ComNav

1201 Autopilot System

Operation & Installation Instructions
Version 1.2

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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 Section 11 of this manual.

OPERATORS WARNING

This Autopilot will automatically steer your vessel, 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. This 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.

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2. INTRODUCTION

2.1 THE 1201 SYSTEM

Congratulations on your purchase of ComNav Marine Limited's 1201 Autopilot System!

The 1201 Autopilot System, incorporating ComNav's **WORK MODE** technology, is superbly suited for commercial vessels requiring ultimate rudder response while dragging, trawling, towing, or travelling at very slow speeds.

The 1201 is designed to operate on a wide variety of vessels operating with power systems of either 12 or 24 VDC.

The output from the Autopilot is designed to drive solenoid valves in a hydraulic steering system. A speed control signal is also available for use with variable speed rudder drives. All of the outputs, either by themselves or with an optional solid state relay box, can be adapted to operate a wide variety of power steering systems. If the Autopilot is installed as a retrofit, it is usually possible to use the existing steering installation.

Heading information from the Autopilot is available in both NMEA 0183 and Furuno AD-10S formats. The heading information may be connected to a variety of devices including radars and ECDIS systems. The 1201 Autopilot is also equipped to interface with a GPS, Loran C, or any other navigation computer that outputs one of the NMEA 0183 formats at 4800 Baud. The Autopilot can use the information received from this interface to steer the vessel to a given waypoint or along a given track. Note that in order to function properly, **WORK MODE** requires a device capable of providing continuous NMEA 0183 **speed** information.

The 1201 Control Head functions as the main interface between the Autopilot System and the user. The Head has a number of controls through which the user governs the operation of the Autopilot. A large Liquid Crystal Display (LCD) screen provides visual feedback of the operator's commands and shows the status of the Autopilot System any time the unit is powered up.

Means are provided for the 1201 Autopilot to accept an Auxiliary Station. This may be either a second 1201 Control Head functioning as a remote unit, or a ComNav Handheld Remote. By adding an optional Remote Expander, the Autopilot can support up to 4 Handheld Remotes, or 3 1201 Control Heads. Combinations of Handheld Remotes and 1201 Control Heads are possible.

Figure 1 (1201 Autopilot System Diagram) shows the possible interconnects between the Autopilot System, its accessories, and external equipment.

2.2 ABOUT THIS MANUAL

This manual provides essential information for the safe and reliable operation of the 1201 Autopilot System. You are urged to read this manual in its entirety *before* you use your Autopilot for the first time, and to keep it handy until you become thoroughly familiar with the operation of your Autopilot.

Throughout this manual, you will see a number of different typefaces used, as well as some distinct phrases, or "jargon". Please take a moment to become familiar with the following terms:

IMPORTANT TERMS IN THIS MANUAL

- **MODE**

Specific "modes of operation" are placed in **BOLD UPPERCASE** lettering.

Example: **POWER STEER** mode.

- BUTTON

Specific 1201 Control Head buttons are placed in UPPERCASE lettering.

Example: the COUNTER RUDDER button.

- System Component

Specific system components are Capitalized.

Example: the 1201 Control Head, or a Handheld Remote Control.

- "press"

A button "press" refers to a single momentary activation of a particular button.

- "double-press"

Press and release the indicated button twice in rapid succession.

Although this sounds a little complicated, it is actually very easy to do. Many users familiar with desktop computers perform a similar function when they "double-click" their mouse pointer.

- "press and hold"

Press and hold the indicated button for a minimum of one-half of a second.

This time delay is purposely programmed for the operation of some buttons to prevent casual or accidental activation of the button function. For example, pressing the WORK button can, depending on system configuration, drastically alter the steering performance of the Autopilot.

- "maintained"

Hold the indicated button for as long as required to achieve a given result.
For example, to **DODGE**, press either the PORT DODGE or STARBOARD DODGE button, and maintain it in that position until the vessel has dodged clear of any obstructions in its path.

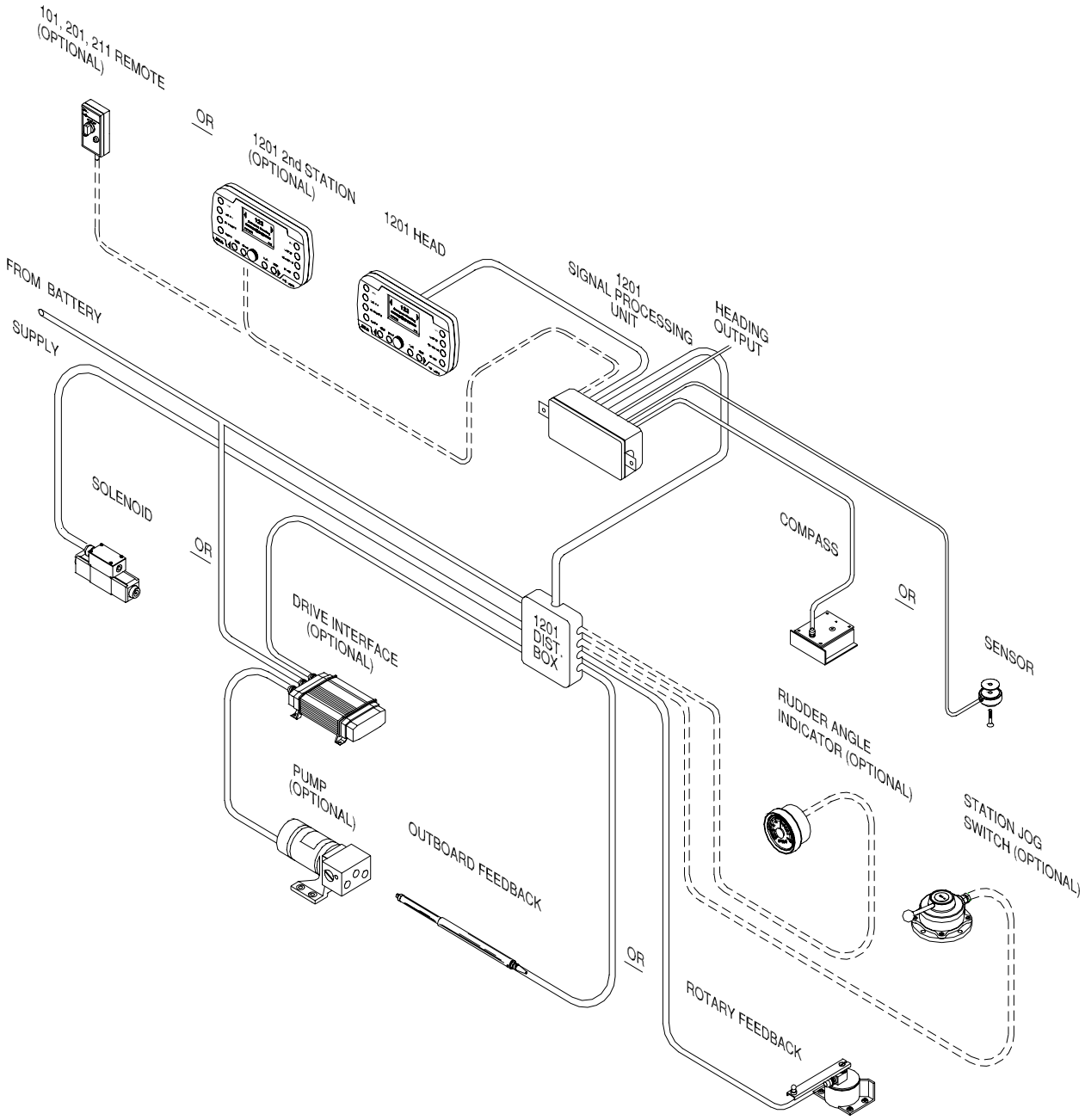


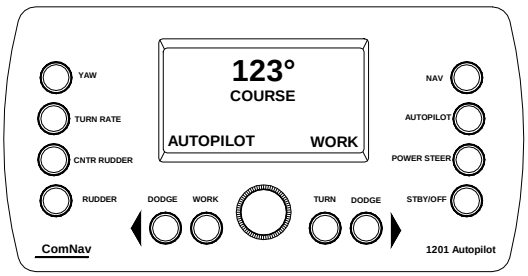
Figure 1 1201 Autopilot System Diagram

3. SYSTEM OVERVIEW

The following section gives a brief description of the major components that comprise the 1201 Autopilot System, their function, and relationship to each other.

3.1 CONTROL HEAD

The 1201 Control Head provides a means for the user to control the Autopilot and monitor the system while it is in use.



The 1201 Control Head may be secured using the stainless steel Angle Mounting Bracket included with the Autopilot System, or surface mounted onto a console panel.

The Control Head connects directly to the Signal Processing Unit, or "SPU" as it is sometimes known, via a 12-conductor cable on the rear of the unit. This cable comes complete with a special connector on the end to allow it to quickly and easily plug in to either the Control Head or Auxiliary Station receptacle on the SPU. The Control Head should be plugged in to the Auxiliary Station receptacle only if there is already a separate 1201 Control Head connected to the Control Head receptacle.

3.2 SIGNAL PROCESSING UNIT

The SPU, as its name suggests, accepts a number of signals from the other components of the Autopilot System and processes them as necessary to control the movement of the vessel's rudder so as to maintain a given heading. As well as steering the vessel, the sophisticated software within the SPU continually checks all aspects of the Autopilot's performance, and will advise the user via the Control Head if there are any problems detected.

3.3 COMPASS

The 1201 Autopilot will function with either a magnetic ship's steering compass fitted with a Fluxgate Sensor, or a direct earth's sensing Fluxgate Compass such as the one made by ComNav. However, any Fluxgate Compass that outputs DC Sine and Cosine signals of up to +/- 3 volts amplitude about a 0 to 6 VDC reference may be used.

The 1201 Autopilot System has been tested with Fluxgate Compasses manufactured by KVH, Brookes and Gatehouse, and VDO. Some of these compasses have to be specially ordered so that they have the required DC Sine and Cosine outputs. If the Fluxgate Compass is not supplemented by a ComNav Heading Rate Stabilizer (ComNav part number 83434), it should not be used on steel vessels. The compass connects directly to the SPU via a 6-conductor cable.

3.4 RUDDER FOLLOWER

The Rudder Follower is used to transmit the position of the vessel's rudder to the SPU. It should be connected to whichever part of the steering system the Autopilot controls. Normally, this is the vessel's rudder,

however, if the vessel has 2-stage steering where the Autopilot drives a control or servo ram, the Rudder Follower should be mounted to the servo ram rather than the rudder.

The 1201 Autopilot System incorporates ComNav's unique "Ghost Rudder" feature. In case of a Rudder Follower failure, the Autopilot will automatically switch on the Ghost Rudder which calculates the position of the rudder (instead of actually measuring it) based on the rudder's past movement characteristics. This allows the Autopilot to continue operation, albeit at a reduced performance level. Of course, the user is notified via the LCD screen on the Control Head any time that the Ghost Rudder is active.

3.5 DISTRIBUTION BOX

The Distribution Box provides a neat and tidy way to wire the SPU to the power supply, output solenoids, navigation computer, Rudder Angle Indicators (RAIs) and other accessories.

4. INSTALLATION

4.1 CONTROL HEAD

The 1201 Control Head is normally mounted in the vessel's wheelhouse. It can also be mounted in more exposed locations, such as on a flying bridge.

SURFACE MOUNTING

1. Ensure that the location you choose for the 1201 Control Head has a behind-the-panel clearance of at least 51mm (2 inches) to allow for the cabling.
2. Place the Angle Mounting Bracket face down on to the panel surface where the Control Head will be mounted. Use the bracket as a template to mark the location of the two outer holes and the center of the large slot onto the panel surface.
3. Drill out the panel using the two smaller holes to a diameter of 5.5mm (7/32"). Drill a 19 mm (3/4") hole where the center of the large slot is marked to accommodate the 1201 Control Head cable.
4. Feed the connector end of the Control Head cable through the large hole in the panel.
5. Ensure that the mounting screws supplied with the Control Head are threaded all the way in to the brass inserts on the rear of the Control Head. Line up the mounting screws with the corresponding holes drilled into the panel, and settle the Control Head so that it lies flush on the surface of the panel.
6. Secure the Control Head with the washers, lockwashers, and hexnuts provided.
7. Route the Control Head cable to the SPU.

4.1.1 ANGLE BRACKET MOUNTING

1. Ensure that the location you choose for the 1201 Control Head and bracket has sufficient clearance to allow for the cabling behind the unit.
2. Using the Angle Mounting Bracket as a template, mark the location of the two mounting holes on the surface to which the bracket will be attached.
3. Drill out the mounting holes to the appropriate diameter for the type of fastener that will be used to secure the Angle Mounting Bracket.
4. Position the Angle Mounting Bracket over the mounting holes and secure it.
8. Ensure that the mounting screws supplied with the Control Head are threaded all the way in to the brass inserts on the rear of the Control Head. Line up the mounting screws with the corresponding holes on the Angle Mounting Bracket and settle the Control Head so that it lies flush on the surface of the bracket.
9. Secure the Control Head with the washers, lockwashers, and hexnuts provided.
10. Route the Control Head cable to the SPU.

4.2 SIGNAL PROCESSING UNIT

The SPU should be mounted in a clean and dry area, away from moisture and salt water.

1. Determine a suitable location for the SPU. Preassemble the U-bracket onto the SPU, and "dry fit" to ensure there will be adequate clearance for the cables.

2. Mark the position of the mounting holes of the U-bracket on the mounting surface, and drill them out for a ¼" bolt or screw.
3. Secure the U-bracket to the mounting surface with ¼" bolts or screws.
4. Slide the SPU into place between the bracket uprights, and attach it using the supplied screws. Be sure to use the nylon spacers and split washers supplied. The nylon spacer goes between the SPU and the bracket, while the split washer goes between the bracket and the screw head.
5. Note that the SPU is supplied with a 2 plastic caps. One is installed on the Auxiliary Station receptacle, the other on the Heading Output receptacle. Leave the caps in place unless you intend to connect devices to these receptacles; the receptacles are weather-resistant only when the cap is installed or when a cable is plugged into it.

   Damage caused by exposing a receptacle to the elements cannot be repaired under warranty.

4.3 DISTRIBUTION BOX

1. Position and mount the Distribution Box underneath or inside the control console in a dry location. The Distribution Box cable, which is pre-wired onto the Distribution Box Printed Circuit Board, should easily reach the SPU.
2. Route any cables into the Distribution Box through the pre-cut openings in the cover. If necessary, file or cut out the pre-formed ports in the cover for any extra cabling. (To ensure a neat appearance, the cover has only had the minimum number of openings prepared in advance).

The suggested types and gauges of cables required to hook up the Autopilot are shown in the following table:

FUNCTION/USE	TYPE/GAUGE
SPU power supply	2 X 16 AWG
Steering Drive; 12 or 24 VDC Solenoid Valve	3 X 18 AWG
Steering Drive; CT2, CT3, CT4, & CT5 Drive Box	Refer to the instructions supplied with Drive Box.
Rudder Follower	3 X 18 AWG shielded cable.
Navigation Computer Interface	2 X 24 AWG shielded cable, shield terminated at NAV device only.
Rudder Angle Indicator	2 X 24 AWG

Table 1 Minimum Recommended Wiring Gauges

DISTRIBUTION BOX CONNECTIONS

The functions of each set of connections to the Distribution Box (see Figure 2, next page) are as follows:

4.3.1.1 AUTOPILOT POWER

These two terminals should be connected to a source of DC power on the vessel. The voltage can be from 10 to 30 VDC. The maximum current requirement is less than 4 amps. The 1201 Autopilot System is configured for negative ground only.

For vessels with positive ground, or with multiple power sources (i.e. AC and DC

power sources) the SPU should be electrically isolated from the vessel. This can be accomplished by mounting it to a non-conducting material, such as wood or fibreglass. This will prevent any damage from ground currents.

Power to supply the Autopilot System should be taken directly from a breaker or power distribution panel. The Autopilot should be wired into its own circuit, however, this circuit can also send power to the drive unit.

If the drive unit installed is a reversing electric type, it should be wired back to the breaker separately from the rest of the Autopilot System (i.e. do **NOT** wire from the breaker to the drive unit, and then from the drive unit to the Autopilot). The combined current requirement of the Autopilot and any reversing electric drive unit manufactured by ComNav will not exceed 30 amps.

UNSWITCHED POWER

The voltage supplied at the Autopilot power terminals appears on this terminal whenever the breaker, which supplies power to the Autopilot System, is turned on.

If a 12 VDC solenoid-operated 4-way valve is being used, wire this terminal to the common of the solenoid valve to ensure adequate voltage supply.

If Jog Levers are being used and are to be active even when the rest of the Autopilot System is turned off, wire this line to the common of the solenoid-operated 4-way valve.

Warning!

If the UNSWITCHED POWER terminal is used and there is a malfunction of the Autopilot or Jog Lever which causes the 4-way valves to be continuously activated, the only way to deactivate the 4-way valve is to turn off the breaker which supplies power to the Autopilot System.

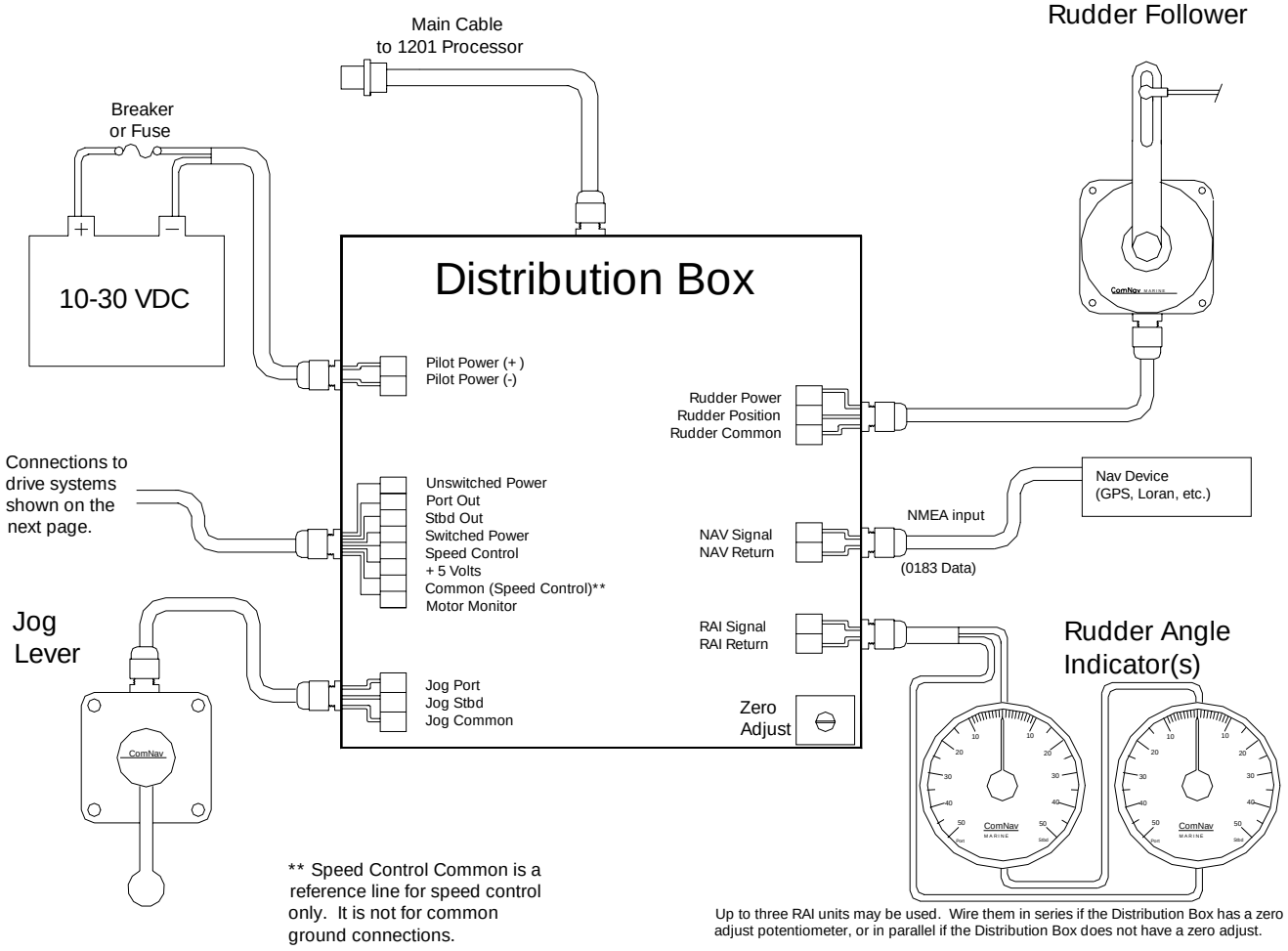
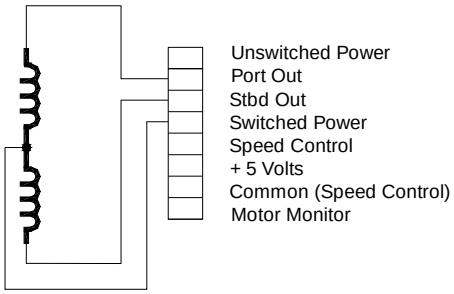
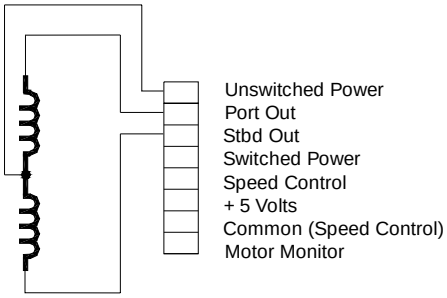


Figure 2 1201 Distribution Box Connections

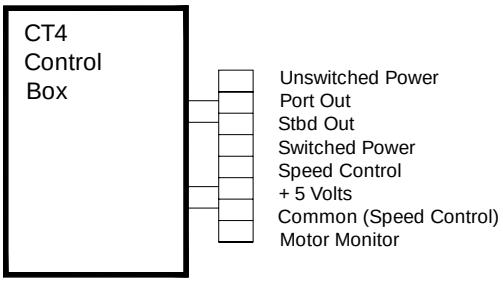
A. For standard four-way valves



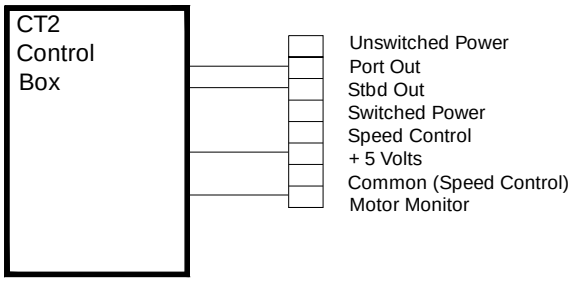
B. For four-way valves, 12V or with jog levers



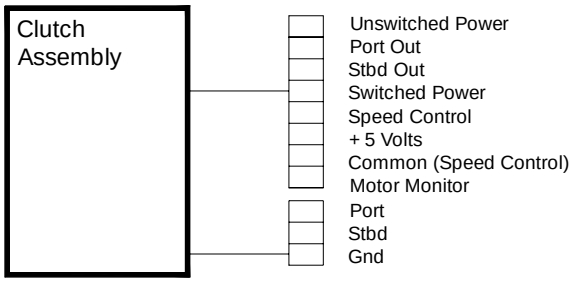
C. For A.C. solenoids



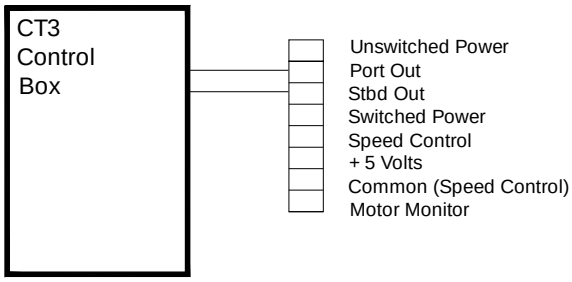
D. For permanent magnet reversing or compound motors with single speed control.



E. For Linear Actuator or Mechanical Rotary Drive



F. For split field reversing motors



G. For controlling the high speed valve (standard, or four-way) of a two speed drive.

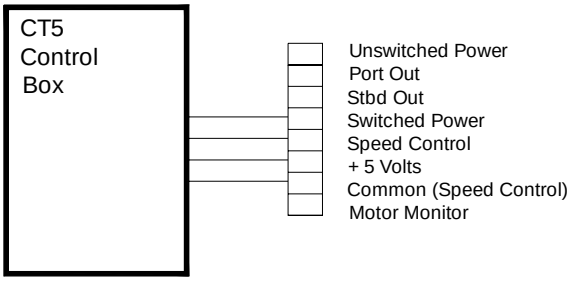


Figure 3 1201 Drive System Options & Interconnections

OPTIONAL DRIVE SYSTEMS FOR 1201 AUTOPILOTS	
For all commercial and pleasure vessels over 50 feet in length, where heavy usage will be the norm (hydraulic steering):	CPUFC Flow Control Uniblock & Pressure Relief Valve (PRV) 12, 24, or 32 VDC Or CPUTS & CT5 – Two-speed Uniblock 12, 24, or 32 VDC And Engine Pump (either Direct or Belt Driven)
For vessels with hydraulic cylinder displacements from 7 to 18 cubic inches:	15 CI Reversing Motor Pump & CT2-20A Drive Box (12 or 24 VDC) Or 18 CI Reversing Motor Pump (Europe) & CT2-20A Drive Box (12 or 24 VDC)
For vessels with hydraulic cylinder displacements from 15 to 30 cubic inches:	25 CI Reversing Motor Pump & CT2-20A Drive Box (12 or 24 VDC) Or 30 CI Reversing Motor Pump (Europe) & CT2-20A Drive Box (12 or 24 VDC)
For vessels with hydraulic cylinder displacements from 30 to 50 cubic inches:	60 CI Reversing Motor Pump & CT2-20A Drive Box (12 or 24 VDC)
For vessels with hydraulic cylinder displacements greater than 50 cubic inches:	Constant Running Electric Pump & Manifold Or Engine Pump (either Direct or Belt Driven) & Manifold
For pleasure vessels with mechanical steering up to 70 feet:	Hydraulic Linear Actuator & CT2-20A Drive Box (12 or 24 VDC) Or Hydraulic Linear Actuator & CT2-40A Drive Box (12 or 24 VDC)
To retrofit to vessels with an existing Autopilot drive system which uses a 2-wire (permanent magnet), 4-wire (shunt field), or 5 wire (compound) reversing electric motor:	CT2-40A Drive Box (12 or 24 VDC)
To retrofit to vessels with an Autopilot drive system using a 3-wire (split field) reversing electric motor:	CT3 (Split Field Reversing Electric Motor) Drive Box
To retrofit to vessels with an Autopilot drive system using a 12 or 24 VDC solenoid-operated 4-way valve:	Nothing extra required (Consult ComNav factory for 32 VDC systems)
To retrofit to vessels with an Autopilot drive system using 115 or 220 VAC solenoid-operated 4-way valves:	CT4 (115 to 220 VAC AC Solenoid) Drive Box
To retrofit to vessels with an Autopilot drive system using proportional valves:	CT6 (Proportional) Drive Box
To retrofit to vessels with electronic Autopilot drive systems:	Z-Drive Isolation Amplifier (Consult ComNav factory before ordering)

Table 2 Optional Drive Systems For 1201 Autopilot

Regardless of the type of drive unit being used, the hard-over to hard-over time of the rudder must be checked. For peak performance this time should be in the range of 8 to 16 seconds.

4.3.1.2 PORT/STBD OUT

These are the two main steering outputs from the Autopilot System. Each output line is driven by a solid state switch that is capable of handling up to 3 amperes of current.

These switches, when “on”, make a closed connection to ground. When they are “off”, the connection to ground is broken, and the output line is effectively open circuit. Due to this configuration, the solid state switches are said to be “open collector” circuits.

These outputs can be used directly to operate a solenoid operated hydraulic 4-way valve. They may also be used as inputs to a solid state drive box for electric steering systems (either hydraulic or mechanical).

Since these outputs are open collector, either of these output lines can be over-ridden with an external switched connection to ground (such as from a Jog Lever).

A pair of diagnostic light-emitting diodes (LEDs) are provided on the Distribution Box Circuit Board to confirm the correct operation of the PORT and STBD OUT lines.

4.3.1.3 SWITCHED POWER

The voltage supplied at the Autopilot power terminals appears on this terminal whenever the Autopilot System is turned on and is not in **STANDBY** mode.

The voltage at this terminal can be used to supply up to 3 amperes of current for a solenoid-operated 4-way valve, or to activate an electric steering system.

SWITCHED POWER should also be used to operate the clutch solenoid on Cable Drives or Linear Actuator systems.

A yellow diagnostic LED is provided on the Distribution Box Circuit Board to confirm the correct operation of this output. For 12 VDC 4-way valve operation, it is recommended that this output not be used; instead, the common lead from the solenoids should be connected to UNSWITCHED POWER (terminal 3).

4.3.1.4 SPEED CONTROL

This is a linear signal used with variable speed drive systems. It is centered between +5 VDC and COMMON (terminals 8 and 9) when no change of rudder angle is required, and moves up or down from that point by as much as 2.5 VDC for maximum rudder position change to port or starboard respectively.

4.3.1.5 +5 VDC / COMMON

+5 VDC appear across these terminals whenever the Autopilot System is turned on. These terminals are used by several of the drive boxes manufactured by ComNav as a reference for SPEED CONTROL (terminal 7).

A yellow LED is provided on the Distribution Box Circuit Board to confirm the operation of the +5 VDC power supply in the Autopilot System.

COMMON (terminal 9) must not be used as the return for a motor field, the clutch, a Rotary Drive, or the lockup valve of a Linear Actuator. Instead, use JOG COMMON (Terminal 13) or PILOT POWER NEGATIVE (Terminal 2).

4.3.1.6 MOTOR MONITOR

This terminal is used with some of the drive boxes manufactured by ComNav to monitor motor current draw. If the current drawn by the motor exceeds a maximum level, this line will be activated, which signals the SPU to sound an alarm.

4.3.1.7 JOG SWITCH INPUTS

If the Autopilot is to be configured with Jog Levers, they are connected to JOG PORT, JOG STBD, and JOG GND terminals. If the Jog Levers are to be active all the time, even when the Autopilot System is turned off, connect the COMMON from the solenoid valve to UNSWITCHED POWER (Terminal 3).

4.3.1.8 RUDDER FOLLOWER

The Rudder Follower connects to the Autopilot System by means of a shielded 3-

wire cable. The signal designations for this cable are RUDDER POWER, RUDDER COMMON, and RUDDER POSITION.

With the SPU's Distribution Box cable disconnected from the SPU and the rudder turned to dead-ahead, the DC resistance between RUDDER POWER and RUDDER POSITION, as well as the DC resistance between RUDDER POSITION and RUDDER COMMON, should be equal. It will measure approximately 600 ohms if you are using a ComNav Rudder Follower.

4.3.1.9 NAV SIGNAL/RETURN

These two terminals connect to the NMEA 0183 output of a GPS Receiver, Loran C, or other type of navigation computer with an NMEA 0183 compliant output.

Whenever the Autopilot System is turned on, the LED next to these terminals will flash on and off as data is being received.

4.3.1.10 RAI SIGNAL/RETURN

These two terminals are used to drive up to three ComNav Rudder Angle Indicators (RAIs). Multiple RAIs must be wired in series.

If all the indicators move to port when the rudder moves to starboard, reverse the connections to these terminals. If only one indicator moves to port when the rudder is moved to starboard, reverse the connections on the back of that particular RAI.

A ZERO ADJUST potentiometer is supplied on the Distribution Box Circuit Board. Use this potentiometer to ensure that all RAIs read zero degrees when the rudder is in the dead-ahead position.

4.4 COMPASS

COMNAV FLUXGATE COMPASS

For best performance, the Fluxgate Compass must be mounted as close as possible to the vessel's center of pitch and roll. This is typically low in the vessel, at or about the waterline, and slightly aft of the center of the vessel.

You must keep the compass at least 1 meter (about 3 feet) away from engines, electric motors, and other magnetic objects. If this is not possible, it may be possible to compensate for the effects of these objects as described in the setup section found later in this manual.

Note:
Because of the sensitivity of Fluxgate Compasses to the earth's vertical magnetic fields, they are NOT recommended for use at latitudes greater than 50 degrees north or south.

Plug the end of the Fluxgate Compass cable into the compass receptacle on the SPU. If the length of cable supplied with the compass is not adequate, obtain an extra plug-in length from your ComNav dealer. Cutting and splicing the compass cable is NOT recommended.

OTHER FLUXGATE COMPASSES

The 1201 Autopilot System can be used with any Fluxgate Compass that outputs DC Sine and Cosine signals of up to +/- 3 volts amplitude about a 0 to 6 VDC reference.

If the compass does not have a HEELING ADJUST control, it should NOT be used on steel vessels.

The 1201 Autopilot System's compass interface has been tested with Fluxgate Compasses manufactured by KVH, Brookes and Gatehouse, and VDO. Some of these compasses have to be specially ordered in order to have the required DC Sine and Cosine outputs.

If your 1201 Autopilot System was ordered without ComNav's Fluxgate Compass, you will have been supplied with a 10-ft. cable fitted with a connector that can be plugged into the compass receptacle on the SPU. The other end of this cable is terminated in flying leads. The following table lists the color and function of each lead:

Cable Plug Pin Number	Wire Color	ComNav Fluxgate Function	Other Fluxgate Function
1	Blue	Sine	Sine*
2	Red	Drive P1	N/C
3	Black	Drive P2	N/C
4	Shield Drain Wire	Ground	Ground
5	White	Ref. Voltage	Ref. Voltage
6	Yellow	Cosine	Cosine*
7	Green	+12 VDC	+12VDC

Table 3 Connections For Other Fluxgate Compasses

Note: If the compass reading on the Control Head decreases while vessel heading is actually increasing, swap these two wires.

+12 Volts will appear on the wire connected to cable pin 7 when the Autopilot System is turned on. This supplies up to 100 milliamps of power to the Fluxgate Compass. If the compass power requirements are above 100 milliamps, it should be powered from a different source.

If the compass is separately powered, the tinned ends should be cut from the wires connected to cable pins 7 & 4. The wires should then be taped back against the cable to prevent accidentally shorting out of the +12 VDC power supply inside the SPU.

All other unused wires should also have their tinned leads cut off, and the wires should be taped back against the cable.

During normal operation, if the reading on the Control Head LCD screen does not agree with the vessel's actual heading, you can compensate by adding an "offset" to the reading. This is done in the Standby menu. Refer to the Basic Operations section for more detailed information.

If the compass you are using is self-compensating, do NOT run the Autopilot System's Compass Compensation routine during **DOCKSIDE SETUP**.

SPECIAL FLUXGATE COMPASSES

Some Fluxgate Compasses, such as the Brookes And Gatehouse Halcyon 3, have a "floating" reference. The reference from the 1201 Autopilot System is also floating. In order for the compass interface circuitry to work correctly, one of the references must be tied to a fixed voltage. The 1201 Autopilot System will automatically do this internally if you select **SPECIAL FLUXGATE** as the compass type in **DOCKSIDE SETUP** mode.

All compasses that do not have floating references should be configured for normal **FLUXGATE COMPASS** in the **DOCKSIDE SETUP** mode.

MAGNETIC COMPASSES

The advantage of using a Magnetic Compass with a Fluxgate Sensor attached to it is that the Autopilot is sensing the position of the magnets on the compass card rather than sensing the earth's magnetic field directly.

Since the card of the compass has physical inertia, it does not react immediately to the changes in the magnetic field it is immersed in, but only to those changes which persist long enough to overcome the resistance of the compass card to movement. This means that the compass is a more stable heading reference than a Fluxgate Compass. The Magnetic Compass will largely ignore changes in the magnetic field in the plane of the compass card caused by vessel motion that the Fluxgate Compass will react to.

This is particularly important in high latitudes, (such as Alaska, Labrador or the North Sea), where the horizontal component of the earth's magnetic field (which is the portion that the compass is trying to detect) is very small relative to the magnetic field of the vessel.

The disadvantage of the Magnetic Compass is that in very rough weather with the vessel going to windward, it is possible for the vessel motion to upset or 'tumble' the compass card, disabling the Autopilot.

Because of the relative insensitivity of the Magnetic Compass to both the earth's and the vessel's vertical magnetic fields, (due to its inertia), it is recommended for use at latitudes higher than 50 degrees (north or south), and for use on steel vessels when optional quadrantal spheres are included.

Locate and mount the compass in a position, which minimizes magnetic interference. *The compass should be at least 1 meter (about three feet) away from such equipment as radios, radars, depth sounders, and engine instruments.*

The compass can be used as a steering compass if desired. If the amount of cable supplied is too short to reach the SPU, obtain an extra plug-in length of cable from your ComNav dealer. *Cutting and splicing the compass cable is NOT recommended*.

To reduce the possibility of the card 'tumbling' in rough weather, mount the compass as close as practical to the center of pitch. Mounting the compass far forward under a bunk or similar location is a poor choice for rough weather performance.

IMPORTANT!

It is important to remember that the compass is a vital part of the 1201 Autopilot System. Locating it properly, particularly on steel-hulled vessels, is essential to ensure proper operation of the Autopilot. We recommend that the services of a qualified compass adjuster be used to select the best installation location and to compensate the compass properly for deviation, including that caused by heeling error.

Care must be taken not to place compensating magnets too close to the compass, as this will cause the Fluxgate Sensor, mounted underneath the compass, to read incorrectly. To correct compass deviation on steel vessels, or on other vessels with magnetic compensating problems due to interference from adjacent iron masses such as an engine block or winches, the use of a pair of 3-1/2 inch (89 mm) compensating quadrantal spheres is recommended. Contact ComNav or an authorized dealer for ordering information.

MOUNTING A FLUXGATE SENSOR TO NON-STANDARD COMPASSES

A Fluxgate Sensor can be mounted to a wide variety of "externally gimballed" compasses. The sensor should not be mounted to "internally gimballed" compasses (where the compass card is gimballed and the bowl of the compass is not), because the compass card does not remain parallel to the sensor when the vessel rolls or pitches, resulting in large errors between the compass and Autopilot.

Mounting the sensor above the compass reduces the possibility of compensating magnets interfering with the operation of the sensor, but also reduces the visibility of the compass if it is to be used as a steering compass.

To determine the best position to mount the Fluxgate Sensor, first remove the rear cover from the Autopilot. Attach a voltmeter between the SINE and +2.5V testpoints on the Processor Board. A diagram showing these points is shown on the following page.

1201 SPU Processor

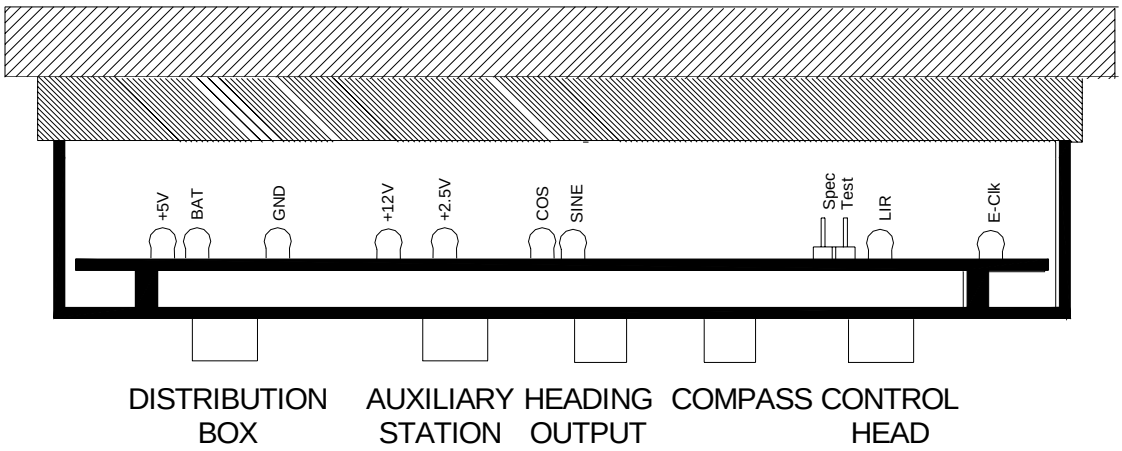


Figure 4 1201 SPU Showing Test Points and connectors

Turn on the Autopilot System, and place it into **STANDBY** mode by pressing and holding the STBY/OFF button. Hold the sensor either above or below the compass, and rotate it until a maximum level is observed on the voltmeter. Move the sensor towards or away from the compass until a new maximum level is observed. This is the optimum distance from the compass to mount the sensor. Any closer and the sensor may interfere with the operation of the compass.

The accuracy of the sensor, and its sensitivity to external fields, will slowly weaken as it is moved further from the compass.

If the reading on the Control Head display decreases when the heading on the compass is increasing, turn the sensor over. Rotate the sensor until the heading on the display of the Control Head matches the reading on the compass, and tighten the mounting screw on the Fluxgate Sensor.

Rotate the compass through 360 degrees, comparing readings every 20 degrees. The readings should agree within +/- 2 degrees (4 degrees total error) if the compass is compatible with the sensor.

As a further test, tilt the bowl of the compass so the card tilts relative to the sensor. The heading on the display of the 1201 Control Head should not change more than two degrees, with the compass still indicating the same heading.

If the heading changes more than two degrees, it is an indication that the magnets on the compass card are not powerful enough, and the compass is not compatible with the sensor.
If the accuracy of the compass and sensor combination cannot be made at least +/- 2 degrees, then the compass is not compatible with the Fluxgate Sensor. Your ComNav dealer can supply a compass specifically designed for the ComNav 1201 Autopilot System.

4.5 RUDDER FOLLOWER

The Rudder Follower is used to transmit the position of the rudder back to the Autopilot. It should be connected to whatever parts of the steering system the Autopilot controls. Normally, this will be the vessels rudder. However, if the vessel has 2 stage steering, such as Wagner M10, Kobelt Power Steering or a similar system where the Autopilot drives a control or servo ram, the Rudder Follower should be mounted to the servo ram rather than to the rudder. If the Rudder Follower is connected directly to the rudder in this case, uncontrollable hunting of the rudder will result.

Normally the Rudder Follower is mounted in the stern of the vessel, close to the rudder post. A mounting base may have to be fabricated to position the Rudder Follower properly. Mount the follower in a location where the possibility of damage from any equipment stowed in the area is minimized.

If a medium-duty Rudder Follower was supplied:

Mount the Rudder Post Arm on the rudder post using a stainless steel band clamp (not supplied). Bolt the ball joint to the hole in the Rudder Post Arm corresponding to the diameter of the Rudder Post in inches, making sure the ball is facing upwards ***(see Figure 5)***. Mount the Rudder Follower so that the Rudder Follower Arm is the same height as the Rudder Post Arm. The Rudder Follower is centered when the arm is directly above the cable gland ***(see Figure 6).***

If a heavy-duty Rudder Follower was supplied:

Mount the Rudder Follower so that the top of the vessel's tiller arm is 1 3/4 inches lower than the top of the Rudder Follower Arm. On the centerline of the vessel's tiller arm, and within 3 to 5 inches from the center of the Rudder Post, either:

- Drill and tap a hole 1/4-20

or

- Drill a clearance hole for a 1/4 inch bolt if enough of the threads of the supplied ball joint will come through the tiller arm to permit the supplied nut to be threaded onto it.

The Rudder Follower is centered when the arm is pointing away from the cable gland and is directly over the stainless rivet in the top cover.

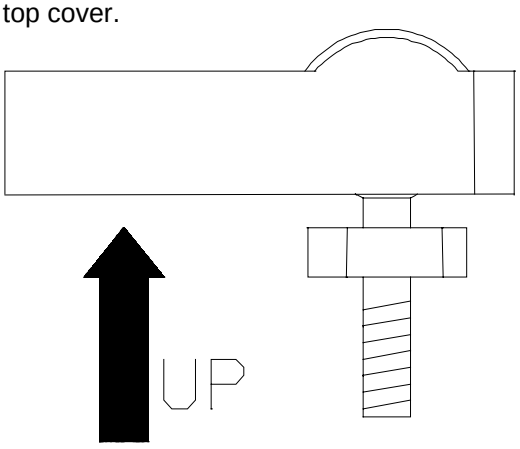


Figure 5 Correct Linkage Orientation

With either Rudder Follower:

The distance between the centerline of the Rudder Post and the Rudder Follower must not exceed 24 inches. Make sure that the ball joints on the Rudder Arm and Rudder Follower arm are facing upwards as shown in Figure 5, above. Snap the rod assembly onto the ball joints. Be sure to close the release clamps on each socket. Refer to Figures 5 and 6, and adjust the length of the rod to get the correct geometry with the rudder dead-ahead.

If the locking screw in the Rudder Follower arm has been loosened, or the arm removed from the Rudder Follower, re-attach the arm and check the potentiometer center position. When the rudder is dead-ahead, the electrical resistance between the black and green wires and the white and green wires should be equal (approx. 600 ohms each).
Be careful to check the installation for any mechanical obstructions or binding of the

linkage, and correct it now, before it becomes a problem.

The Rudder Follower is supplied with 50 feet of cable. Run the cable from the Rudder Follower towards the Distribution Box, ensuring that a hose or conduit protects it wherever it passes through fish or cargo holds, or any other area where it could be damaged.

If the length of cable supplied is too short to reach all the way to the Distribution Box, obtain a terminal strip and sufficient additional cable from your dealer. Mount the terminal strip in a convenient DRY location. Connect the Rudder Follower cable to the terminal strip and then add the additional length of cable.

Strip the wires, and attach them to the terminals in the Distribution Box as shown in the table below:

COLOUR	TERMINAL	SIGNAL
White	14	+5 Volts
Green	15	Rudder Position
Black	16	Common
Shield	2	GND (Ground)

Table 4 Rudder Follower Cable Connections

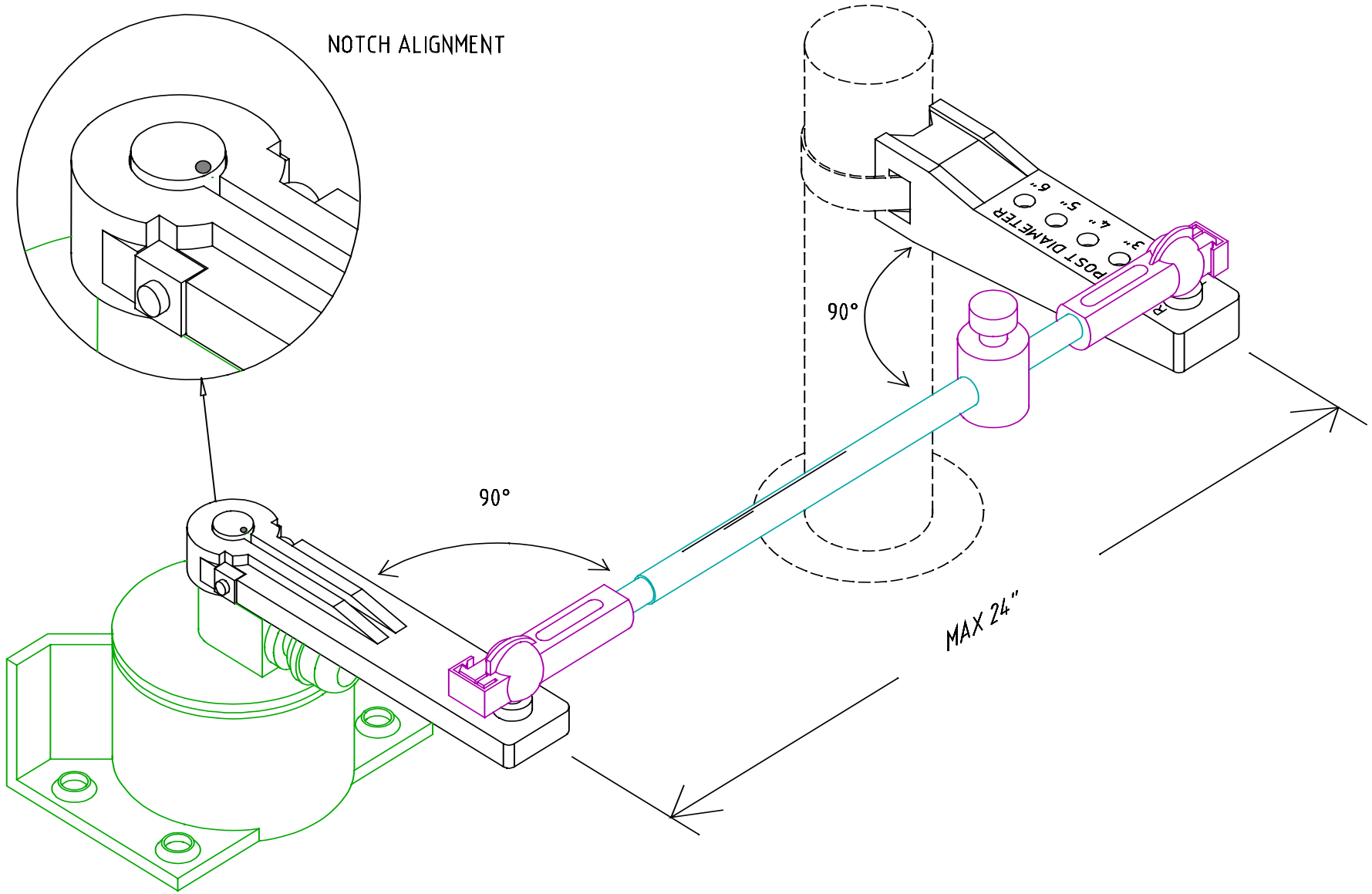


Figure 6 Rudder Follower Linkage Detail

4.6 NAVIGATION INTERFACE

For the 1201 Autopilot to operate in **NAV** mode, it must receive navigation information from a Nav Device. It is connected through the Distribution Box.

If the Autopilot is being interfaced to a Nav Device with several NMEA outputs, determine the type of output formats that are available from its data sheets. The 1201 Autopilot only supports NMEA 0183 data format and therefore that format must be selected.

NMEA 0183

This data format was developed to allow a number of pieces of electronic equipment on the vessel to communicate with each other. It consists of a large number of data 'sentences', which can transmit anything from the vessel's water speed to its present position from one device to another.

The standard baud rate for the 0183 data format is 4800 Baud.

A data sentence consists of a two letter identification of the sending device, followed by a three letter identification of the data sentence, followed by the corresponding information.

The Autopilot can understand a number of data sentences that contain steering or speed information. It ignores the two-letter device identifier, and only looks for the three-letter sentence identifier, so it will receive information from any Nav Device that transmits the correct data sentences.

Some NMEA 0183 data sentences supply heading from the beginning of track to the end of the track, which remains constant until the Nav Device sequences to the next waypoint. This is the best type of “Heading To Steer” information, as it prevents the wandering which may occur when the vessel is close to the destination waypoint.

Depending on the type of Nav device and how it is configured, the Autopilot may sound its alarm and display "Waypoint Arrival" when the vessel enters an arrival circle.

NMEA NAVIGATION SENTENCES

The 1201 Autopilot System is capable of receiving a number of different NMEA authorized “sentences”. Each sentence contains specific information that the Autopilot can use while in **NAV** mode. The sentences currently supported by the Autopilot along with the information the Autopilot uses from that sentence, are listed below:

RMA	Loran C Navigation Information – Receiver Status plus Vessel Speed plus Variation.
RMC	GPS Navigation Information – Receiver Status plus Vessel Speed plus Variation.

The RMA or RMC data sentence is always combined with the RMB data sentence.

RMB	Generic Navigation Information – Cross Track Error plus Heading To Steer from vessels present position to the end of the track (Degree's True only).
APB	Autopilot Interface Format – King Version - Cross Track Error plus Heading To Steer from the vessel's present position to end of track.

APB	Autopilot Interface Format – NMEA Version - Cross Track Error plus Heading To Steer from the vessel's present position to end of track.
APA	Autopilot Interface Format – Cross Track Error plus Heading To Steer from beginning to end of track.
XTE	Cross Track Error - Cross Track Error plus Receiver Status.

XTE is always combined with one of the following:

BOD	Bearing Origin to Destination - Bearing from the beginning of the track to end of the track. This is the preferred heading format, or;
WBD	Waypoint Bearing and Distance – Proprietary output from Northstar Lorans. Heading to Steer is from the vessel's present position to the end of the track.
HSC	Heading Steering Command – Heading To Steer from the vessel's present position to the end of the track.

The vessel's speed is read from the RMA or RMC data sentence or one of the following:

VBW	Vessel Speed relative to water from Dual Doppler Speed Log.
VHW	Vessel Heading and Water Speed.
VTG	Vessel Track and Ground Speed.

CROSS TRACK ERROR RESPONSE

Cross track error contains two pieces of information: the amount of the error, and the 'sense' of the error (i.e. whether the vessel is to the left or the right of the line between the beginning and ending waypoints).

The *National Marine Electronics Association* (NMEA) has specified how the cross track error should be identified (i.e. a (L)eft indicator in the data sentence means the vessel should steer to the left, with a (R)ight indicator meaning the opposite). However, some manufacturers have used the (L)eft indicator to mean that the vessel is to the left of the line, which means the vessel should steer to the right, and the (R)ight indicator to mean the opposite.

Because of this confusion, the ComNav 1201 Autopilot has been designed so that the user can toggle the cross track error response between NORMAL (as per NMEA specifications) and REVERSED.

If the setting is incorrect, the vessel will initially turn to the correct heading, but then as some cross track error develops, the vessel will continually turn further and further away from the correct heading to the waypoint.

The cross track error response of the Autopilot is set in **NAV** mode. To enter **NAV** mode, press and hold the NAV button for 0.5 seconds.

Double click the NAV button (while in **NAV** mode), to enter the Nav menu. Use the knob to select the parameter you wish to adjust (XTE Sense) and press the NAV button again. While the selection is flashing it can be changed. The options are NORM and REV.

CHECKSUM EVALUATION

Some Nav Devices incorrectly calculate the checksum, causing the checksum error message to be displayed repeatedly.

The checksum evaluation can be turned off through use of the Standby menu. Press the STBY/OFF button, while in **STANDBY** mode, to enter the Standby menu. Use the ADJUSTMENT KNOB to select the parameter you wish to change (NMEA checksum), and click the STBY/OFF button again. While the selection is flashing you may change your checksum to “ON or “OFF” with a turn of the ADJUSTMENT KNOB. Press the STBY/OFF button once to exit the current selection, and then double press to exit the menu back into **STANDBY** mode.

The RMA, RMB and RMC data sentences contain a 'checksum' which is determined by the contents of the sentence. The Autopilot can calculate what the checksum should be and compare it to the sentence. If the sentence was received correctly, the two checksums should be the same. If they are different the Autopilot assumes that the sentence was incorrectly received and displays 'Checksum Error'.

4.7 HEADING OUTPUT INTERFACE

The 1201 Autopilot system provides heading information in both NMEA 0183 and Furuno AD-10S formats. The information is available in all modes of operation except **DOCKSIDE SETUP** whenever there is a valid signal from the compass. The Autopilot transmits the information at a fast repetition rate so that it can be utilized by compatible radar and ECDIS systems.

Included with every 1201 Autopilot system is a 10-ft. cable fitted with a connector that can be plugged into the Heading Output receptacle on the SPU. Unused wires should have their tinned leads cut off, and the wires should be taped back against the cable.

The table to the right lists the color and function of each lead:

Cable Plug Pin Number	Wire Color	Function
1	Blue	AD-10S Clock
2	Red	Not used
3	Black	Not used
4	Shield Drain Wire	AD-10S Common/ NMEA 0183 Shield
5	White	NMEA 0183 “B”
6	Yellow	AD-10S Data
7	Green	NMEA 0183 “A”

Table 5 Connections for Heading Output Cable.

NMEA 0183 OUTPUT

The 1201 Autopilot outputs the HDG sentence at a rate of 10 times per second.

HDG sentence structure provides for magnetic sensor reading, deviation, and variation. However, since the Autopilot cannot know the deviation and variation for a given location, this information is transmitted as “null” (empty) fields, as per the NMEA specifications.

FURUNO AD-10S OUTPUT

The 1201 Autopilot outputs the Furuno AD-10S sentences. Like the NMEA output, this information is transmitted at a rate of 10 times per second.

When interfacing to Furuno equipment which is compatible with the Furuno AD-10S gyrocompass interface, AD-10S Clock corresponds to CLK-H, AD-10S Data corresponds to DATA-H, and AD-10S Common corresponds to both CLK-C and DATA-C. If your equipment does not support CLK-H and DATA-H, it may still be possible to interface to the 1201 Autopilot System. Contact your ComNav Dealer or ComNav’s Factory Service Department for assistance.

4.8 FINAL CHECKS

***** IMPORTANT *****

If you have installed a ComNav Marine 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 dangerous steering performance. During this period you must check for air or leaks in your hydraulic system.

Residual air in your steering system
Following the initial installation and bleeding of your ComNav pump, 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 the oil level may go down. Check several times and add more oil as required.

Leaking fittings or equipment
Following the initial installation and bleeding of your ComNav pump continuously monitor the oil level of the reservoir or the highest helm pump in your steering system and add oil as required. If this condition persists, it may be an indication of leakage in your steering system. Check all hydraulic steering fittings and equipment for leakage.

5. SETUP

The Setup procedures in this section enable the Autopilot to familiarize itself with the other electronic devices on your vessel, as well as the mechanical rudder limits and the best steering settings for two different speed settings.

There are two types of setup procedures:

1) **DOCKSIDE SETUP**
2) **SEA TRIALS**

Dockside Setup is necessary before you leave the dock for the first time. It will set up the compass type and the maximum rudder movements.

Sea trials are to customize the turning and steering parameters in the Autopilot that help your vessel run most efficiently with the Autopilot.

5.1 DOCKSIDE SETUP

Dockside Setup is used to familiarize the Autopilot with your boat and its rudder and compass characteristics. It is essential that the Dockside Setup procedure be performed before taking the vessel out on the water. This procedure will be easier to do if you have a helper, especially if you don't have a Rudder Angle Indicator (R.A.I.).
The goals of the Dockside Setup are:
To set the limits of the rudder travel.
To adjust the R.A.I.
To configure the compass.

ENTERING DOCKSIDE SETUP

Dockside Setup can be entered by two methods:

5.1.1.1 NORMAL DOCKSIDE SETUP

This mode will allow you to set up the rudder travel limits or to go directly to the compass configuration.

1. Turn off power to the Autopilot.
2. Using the Control Head, press and hold both DODGE buttons and the STBY button simultaneously until the Autopilot enters **DOCKSIDE SETUP** mode.

5.1.1.2 FULL RESET

A **FULL RESET** resets all user-configurable parameters in the Autopilot back to factory default settings. This includes the old rudder travel limits and compass selection, so you will have to perform a complete Dockside Setup after doing a Full Reset. A Full Reset is initiated by the following steps:

1. Place the Autopilot in **STANDBY** mode and take command with the Control Head (from power off, press and hold the STBY button until power remains on).
2. On the Control Head, press and hold the TURN RATE, RUDDER and STBY buttons simultaneously until the Autopilot enters DOCKSIDE SETUP mode.

RUDDER TRAVEL LIMITS

The rudder travel limits are used to keep the Autopilot from trying to turn the rudder further than it can mechanically move.

Once you are in the Dockside Setup menu, choose “Set Up Rudder” by pressing the WORK button while the cursor is pointing at the “Set Up Rudder” line on the LCD screen.

When you enter the rudder setup the LCD screen will read “Move Rudder To Hard – Over Starboard”. When you have completed this motion, press the WORK button. The LCD screen will now read “Move Rudder Hard-Over Port”. After doing so, again press the WORK button. The LCD screen should then ask you to center the rudder. Turn the rudder until it is approximately mid-ships and press the WORK button.

The Autopilot should now go through about 30 seconds of rudder movement to ensure that it can move the rudder hard over to hard over within the allotted time period.

COMPASS CONFIGURATION

You must tell the Autopilot what kind of compass you are using so that it knows which signals to look for.

To choose your compass type, press the WORK button while the cursor is pointing at the “Setup Compass” line on the LCD screen.

If you have a Magnetic Compass, press the WORK button while the cursor is pointing to “Magnetic Compass. “

If you have a Fluxgate or special Fluxgate Compass (see Section 4.4.2, 4.4.3, and 4.4.4 to determine what kind of compass you have), you will be given the option of adjusting your compass. You will not want to do this unless you are in an area suitable for turning your boat in a complete circle. Details for adjusting your compass is covered in Section 5.2.1.

EXTERNAL RUDDER ANGLE INDICATOR ADJUSTMENT

If you also have external R.A.I. units on board, you can now check to see if they are working properly.

Place the Autopilot in **STANDBY** mode. (Press and hold the STBY button).

Turn the wheel to port and then to starboard. If the R.A.I. moves to port when the rudder moves to starboard, reverse the R.A.I. signal and R.A.I. return leads in the Distribution Box.

Center the rudder. If the RAIs do not read 0° when the rudder is dead-ahead, adjust the ZERO ADJUST potentiometer on the Distribution Box Circuit Board until they do.

5.2 SEA TRIALS

Sea Trials are the second part of the setup process. They will setup the parameters that the vessel uses while moving. The more accurately you set up the parameters, the better the Autopilot will operate.

If the Autopilot is using a Magnetic Compass and Fluxgate Sensor combination or a self-compensating Fluxgate Compass (such as the KVH Autocomp 1000), skip compass compensation.

COMPASS COMPENSATION

Turn the Autopilot off.
Press and hold the STBY button down while holding the two DODGE buttons down. This will turn the Autopilot on in Dockside Setup menu.
Select the compass setup parameter by turning the ADJUSTMENT KNOB until the cursor is pointing at the “Setup Compass” line. Press the WORK button to select “Compass Setup”, and choose your

compass type again. When given the option to compensate your compass, you press the WORK button and the LCD screen should start to flash the message "Turn Vessel 360 Degrees".

Slowly turn the vessel in one complete circle either to port or to starboard. The direction does not matter, but the rate of turn should be slow enough so that the entire circle takes at least one minute to complete.

When the circle is complete, the Autopilot will beep and display first a north/south correction, followed by an east/west correction.

If either correction is greater than 30° then the compass should be moved and re-swung, or corrected manually by a qualified compass adjuster. If the Autopilot determines this to be the case, the LCD screen will show “ERROR, Move Compass And Redo Setup”.

If you choose to have someone manually compensate the compass please see that the following procedure is used:

Turn the Autopilot off.

Press and hold the STBY button down while holding the two DODGE buttons down. This will turn the Autopilot on in **DOCKSIDE SETUP** mode.

Select the compass setup parameter by turning the ADJUSTMENT KNOB until the cursor is pointing at the “Setup Compass” line. Press the WORK button to select “Compass Setup”, and choose your compass type again.

This time exit the next menu without compensating the compass. All of the previous adjustments have now been turned off, and the raw compass data is now shown on the display. The compass adjuster can use this display to adjust the compass manually.
After the compass adjuster is finished, re-swing the vessel using the automatic method described above to remove any minor errors that may persist.

ComNav’s Fluxgate Compass, like most self compensating compasses, removes the effect of the deviating magnetic field, but does not actually remove the field itself. If the field is sufficiently large, when the vessel rolls, the portion of the field in the plane of the sensor changes, and is interpreted as a turn by the compass, causing the vessel to wander. The compass adjuster, by placing magnets around the compass, removes the deviating field itself from the vicinity of the compass, resulting in much more accurate steering in all sea conditions.

A final check of compass accuracy may be made once the compass is properly compensated. Place the vessel on a known heading. If the reading on the Autopilot display disagrees with the vessels actual heading, correct it with a permanent heading offset.

To do this, enter the Standby menu, by double pressing the STBY button while in **STANDBY** mode. Use the ADJUSTMENT KNOB to move the cursor to the “Compass” line on the LCD screen and press the STBY button again. An offset may be entered by turning the ADJUSTMENT KNOB. See Section 6.1.1.3.5 for more details on this operation.

When you are finished, double press the STBY button to return to **STANDBY** mode. The compass heading should now be correct.

STEERING PARAMETERS (RUDDER & COUNTER-RUDDER)

The 1201 Autopilot System offers automatic selection of user-adjusted FAST and SLOW vessel control settings. To adjust or fine-tune these settings to your vessel's characteristics, follow the steps outlined below:

5.2.1.1 SLOW

The slow setting should be configured while the vessel is moving at a slow cruising speed, below the Trip Point set in the Standby Menu.

Press and hold the AUTOPILOT button to place the Autopilot into **AUTOPILOT** mode. If the display reads “FAST” in the bottom right corner, decrease the vessel's speed until the display reads “SLOW”.

Make a 40° course change.

The vessel should settle onto the new course with one overshoot of 5° or less.

If the vessel stops turning before the new heading is reached and then approaches it slowly, either:

1. Increase the rudder one level. (Press the RUDDER button to enter the Steering Parameter menu and turn the ADJUSTMENT KNOB one click clockwise to increase the rudder setting by one level).
2. Decrease the counter rudder one level. (Press the COUNTER RUDDER button once to enter the Steering Parameter menu and turn the ADJUSTMENT KNOB one click counter-clockwise to decrease the counter rudder setting by one level).

If the vessel overshoots the new heading, and then makes several turns across the new heading before settling down, either:

1. Decrease the rudder one level. (Press the RUDDER button once to enter the Steering Parameter menu and turn the ADJUSTMENT KNOB one click counter-clockwise to decrease the rudder setting by one level).

Increase the counter rudder one level. (Press the COUNTER RUDDER button once to enter the Steering Parameter menu and turn the knob one click clock-wise to increase the counter rudder setting by one level).

5.2.1.2 FAST

Be sure that the Autopilot is connected to a working Nav device that is providing valid NMEA 0183 speed information.

Set the Trip Point in the Standby Menu to a value above which the vessel can be considered to be running "fast".

Press and hold the AUTOPILOT button to place the Autopilot into **AUTOPILOT** mode. If the display reads “SLOW” in the bottom right corner, increase the vessel's speed until the display reads “FAST”.

Make a 40° course change.

The vessel should settle onto the new course with one overshoot of 5° or less.

If the vessel stops turning before the new heading is reached and then approaches it slowly, either:

1. Increase the rudder one level. (Press the RUDDER button to enter the Steering Parameter menu and turn the ADJUSTMENT KNOB one click clockwise to increase the rudder setting by one level).
2. Decrease the counter rudder one level. (Press the COUNTER RUDDER button once to enter the Steering Parameter menu and turn the ADJUSTMENT KNOB one click counter-clockwise to decrease the counter rudder setting by one level).

If the vessel overshoots the new heading, and then makes several turns across the new heading before settling down, either:

1. Decrease the rudder one level. (Press the RUDDER button once to enter the Steering Parameter menu and turn the ADJUSTMENT KNOB one click counter-clockwise to decrease the rudder setting by one level).

2. Increase the counter rudder one level. (Press the COUNTER RUDDER button once to enter the Steering Parameter menu and turn the knob one click clockwise to increase the counter rudder setting by one level).

5.2.1.3 WORK MODE

The **WORK MODE** rudder Scale Factor, set in the Standby Menu should be adjusted only after achieving satisfactory performance from the Autopilot System while using the SLOW steering parameters.

The default setting for rudder Scale Factor is 1.00, which means that while in **WORK MODE** the rudder will respond in approximately the same manner as if **WORK MODE** were not engaged, but there will not be any counter-rudder to dampen the rudder response. Start your Sea Trials for **WORK MODE** using the default setting of 1.00.

While underway in **AUTOPILOT** mode, press and hold the WORK button until the lower right corner of the LCD screen displays “Work”. If the word “Work” is flashing, reduce the vessels speed so that it is below the speed Trip Point set in the Standby Menu, or set a higher Trip Point. Once the word “Work” is shown in solid, the Autopilot is in **WORK MODE**.

It is advantageous to set up WORK MODE in as near to “working” conditions as possible. If the vessel is normally used for towing, then it would be best if WORK MODE was set up while towing a typical load.

Evaluate the steering response with the rudder Scale Factor at 1.00.

If the vessel is not responsive enough, increment the rudder Scale Factor in the Standby Menu by 0.25, and re-evaluate. Continue to make incremental changes while evaluating the performance of the Autopilot. Once satisfactory performance is achieved, note the settings for the rudder Scale Factor for future reference.

If the vessel begins an “ess-ing” motion, try reducing the rudder Scale Factor by a single step of 0.25 and re-evaluate.

Once the rudder Scale Factor has been set up, further changes to the steering performance to compensate for changing sea-state, etc. may be made by using the RUDDER button to enter the Steering Parameter menu.

TURN RATE

The Turn Rate parameter is adjusted in both SLOW and FAST Steering Parameter menus, and should be adjusted to a comfortable level.

YAW

The Yaw setting tells the Autopilot how far off course the vessel may ‘wander’ before the Autopilot corrects the error.

At the default value of ‘1’, there is a 0.5° dead band on either side of the programmed course.

The Yaw setting is adjusted in both SLOW and FAST Steering Parameter menus. The value should be adjusted according to sea conditions. As the conditions worsen the yaw setting can be increased. This will result in slightly worse steering, but will reduce the amount of rudder movement and strain on the steering system.

NAVIGATION EQUIPMENT INTERFACE

During your Sea Trials you should test and verify that your Nav Device(s) are working properly with the Autopilot.

The first step is to make sure Nav device is turned on and a waypoint programmed in and active. The Autopilot should then be placed into **NAV** mode. (Press and hold the NAV button). The heading displayed on the LCD screen should start to change towards the heading to be steered to reach the waypoint.

Double press the NAV button to confirm the correct programming of the Nav Device. If the display starts flashing “No Data From Nav Device” then re-check your installation: check that the signal and return lines from the Nav Device are not reversed, and that the output from the Nav Device is programmed correctly.

Check that the data LED in the Autopilot Distribution Box is blinking periodically. If the interface still cannot be made to work, contact your dealer or ComNav Marine's Factory Service department directly for assistance.

SEA TRIAL TROUBLESHOOTING

If the vessel steers properly on some headings but not on others, particularly north or south, this indicates a magnetic interference problem. Have a qualified compass adjuster compensate the compass. After the compass has been manually adjusted, re-swing the compass to remove any small errors.

If the Autopilot is using a different brand of Fluxgate Compass, or a Magnetic Compass with Fluxgate Sensor, a qualified compass adjuster will be required to reduce or eliminate this interference.

For best operation, in addition to normal adjustments, the compass should be compensated for deviation caused by heeling error. (Particularly on steel hulled vessels).

6. DETAILED OPERATION

This section will describe all of the features, controls, and settings of the 1201 Autopilot System, explaining what they are and how to use them.

6.1 MODES

The 1201 Autopilot has 4 different modes of operation, each serving a different purpose. The four modes are **STANDBY**, **POWER STEER**, **AUTOPILOT**, and **NAV**. Each is discussed in detail in the following pages.

STANDBY MODE

The Autopilot first turns on in **STANDBY** mode. The display will show the vessel's actual compass heading, but the Autopilot has no control over the steering of the boat.

6.1.1.1 ON

To turn the Autopilot on, press and hold the STBY/OFF button until the Autopilot is in the **STANDBY** mode. If you release the button too soon, the Autopilot will turn itself off.

6.1.1.2 OFF

To turn the Autopilot off, press and hold the STBY/OFF button for 2 seconds.

6.1.1.3 STANDBY MENU

In **STANDBY** mode there are several parameters that can be changed. These parameters appear in a menu that can only be accessed from the **STANDBY** mode.

Double press the STBY button while in **STANDBY** mode to enter the Standby Menu. Turning the ADJUSTMENT KNOB will move the cursor up and down selecting the parameter to be changed.

In the Standby menu there are two pages of parameters. If you are on the last parameter of the upper page and turn the ADJUSTMENT KNOB clockwise you will move to the second page. If you are on the top parameter of the second page and turn the ADJUSTMENT KNOB counter-clockwise you will move up to the top page.

6.1.1.3.1 (FAST/SLOW/WORK) TRIP POINT

During your Sea Trials with the 1201 Autopilot you will set the rudder, counter rudder, and turn rate for your vessel at two different speeds, one fast and the other slow. The speed Trip Point is the speed at which the Autopilot steering settings change from fast to slow or vice-versa. It is also the point where the Autopilot system engages and disengages the **WORK MODE** steering parameters.

To change the speed Trip Point setting, use the ADJUSTMENT KNOB to move the cursor until it is pointing at speed Trip Point, and press the STBY button. While the number is flashing you may change the Trip Point with the knob to any value from 1 to 10 knots.

To use the speed trip point feature, the Autopilot requires that you be interfaced to a Nav Device that can send the speed data. If no speed information is available, the Autopilot system will steer using the Fast set of steering parameters. A flashing message, "No Speed Data" will also periodically appear while in **AUTOPILOT** or **NAV m**ode if no speed data is available.

6.1.1.3.2 SCALE FACTOR

While operating in **WORK MODE**, the Autopilot steers the vessel using a special steering algorithm. Part of this algorithm is to multiply the user-set Rudder value by a "scaling" value, also set by the user.

To change the rudder Scale Factor setting, use the ADJUSTMENT KNOB to move the cursor until it is pointing at "SCALE FACTOR", and press the STBY button. While the number is flashing you may change the Scale Factor to any value from 0.25 to 3.00 in increments of 0.25.

The rudder Scale Factor that is right for your vessel will depend on the characteristics of the vessel itself, the type of work it does, and the vessel's speed. To determine the correct Scale Factor, make incremental changes starting from 1.00 until satisfactory **WORK MODE** operation is achieved. Once this is accomplished, do not make further increments; the Autopilot may begin over-correcting, resulting in an "ess-ing" effect.

More details about **WORK MODE** are given in Section 6.1.3 (AUTOPILOT MODE) and Section 6.2 (STEERING RESPONSE).

When a FULL RESET is executed, the rudder Scale Factor is defaulted to a value of 1.00.

6.1.1.3.3 BRIGHTNESS

The brightness setting changes the illumination of the display. In well-lit areas you may want a lower brightness setting, while in darker areas you may want a higher brightness setting.

To change the brightness, use the ADJUSTMENT KNOB to move the cursor until it is pointing at brightness, and press the STBY button. While the number is flashing you may change the brightness level.

For no illumination at all, turn the brightness setting to 0, and for full illumination turn the brightness to 7.

6.1.1.3.4 CONTRAST

The 1201 LCD is made up of a matrix of 64x128 pixels. When an image is placed on the screen, some of these pixels are lit up while the other pixels are left at the background darkness. The contrast is how light/dark the image pixels are in relation to the background pixels.

To change the contrast, use the ADJUSTMENT KNOB to move the cursor until it is pointing at contrast, and press the STBY button. While the number is flashing you may change the contrast level.

The contrast setting ranges from 0 (dark foreground and dark background) to 15 (light foreground and light background).

6.1.1.3.5 COMPASS OFFSET

The compass offset is the number that is added (or subtracted) from the compass heading to compensate for electrical and magnetic deviations.

To change the compass offset, use the ADJUSTMENT KNOB to move the cursor until it is pointing at COMPASS OFFSET, and press the STBY button. While the number is flashing you may change the compass offset.

An offset of 005° will add five degrees to the compass heading and an offset of 355° will subtract five degrees from the compass heading.

6.1.1.3.6 BATTERY VOLTAGE

Displays the current battery voltage supplied to the Autopilot.

This is a “read-only” field, and cannot be changed.

6.1.1.3.7 NMEA CHECKSUM

The NMEA checksum is an error-checking routine used to determine when NMEA data received by the Autopilot does not match the data sent from the Nav Device.

To turn the NMEA checksum on and off, use the ADJUSTMENT KNOB to move the cursor until it is pointing at NMEA checksum, and press the STBY button. While the selection is flashing you may turn off/on the NMEA checksum.

6.1.1.3.8 TURN SETUP

Turn setup allows you to specify the type of special turn that the Autopilot will initiate when the TURN button is pressed. See section 6.3 (SPECIAL TURNS) for more details.

To select the type of special turn, use the ADJUSTMENT KNOB to move the cursor until it is pointing at SPECIAL TURN, and press the STBY button. While the selection is flashing you may change the type of special turn.

POWER STEER MODE

The next operating mode is **POWER STEER**. To enter **POWER STEER** mode, press and hold the POWER STEER button until the confirming "beep". In this mode, the display still shows the actual compass heading, but now also has a graphical Rudder Angle Indicator (R.A.I.) in the center of the display as well as a digital R.A.I. in the bottom right corner.

The PORT and STARBOARD DODGE buttons are used to control the rudder when in **POWER STEER** mode.

With hydraulic steering, you may still manually turn the rudder. If you have mechanical steering, the only operating mode where you can manually turn the rudder is **STANDBY**.

6.1.1.4 POWER STEER MENU

Double press the POWER STEER button while in **POWER STEER** mode to enter the Power Steer menu. Turning the ADJUSTMENT KNOB will move the cursor up and down letting you select the menu item.

6.1.1.4.1 RUDDER ANGLE OFFSET

The rudder angle offset can be used to adjust the dead ahead movement of the boat to show a centered rudder display. To select the rudder angle offset, use the ADJUSTMENT KNOB to move the cursor until it is pointing at rudder angle offset, and press the POWER STEER button. While the number is flashing you may change the rudder angle offset with the ADJUSTMENT KNOB.

6.1.1.4.2 HARD-OVER TO HARD-OVER

This is used to more accurately calibrate the graphical RAI and the digital rudder angle reading and does not affect how far the rudder moves.

To select the hard-over to hard-over, use the ADJUSTMENT KNOB to move the cursor until it is pointing at hard-over to hard-over, and press the POWER STEER button. While the number is flashing you may change the hard-over to hard-over by turning the knob.

AUTOPILOT MODE

6.1.1.5 GENERAL AUTOPILOT FUNCTIONS

In **AUTOPILOT** mode, the Autopilot system will steer the vessel on your commanded heading.

To enter **AUTOPILOT** mode, press and hold the AUTOPILOT button until the confirming "beep". At this point the Autopilot will steer the vessel to the last course the vessel was on prior to switching into **AUTOPILOT** mode.

To change the vessel's course turn the ADJUSTMENT KNOB. A clockwise turn will result in an increase of your heading, and a counter-clockwise turn will result in a decrease of your heading. Rapidly turning the knob will result in a 10° course change while slowly turning the knob will result in a 1° course change. The Autopilot will bring the vessel around to the new course at the turn rate set in the Steering Parameter menu.

While in **AUTOPILOT** mode, a fast turn can be made to avoid an obstacle in the water by pressing either the PORT or STARBOARD DODGE buttons. After the object has been maneuvered around and

the DODGE button is released, the vessel will return to its original course.

To **DODGE** around large objects, press the PORT or STARBOARD DODGE button until the vessel is clear of the obstructing object, then press both PORT and STARBOARD DODGE buttons to center the rudder. The vessel will continue in a straight line until the DODGE buttons are released, at which time it will return to its original course.

Pressing the TURN button followed by either DODGE button, and the vessel will make a special turn. (The type of special turn is selected in the Standby Menu). The display will show a flashing "E-TURN', 'C-TURN', or 'U-TURN' until the turn is complete.

The automatic speed Trip Point set in the Standby Menu is active in **AUTOPILOT** mode as long as you have a Nav Device connected and providing valid speed data. This enables the Autopilot to switch between the fast and slow modes of operation automatically.

If the Autopilot fails to receive any speed data from the Nav Device it will sound an alarm and display "NO SPEED DATA" on the screen once every twenty seconds. In this case the Autopilot will steer using the Fast steering parameters only. See section 6.2 (STEERING RESPONSE) for more details.

6.1.1.6 WORK MODE

WORK MODE is special case of **AUTOPILOT** mode to be used under conditions that are different from "normal" Autopilot operation. Prime examples are dragging, trawling, and pair trawling. It is also useful for towing or when traveling at very slow speeds.

Setting up **WORK MODE** is easily accomplished from the Standby Menu. Only two parameters are input by the end user: a speed **Trip Point**, and a **Rudder Scaling Factor**. These parameters can easily be fine-tuned as required by re-entering the Standby Menu and making the necessary adjustments.

WORK MODE can be activated in either **AUTOPILOT** or **NAV** mode. The 1201 Autopilot can even be switched from **AUTOPILOT** to **NAV** mode, or vice-versa, while **WORK MODE** is active.

To use **WORK MODE**, first go into either **AUTOPILOT** or **NAV** mode. Then press and hold the WORK button until a confirming beep is heard. The word "*Work*" will appear in the lower right of the LCD screen on the Control Head. If the vessel is traveling at a speed above the speed Trip Point defined in the Standby Menu, the word "*Work*" will be flashing. This indicates that **WORK MODE** will automatically be engaged once the vessel's speed falls below the trip point.

If the word "*Work*" is steady and not flashing, then the system has engaged **WORK MODE**. The current rudder position will be taken as a fixed helm bias. Subsequent rudder calculations will be based on this position being "dead-ahead".

While in **WORK MODE**, the Rudder gain setting will automatically be multiplied by the Scaling Factor that was input in the Standby Menu. Normally the rudder is moved an amount proportional to the course error detected, but now that calculation will be multiplied, resulting in larger rudder movements for a given course error.

Other effects take place in **WORK MODE** too. Counter-Rudder is reduced to a minimum, enhancing the effect of the Rudder gain and Scaling Factor. Turn Rate is not governed while **WORK MODE** is active. Particularly useful for pair trawling, the Autopilot also disables the automatic course trim. And finally, the built-in course alarm will be disabled the entire time **WORK MODE** is engaged.

If the user is not satisfied with the fixed helm bias determined by the Autopilot at the onset of **WORK MODE**, manual adjustments can be made "on-the-fly" while **WORK MODE** is engaged. A double-press of the WORK button will bring up a menu screen showing the current helm bias position. By using the adjustment knob, the user can change this to whatever setting suits the need. This feature is useful in order to accommodate changing load or sea conditions.

WORK MODE will automatically be suspended if the vessels speed rises above the speed Trip Point set by the user. The word "*Work*" in the lower right will flash should this occur. While the word "*Work*" is

flashing, the Autopilot will steer using the normal “Fast” steering parameters. All normal features such as automatic trim and course alarm will be operational.

Work Mode can be cancelled completely by changing modes to either **POWER STEER** or **STANDBY**, or by pressing the WORK button until a confirming beep is heard and FAST or SLOW is displayed in the lower corner.

NAV MODE

The last operating mode is **NAV** mode. If you have a GPS, Loran C or other Nav Device interfaced to the Autopilot, it can steer from the NMEA 0183 data.

Turn the Nav Device on and activate a waypoint. Press and hold the NAV button down to place the Autopilot into **NAV** mode. If the Nav Device and Autopilot are properly interfaced, the display on the Autopilot should begin to change towards the waypoint selected on the Nav Device.

The Autopilot will then further alter its course to keep the cross track error as indicated by the Nav Device, to a minimum. If you are in doubt as to whether things are working correctly, *watch the cross track error*. If it is being maintained at a low level (0.02 nautical miles) everything is fine.

If the vessel is wandering back and forth but there are no alarms on the Autopilot or Nav Device, the most common cause (particularly with Loran) is poor signal quality. This may be attributed to:

- Improper grounding of the Loran (also applies to other Nav Devices).
- Electrical noise generated with in the vessel (such as alternators, power packs, etc.).
- Antenna location.

Refer to the Nav Device manual for signal quality displays and ideas on making improvements.

You may still use the DODGE buttons to avoid obstacles in the water. The only difference between **NAV** and **AUTOPILOT** modes are that after you release the DODGE buttons, the vessel will return to its original track, rather than its original course.

MENU

The Nav menu allows you to change the sense of your cross track error and will also allow you to view the different NMEA sentences that it is receiving from the attached Nav Device.

To enter the Nav menu, double press the NAV button while in **NAV** mode.

WORK MODE
To enter **WORK MODE** when in **NAV** mode, simply press the WORK button until the confirming beep. The work “Work” will be displayed in the lower right side of the LCD screen.
Refer to **AUTOPILOT** mode, above, for more details about **WORK MODE** and its effects.

6.2 STEERING RESPONSE

The steering response parameters are the fine tuning of the Autopilot. Each vessel could have different settings at different speeds.

RUDDER

Controls the amount of rudder applied for a given amount of course error. At the maximum setting of '9', 3 degrees of rudder will be applied for each degree of course error. Every two-position reduction in the setting cuts the amount of correction applied in half.

COUNTER RUDDER

Controls the amount of rudder applied for a given rate of change of course error. If the course error is increasing, the counter rudder adds to the rudder correction applied, and if the course error is decreasing the counter rudder subtracts from the rudder correction applied. At the maximum setting of '9', 10 degrees of rudder will be applied for a 1 degree per second rate of change of the course error. Every two-position reduction in the setting cuts the amount of correction applied in half.

TURN RATE

Controls the rate at which the vessel makes a course change, returns to its original course after a dodge, or changes course under Nav Device control. The turn rate corresponding to each control setting is shown in the following table

TURN RATE SETTING	ACTUAL TURN RATE (DEGREES)
0	0.5
1	1.0
2	1.5
3	2.0
4	2.5
5	3.0
6	3.5
7	4.0
8	4.5
9	5.0

Table 6 Turn Rate Correlation Table

YAW

Controls the amount of deviation from the programmed course the Autopilot will allow before correcting the vessel's heading.

Increasing the setting will increase the amount of heading deviation allowed. The number shown on the display is the number of degrees of heading deviation allowed, centered on the programmed course.

FAST/SLOW SPEED

The FAST/SLOW option on the 1201 Autopilot gives you the ability to store two different sets of steering response parameters. This allows for best performance under varying vessel speeds and/or loading conditions. To store the parameters in fast or slow mode you only need to adjust them while underway in that speed range. The parameters will be automatically saved, even when the unit is shut off.

6.3 SPECIAL TURNS

A special turn is a series of turn commands the Autopilot knows to follow a specific course. To initiate a special turn you must be in **AUTOPILOT** mode. Press the TURN button. The LCD screen will come up with the type of special turn programmed in the standby menu. You must press either PORT of STARBOARD DODGE buttons to instruct the Autopilot as to which direction to turn. Once a turn has been started you can change mode or turn the ADJUSTMENT KNOB to cancel the turn.

EMERGENCY TURN

The Emergency turn, also known as the "Man Overboard" turn or Williamson turn, will turn the vessel around and follow the same path back, as long as the vessels turn rate and speed have not been changed.

To initiate an emergency turn press the TURN button, while in **AUTOPILOT** mode, followed by one of the two DODGE buttons.

If the PORT DODGE button is pressed, the Autopilot will make a 90° turn to port, followed by a 270° turn to starboard, and retrace its track in the water. If the STARBOARD DODGE button is pressed, then the 90° turn will be to starboard, and the following 270° turn will be to port.

A flashing E-TURN will be shown in the center of the screen while the Emergency Turn is executed.

The Emergency Turn is not allowed while **WORK MODE** is engaged. Press the WORK button to cancel WORK MODE before initiating an Emergency Turn.

U-TURN

The U-Turn is just what it sounds like. The vessel makes a 180° turn in the direction that you ask it to. To initiate a U-Turn press the TURN button, while in **AUTOPILOT** mode, followed by one of the two DODGE buttons.

If the PORT DODGE button is pressed, the Autopilot will make a 180° turn to port, and if the STARBOARD DODGE button is pressed, the Autopilot will make the 180° turn in the starboard direction.

U-Turns are often used on work vessels to cover a grid-pattern. For this reason, U-Turns are allowed in **WORK MODE** as well as normal **AUTOPILOT MODE.**

CONTINUOUS CIRCLE

The Continuous Circle turn, also known as C-Turn, will turn the vessel in a circle until the turn is disabled by either turning the knob or by changing modes.

To initiate a C-Turn press the TURN button, while in **AUTOPILOT** mode, followed by one of the two DODGE buttons.
If the PORT DODGE button is pressed, the turn will be in the port direction, and if the STARBOARD DODGE button is pressed, the turn will be in the starboard direction.
C-Turns are often used on work vessels to perform specific tasks. For this reason, C-Turns are allowed in **WORK MODE** as well as normal **AUTOPILOT MODE.**

6.4 TRANSFER TO AUX/REMOTE CONTROL

To take control at a Remote or Auxiliary Station that is not currently in command you must press and hold the two DODGE buttons on the remote unit, at the same time. The Autopilot will beep once and you should be able to use the Remote/Auxiliary Station to control the vessel. The Unit that was in control will now be flashing "NOT IN COMMAND". To reclaim command at another station, you must once again press and hold its two DODGE buttons.

7. AUXILIARY STATION

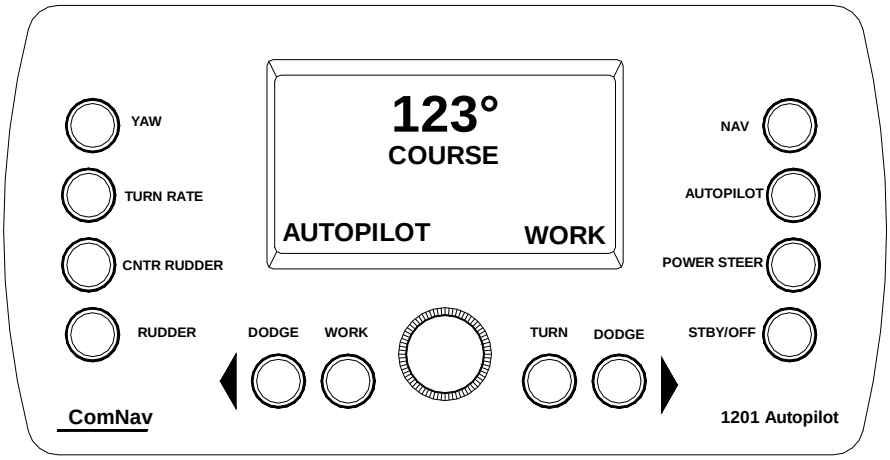


Figure 7 1201 Auxiliary Station Control Head

The 1201 Auxiliary Station is identical to the 1201 Control Head except that its cable is plugged into the auxiliary connector on the SPU. This reconfigures the Unit as an Auxiliary Station. It has all of the functions of a Control Head except that it cannot turn the system power on or off and therefore it cannot be used to do a full reset or initiate a Dockside Setup.

When the main Control Head is turned on, the Auxiliary Station LCD screen will show a flashing “NOT IN COMMAND”. The Auxiliary Station can be made to take command by pressing and holding both DODGE buttons. Similarly, the main Control Head can be made to re-take command by pressing and holding both of its DODGE buttons.
Otherwise, the Auxiliary Station functions are identical to those for the Control Head. Please see previous sections for details.

The Auxiliary Station can be mounted either flush or with an optional Angle Mounting Bracket in exactly the same manner as the Control Head. Refer to Section 4.1 for mounting details.

8. REMOTE CONTROL

8.1 GENERAL REMOTE OPERATION

When “taking command” with a Remote Control it is advisable to first ensure that the MODE SELCTOR switch on the Remote Control is in the same position that the Autopilot System is currently operating in. This will keep the steering results predictable. To “take command” with a Remote Control, press and hold both DODGE buttons simultaneously until the command point moves to the REM position. The Remote Control is now in command of the Autopilot.

For a dodge, hold the Toggle Switch in the DODGE position, and press either the PORT or STARBOARD button. As with the Control Head, this function will only work in **AUTOPILOT** or **NAV** mode.

To lock the rudder at its current angle, hold the Toggle Switch in the DODGE position without pressing either button. Release the Toggle Switch to return to the original course.

To initiate a special turn while in **AUTOPILOT** mode, push the Toggle Switch to the TURN position and release it. Then press either DODGE button to initiate the special turn in the desired direction.

To change the type of turn, place the Master Select Switch on the remote in the STANDBY position. Push the Toggle Switch to the TURN position and release it. Select the type of turn desired by pressing and releasing either DODGE buttons.

To recall the Autopilot’s last programmed course, hold the Toggle Switch in the DODGE position while rotating the Master Select Switch from POWER STEER to PILOT.

If you have mechanical steering, you can disengage the clutch on the drive unit and return to hand steering by selecting the **STANDBY** mode.

To take command at the main control unit, leave the remote in the **AUTOPILOT** mode, to keep the vessel under command, and return to the main Control Head. Press and hold the two DODGE buttons to regain command.

8.2 MOUNTING REMOTES

FIXED POSITION MOUNTING

Drill two holes for the mounting screws 3.5 in (90mm) apart.
Drop the screw head into the keyhole slots and then into the two holes drilled. Fasten the screws with washers and nuts from the back of the mounting surface.

REMOVABLE (HANDHELD) MOUNTING

Two #10 pan-head stainless steel screws will be required. Select a flat surface where you want the remote to be located and install the screws on 3” (76mm) centers. Do not screw them in all the way, leave a gap of about a tenth of an inch (2.5mm) between the underside of the screw heads and the mounting surface.

The back of the remote is equipped with slots that can be used to hang the remote on the screws when it is not in use. The remote can easily be removed by a lift-and-pull motion when it is required.

8.3 COMNAV 101 REMOTE CONTROL

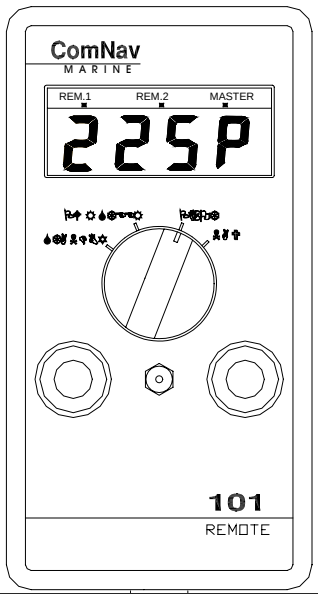


Figure 8 ComNav 101 Remote Control Unit

The 101 Remote Control plugs into either the Remote Receptacle on the rear of the SPU or into the Remote Expander. Command is taken at the remote by pressing both DODGE buttons for one second. The command point on the LCD display should move to the REM.1 position.

The 101 Remote has a Display, Master Select Switch, Pushbuttons, and a DODGE/TURN Toggle Switch. Its operation is identical to the operation of the Autopilot with the exception of the ADJUSTMENT KNOB and the DODGE/TURN Toggle Switch. As there is only one remote jack on the 1201 SPU, MASTER indicates the Control Head, and REM.1 indicates that a Remote/Auxiliary Head is in control.

On the 101 Remote**,** the REM.2 point indicates the Rudder Follower has failed.

Place the Master Select Switch in the STANDBY position. To display the currently selected type of special turn, move the Toggle Switch to the TURN position and release it.

To change the currently selected type of special turn, press either the PORT or STBD pushbuttons.

Caution:
*If you are in **AUTOPILOT** mode this will initiate the special turn. You must be in **STANDBY** mode to change your special turn.*

Place the Master Select Switch in the TILLER position. To move the rudder port or starboard, the red and green pushbuttons can be used.

The vessel's rudder angle will be displayed while the pushbuttons are depressed.

To recall the vessel's last course:

Hold the Toggle Switch in the DODGE position and then rotate the Master Select Switch in the PILOT position. The Autopilot is now steering the vessel on its current heading.

If the Toggle Switch was held in the DODGE position while the Master Select Switch was rotated to PILOT, the Autopilot will steer the vessel back to its last course.

To change the vessel's course by 1° press and release either the PORT or STBD pushbuttons. To change the vessel's course by 10° per second, press and hold either the red or green pushbuttons. The vessel will turn to the new heading at the current turn rate setting.

The vessel can be dodged off course by holding the Toggle Switch in the DODGE position and pressing one of the pushbuttons. The vessel's rudder angle will be displayed. The rudder can be returned to the dead-ahead position, holding the vessel off course, by holding the Toggle Switch in the DODGE position without pressing either pushbutton. Release the Toggle Switch and the vessel will return to the programmed course at the current turn rate setting.

Pulling the Toggle Switch to the TURN position, releasing it and then pressing either the PORT or STBD pushbutton can start the currently selected type of special turn. The direction of the special turn is determined by which pushbutton is used.

To interface the Autopilot with a Nav Device, place the Master Select Switch in the NAV position.

To display the incoming data type and cross track error sense, pull the Toggle Switch to the TURN position and release it. To select either normal or reversed response to cross track error, press the STBD pushbutton.

The DODGE function works as described earlier, except that the vessel will return to the track to the waypoint rather than the programmed course after the DODGE is released.

8.4 COMNAV 201 REMOTE CONTROL

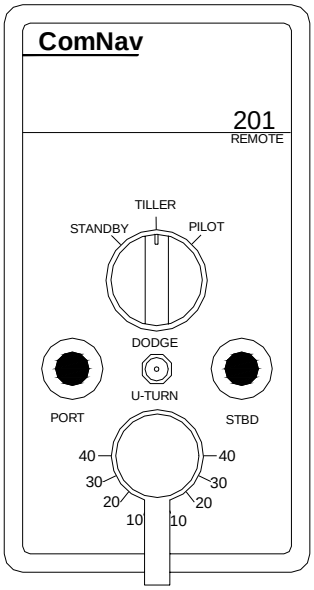


Figure 9 ComNav 201 Remote Control Unit

The 201 Remote Control plugs into either the remote receptacle on the SPU or the Remote Expander. Control is taken at the remote by pressing both pushbuttons simultaneously for one second. The Control Head will now read “NOT IN COMMAND”. The **STANDBY** mode is a safety feature that allows the Remote Station to de-activate the Autopilot output to the Steering Drive unit. When the switch is in the TILLER position, the vessel’s rudder will be turned to the same angle as indicated by the control knob.

To lock the vessel onto a heading under Autopilot control, point the vessel onto a desired heading, and then place the switch in the PILOT position. The pushbuttons can be used to alter the vessel’s heading in 1° steps, or by 10° per second after holding the pushbutton for half a second.

See the information under the section “ComNav 101 Remote Control” for details about remote use.

8.5 COMNAV 211 REMOTE CONTROL

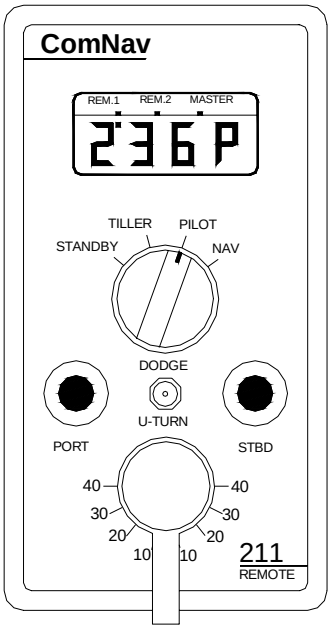


Figure 10 ComNav 211 Remote Control Unit

The 211 Remote Control plugs into either the remote receptacle on the SPU or the Remote Expander. Control is taken at the remote by pressing both pushbuttons simultaneously for one second. The 1201 Control Head will now be flashing "NOT IN COMMAND". The *STANDBY* ***mode is a safety feature that allows the Remote Station to de-activate the Autopilot output to the Steering Drive unit. When the switch is in the TILLER position, the vessel's rudder will be turned to the same angle as indicated by the control knob.***

To lock the vessel onto a heading under Autopilot control, point the vessel onto a desired heading and place the switch in the PILOT position. The pushbuttons can be used to alter the vessel's heading in 1° steps, or by 10° per second after holding the pushbutton for half a second.

See the information under the section "ComNav 101 Remote Control" for details about remote use.

9. CARE AND MAINTENANCE

The 1201 Autopilot System has been design to provide many years of reliable and trustworthy service. To ensure this, a few simple guidelines are presented for its CARE and MAINTENANCE.

1. After installation, ensure that the units are securely mounted and will not shake loose under the vibrations that can be expected in a ship. Also ensure that the cabling and wires to the units are well secured with clamps or other means. Many potential future problems can be avoided by ensuring that the cables do not cause strain on the connectors.

2. After the first six months of operation, all of the electrical connections, cables, clamps, mounting brackets, and mechanical connections such as to the Rudder Follower should be carefully checked to ensure that they are secure.

3. It is recommended that a thorough check be done annually thereafter.

4. Both the Control Head and the SPU can be carefully cleaned with a soft damp cloth and mild soap. This is particularly important for the LCD screen. DO NOT use abrasive cleaners or chemicals.

5. The Control Head is designed to be weatherproof and splash resistant but it should not be immersed for any prolonged time.

6. Heat from the direct sun for a prolonged time should also be avoided as it could cause damage to the electronics and to the housing. Environments exceeding a maximum temperature of 140°F (60°C) or below a minimum temperature of 5° F (-15°C) must be avoided.

7. If the Control Head or Auxiliary Station is mounted in an exposed location, you may want to consider the use of an optional form-fitting Head Cover. The ComNav part number for this item is 65610013. Contact your nearest ComNav dealer for price and availability.

10. TROUBLESHOOTING

10.1 GENERAL PROBLEM SOLVING

Several different problems and possible solutions are outlined below. If the recommended solution does not solve the problem, return the Autopilot to an authorized service center. Often the cause of a problem is not with the Autopilot itself, so checking it in place can more quickly resolve the fault. Spending a few minutes troubleshooting your Autopilot may allow you to return it to service more quickly. Some of the following tests require a DC voltmeter.

THE AUTOPILOT DOES NOT TURN ON

1) Check for power reaching the Autopilot Distribution Box.

2) Check the main fuse or breaker panel.

3) Check that the main interconnection cable is properly plugged into the rear of the Autopilot.

4) Check the fuse in the Autopilot Distribution Box. If it is blown, replace it with a 5 x 20mm, 3.15 amp fuse. One spare fuse of this value has been taped to the underside of the Autopilot Distribution Box lid. Check that the power leads are not reversed before using the spare fuse since this will cause the fuse to blow again, to prevent damage to the electronics.

THE AUTOPILOT DOES NOT TURN ON, BUT POWER IS AVAILABLE AT THE DISTRIBUTION BOX

1) Check for a short circuit between +5V and ground.

2) Disconnect all leads in the Distribution Box except PILOT PWR (+) and PILOT PWR (-). If this solves the problem, then reconnect one set of leads at a time until the problem re-occurs. The problem must lie with the cabling to that external device or with that external device itself.

3) If the problem does not disappear after disconnecting all the leads, then there is something wrong with the Autopilot. Return it to an authorized ComNav dealer or the factory or for servicing.

THE AUTOPILOT TURNS ON, BUT DOES NOT TURN THE RUDDER

Press the PORT DODGE button when the Autopilot is in the **POWER STEER** mode. The red PORT LED should come on in the Distribution Box. Similarly check the STARBOARD DODGE button for the green STBD LED to come on. If all is correct, the problem is not in the Autopilot. Otherwise:

1) Check for a fault in the power steering system (i.e. blown breaker or fuse in electric system, broken drive belt or jammed four-way valve, etc.).

2) Check for a possible short in the output cable to the rudder drive.

3) Check for full output voltage on the SWITCHED PWR line with Autopilot in the **POWER STEER** mode. The yellow SWI POWER LED in the Distribution Box should come on when the Autopilot is in **POWER STEER, NAV** or **AUTOPILOT** modes. Check that the voltage on the PORT OUT and STBD OUT lines drop to less than 1.5 volts when their respective button is pressed.

4) Check the rudder drive for correct operation. For a 12-volt four-way valve, the common line from the solenoids must be connected to UNSWITCHED PWR (terminal 3 in the distribution box), rather than to SWITCHED PWR.

THE RUDDER TURNS HARD-OVER TO ONE SIDE

1) Check the Rudder Follower for correct operation.

2) Check the rudder drive for correct operation. (I.e. sticking relays, sticking solenoid valves, etc.).

3) If the rudder appears to move normally with the Autopilot in **POWER STEER** mode, but goes hard over with the Autopilot in **AUTOPILOT** mode, recheck the Rudder Follower and rudder drive connections in the Distribution Box for correct hookup. Perform the Dockside Setup again.

THE AUTOPILOT TURNS ON, BUT DOES NOT OPERATE PROPERLY

1) Turn the Autopilot off and on again.

2) Check the Voltage in the Distribution Box for a minimum of 12 VDC between PILOT PWR(+) and PILOT COM(-).

3) Check for problems in the cables leading to the optional remote controls by unplugging them from the rear of the Autopilot.

THE DISPLAYED COMPASS HEADING DOES NOT FOLLOW THE ACTUAL COMPASS HEADING PROPERLY OR THE AUTOPILOT STEERS NORMALLY ON SOME COURSES, BUT NOT ON OTHERS, PARTICULARLY NORTH OR SOUTH

1) Check for any compensating magnets, particularly heeling magnets, which are placed too close to the Fluxgate Sensor.

2) Check for any magnetic material such as tools, tin cans, etc., near the compass, or directly underneath it, perhaps in a drawer or cabinet.

3) The problem most likely lies with poor compass adjustment. Contact a compass adjuster to have the compass compensated for deviation, including that caused by heeling error. Proper compass adjustment is particularly important on steel-hulled vessels. Do not attempt to move any compensating magnets yourself, as the may make the compass dangerously inaccurate, particularly if it is used as a steering compass.

THE AUTOPILOT STEERS POORLY ON ALL COURSES

1) Watch the card on the Autopilot Compass to make sure that it follows the vessels' movements properly. If the card seems to turn with the vessel for a few degrees, and then come free, either the pivot or jewel in the compass may be defective.

THE REMOTE CONTROL DOES NOT WORK AT ALL

1) Check the 'Remote in Command' point on the remote display to see if the remote is in control.

THE RUDDER DOES NOT ALWAYS MOVE EVEN THOUGH THE PORT OR STARBOARD OUTPUT LED IS LIT ON THE AUTOPILOT FRONT PANEL AND THE AUTOPILOT IS USING A CT1 DRIVE BOX

1) Recheck all the connections between the Autopilot and the Drive Box, making sure that none are interchanged.

2) Remove the cover of the CT1 Motor Drive Box and check the setting of the minimum speed potentiometer for too low a minimum speed.

THE RUDDER LIMITS DO NOT SEEM TO BE CORRECTLY SET AND THE AUTOPILOT IS USING A CT2 DRIVE BOX

1) Make sure that there is no connection between the COM terminal in the Drive Box and any terminal in the Autopilot Distribution Box.

10.2 ERROR MESSAGES

Your Autopilot continuously monitors various parameters during its operation to check for faults. A detection of these faults can cause an ERROR message. The Autopilot will display the ERROR message and sound the Alarm whenever any of the following conditions occurs:

CHECKSUM ERROR

The checksum in one of the RMA, RMB, or RMC data sentences set incorrectly or there is a transmission problem between the Nav Device and the Autopilot.

1) To continue using the Nav Device while receiving checksum errors, the error checking can be turned off. To turn the NMEA checksum off, while in STANDBY mode, double press the STBY/OFF button to enter the Standby menu.

2) Use the ADJUSTMENT KNOB to select the parameter you wish to change (NMEA checksum), and press the STBY/OFF button again. When the selection is flashing you may change your checksum ON or OFF with the ADJUSTMENT KNOB. Press the STBY/OFF button once to exit the current selection, and then a double press to exit the menu back into the **STANDBY** mode.

COURSE ERROR

The vessel has fallen more than 20° off course and has remained off course for a minimum of 30 seconds.

1) This indicates a possible failure of the Rudder Follower, or the Power Steering System. Check for an inoperative motor drive, blown breaker to the motor, jammed four-way-valves, etc.

FAULTY COMPASS ERROR

There is a problem with the circuitry inside the Autopilot associated with the compass interface.

1) The Autopilot is operable only in the manual modes. (I.e. **STANDBY** or **POWER STEER**).

FAULTY DATA FROM NAV DEVICE ERROR

One or more of the alarm flags in the data sentence from the Nav Device are set.

1) The Autopilot will continue to use the data, but will sound the alarm and display this error message after every data sentence received until the error flags are cleared. Extreme caution should be used if the Autopilot is left in **NAV** mode because faulty data could cause erratic operation.

2) Check the front display of the Nav device for an alarm message. If the alarm continues for more than 30 seconds disengage the Autopilot.

BUTTON ERROR

One or more of the buttons on the Front Panel are stuck in the closed position or a Remote Control unit may have a faulty button.

1) The alarm will sound while the display shows BUTTON ERROR. The Autopilot will switch into **STANDBY MODE** and the system can be shut down to shut off the alarm.

2) Correcting the stuck button will allow normal operation of the Autopilot.

FULL RESET

If a test of the permanent memory indicates that one or more of the bytes of stored data were not correct, a number of controls are reset to pre-determined default values.

1) Return the Fast and Slow settings for Rudder, Counter Rudder, Yaw and Turn Rate to their previous values. The Autopilot will automatically start the Dockside Setup program after a full reset.

GHOST RUDDER ON

If the Rudder Follower is defective the Autopilot will display this message each time it is switched between **POWER STEER** and **AUTOPILOT** modes.

1) This will remind you that it is using the Ghost Rudder program. The Autopilot will not work as well with the Ghost Rudder as it will with the Rudder Follower so the Rudder Follower should be repaired or replaced as soon as possible.

HIGH POWER ERROR

The voltage into the Autopilot has risen above 35VDC and the Autopilot may become damaged.

1) Open the breaker, which supplies power to the Autopilot, determine the cause of the high voltage and solve the problem. Check the voltage regulator, as it is the most likely problem.

MOTOR LOAD ERROR

The Autopilot is being used with a motor drive which feeds its operating current & temperature back to the Autopilot (i.e. CT2 Drive Box), and levels exceed safe margins for more than 4 seconds. (**AUTOPILOT** or **NAV** modes).

1) Check for a jammed rudder, or similar problem, which would cause this to happen.

DRIVE BOX OVERHEATED

The Autopilot is being used with a motor drive that feeds its operating current & temperature back to the Autopilot and levels exceed safe margins for more than 4 seconds. (**STANDBY** or **POWER STEER** modes).

1) Check for a jammed rudder, or similar problem that would cause this to happen.

LOW POWER ERROR

The Autopilot has detected that its input voltage has dropped to less than 10 VDC.

1) Check for proper alternator operation, batteries low on water, or some other condition that has caused the input voltage to drop.

NO COMPASS DATA ERROR

The computer is not receiving any data from the compass. The Autopilot is only operable in the non-**AUTOPILOT** modes (i.e. **STANDBY** or **POWER STEER**).

1) Check that the compass is plugged into the Autopilot. Check that the Autopilot is programmed for the correct type of compass (see Dockside Setup).

NO DATA FROM NAV DEVICE ERROR

The Autopilot is not receiving any recognizable data from the Nav Device.

1) Nav Device is not programmed correctly;

2) Nav Device is not putting out any data;

3) There is a problem with the cabling between the Nav Device and the Autopilot (broken cable);

4) There is a fault with the Autopilot interface circuitry.

Some Nav Devices will not put out a data sentence for the Autopilot until a waypoint has been entered, and navigation towards it has started.

NO SPEED ERROR

The Autopilot is in the **AUTOPILOT** or **NAV** mode and the Autopilot is not receiving any speed information from the Nav Device.

1) Check that the device transmits one of the RMA, RMC, VBW, VHW or VTG data sentences and that it is turned on.

2) Check the cable that connects the Nav Device to the Autopilot Distribution Box, especially if you also get a "No Data" error when the Autopilot is in the **NAV** mode.

PROM MEMORY ERROR

The memory chip that contains the Autopilot program has tested faulty.

1) The Autopilot is not operable.

RAM MEMORY ERROR

The portion of RAM memory used for temporary data storage has tested faulty.

1) The Autopilot is not operable.

RUDDER FOLLOWER ERROR

The Autopilot has detected a problem with the Rudder Follower.

1) Check for broken, disconnected or shorted wires.

2) Check for a defective Rudder Follower.

The Autopilot will automatically switch to using the Ghost Rudder program to control the rudder when the Autopilot is in the **AUTOPILOT** or **NAV** mode. The digital and analog Rudder Angle Displays will not function in any mode. The error message will remain visible and the audible alarm will stay on until cleared. Even though the alarm is cleared, the Rudder Follower "Failed Point" on the display will remain visible.

RUDDER ERROR

The Autopilot has failed to detect any movement by the rudder in response to a command to move.

This error will only occur if the Autopilot is in the **NAV** or **AUTOPILOT** mode.

Place the Autopilot in **POWER STEER** mode and measure how long it takes after pressing one of the DODGE buttons until the digital rudder angle reading begins to change, particularly when the last rudder movement was in the other direction.

1) If it takes longer than one second for the rudder to begin to move, check for something which could cause a delay in the response of the steering system such as air in the hydraulic steering or slack or worn parts in the mechanical steering system.

2) Check for too low a setting of the Minimum Speed Potentiometer in the CT1 Motor Drive Box (if one is used by the Autopilot).

3) If the digital rudder angle reading does not change, but the rudder is definitely moving, check for a broken Rudder Follower Linkage, or a defective Rudder Follower.

If any of the above alarm conditions occur, and cannot be easily rectified, return the Autopilot to an authorized ComNav Dealer or Distributor for service.

11. 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;

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 end-user 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 1-604-207-8008, 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 (7^{th}) day first following the date of posting in North America and on the tenth (10^{th}) 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 1-604-207-1600 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 Center ("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.

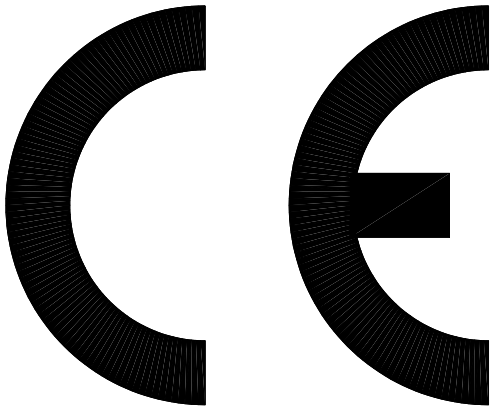
12. SPECIFICATIONS

12.1 GENERAL

The Specifications for the 1201 Autopilot System define the basic capabilities and operational limits of the equipment. These are as follows:

Operating Voltage:	10 VDC to 30 VDC For use with 12 or 24 VDC Battery Systems
Operating Current:	400 Milliamps (minimum)
Operating Temperature Range:	5° to 140° F (-15 to +60° C)
Heading Resolution:	0.25 Degrees
Heading Accuracy:	± 2.0 Degrees
Course Set Resolution:	1.0 Degrees
PORT/STBD Output Type:	Open Collector, 3 Amps Max
Speed Control Output:	2.50 VDC for No Movement 5.00 VDC for Maximum Speed to Port VDC for Maximum Speed to Starboard (10K ohm Source Impedance)
Navigation Input:	NMEA 0183 (4800 BAUD):RMA, RMB, RMC, APB APA, XTE, BOD, WBD, HSC, VBW, VHW, VTG
Heading Output:	NMEA 0183 (4800 BAUD): HDG, repeated 10 times per second. Furuno AD-10S, repeated 10 times per second.
Rudder Angle Indicator Output:	± 500 Micro-Amps Full Scale Deflection
Size of Control Head Width:	7 inches (178 mm)
Height:	3.625 inches (92 mm)
Depth:	1.375 inches (35 mm) (1.5 inches (38 mm) required behind unit for cabling)
Weight of Control Head:	1 lbs (450 gm)
Size of Signal Processing Unit Width:	8.25 inches (210 mm)
Height:	3.75 inches (95 mm)
Depth:	2.25 inches (57 mm) (3 inches (76 mm) required behind unit for cabling)
Weight of System Processing Unit:	4.0 lbs (1.8 Kgm)

12.2 CE COMPLIANCE



This product has been tested and is in compliance with the Electro-Magnetic Compatibility (EMC) standards of the European Community and bears the CE label. It has been tested according to the applicable sections outlined under;
Technical standard #IEC945/EN60945
Marine Navigation Equipment
General Requirements

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.6:	**Immunity to Radiated Interference**

Test results and a declaration of conformity are on file at the ComNav plant;

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