 6 to 11 at least 10 times.
13. Close all bleeding screws or nipples. Clean up any oil spills and wipe fittings clean. Remove any buckets or equipment a short distance from the cylinders and fittings.
14. Use the Control Head to extend the rod fully in one direction and then the other.
15. Check for leaks by looking for spilled hydraulic fluid on or near fittings and cylinders.
16. Check that a hard-over to hard-over time of 10 - 15 seconds can be attained with your drive system.
17. Return to Step 9 of the Autopilot Setup Routine.

****** IMPORTANT ******

If you have installed a reversing motor pump, a constant running pump or an engine driven-pump, there are several checks that must be done during the first several weeks of usage, in order to prevent poor – *or even possibly-dangerous* – steering performance.

As a general rule, you should ***always*** regularly monitor the oil level of the reservoir, or in the highest helm pump, in your steering system, and add oil as required. But this is ***especially*** important following the initial installation and bleeding of your system.

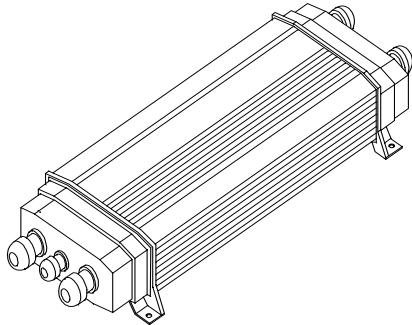
Residual air in your steering system

Some residual air may remain suspended in the hydraulic fluid. During the first few weeks, this air will gradually bleed out through the header tank, or the highest helm pump, and as a result the oil level may go down. *Check several times and add more oil as required.*

Leaking fittings or equipment

If the oil level continues to go down, even after a few weeks (when all the residual air should have it been expelled), it may be an indication of leakage in your steering system. *Carefully check all hydraulic steering fittings and equipment for leakage.*

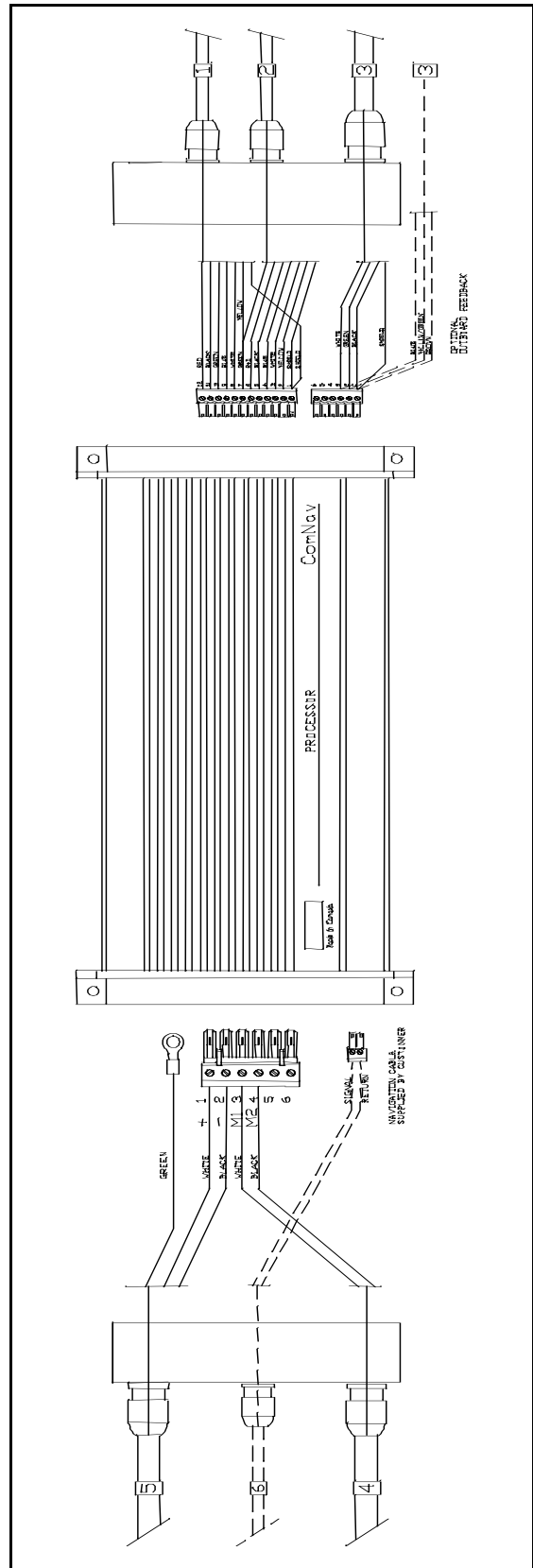
Wiring the Processor

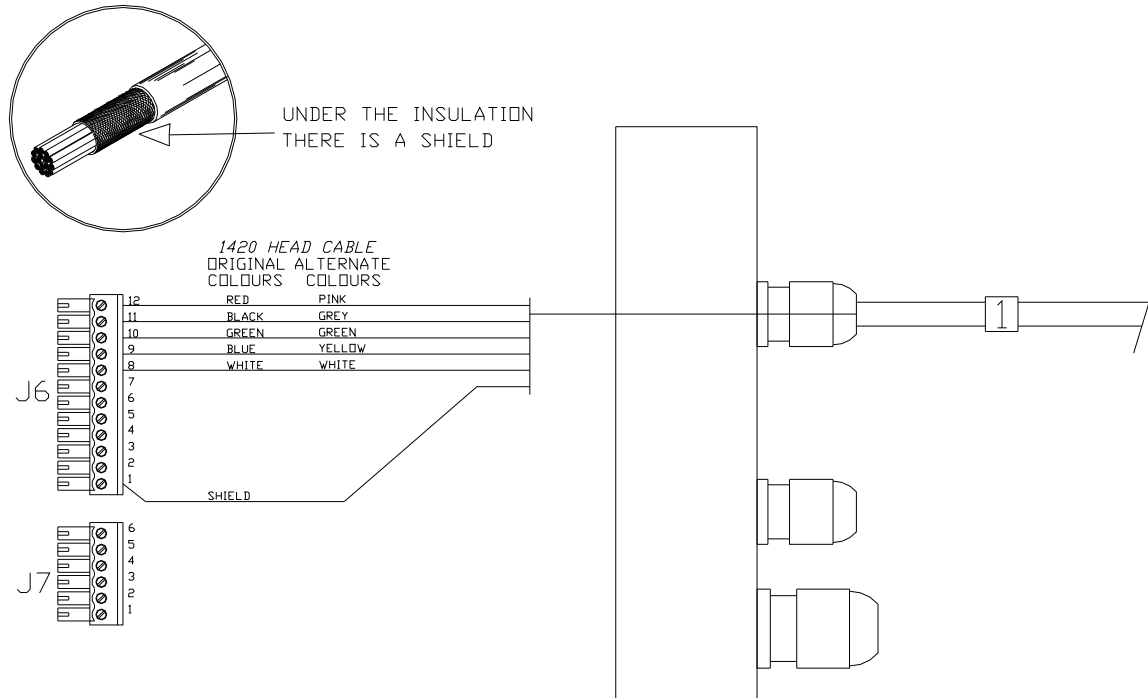


Place the Processor in front of you with the lettering right side up. Remove the four Phillips screws from each end. Remove the end pieces of the Processor enclosure.

Looking into the open ends of the Processor you will see several green terminal strips. These terminal strips are mounted into sockets. You can remove the terminal strips from the processor by gently pulling them away from the end of the Processor.

The terminal strips are labelled with numbers corresponding to the wiring diagrams on the following pages.





Right Side, Cable 1 (Control Head) to J6

Note: There is an extra wire that is not used, in the 1420 Head's cable; the wire is yellow on the original cable, brown on the alternate cable.

Right Side Connections

Pull all of the terminal strips from the right hand end of the Processor.

Note that there is an empty socket that does not have a terminal strip. When you replace the terminal strips, do not accidentally place one into the empty socket!

Pass the cables numbered "1", "2" and "3" through the watertight glands on the right end cap, and then connect each cable's wires to the terminal strips, as shown in the diagram above & those on the following pages:

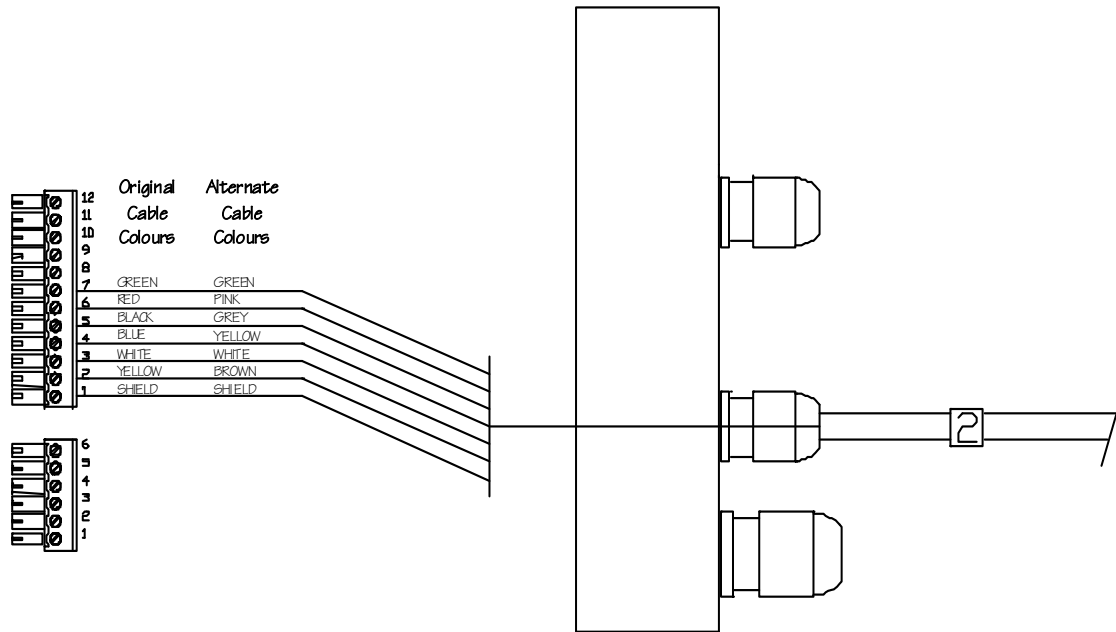
- Right Side, Cable 1 (Control Head) to J6
- Right Side, Cable 2 (Compass) to J6
- Right Side, Cable 3 (Rudder Feedback) to J7

Caution: *there are some differences in the colour codes of the cable types that can be used for Cable 1 (the Head), and Cable 2 (the Fluxgate Compass). Pay attention to the colours shown in the wiring diagrams, and in the wiring table on the next page!*

Insert the bared end of the wire into the terminal strip and fasten it there by tightening the screw on the terminal strip. Start from one end of the terminal strip and work to the other in sequence.

Check your work!

Leave the strips unplugged when you are done; they will be plugged back in when you mount the Processor (see page 39)



Right Side, Cable 2 (Compass) to J6

Be Careful

The entire stripped end – but no portion of the insulation – of all wires into the terminal strip plugs must be completely inside the plugs. The stripped ends of wire must not be able to touch each other.

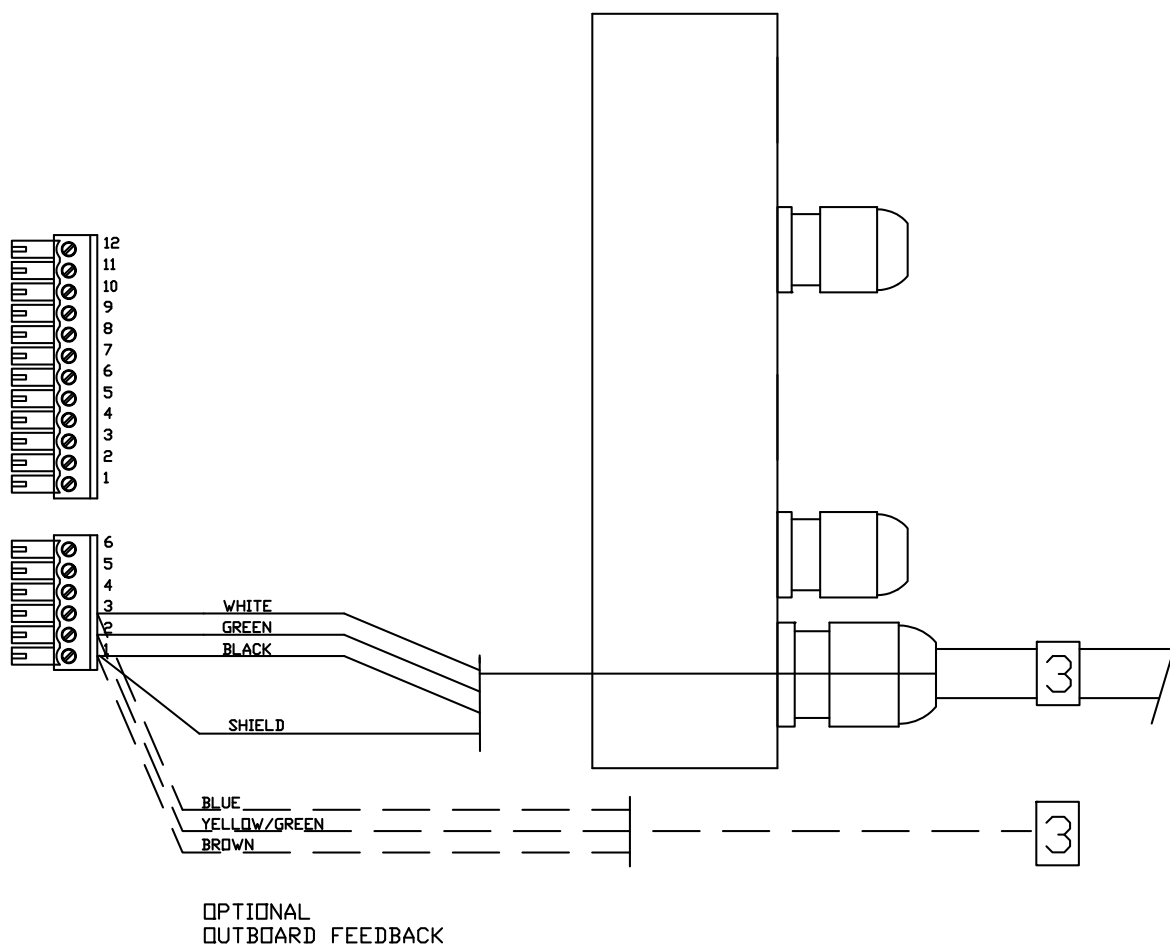
Every wire must be connected to the correct terminal on its plug!

Connections For Fluxgate Compasses

J6 PIN	Cable 2		Signal Function	
	Original Wire Colours	Alternate Wire Colours	ComNav Fluxgate Compass	Other Compass
1	SHIELD	SHIELD	GROUND	GND
2	YELLOW	BROWN	COSINE	COSINE *
3	WHITE	WHITE	REF	REF
4	BLUE	YELLOW	SINE	SINE *
5	BLACK	GREY	DRIVE P2	N/C **
6	RED	PINK	DRIVE P1	N/C **
7	GREEN	GREEN	+12V	+12V

* If the compass reading is reversed, swap these two wires

** These wires must not be connected to non-ComNav compasses



Right Side, Cable 3 (Rudder Feedback) to J7

Left Side Connections

Next, do the left side wiring. Remove the terminal strips from the left side end piece.

Apply a "4" wire label to the cable from the Pump, and pass it and Cable "5" through the glands in the left side end cap; wire each cable's wires to the terminal strips, as shown in the diagrams on the following page:

- Left Side, Cable 4 (Pump Motor)
- Left Side, Cable 5 (Power)

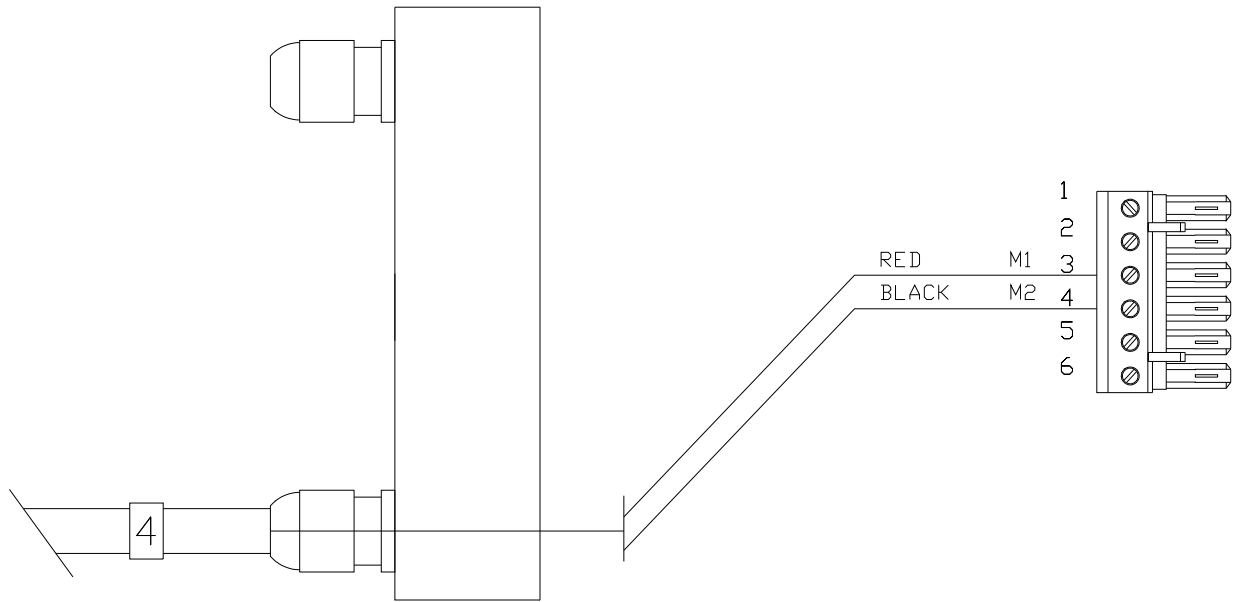
Make sure all stripped wire ends are completely inside the terminal strips.

Connecting the Ground Wire

In the Cable 5 diagram below, the Ground is the green wire. It is connected to the bolt beside the terminal sockets for the power connection.

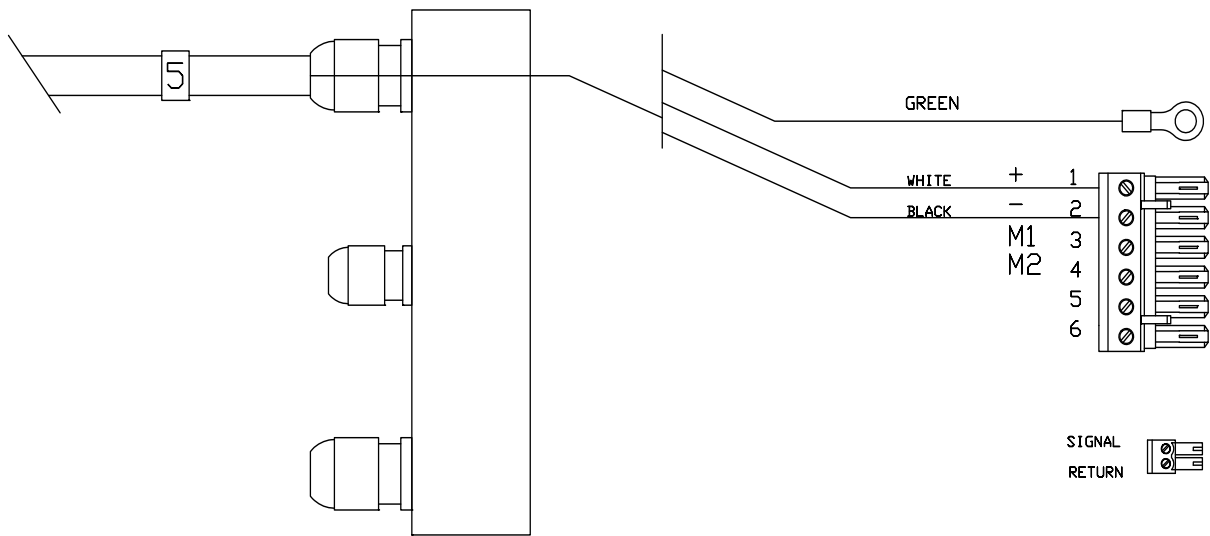
The green wire is connected by removing one of the nuts and the lock washer from the bolt. Place the ring terminal on the end of the green wire over the bolt. Replace the lock washer. Replace the nut and tighten it securely.

The other end of this wire should be connected to the grounding point you have chosen aboard your boat. See *page 14* for examples of possible grounding points.

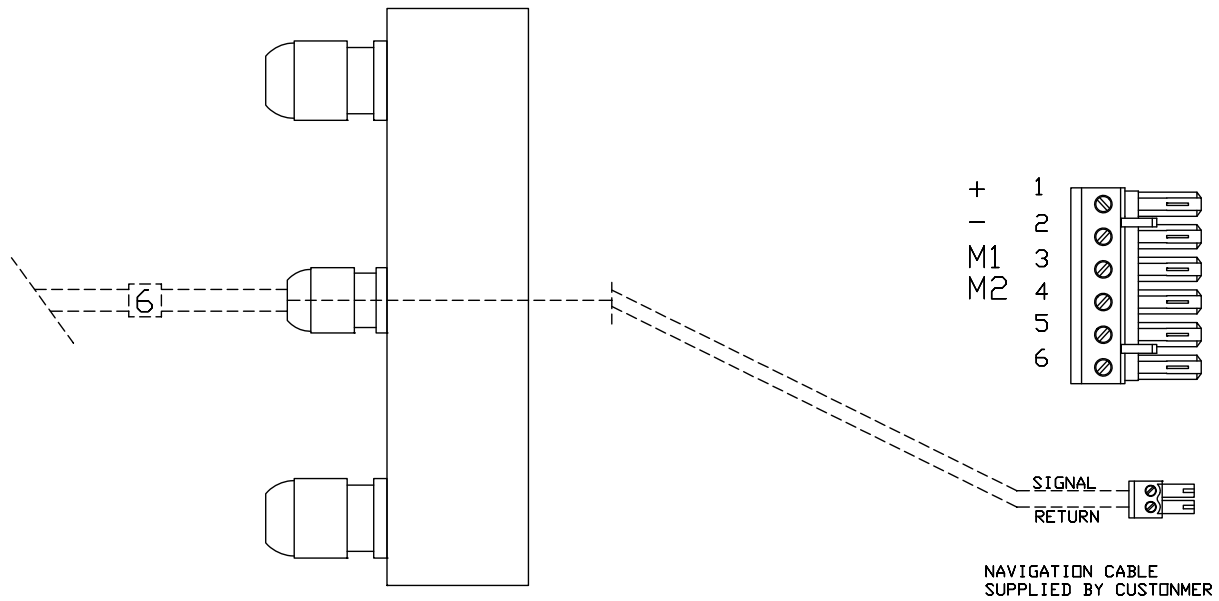


Left Side, Cable 4 (Pump Motor)

Please see the Appendices for wiring to other types of motors, or solenoids.



Left Side, Cable 5 (Power)



Left Side, Optional Navigation Input Connection

Connecting the Navigation Cable

The optional navigation data input cable may be connected at this time. Parts for this are in the Accessory Kit. We do not supply the cable for this connection.

First, the gland for this input must be mounted on the end cap. To locate the hole for the gland, look on the inside of the end cap. You will see several places where the plastic has been formed so that a hole may be easily drilled. Drill the hole using a 15/32" (12 mm) drill.

Place the gland from the Accessory Kit in the hole. Fasten it with the supplied plastic nut and tighten securely.

Use the diagram above to wire the navigation input. The terminal strip for this is in the Accessory Kit.

See your GPS receiver, plotter and/or other navigation device manuals for information about wiring connections to & from them.

Note that the cable's shield should be connected only to the Nav device.

Mounting the Processor

Once you have completed and checked the wiring, you are ready to mount the Processor.

There are two ways this can be done, depending on the amount of space you have. The first method will usually be easier.

1) The first method:

- Plug the terminal strips into their correct positions on the processor.
- Attach the end pieces. Do not cut or crimp any wires while tightening the screws. Tighten the nuts on the watertight glands. Tighten these nuts firmly with your hand. If you must use a tool, be very careful. It is very easy to damage the glands by using too much force.
- Mount the Processor in its location.

2) The second method:

- Mount the processor in its location.
- Plug the terminal strips and wires into the correct locations.
- Attach the end pieces. Do not damage any wires while tightening the screws. Tighten the nuts on the watertight glands firmly with your hands. If you must use a tool, be very careful. It is very easy to damage the glands by using too much force.

During the first year of use, check that the glands are hand-tight, after 6 and after 12 months of operation.
Check yearly thereafter.

Powering Up the System

Turn on the breaker for the Autopilot or connect the Power cable to the breaker.

The black wire connects to the negative terminal. The white wire connects to the positive terminal. The green wire is ground. See page 14 if you have not already decided on a ground.

Congratulations!

The Installation of your Autopilot System is complete. You are now ready to begin the Setup Routine.

Fuse Replacement

The 1420 Processor is protected against reversed power connection by a fuse. The fuse will blow if the power wiring is reversed; but the fuse will usually not fail otherwise.

So, if you ever do need to replace this fuse, re-check your power supply wiring for correct polarity.

To replace the fuse:

1. Turn off the power to the 1420.
1. Loosen the right side watertight glands on the Processor, and remove the end cap. Disconnect the plugs.
2. Remove the 4 Phillips screws holding the inner end cap. Remove the inner end cap.
3. Bend up the copper ground tabs so that they are parallel to the body of the Processor.
4. Loosen the left hand side watertight glands, and remove the outer end cap. Disconnect the plugs.
5. Remove the four Phillips screws holding the inner end cap.
6. Hold the left hand inner end cap. Slide the Processor case to the right. This will expose the circuit board.
7. The fuse is located on the top left hand corner of the board. If it is damaged, replace it with a 20 Ampere AGC fuse.
8. Reassemble the Processor by working through the above Steps in reverse order. **Recheck your power supply polarity before you insert the power connector.**

Check the Fuse

Do this *before* leaving the dock:

- turn on the Autopilot. Press the Red and Green Keys to move the rudder (or outboard motor).

⇒ *If the new fuse fails at this time, you still have an electrical problem on your boat, or the Autopilot needs repair.*

Setting Up the Autopilot System

Setup Routine

The 1420 System must be OFF before you begin the Setup Routine.

The first part of this routine can be done at the dock. If you have a Fluxgate Compass, you will later repeat the first part out on open water.

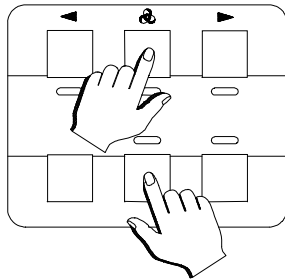
If the light above the Pilot Key flashes at any time during the Setup Routine, the 1420's firmware has detected an error in the procedure, or in the system's wiring. Refer to the Problems during the Setup Routine section, page 54.

Correct the fault before proceeding to the next Step!

You may stop the Setup Routine at any time by pressing the Off Key.

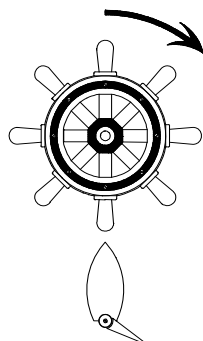
Setting Up – Step by Step

1. Press and hold the Speed Key. Then press the Pilot Key until the Autopilot System turns on.

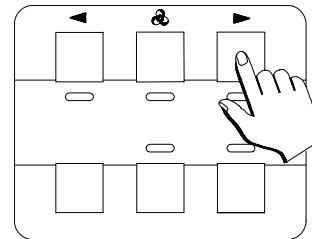


The Autopilot will beep. All the lights will flash briefly. Then the light beneath the Green Key will begin to flash.

2. Turn the steering wheel (or tiller) fully to Starboard.

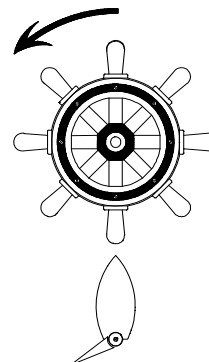


3. Press the Green Key.

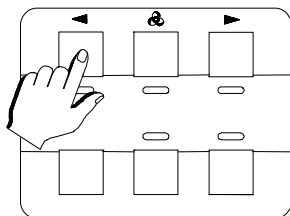


The Autopilot will beep. The light beneath the Green Key will stop flashing. The light beneath the Red Key will begin to flash.

4. Turn the steering wheel fully to Port.

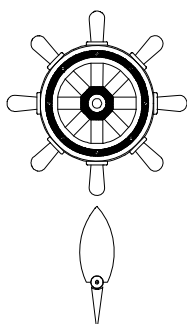


5. Press the Red Key



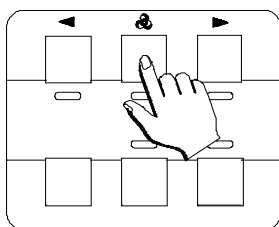
The Autopilot will beep. The light under the Red Key will stop flashing. The light under the Speed Key will begin to flash.

6. Move the steering wheel to the mid-ships position



Position the wheel as if you were going Dead Ahead, in a straight line.

7. Press the Speed Key



The autopilot will now begin to make a number of rudder movements. It is learning your steering system.

Please wait!

When the Autopilot has finished the rudder movements, the light below the Speed Key will blink alternately with lights below the Red and Green Keys.

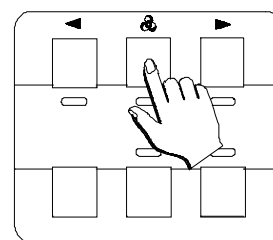
8. You are now in the Bleed Mode

Turn to *Fill And Bleed* on page 30.

Come back here, when done.

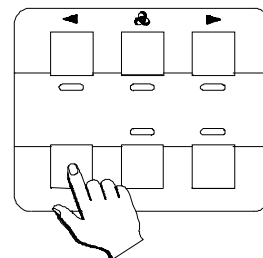
If you did not install a Reversing Pumpset, or you are not retro-fitting the 1420 on a vessel that already has hydraulic steering, you will not have to bleed your hydraulic system. Go to step 9 instead.

9. Press the Speed Key again



After you press the Speed Key the Autopilot will do one of two things:

- 1) The light under the Speed Key will be flashing – indicating that you have a magnetic sensor:
⇒ Skip to *Magnetic Compass Alignment* on the next page.
- 2) All the lights will be turning off and on in a rotating pattern, which indicates that you have a fluxgate compass – which you must now compensate. However, you must do that out on open water – so for now, you can turn off the Autopilot System.
⇒ Press the Off Key.



Fluxgate Compass Compensation

In order to complete the setup of a Fluxgate Compass, it is necessary to take a short trip with your boat.

Put your tools and other magnetic objects in storage places away from the Fluxgate Compass.

Check your hydraulic installation for any leaks or loose components.

Move your vessel to a location that is:

- Free from other traffic.
- Far away from large magnetic objects.
⇒ *Do not attempt to compensate the compass near a steel bridge, a submarine cable, or a steel ship.*

Repeat the Setup Routine, starting at Step 1 and continue until the point in Step 9 where all the lights are turning off and on in a rotating pattern. *Do not turn the autopilot off.*

The Autopilot is now ready to measure & compensate for any irregularities in the magnetic field aboard your vessel.

10. Slowly turn the boat in as small a circle as possible. Maintain as steady a rate of turn as you can.

Use a boat speed and rate of turn that results in the turn taking between about one to three minutes to complete.

It should only take slightly more than one full turn to complete the measurements. While the routine is running, the lights will continue to flash in a rotating pattern.

⇒ *If the lights keep rotating after several turns, or if the light above the Pilot Key flashes, the measurements were not successful. If this occurs, try re-locating the compass some distance away from its present location; also, re-check the wiring. Then repeat this Step.*

When the measurements are successful, the Autopilot will turn off.

The Setup Routine is now completed.

When all is done, permanently mount your Fluxgate Compass in its location, using four #10 (5mm) fasteners made of non-magnetic materials such as high quality stainless steel or brass.

Go to *Finishing the Setup*, below.

Magnetic Compass Alignment

You have completed Step 9 and the light below the Speed Key is flashing.

Turn your vessel, or simply turn the compass, until the compass is pointing due North.

11. Press the Speed Key

The Autopilot's Heading display is now aligned to the magnetic direction values sensed by your magnetic sensor.

The autopilot will turn off.

The Setup Routine is now completed.

Finishing the Setup

Do a final check of your hydraulic installation for any leaks or loose components.

Please be aware that the Autopilot can not adjust for any differences between North, as shown by your compass, and the real direction of Magnetic North.

You alone are responsible for the accuracy of your compass in its location.

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Piloting with the 1420 Autopilot System

This section will introduce you to your ComNav 1420 Autopilot System. Learn your Autopilot's operations step by step; you will find it is one of the simplest things on your boat!

Steering Control Settings

The 1420 Autopilot has a wide range of steering control settings. There are:

- two Rudder Response settings
 - one for "Slow" boat speeds
 - one for "Fast" boat speeds
- fourteen Sensitivity steps for each Rudder Response setting

Each Rudder Response setting controls the steering in a very different way.

In this section, you will learn how to select both the Slow and Fast Rudder Responses. You will also learn how to select the correct Sensitivity step in each Rudder Response.

After you have learned how to do this, experiment with your boat, to find the combination of Rudder Response and Sensitivity which works the best for you.

⇒ *Some vessels may not use both Rudder Response settings.*

• **Slow Boat Speed Response:**

Some vessels always require large amounts of steering wheel movement to start and stop a turn. These might get the best steering performance by using only the Slow Speed Rudder Response setting for all speeds.

When the boat speed varies, change the Sensitivity of the Slow Speed Rudder Response by a few steps. This may be all that is required.

• **Fast Boat Speed Response**

Some vessels always respond quickly to a small movement of the steering wheel, regardless of the boat speed. These boats might get the best steering control by always using the Fast setting.

When the boat speed varies, change the Sensitivity of the Fast Speed Rudder Response by a few steps. This might give you better steering performance than using the Slow Speed Rudder Response setting.

Turning ON the Autopilot:

To turn the Autopilot ON, hold down the Pilot Key for 2 seconds. All the lights will briefly turn on for self-testing purposes, followed by the Pilot light only being on (the Speed light may also be on).

The Autopilot will now begin to steer the boat along the course you were on when you turned it on.

When your 1420 Autopilot is working properly, it will steer your vessel in a straight line. The boat will not wander back and forth across the Course line, nor make any sudden turns unless you command them.

When you do make turns, they will be smooth and quick, but without a lot of overshoot & corrections as the boat settles on the new Course.

Turning the Autopilot OFF

If you wish to turn off the Autopilot, press and hold the Off Key for 2 seconds. Immediately after pressing this key, you will have manual vessel steering control.

Determining Rudder Response Settings

At this point, you will have finished adjusting your compass. Move your boat to an open area of water away from docks and other boats.

Your vessel will normally make several turns, while you are setting the Rudder Responses. Make sure that you and your passengers are braced for unexpected movement.

These adjustments are much easier to do if the water is calm and there is little wind.

Setting the Slow Speed Rudder Response

It is best to set the slow speed Rudder Response first.

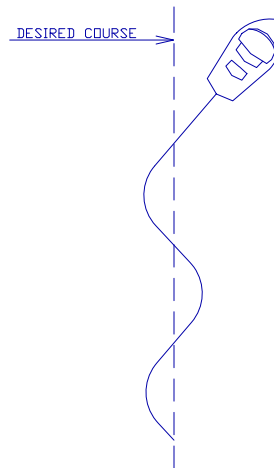
Adjust your throttle so that your boat is moving at the “slow” speed which you normally use. For example, if you often go fishing, this would be your trolling speed.

Bring your boat onto a Course.

Turn the Autopilot ON.

If the light beneath the Speed Key is on, the Autopilot is using the Fast Speed Response, so press the Speed Key twice quickly to select Slow Speed Response (the Speed Key light should be off).

⇒ *If your vessel is swinging back and forth across the Course line, like this:*



– ... the Rudder Response Sensitivity is set too high. The swinging occurs because the Autopilot is overcorrecting for course errors.

⇒ *You must decrease the Slow Speed Rudder Response Sensitivity.*

But that's easy to do – and the 14 Sensitivity levels mean you can find one that suits your vessel.

To decrease the Sensitivity:

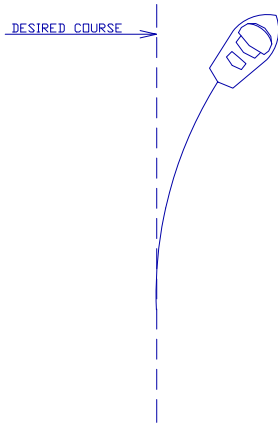
Press and hold the Speed Key. Press the Red Key once: Sensitivity decreases by one step. Wait for the vessel to settle on a steady Course. *This could take up to 5 minutes, so please be patient.*

Continue this procedure until the boat is steering satisfactorily.

If the pilot light goes off, followed by blinking port and starboard lights, you have reached the lowest level of the Slow Response Sensitivity. From here, you can only increase Sensitivity (using the Green Key)².

² You cannot make adjustments during the “limit reached” blinking-lights interval (4 seconds).

⇒ *If your vessel is gradually falling away from the Course line, like this:*



- ... the Rudder Response Sensitivity is set too low. The fall-off occurs because the Autopilot does not use enough Rudder movement to correct for the increasing Course error.
- ⇒ *You must increase the Slow Speed Rudder Response Sensitivity.*

To increase the Sensitivity:

Press and hold the Speed Key. Press the Green Key once: the Sensitivity increases by one step. Wait for the vessel to settle on a steady Course. *This could take up to 5 minutes, so please be patient.*

Continue this procedure until the boat is steering satisfactorily.

If the pilot light goes off, followed by blinking port and starboard lights, you have reached the highest level of the Slow Response Sensitivity; from here, you can only decrease Sensitivity (using the Red Key).

If you lose count of which Sensitivity step you are using: press and hold the Speed Key. Then press the Red Key 9 times. This will set the Sensitivity to its lowest level.

Slow Speed Turns and Course Changes

At this point – while you are still travelling slowly, and with the Slow Speed Response set properly – it's a good time to learn how to use your 1420 Autopilot to make turns and changes in Course at Slow speed.

To make a one degree Course change to Starboard, briefly press the Green key.

To make a one degree course change to Port, briefly press the Red Key.

To make a large Course change, press and hold either the Green (or Red) Key. The vessel will turn to Starboard (or Port); when the bow is pointing in the direction you wish to travel, press the Pilot Key once.

With practice, you will find this an easy way to change Course.

However, another way to make a large course change is to turn off the Autopilot, and then use the steering wheel to set the new Course. Press the Pilot Key again, and your 1420 Autopilot will steer your boat along your new Course.

To dodge around an object in the water, press and hold either the Green (or Red) Key. The vessel will turn to Starboard (or Port), and continue to turn until the key is released – whereupon it will turn back the other way, until you are back on Course³.

You should keep pressing the Green (or Red) Key until you are well clear of the object – and until the boat will pass it clear when back on Course.

³ But you will not be on the same **Track**, rather on a Track parallel to the one you were on before the Dodge.

Setting the Fast Speed Rudder Response

In order that the 1420 Autopilot can steer your boat in a straight line & make smooth turns when your boat is moving at “fast” speeds, you will need to adjust the Sensitivity of the Fast Speed Rudder Response.

These adjustments are very similar to the ones you made for Slow Speed Rudder Response.

Press the Pilot Key to start steering a Course with the Autopilot.

Advance the throttle so that your vessel is moving at a “fast” speed (for example, your normal Cruising speed).

To select the Fast Speed Rudder Response, press the Speed Key twice quickly. The light below the Speed Key will turn on to tell you that the fast speed Rudder Response is now active.

⇒ *If your vessel is turning back and forth across the course line, the Fast Speed Sensitivity is set too high.*

To decrease the Sensitivity

Press and hold the Speed Key. Press the Red Key briefly. Wait a few minutes, and see if the boat settles on a steady Course.

Continue this procedure until the boat is steering satisfactorily.

⇒ *If your vessel falls away from the Course line, the Fast Speed Rudder Response Sensitivity is set too low.*

To increase Sensitivity:

Press and hold the Speed Key. Press the Green Key.

If the vessel continues to fall away from its course, repeat the above steps.

Fast Speed Turns and Course Changes

All the Autopilot’s Turn, Course Change and Dodge features described above for the Slow Speed Rudder Response also work when Fast Speed Response is selected.

But!

Your vessel **will** turn more quickly than it does when you are using the Slow Speed Rudder Response.

Experiment with Turns, etc. at Fast Speed Response, so that you will be familiar with the effects.

All commands in the Fast Speed Rudder Response setting work as they did in the Slow Speed Response setting.

A table of all Autopilot commands is provided at the end of this manual (see page 53).

The Navigation Interface

The 1420 Autopilot System can use navigation data information sent to it from a navigation device (such as a GPS receiver or a chartplotter), if the data is in NMEA 0183 format.

See page 38 for navigation input connection instructions.

By using the vessel's current Heading information (from a fluxgate compass or magnetic sensor), and the data from the navigation device, the Autopilot can steer your vessel along a Course line to a Waypoint. The Autopilot can also steer your vessel through a series of Waypoints which the navigation device has grouped together as a Route.

NOTE: the Autopilot can NOT steer by the information from the navigation device alone!

NMEA 0183

The 1420 can receive information from GPS, plotters, and/or other devices, in the *National Marine Electronics Association's* NMEA 0183 language.

Below is the list of the NMEA 0183 data sentences from which the Autopilot can obtain navigation data, and the order of priority in which the 1420 can use these sentences:

1. **RMB + RMC**
2. **RMB + RMA**
3. **APB**
4. **APA**
5. **XTE + BOD**
6. **XTE + HSC**
7. **VBW**
8. **VHW**
9. **VTG**

Note: ComNav Autopilots fully conform to the syntax of the NMEA 0183 Standard's language.

However, not all models & types of "navigation equipment" do in fact conform to the NMEA standard (especially older models).

It sometimes happens that statements in the data sheets, brochures, etc. of a given GPS, plotter, etc. that it "provides navigation data" only mean that the data is provided in the manufacturer's own (non-NMEA, and often proprietary) language.

So, if you are purchasing a GPS, plotter, etc., make sure that it does transmit enough of the NMEA 0183 data sentences listed here that the 1420 has sufficient, useable "navigation data".

If you have further questions about the purchase of a navigation device, or if you experience difficulties using the NAV MODE of your 1420 Autopilot, please contact your ComNav Dealer.

Using the Navigation Interface

To be safe, learn to use your Navigation Interface at slow speeds, away from other vessels.

Turn on the navigation device.

This could be a GPS, plotter, or other device. Give it time to find its position accurately and turn off its warning indicators.

Enter a Waypoint into the navigation device.

With some navigation devices, it is necessary to tell them to send information to the Autopilot. Make sure that it is sending information in the correct NMEA 0183 format.

Turn the Autopilot System on & Press the Nav Key.

Watch the Control Head. The light above the Nav Key should turn on. This indicates that the Autopilot is receiving useable NMEA 0183 navigation data.

Your boat will steer towards the Waypoint, using the information from the Nav device and from the Compass.

⇒ *If the vessel seems to steer away from the Course line, see Cross Track Error, next.*

If the light above the Nav Key does not come on and all the other lights are flashing, the Autopilot is not receiving any useable information from your navigation device.

The first thing to check is your wiring and your navigation device. Read the owner's manual for the navigation device to make sure that it is sending out correctly-formatted NMEA 0183 sentences. Also see the *Problem Solving* section (page 54).

Cross Track Error

Cross track error is a measure of the distance your boat has fallen away from the Course line.

Cross track error is measured as the length of a line drawn from the Course line to your position, at right angles to the Course line.

Cross track error also has a left or right hand direction. For example: the boat can be ½ mile to left of the Course line.

Different manufacturers have defined the direction of the “cross track” differently. There is no agreement on whether a “left-hand” cross track error means that the boat is to the left of the Course line, or that the line is to the left of the boat.

Because of this, the 1420 Autopilot lets you change the way it interprets the direction of cross track error. By pressing and holding the Nav Key and pressing the Green Key you can change the interpretation from “normal” to “inverted”, or vice-versa.

⇒ *Your cross track error direction is correct if the Autopilot is following the Course line.*

⇒ *If the Autopilot is steering away from the Course line while the Navigation Interface is on, then **the cross track error direction may be incorrect!***

Change the cross track error direction, if necessary. If the Autopilot begins steering towards the Course line, you have solved the problem.

If the problem persists, check that the light above the Nav Key is on. If it is off, see the *Problem Solving* section. If it is on, re-check your navigation device's settings.

Operation Commands

COMMAND	ACTION	RESULT
Steer by Compass	Point bow onto desired Course Press <u>Pilot Key</u>	Boat will settle on Course
Course Change: small, to Port	Press <u>Red Key</u> once <i>for every degree of desired change</i>	Course change to Port <i>Note: also influenced by <u>Speed Key</u> setting</i>
Course Change: small, to Starboard	Press <u>Green Key</u> once <i>for every degree of desired change</i>	Course change to Starboard <i>Note: also influenced by <u>Speed Key</u> setting</i>
Course Change: large, to Port	Press and hold <u>Red Key</u> . – Before bow reaches new heading, release key – Allow bow to arrive at new heading Press <u>Pilot Key</u>	Boat will settle on new Course's heading <i>Rate of turn:</i> – 5° per second if <i>Slow Speed Rudder Response</i> is selected (<i>light below <u>Speed Key</u> is off</i>) – 10° per second if <i>Fast Speed Rudder Response</i> is selected (<i>light below <u>Speed Key</u> is on</i>)
Course Change: large, to Starboard	Press and hold <u>Green Key</u> – Before bow reaches new heading, release key – Allow bow to arrive at new heading Press <u>Pilot Key</u>	Boat will settle on new Course's heading <i>Rate of turn:</i> – Same as large Course change to Port (see above) –

Operation Commands (continued)

COMMAND	ACTION	RESULT
Dodge: to Port	Press and hold <u>Red Key</u>	Vessel turns to Port <i>Rate of turn:</i> – Same as large Course change to Port (see above)
Dodge: to Starboard	Press and hold <u>Green Key</u>	Vessel turns to Starboard <i>Rate of turn:</i> – Same as large Course change to Port (see above)
Rudder Response: change	Press <u>Speed Key</u> twice quickly	The Autopilot will switch to the other set of Rudder Response settings
Steer by GPS, plotter, etc.	Enter Waypoint on device Press <u>Nav Key</u>	The Light above the <u>Nav Key</u> will turn on. The Autopilot will steer by compass and the NMEA data received. – If no NMEA data is received, the Autopilot will return to steering by compass only.
Dim or brighten lights on Control Head	Press <u>Speed Key</u> once	Control Head lights will move through five levels of brightness in sequence

Adjustment Commands

COMMAND	ACTION	RESULT
Rudder Response Sensitivity: decrease	Press and hold <u>Speed Key</u> & then press <u>Red Key</u> once <i>for each step of reduction in Response Sensitivity</i>	The Autopilot will not react as strongly to course deviations. It may "settle down" onto a Course line more quickly, and/or stop swerving back and forth across the Course line. <i>There are two Rudder Response settings. Only the Sensitivity of the currently selected Rudder Response will change.</i>
Rudder Response Sensitivity: increase	Press and hold <u>Speed Key</u> & then press <u>Green Key</u> once <i>for each step of increase in Response Sensitivity</i>	The Autopilot will more strongly correct Course deviations. It may steer in a straighter line. <i>There are two Rudder Response settings. Only the Sensitivity of the currently selected Rudder Response will change.</i>
Change the direction of the Cross Track Error	Push and hold <u>Nav key</u> & then press <u>Green key</u>	The Autopilot will steer properly along Course line, when the Cross Track direction setting is correct.
Setup Routine	Start with Autopilot off Press and hold <u>Speed Key</u> & then press <u>Pilot Key</u> once	The Setup Routine begins

Problem Solving

Problems during the Setup Routine

If the 1420 Autopilot finds a problem during the Setup Routine, the Pilot Key light will flash repeatedly. The problems which the Autopilot can detect during the various steps of the Setup Routine are listed below.

Once you have fixed the problem, press the Pilot Key to begin the Setup Routine from where you left off.

HEAD INDICATION	PROBLEM & HOW TO FIX
If the <u>Pilot Key</u> flashes:	You have one of the following problems.
<ul style="list-style-type: none"> • during Steps 1 to 7: 	<ol style="list-style-type: none"> 1. The Autopilot has found a fault in the Rudder Feedback wiring. CHECK: <ul style="list-style-type: none"> • the Rudder Feedback wiring at the Processor 2. The Autopilot has tried to move the rudder but it has not detected any rudder movement. CHECK: <ul style="list-style-type: none"> – that the rudder is moving <ul style="list-style-type: none"> • that the Rudder Feedback is moving with the rudder
<ul style="list-style-type: none"> • at the end of Step 9: 	The Autopilot is not receiving any information from either a Fluxgate or a Magnetic Compass. CHECK: <ul style="list-style-type: none"> • the compass wiring connections at the Processor
<ul style="list-style-type: none"> • while compensating a Fluxgate Compass: 	The Autopilot cannot compensate the compass in the present location. Move the compass to a new location on your boat.

Problems during Normal Operation

When the 1420 Autopilot detects a problem it will flash the lights on the Control Head.

Note: it is not possible for the Autopilot to warn you of every potentially serious problem which can occur. You must be responsible for the safe operation of your vessel.

HEAD INDICATION	PROBLEM & HOW TO FIX
<p>All the lights blink on and off</p>	<p>You have one of the following problems:</p> <ol style="list-style-type: none"> 1. Your vessel is off course. CHECK: <ul style="list-style-type: none"> • Do you have enough speed to allow the Autopilot to steer your vessel? • Are you able to steer the vessel manually? If you can't, then look for hydraulic leaks, check the hydraulic fluid level. If you can steer by hand, see if the Reversing Pumpset is working. Check connections between Processor and Pumpset Motor. 2. There is no information from the Compass. CHECK: <ul style="list-style-type: none"> • the Compass wiring connections 3. The rudder is not moving in response to the Autopilot. CHECK: <ul style="list-style-type: none"> • Is the steering system working properly? • Is the Rudder Feedback moving with the rudder? 4. The Processor is overheating but it is still able to operate. If possible, shut off the Autopilot to let it cool. CHECK: <ul style="list-style-type: none"> • Is the rudder or outboard motor free from any debris which would interfere with its motion? <p>If you cannot find the problem, have the Autopilot serviced as soon as possible.</p>

HEAD INDICATION	PROBLEM & HOW TO FIX
<p>The lights are all blinking and the Autopilot is no longer moving the rudder or the outboard.</p>	<p>The Processor has overheated.</p> <p>CHECK:</p> <ul style="list-style-type: none"> • Is there a short circuit in the connection to the Reversing Pump? • Is the rudder or outboard motor free from any debris which would interfere with its motion?
<p>The light above the Pilot Key is blinking.</p>	<p>The Rudder Feedback has failed and the Ghost Rudder program is running. Your Autopilot will work but the quality of steering control will not be as good.</p> <p>CHECK:</p> <ul style="list-style-type: none"> • The Rudder Feedback wiring at the Processor. <p>If you cannot find the problem, have the Rudder Feedback fixed as soon as you can.</p>
<p>The light above the Nav Key is blinking.</p>	<p>The navigation device (GPS, plotter, etc.) has detected a problem with the signals it is receiving. It has sent a warning to the Autopilot. The Autopilot is flashing the light above the Nav Key to warn you that your navigation information might not be correct. <u>Make sure that you are navigating safely.</u></p> <p>CHECK:</p> <ul style="list-style-type: none"> • Your navigation device for warning indicators. Follow the instructions in the owner's manual of your navigation device.

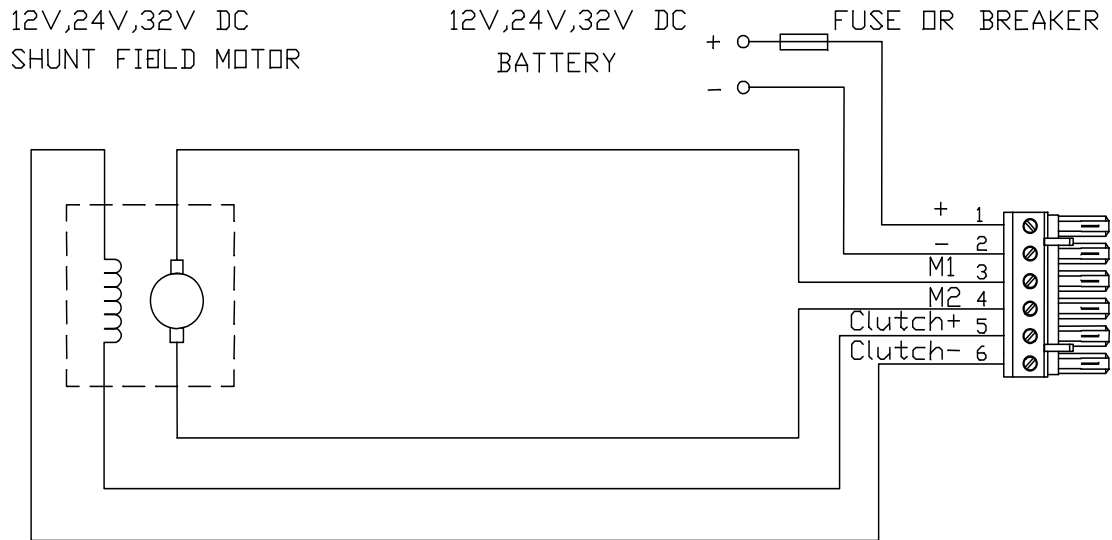
HEAD INDICATION	PROBLEM & HOW TO FIX
<p>The Autopilot will not switch to Nav function.</p>	<p>The Autopilot is not receiving any useful navigation data from the navigation device.</p> <p>CHECK:</p> <ul style="list-style-type: none"> • That the navigation device is turned on. • That you have entered a destination or waypoint into the navigation device. • That your wiring is correct at the Processor and at the back of the navigation device. • That your navigation device indicates it is receiving accurate navigation signals. • That your navigation device is sending out information in the NMEA 0183 format.
<p>The Autopilot has switched out of Nav function and back to Pilot function.</p>	<p>The navigation device has stopped sending information to the Autopilot. The Autopilot has returned to steering by the compass only.</p> <p>CHECK:</p> <ul style="list-style-type: none"> • That the navigation device is turned on. • That you have entered a destination or waypoint into the navigation device. • That your wiring is correct at the Processor and at the back of the navigation device. • That your navigation device is receiving accurate navigation signals.

Problems during Turn On

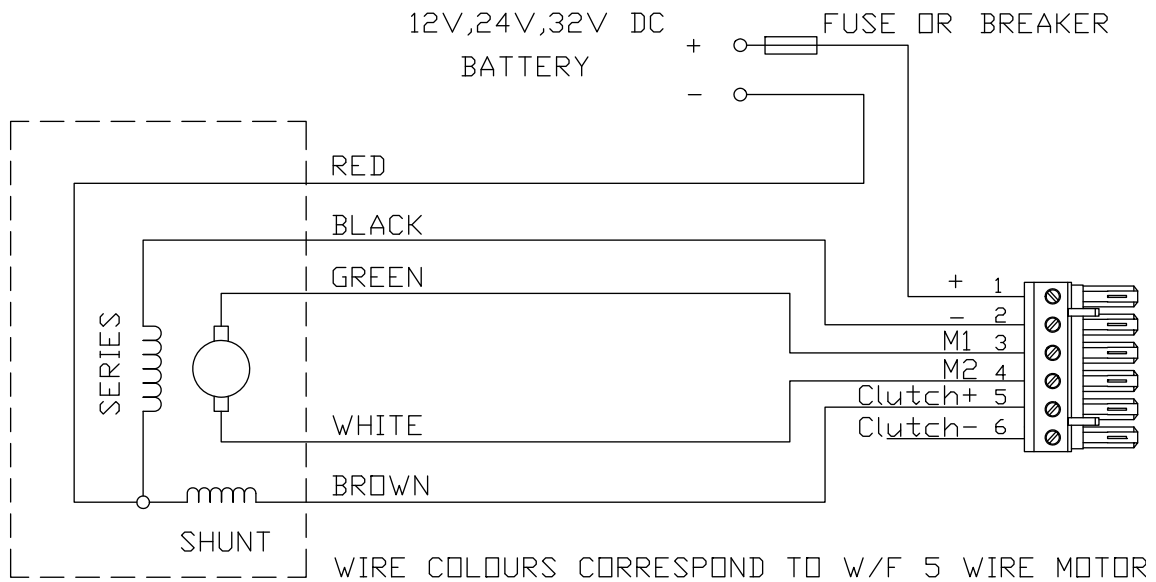
<p>The Autopilot will not turn on</p>	<p>You may have one of the following problems:</p> <ol style="list-style-type: none"> 1. The battery is dead or the battery connections are faulty 2. The fuse is faulty and must be replaced <ul style="list-style-type: none"> – See page 40. 3. The Off Key is stuck <ul style="list-style-type: none"> – Try to free the Off Key. 4. The Autopilot hardware or firmware is faulty <ul style="list-style-type: none"> – Call your ComNav Marine Dealer for service.
<p>The lights are blinking</p>	<p>Either of the Red Key, Green Key or Nav Key has stuck.</p> <ul style="list-style-type: none"> – Try to free the keys. <p>Call your ComNav Dealer for service.</p>
<p>The light below the Green Key is blinking; the Autopilot starts the Set Up Routine</p>	<p>You have one of the following problems:</p> <ol style="list-style-type: none"> 1. The Speed Key has stuck. Try to free the Speed Key. Turn the Autopilot off and turn it back on. 2. The Autopilot detected an error in its memory and then erased the defective memory. You must now do the Setup Routine. You will not have to bleed your hydraulic system unless you have opened the hydraulic lines or run out of hydraulic fluid. <p>The random occurrence of this problem is possible but unlikely. If this problem occurs twice, your Autopilot may need servicing. Contact your ComNav Dealer.</p>

Appendix A

Connections to 4 and 5 Wire Motors



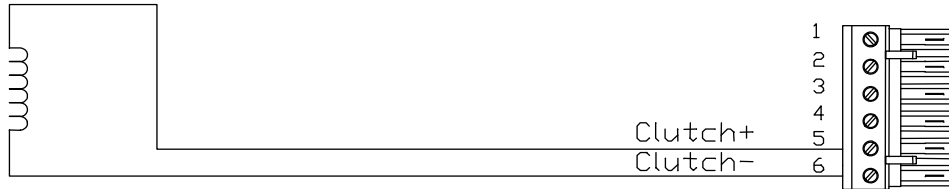
4 - WIRE MOTOR HOOKUP



5 - WIRE MOTOR HOOKUP

Appendix B

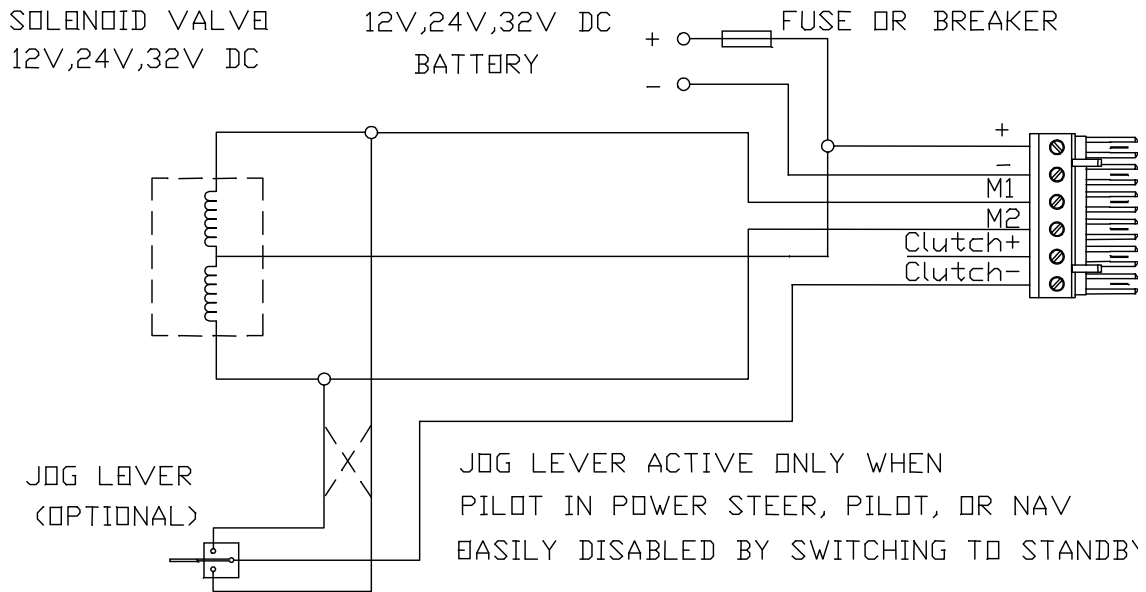
Connections to 4 and 5 Wire Motors (using a clutch or lockup valve)



CLUTCH OF ROTARY DRIVE OR LOCKUP VALVE OF LINEAR ACTIVATOR

Appendix C

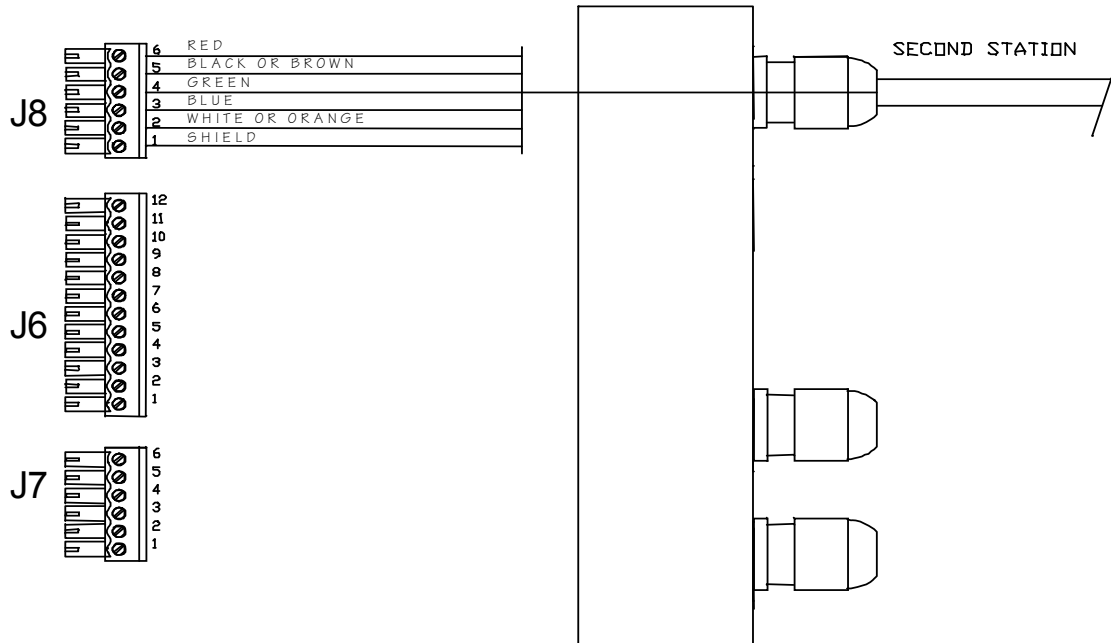
Connections to Solenoid Valves



COMMON POSITIVE SOLENOID HOOKUP

Appendix D

Connecting a Second Station



Right Side, Optional Second Station Connections (J8)

Installation

The cable gland for the Second Station is included in the package with the Second Station Kit; the gland must be mounted on the end cap.

To locate the hole for the gland, look on the inside of the end cap. You will see several places where the plastic has been formed so that a hole may be easily drilled. Drill the hole using a 15/32" (12 mm) drill.

Place the gland in the hole. Fasten it with the supplied plastic nut and tighten securely.

Then, insert the Second Station Head's cable through the gland and tighten the outer locking nut of the gland by securely by hand.

Warning: using a wrench may cut the conductors in the cable.

Connect the Second Station according to the diagram above (note that there are different colour codes that can be used in the Head cable – see page 34).

Operation

The 1420 Second Station is identical in operation⁴ to the main Control Head, as described in the section *Piloting with the 1420 Autopilot System*.

Only **one** of the Control Heads can operate the autopilot at any time. The unit that is non-active will have all 5 LEDs on at once.

To activate the non-active control, press and hold both the Red & Green Keys. The Control Head will come on in the same mode in which the previously active Control Head was operating.

Turning the Autopilot On from the Second Station

To turn your 1420 on from either the Second Station Head or the main Head, press the Pilot Key on that Head. The Autopilot will turn on, but always with the main Control Head active. Then, press and hold the Red & Green Keys to take control with the Second Station.

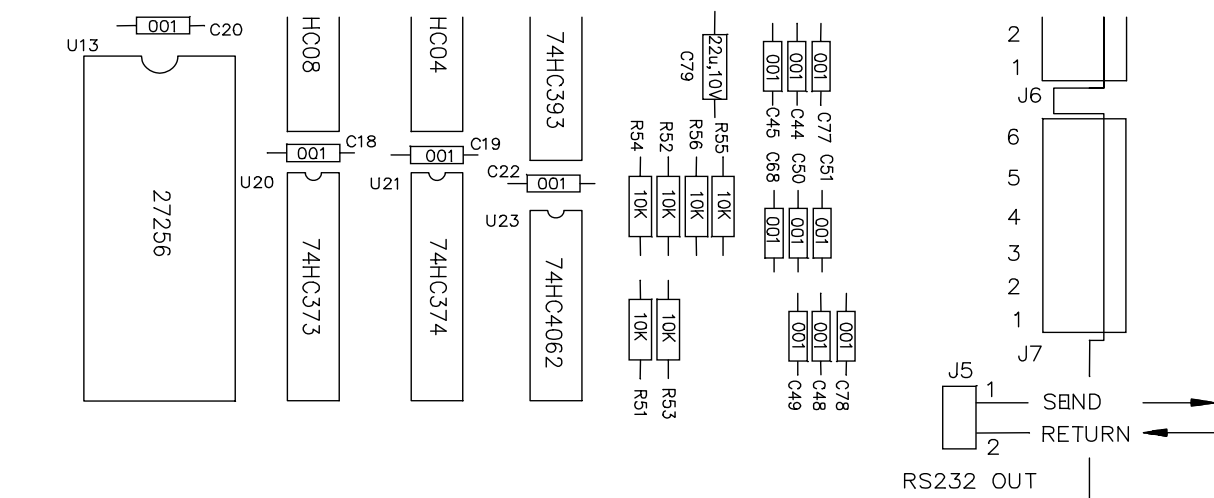
Turning the Autopilot Off from the Main or Second Station

At the Head which **is** the active one, press and hold the Off key. Note that the 1420 cannot be turned off from a Control Head which is not the active one.

⁴ Note: Setup cannot be done from the Second Station.

Appendix E

Connecting the NMEA 0183 Heading Output



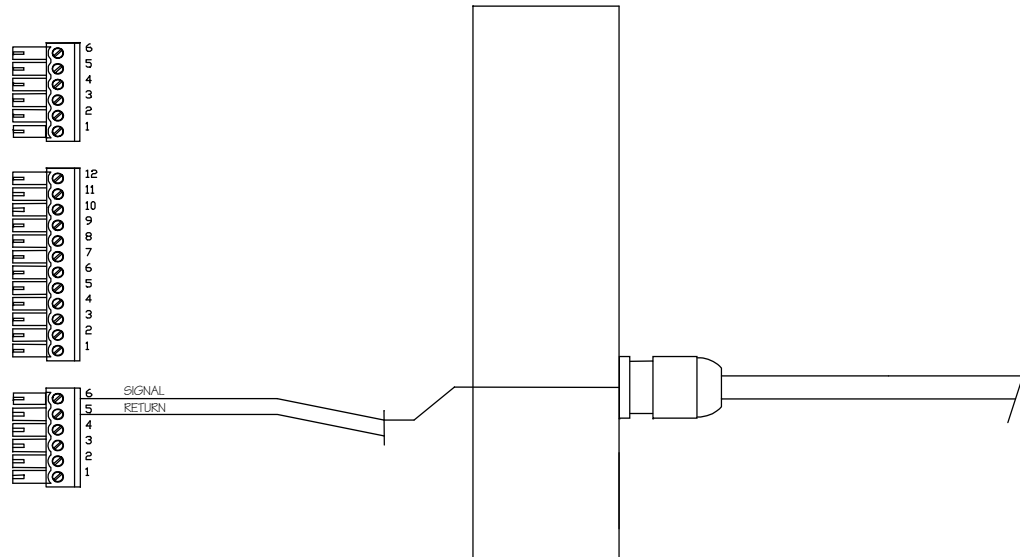
Location of terminal strip J5

The 1420 Autopilot has a data bus that sends out NMEA 0183 heading information to other external devices such as Radars. Heading data is transmitted once per second and provides two NMEA sentences: HDM (magnetic heading) and HDG (magnetic heading, deviation & variation). The serial data rate is 4800 Baud. The output signal has enough drive capability for up to six NMEA 0183 Listeners.

The NMEA 0183 data output format is a two-wire signal. One wire (the 'A' signal) connects to pin 1 of terminal strip J5 and the other wire (the 'B' or 'return' signal) connects to pin 2 of terminal strip J5. Terminal strip J5 is located in the lower right side of the Processor circuit board (see above). The two pin connector required for connecting to the heading output is included in the Accessory Kit.

Appendix F

Connecting a Rudder Angle Indicator



Right-Side, Optional RAI Connection

The cable gland for a Rudder Angle Indicator is in your Accessory Kit.

We **do not** supply a cable for this installation.

We recommend #22 AWG, two conductor cable; it must be **round**, in order to make a water-tight seal in the gland. The outer diameter of this cable must not exceed 1/4" (6.5 mm), nor be less than 5/32" (4 mm).

The gland for this output must be mounted on the right side end cap. To locate the hole for the gland, look on the inside of the end cap. You will see several places where the plastic has been formed so that a hole may be easily drilled.

Drill the hole using a 15/32" (12 mm) drill.

Place the gland from the Accessory Kit in the drilled hole. Fasten it into the end cap with the supplied plastic nut, and tighten securely.

Feed the RAI cable through the gland, connect it as shown above, and then tighten down the gland's outer water-seal/strain-relief piece securely.

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WARRANTY INFORMATION

Limited Warranty Agreement

Congratulations! You have purchased sophisticated and sensitive marine equipment (the "Equipment") manufactured by ComNav Marine Ltd. of #15 13511 Crestwood Place, Richmond, British Columbia, Canada, V6V 2G1 ("ComNav").

LIMITED ONE YEAR WARRANTY

ComNav warrants to the Purchaser, provided that the recommended installation and maintenance procedures set forth in the manual that has been provided with the Equipment (the "Manual") have been followed, and subject always to the other provisions of this Agreement, that the Equipment is free from defects in workmanship and materials under normal use and service and will perform substantially in accordance with the specifications set forth in the Manual for a period of one (1) year from the date of purchase of the Equipment by the Purchaser.

EXTENDED THREE YEAR LIMITED WARRANTY

If;

- a) the Equipment is installed:
 - i. by an authorized ComNav Dealer; or
 - ii. by someone other than an authorized ComNav Dealer, and such installation has been inspected by an Authorized ComNav Dealer;

and

- b) the Limited Warranty Registration Card has been returned to ComNav within 14 days of the date of purchase of the Equipment by the Purchaser with Part I thereof having been completed by the Purchaser, and with the Extended Limited Warranty Card having been completed and signed by an authorized ComNav Dealer and returned to ComNav within 14 days of that inspection;

then;

ComNav warrants to the Purchaser that the Equipment is free from defects in workmanship and materials under normal use and service and will perform substantially in accordance with the specifications set forth in the Manual for a period of three (3) years from the date of purchase of the Equipment, subject to the other provisions of this Agreement.

NO OTHER WARRANTIES

TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, COMNAV DISCLAIMS ALL OTHER WARRANTIES AND CONDITIONS, EITHER EXPRESSED OR IMPLIED, STATUTORY OR OTHERWISE WITH RESPECT TO THE EQUIPMENT, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR THE ORDINARY PURPOSES FOR WHICH THE EQUIPMENT IS USED OR FITNESS FOR A PARTICULAR PURPOSE AND ANY OTHER OBLIGATIONS ON THE PART OF COMNAV, ITS EMPLOYEES, SUPPLIERS, AGENTS, OR REPRESENTATIVES.

NO LIABILITY FOR CONSEQUENTIAL DAMAGES

TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL COMNAV, ITS EMPLOYEES, SUPPLIERS, OR REPRESENTATIVES BE LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING WITHOUT LIMITATION DAMAGE FROM COLLISION WITH OTHER VESSELS OR OBJECTS, INJURY TO ANY PERSON OR PERSONS, DAMAGE TO PROPERTY, LOSS OF INCOME OR PROFIT, BUSINESS INTERRUPTION, OR ANY OTHER CONSEQUENTIAL, INCIDENTAL, RESULTING PUNITIVE, OR SPECIAL DAMAGES ARISING OUT OF THE USE OF OR INABILITY TO USE THE EQUIPMENT, INCLUDING THE POSSIBLE FAILURE OR MALFUNCTION OF, OR DEFECTS IN THE EQUIPMENT, OR ANY PART THEREOF, EVEN IF COMNAV HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. SOME STATE/JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF CONSEQUENTIAL OR INCIDENTAL DAMAGES, SO THE ABOVE LIMITATION MAY NOT APPLY TO THE PURCHASER.

REMEDIES NOT TRANSFERABLE

The Purchaser's remedies under this Agreement only apply to the original enduser of the ComNav Equipment, being the Purchaser, and only apply to the original installation of the Equipment. The Purchaser's remedies under this Agreement are not transferable or assignable by the Purchaser to others in whole or in part.

NOTICE OF DEFECT

The Limited Warranty and the Extended Warranty will not apply with respect to any defective Equipment unless written notice of such defect is given to ComNav, by mail to the address for ComNav set forth above, or by facsimile to ComNav at 604-207-8008, and is received by ComNav within 10 days of the date upon which the defect first became known to the Purchaser. Notices sent by mail will be deemed to be received by ComNav on the seventh (7th) day first following the date of posting in North America and on the tenth (10th) day next following the date of posting anywhere else in the world. Notices sent by facsimile will be deemed to be received by ComNav on the date of transmission with appropriate answerback confirmation.

WARRANTY LIMITATIONS

Reversing Pumps & Motors, Hydraulic Linear Actuators, Watch Alarms & Motor Control boxes which may comprise part of the Equipment are warranted by ComNav for a period of two (2) years under the Extended Limited Warranty described above. All Remote Controls, Remote Cables, Jog Switches, Analog meters (rudder angle indicators), Rudder Angle Indicator Systems & Accessories, Magnetic Compasses & Accessories, Constant Running Pumps, Engine Driven Pumps, Hydraulic Manifolds & Hydraulic Steering are warranted by ComNav for a period of one (1) year under the Limited Warranty described above.

IMPLIED WARRANTIES

Any implied warranties with respect to the Equipment are limited to one (1) year. Some states/jurisdictions do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to the Purchaser.

CUSTOMER REMEDIES

ComNav's entire liability and the Purchaser's exclusive remedy against ComNav for the defective Equipment shall be, at ComNav's option, either: (a) repair or replacement of the defective Equipment under the warranties set forth in this Agreement, or, (b) refund of the purchase price of the defective Equipment, all pursuant to and in accordance with the conditions set forth below:

1. If the Equipment, or any part thereof, proves to be defective within the relevant warranty period, the Purchaser shall do the following:
 - a. contact ComNav by phoning 604-207-1600 to discuss the nature of the problem and obtain shipping instructions (many times a satisfactory solution can be reached without returning the item); and
 - b. prepare a detailed written statement of the nature of the circumstances of the defect, to the best of the Purchaser's knowledge, including the date of purchase of the Equipment, the place of purchase, the name and address of the installer, and the Purchaser's name, address and telephone number to be sent, along with proof of purchase, to ComNav;
2. If upon examination by either ComNav or an authorized ComNav Dealer, the defect is determined to result from defective workmanship or material and if the defect has occurred within the relevant warranty period set forth above, the Equipment or the defective parts thereof shall be repaired or replaced, at ComNav's sole option, without charge, and shall be returned to the Purchaser at ComNav's expense. Return delivery will be by the most economical means. Should the Purchaser require that the Equipment be returned by a faster method, the costs incurred by the expedient delivery will be pre-paid by the Purchaser;
3. No refund of the purchase price for the Equipment will be made to the Purchaser unless ComNav is unable to remedy the defect after having a reasonable number of opportunities to do so. Prior to the refund of the purchase price, the Purchaser must submit a statement in writing from an Authorized ComNav Dealer that the installation instructions in the manual have been complied with in full and that the defect remains.
4. Warranty service shall be performed only by ComNav or an Authorized ComNav Dealer. Any attempts to remedy the defect by anyone else shall render the warranties set forth in this Agreement void;
5. Charges for overtime, standby, holiday and per diem will not be paid by ComNav and are specifically excluded from the warranties set forth in this Agreement. ComNav may, under special circumstances, and with ComNav's PRIOR approval, pay ONE TIME travel costs. Any cost of ferry, boat hire, or other special means of transportation must have prior approval from ComNav. ComNav reserves the right to refuse service charges in excess of one hour if the technician has not contacted ComNav's service department for assistance. Travel cost allowance to service certain Equipment with a suggested retail price of below \$2,500.00 (Canadian funds or equivalent) is not authorized. If repairs are necessary, these products must be forwarded to ComNav or an authorized ComNav Dealer at Purchaser's expenses and will be returned as set out in **CUSTOMER REMEDIES**, Item 2;
6. There shall be no warranty for defects in, or damages to, the Equipment caused by:
 - a. faulty installation or hook-up of the Equipment;
 - b. abuse, misuse or use of the Equipment in violation of the instructions set forth in the Manual;
 - c. shipping, alterations, incorrect and/or unauthorized service;
 - d. accident, exposure of the Equipment to excessive heat, fire, lightning, salt or fresh water spray, or water immersion except for Equipment specifically designed as, and stated in the Manual to be, waterproof. Water damage to the Equipment due to failure to cover unused receptacles is specifically excluded from any warranty set forth in this Agreement; and
 - e. improper or inadequate ancillary or connected equipment;
7. This warranty does not cover routine system checkouts, alignment, or calibration unless the service has been authorized in writing by ComNav PRIOR to its commencement; and
8. No Equipment shall be repaired or replaced under warranty if the serial number of that Equipment has been removed, altered or mutilated.

CHOICE OF LAW AND JURISDICTION

This Agreement is governed by the laws of the Province of British Columbia, Canada. If you acquired the Equipment outside of Canada, each of the parties hereto irrevocably attorn to the jurisdiction of the courts of the Province of British Columbia, Canada and further agree to settle any dispute, controversy or claim arising out of or relating to this Limited Warranty, or the breach, termination, or invalidity of it, by arbitration under the rules of the British Columbia International Commercial Arbitration Centre ("BCICAC"). The appointing authority shall be BCICAC [or, if the BCICAC shall cease to exist, the Chief Justice of the Supreme Court of British Columbia]. BCICAC shall administer the case in accordance with BCICAC Rules. There shall be one arbitrator and the place of arbitration shall be Vancouver, British Columbia.

The United Nations Convention on Contracts for the International Sale of Goods Act, S.B.C 1990, c. 20, and any other statutory enactments of the United Nations Convention on Contracts for the International Sale of Goods do not apply to this Agreement.

THIS LIMITED WARRANTY GIVES THE PURCHASER SPECIFIC LEGAL RIGHTS. THE PURCHASER MAY ALSO HAVE OTHERS WHICH VARY FROM STATE/JURISDICTION TO STATE/JURISDICTION.

This Agreement is a legal contract between you (the "Purchaser") and ComNav. By retaining the Equipment for more than thirty (30) days and/or installing and/or using the Equipment, the Purchaser agrees to be bound by the terms of this Agreement. If the Purchaser does not agree to be bound by the terms of this Agreement, the Purchaser may return the Equipment in the same condition in which it was received for a full refund (less shipping and handling costs) within thirty (30) days of purchase.

WARNING

The Equipment is an aid to navigation only. It is not intended or designed to replace the person on watch. A qualified person should always be in a position to monitor the vessel's heading, watch for navigational hazards and should be prepared to revert to manual steering immediately if an undesired change of heading occurs, if the heading is not maintained within reasonable limits, or when navigating in a hazardous situation.

**ALWAYS REMEMBER:
WHENEVER UNDER WAY, A QUALIFIED PERSON ON WATCH IS REQUIRED BY LAW.**



CE COMPLIANCE

This product is in compliance with the Electro-Magnetic Compatibility (EMC) standards of the European Community, and bears the CE mark. It was tested according to the applicable sections contained in:

**CE Directives IEC 945:1994, BS EN 60945:1996
Marine Navigational Equipment, General Requirements**

The applicable sections for methods of testing and required test results are:

- Section 4.5.4: Radiated interference**
- Section 4.5.4: Immunity to electro-Magnetic Environment**
- Annex A, Section A.3: Immunity to conducted audio frequencies**
- Annex A, Section A.4: Immunity to earth lead coupling**
- Annex A, Section A.5: Immunity to conducted radio frequencies**
- Annex A, Section A.6: Immunity to radiated interference**

The tests were done 05 & 06 July 2000. Results and a declaration of conformity are on file at:

**ComNav Marine Ltd.
#15 13511 Crestwood Place
Richmond, BC V6V 2G1
Canada**

