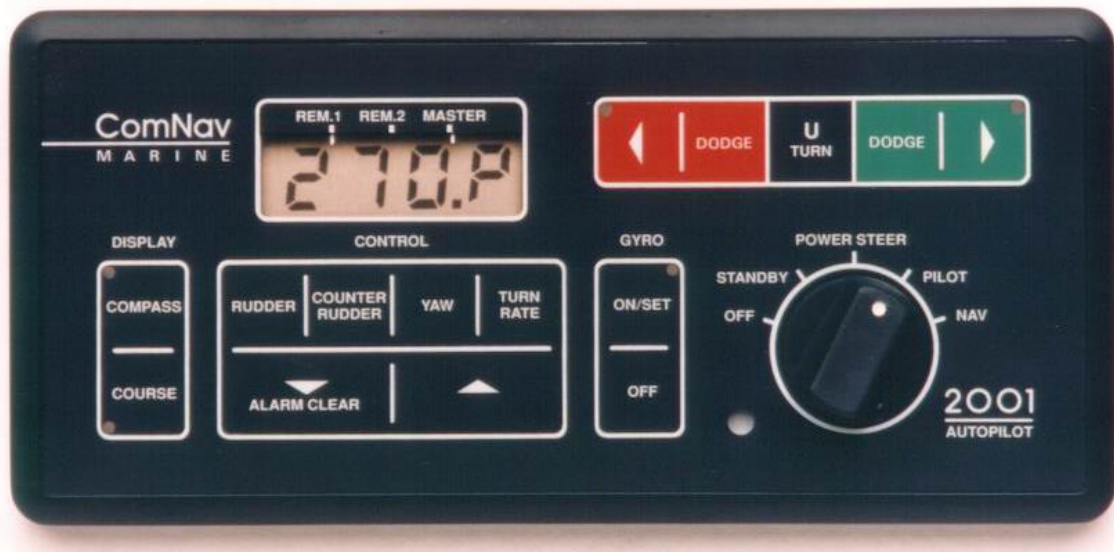


ComNav[®]



INSTALLATION AND OPERATION MANUAL

**2001
AUTOPILOT**

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 on the following pages.

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.

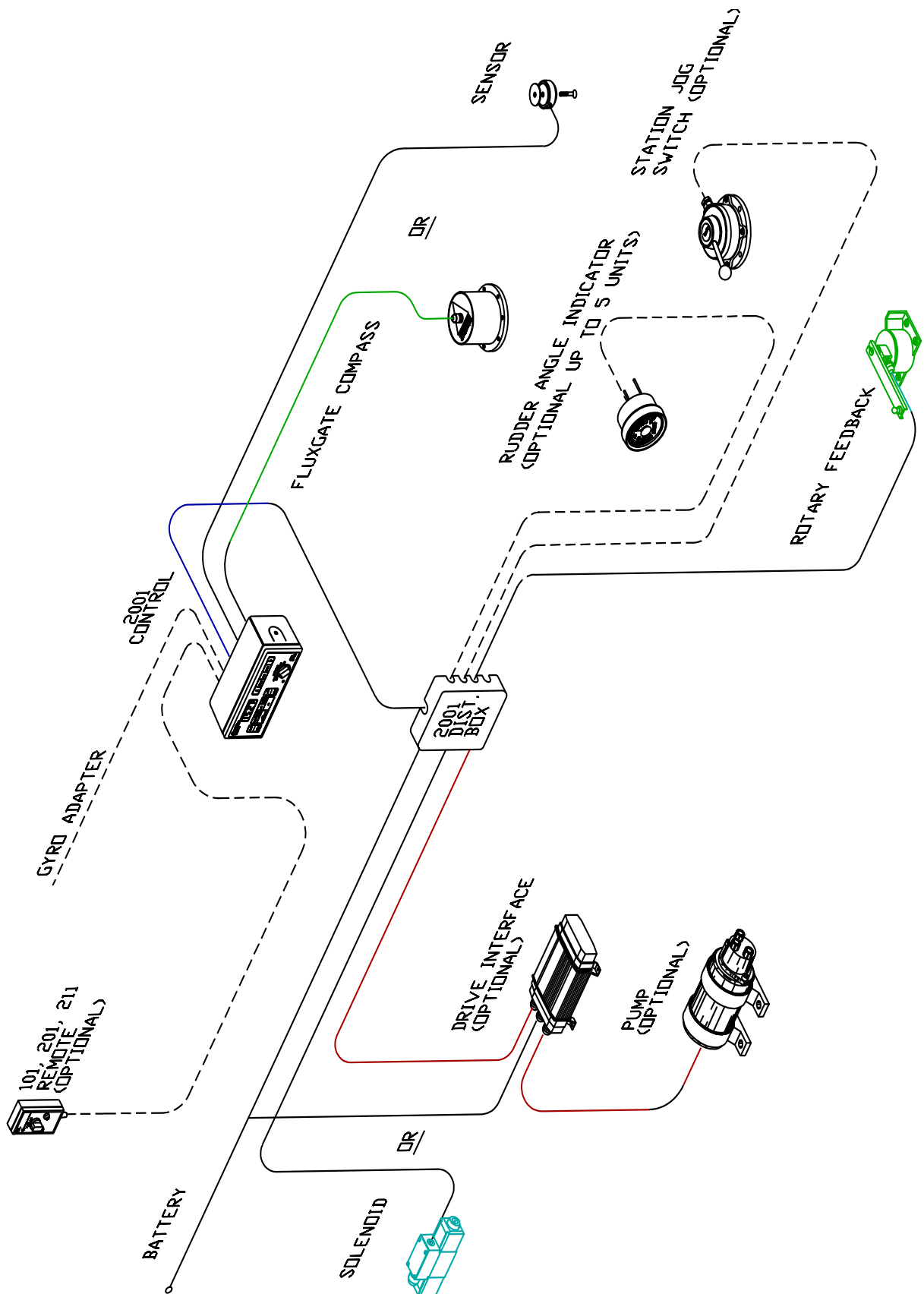


Figure 1 - 2001 SYSTEM LAYOUT

BASIC OPERATION AUTOPILOT

1. TO INITIALIZE THE AUTOPILOT:

Turn the master select switch to the **STANDBY** position. The display will show the vessel's current compass heading. If the heading displayed by the autopilot does not agree with the compass, press and hold the **GYRO OFF** or **WIND OFF** key, and then use the up or down **ARROW** key to adjust the heading on the display.

2. TO POWER STEER THE VESSEL:

Turn the master select switch to the **POWER STEER** position. The red and green **ARROW** keys can now be used to turn the rudder port and starboard. The display will continue to show the vessel's current compass heading.

3. TO BEGIN AUTOPILOT CONTROL OF THE VESSEL:

Turn the master select switch to the **PILOT** position. The vessel will continue on its present heading under autopilot control. Adjust the **RUDDER**, **COUNTER RUDDER**, and **YAW** controls for the best steering. Touch the **COMPASS** key to view the vessel's actual compass course on the display. Touch the **COURSE** key to return the programmed course to the display.

4. TO CHANGE THE VESSEL'S COURSE:

Leave the master select switch in the **PILOT** position. Estimate the number of degrees of course change required. Alter course in one degree steps by pressing and releasing either the red or green **ARROW** key. Alter course by ten degrees per second by pressing and holding either the red or green **ARROW** key until the display

shows the desired course. Press the **U-TURN** key together with either the red or green **ARROW** key for 1 second to start a special turn (U-Turn, Emergency Turn, or Continuous Turn) in that direction.

5. TO DODGE THE VESSEL OFF COURSE:

Press either the red or green **DODGE** key for a panic turn in that direction to avoid obstacles in the water. When the vessel has turned far enough to clear the obstacle, press and hold both **DODGE** keys to hold the vessel off course. The vessel will return to the programmed course at the rate set by the **TURN RATE** control when the **DODGE** keys are released.

6. TO INTERFACE WITH A NAVIGATION COMPUTER:

Turn the master select switch to the **NAV** position when the autopilot is to interface with a Navigation Computer. The autopilot will set its own course using information sent to it by the Navigation Computer. To select which Nav Port is active, press the **U-TURN** key followed by the red **ARROW** key. To select the Cross Track Error sense (normal or inverted) for the selected Nav Port, press the **U-TURN** key followed by the green **ARROW** key. The **DODGE** keys operate as described in (5) above, except that the vessel will return to the original track to the waypoint, rather than the original course, when the **DODGE** keys are released.

For more complete operating instructions, refer to the CONTROLS and OPERATION sections.

REMOTE CONTROL

The autopilot must be turned on at the master control unit to use any remote control.

1. TO USE THE COMNAV 101 REMOTE CONTROL:

Take control at the Remote by pressing both its pushbuttons for one second. The decimal point on all displays will move to the **REM.1** or **REM.2** position. This control operates identically to the autopilot, except that there is a toggle switch, used together with one of the pushbuttons, to dodge or select a U-Turn.

2. TO USE THE COMNAV 201 REMOTE CONTROL:

Take control at the Remote by pressing both its pushbuttons for one second. The decimal point on all displays will move from the **MASTER** position to the **REM.1** or **REM.2** position. For direct control of the rudder angle using the lever, place the toggle switch in the **TILLER** position. To begin autopilot control of the vessel on its present course, place the rotary switch in the **PILOT** position. The pushbuttons can be used to alter the vessels course, either one degree per push, or, push and hold for 10 degrees per second.

3. TO USE THE COMNAV 211 REMOTE CONTROL:

Take control at the Remote by pressing both its pushbuttons for one second. The decimal point on all displays will move to the **REM.1** or **REM.2** position. The **STANDBY**, **PILOT**, and **NAV** modes operate identically to the autopilot, except there is a toggle switch, used together with one of the pushbuttons, to dodge or select a U-Turn. The **TILLER** mode provides direct control of the rudder angle using the lever.

4. TO TAKE CONTROL AT THE AUTOPILOT FRONT PANEL:

Take control at the autopilot front panel by pressing both the red and green **ARROW** keys on the autopilot front panel for one second. The decimal point on all displays will move back to the **MASTER** position.

For more complete operating instructions refer to the REMOTE CONTROLS section.

LIMITED WARRANTY AGREEMENT

Congratulations, you have purchased sophisticated and sensitive marine navigation 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 always 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 EXPRESS 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 Limited 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 ten (10) days of the date upon which the defect first became known to the Purchaser. Notices sent by mail will be deemed to be received by ComNav on the seventh (7th) day first following the date of posting in North America and on the tenth (10th) day next following the date of posting anywhere else in the world. Notices sent by facsimile will be deemed to be received by ComNav on the date of transmission with appropriate answerback confirmation.

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

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

CUSTOMER REMEDIES. ComNav's entire liability and the Purchaser's exclusive remedy against ComNav for the defective Equipment shall be, at ComNav's option, either: (a) repair or replacement of the defective Equipment under the warranties set forth in this Agreement, or, (b) refund of the purchase price of the defective Equipment, all pursuant to and in accordance with the conditions set out 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 and 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 by 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 will 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 the Equipment to be returned by a faster method, the costs incurred by expedited 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 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 by an Authorized ComNav Dealer. Any attempt to remedy the defect by anyone else shall render the warranties set forth in this Agreement void;
5. Charges for overtime, stand-by, 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;

6. This warranty does not cover routine system checkouts, alignment, or calibration unless the service has been authorized in writing by ComNav PRIOR to its commencement; and

8. No Equipment shall be repaired or replaced under warranty if the serial number of that Equipment has been removed, altered or mutilated.

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

The *United Nations Convention on Contracts for the International Sale of Goods Act*, S.B.C. 1990, c. 20, and any other statutory enactments of the *United Nations Convention on Contracts for the International Sales 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**

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REVISED MARCH 2002

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INTRODUCTION

This autopilot is a microprocessor operated PID (Proportional/Integral/Differential) controller, working from a high quality, externally gimballed magnetic ships steering compass fitted with a flux-gate sensor.

An analog to digital converter changes the signals from the sensor into digital heading information with a resolution of 1/2 of a degree, and an overall accuracy of +/- 2 degrees or better. This heading information is compared against the programmed heading, and the desired rudder position determined.

The desired rudder position is compared against the actual rudder position transmitted by the rudder follower, and if they are not the same, either the Port or Starboard output line is activated. The Port and Starboard output lines can drive a load at up to 3 amps. They are designed to operate solenoid valves in a hydraulic steering system.

A speed control signal is also available for use with variable speed rudder drives. The outputs, either by themselves or with an optional solid state control 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 power steering installation. The autopilot can operate from any DC voltage between 10 and 40 volts.

The autopilot is equipped to interface with a Loran C Receiver, Satnav Receiver, GPS Receiver, or any other navigation computer which outputs one of the NMEA 0180, 0182, or 0183 formats at either 1200 or 4800 Baud. It can also transmit heading information in a variety of formats.

The autopilot is designed to accept up to two remote controls. Control can be taken at either remote simply by pressing both its pushbuttons simultaneously for one second.

Control is taken at the other remote, or at the autopilot front panel the same way. By adding a remote expander, each remote receptacle on the rear of the autopilot can support up to four remote controls, for a total of eight

The autopilot can drive up to four Remote Heading Displays which continuously display the vessel's actual compass heading. The autopilot can run up to 4 rudder angle indicators which continuously display the vessel's actual rudder angle.

I shows most interconnections between the autopilot, its accessories, and other external equipment.

SPECIFICATIONS

OPERATING VOLTAGE:	10 VDC TO 40 VDC
POWER CONSUMPTION:	6 WATTS
OPERATING TEMPERATURE RANGE:	-15 TO +60 DEGREES CENTIGRADE
OUTPUT TYPE:	OPEN COLLECTOR TRANSISTOR 3 AMPS MAXIMUM
HEADING RESOLUTION:	1/2 DEGREE ON MAGNETIC COMPASS 1/2 DEGREE ON 1X GYROCOMPASS 1/3 DEGREE ON 90X GYROCOMPASS 1/6 DEGREE ON 180X OR 360X GYROCOMPASS
COURSE SET RESOLUTION:	1 DEGREE _v
SPEED CONTROL OUTPUT:	2.57 VDC FOR NO MOVEMENT 4.07 VDC FOR MAX SPEED PORT 1.07 VDC FOR MAX SPEED STBD 10 Kohm SOURCE IMPEDANCE
HEADING OUTPUTS:	DIP SWITCH SELECTABLE BETWEEN REMOTE HEADING DISPLAY or N+1 or BCD NMEA 0183
SIZE:	8.25/210 WIDE X 3.75/95 HIGH X 3.25/83 DEEP inch/mm 3/76 inches/mm required behind unit for cabling
WEIGHT:	4/1.6 lb/kg

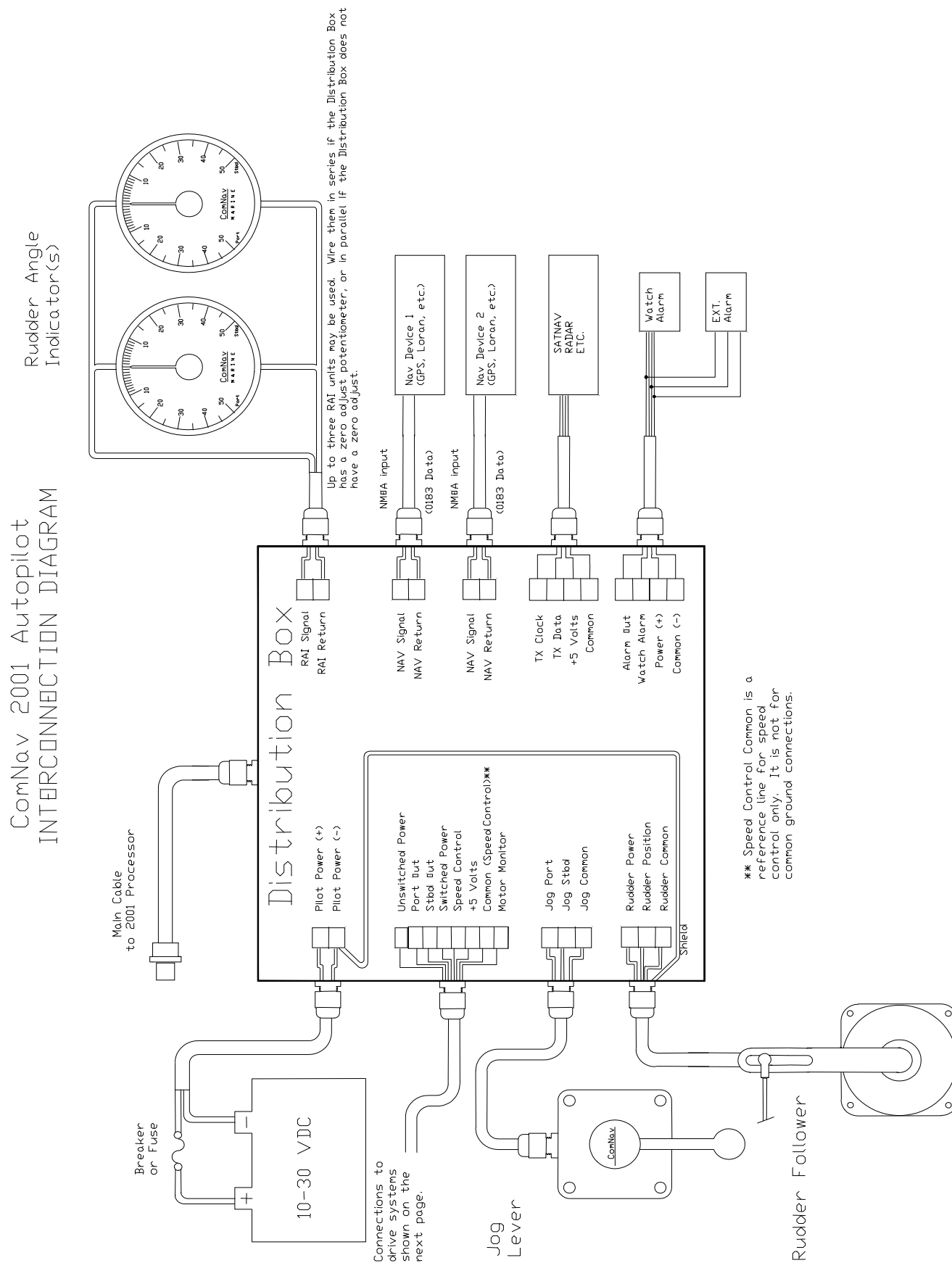
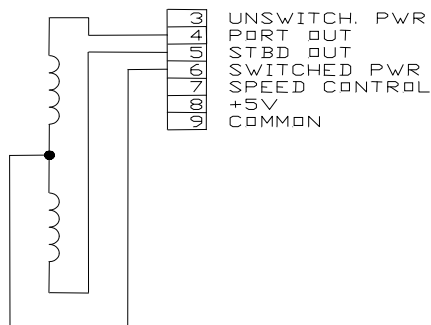


Figure 2 - 2001 AUTOPILOT INTERCONNECTION DIAGRAM

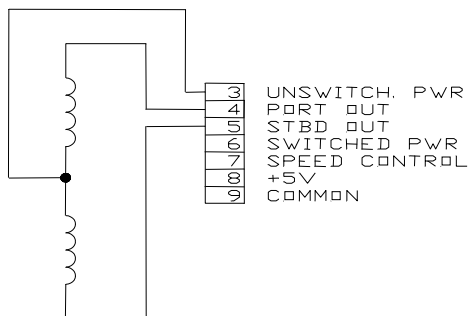
IMPORTANT – DISTRIBUTION BOX TERMAIL #9 IS A REFERENCE ONLY, IT IS NOT NEGATIVE POWER

DRIVE SYSTEM OPTIONS

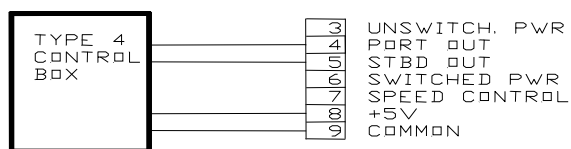
A) FOR STANDARD FOUR-WAY VALVES



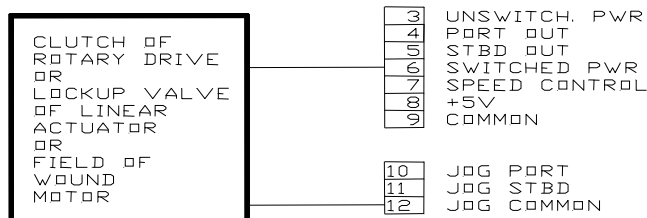
B) FOR FOUR-WAY VALVES, 12V OR WITH JOG LEVERS



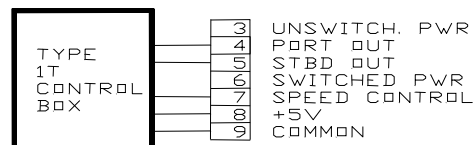
C) FOR AC SOLENOIDS



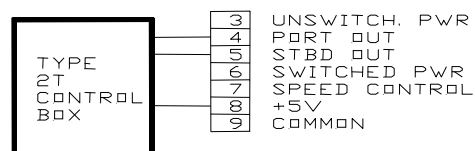
D) FOR CONTROLLING THE CLUTCH OF A ROTARY DRIVE OR THE LOCKUP VALVE OF A LINEAR ACTUATOR OR THE FIELD OF A WOUND MOTOR



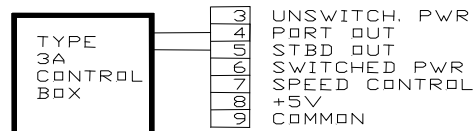
E) FOR PERMANENT MAGNET SHUNT FIELD AND COMPOUND REVERSING MOTORS



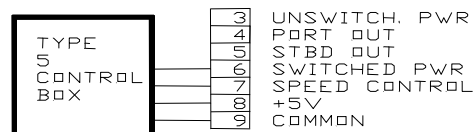
F) FOR PERMANENT MAGNET REVERSING MOTORS SINGLE SPEED CONTROL



G) FOR SPLIT FIELD REVERSING MOTORS (ie WOOD FREEMAN 11/15)



H) FOR CONTROLLING HIGH SPEED VALVE (STD. OR FOUR-WAY) OF TWO SPEED DRIVE



CompuNav Systems Ltd.		
Title		
2001 AUTOPILOT INTERCONNECTIONS		
Size	Document Number	REV
B	2001INT.SCH	2
Date:	April 6, 1992	Sheet 1 of 1

Figure 3

IMPORTANT – DISTRIBUTION BOX TERMINAL #9 IS A REFERENCE ONLY, IT IS NOT NEGATIVE POWER

INSTALLATION INSTRUCTIONS

AUTOPILOT

The autopilot is normally mounted in the vessel's wheelhouse. It can also be mounted in a more exposed location such as a sailboat cockpit or on the flying bridge of a sportsfisherman if it is flush mounted and the rear of the autopilot is protected from spray.

Select either the bag containing the flush mount bezel and cutting template, or the bag containing the mounting bracket and knobs.

If the autopilot is to be bracket mounted, position the mounting bracket so that the front of the autopilot will be easily visible. There must be a minimum of three inches (76 millimetres) of clearance behind the autopilot to allow for cabling.

Screw the knobs part way into the threaded holes on both sides of the autopilot rear cover. Insert the autopilot into the mounting bracket, making sure that one plastic spacer is between the cover and the bracket, and the other is between the bracket and the head of the knob. Tilt the autopilot to the desired angle, and tighten the knobs securely.

If the autopilot is to be flush mounted, ensure that there is at least six inches (155 millimetres) of depth in the mounting cavity to allow clearance behind the autopilot for cabling.

If the autopilot is being flush mounted in an exposed location, care should be taken to ensure that the rear of the autopilot is not exposed to salt spray or other moisture, as the flush mount bezel reduces the effectiveness of the sealing gasket on the rear of the autopilot.

To improve the seal on the rear of the autopilot, an extra gasket for the rear cover has been supplied.

Unscrew the two large screws from the rear of the autopilot and remove the rear cover. Peel the protective backing off the extra gasket, and carefully position it on top of the one already in the rear cover.

Position the cutting template on the panel where the autopilot is to be mounted, and mark the opening onto the panel. Cut the opening in the panel around the outside of the markings.

Remove the rear cover, slide the flush mount bezel over the autopilot chassis, and replace the rear cover and screws. Tighten the screws only enough to slightly compress the gaskets. Slide the autopilot into the hole in the panel, and mark the positions of the four mounting holes. Use the supplied screws to mount the autopilot.

If you have access to the rear of the mounting panel, the autopilot can be easily removed from the panel by simply unscrewing the two large screws in the rear and sliding the autopilot out, without having to remove the bezel from the panel.

The autopilot is supplied with covers over the two remote control receptacles on the back. If either or both of these receptacles are unused, the cover should be left on it. The receptacles are weather-resistant only with the cover on or when a plug is connected to it. Damage caused by exposing a receptacle to the elements will NOT be repaired under warranty.

COMPASS

Locate and mount the compass in a position which minimizes magnetic interference. It should be at least 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 rear of the autopilot, obtain an extra plug-in length of cable from your dealer. Cutting and splicing the compass cable is NOT recommended.

If the heading displayed by the autopilot does not agree with the compass, place the master select switch in the STANDBY position and press the GYRO (WIND) OFF key together with the up or down ARROW key to adjust the offset by the amount of the error.

**** IMPORTANT ****

It is important to remember that the compass is a vital part of the 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 Flux-Gate Sensor, mounted underneath the compass, to read incorrectly.

The use of a pair of 3-1/4 inch (83 millimetre) Compensating Quadrantal Spheres is recommended 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.

MOUNTING THE SENSOR TO NON-STANDARD COMPASSES

The fluxgate sensor supplied with the autopilot 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. This results in large errors between the compass and autopilot.

METHOD 1

Remove the rear cover from the autopilot. Fasten a pair of voltmeter probes between the SIN and GND testpoints on the Compass Interface Circuit Board (see figure 7). Turn the master select switch on the autopilot to the **STANDBY** position. 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 worsen as it is moved further from the compass. If the reading on the autopilot 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 autopilot matches the reading on the compass and tighten the mounting screw. Rotate the compass through 360 degrees, comparing readings every 20 degrees. If the compass is compatible with the sensor, the readings should agree within +/- 2 degrees (4 degrees total error).

METHOD 2

Mount the compass sensor either above or below the compass, spaced a minimum of 1 inch (25 millimetres) away from the compass card. Turn the master select switch on the autopilot to the **STANDBY** position. Rotate the sensor until the reading on the autopilot display matches the compass reading.

If the reading on the display of the autopilot decreases when the heading on the compass is increasing, turn the sensor over. Rotate the compass through 360 degrees, comparing readings every 20 degrees. If the readings differ by more than +/- 2 degrees (4 degrees total), remount the sensor a further 1/2 inch (12 millimetres) from the compass, and repeat. Continue repeating until the accuracy of the sensor begins to deteriorate. The final mounting position for the sensor should be the one where the best accuracy was obtained.

Either method will determine the optimum distance between the compass and the sensor.

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.

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 autopilot should not change more than two degrees, with the compass still indicating the same heading.

If the heading changes more than two degrees, 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 autopilot sensor. Your dealer can supply a compass specifically designed for the ComNav 2001 autopilot.

INSTALLATION INSTRUCTIONS

DISTRIBUTION BOX

Position and mount the distribution box underneath or inside the control console in a DRY location so that the main cable from the distribution box will easily reach the autopilot. Cables are inserted into the distribution box by filing or cutting out the pre-formed ports in the cover. To ensure a neat appearance, the cover has only had the minimum number of openings prepared in advance.

The suggested types and gauges of the cables required to hook up the autopilot are listed in Table II.

The functions of each set of connections in the distribution box are as follows:

- 1. PILOT PWR (+)**
- 2. PILOT PWR (-)**

These two terminals should be hooked to a source of DC power on the boat. The voltage can be from 10 to 40 VDC. The maximum current requirement is less than 4 amps. The autopilot is negative ground.

For vessels with positive ground, or with multiple power sources (ie. AC and DC power sources), the autopilot should be electrically isolated from the vessel. This can be done by mounting the autopilot to a non-conducting material, such as wood or fibreglass. This will prevent any damage from ground currents. The power should be taken directly from a breaker or power distribution panel. The autopilot should have its own circuit. This circuit can also send power to the drive unit. If the drive unit is a reversing electric type, it should be wired back to the breaker separately from the autopilot (ie. do NOT wire from the breaker to the drive unit, and from the drive unit to the autopilot). The combined current requirements of a typical ComNav autopilot and reversing motor drive unit will not exceed 25 amps. The only exception would be when a CT2-40A drive unit is used. The CT2-40A drive unit may draw up to 40 amps.

3. UNSWITCH. PWR

The input voltage appears on this terminal at all times when the breaker which supplies power to the autopilot is 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 an adequate voltage supply. If Jog Levers are being used, and are to be active with the autopilot turned off, wire this line to the common of the solenoid operated 4-way valve.

WARNING

If there is a malfunction of the autopilot or jog lever which continuously activates the 4-way valve, the only way to deactivate the 4-way valve, is to turn off the breaker which supplies power to the autopilot.

- 4. PORT OUT**
- 5. STBD OUT**

These are the two main steering outputs from the autopilot. They are open collector (ie. switch to ground) and can sink up to 3 amps of current. They can be used directly to operate a solenoid operated hydraulic 4-Way Valve, or, as inputs to a solid state control box for electric steering systems (either hydraulic or mechanical). **Please note: it is important that you check that your steering drive unit is capable of attaining a hardover to hardover time of 10 to 15 seconds for proper performance.**

Either output can be overridden with a switched connection (such as a jog lever) between JOG PORT or JOG STBD and JOG COM (terminals 10, 11, and 12) without damaging the autopilot. A pair of diagnostic LED's, one red and one green, are provided in the distribution box to confirm the correct operation of these two outputs.

6. SWITCHED PWR

The input voltage appears on this terminal when the autopilot is in any mode except **STANDBY** or **OFF**. It can supply up to 3 amps of current for use as the power source for a solenoid operated 4-Way Valve, or, to activate an electric steering system. A yellow diagnostic LED is provided in the distribution box to confirm the correct operation of this output.

For 12V 4-Way Valve operation, it is recommended that this output not be used. The common lead from the solenoids should be connected to UNSWITCH. PWR (term. 3).

7. SPEED CONTROL

This is a linear signal used with variable speed drive systems. It is centred between +5 VOLTS 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 1.5 VDC for maximum rudder position change to port or starboard respectively.

8. +5V 9. COMMON (REFERENCE ONLY)

+5 volts appears across these terminals whenever the autopilot is turned on. These terminals are used by several of the Control Boxes manufactured by ComNav Marine Ltd as a reference for SPEED CONTROL (terminal 7). A yellow LED is provided in the distribution box to confirm the operation of the 5V power supply in the autopilot.

10. JOG PORT 11. JOG STBD 12. JOG COMMON

If any jog levers are being used in the system, they should be connected to these three terminals. If the jog levers are to be active all the time, whether the autopilot is turned on or off, connect the common from the solenoid operated 4-way valve to UNSWITCH PWR (terminal 3) rather than SWITCHED PWR (terminal 6).

13. RUDDER PWR 14. RUDDER POS'N 15. RUDDER COM.

These three terminals connect to the rudder follower. With the cable from the distribution box unplugged from the rear of the autopilot, and the rudder turned to dead ahead, the resistances between RUDDER PWR and RUDDER POS'N, and RUDDER POS'N and RUDDER COM. should be equal, and each measure approximately 600 ohms.

16. RAI SIGNAL 17. RAI RETURN

These two terminals are used to run one or more rudder angle indicators of the zero centre type (ie. the needle should indicate zero degrees of rudder with no power applied to the indicator). The total current drain may not exceed +/- 2.0 milliamps.

ComNav supplied rudder angle indicators each draw +/- 0.5 milliamps for full-scale deflection, so up to four may be used.

Other manufacturer's rudder angle indicators may require different amounts of current for full-scale deflection. If more than one rudder angle indicator is used, each should have the same current requirements.

Multiple rudder angle indicator installations should be wired in parallel. The RAI GAIN potentiometer may need to be adjusted as

described in the DOCKSIDE SETUP section of the manual to make the rudder angle indicator readings match the vessels actual rudder angle.

18. NAV 1 SIGNAL
19. NAV 1 RETURN

These two terminals connect to the NMEA 0180, 0182, or 0183 output of a Loran C Receiver, GPS Receiver, or other type of navigation computer so equipped. This Nav Port is selected for use by placing the master select switch in the **NAV** position, pressing the **U-TURN** key and then the red **ARROW** key until the display shows P1.

20. NAV 2 SIGNAL
21. NAV 2 RETURN

These two terminals connect to the NMEA 0180, 0182, or 0183 output of a Loran C Receiver, GPS Receiver, or other type of navigation computer so equipped. This Nav Port is selected for use by placing the master select switch in the **NAV** position, pressing the **U-TURN** key, and then the red **ARROW** key until the display shows P2.

22. TX CLOCK
23. TX DATA
24. +5V
25. COMMON (REFERENCE ONLY)

These terminals are used for transmitting data out of the autopilot to either, a ComNav Remote Heading Display, a satnav, or other type of navigation computer.

The function of these terminals is determined by dip switch settings inside the autopilot (see Table III) between ComNav's Remote Heading Display format, the N+1 Heading format (used with the Magnavox MX4102 or MX5102 SatNav equipped with the MX41D N+1 interface circuit board, for example), or the BCD Heading format (used with the Furuno FSN 50 SatNav equipped with the DE-FSN8-8M-1 interface circuit board,

for example). These terminals can also be configured as an NMEA 0183 data output port by special factory order. The +5V terminal is included as a convenience for wiring a Remote Heading Display.

26. ALARM OUT
27. WATCH ALARM
28. +PWR
29. - PWR

The Alarm Out terminal is used to run external alarms. +PWR volts will appear on this line in the event of a fatal alarm (ie. an off course alarm, output failure alarm, etc.), or if the man on watch fails to respond to the autopilot Watch Alarm.

The Watch Alarm terminal is an input to the autopilot used to turn the optional Watch Alarm on and off. The +PWR Volt and Common terminals are provided as a convenience for wiring up either the Watch Alarm controller or an External Alarm.

INSTALLATION INSTRUCTIONS

RUDDER FOLLOWER

The rudder follower is used to transmit the position of the rudder back to the autopilot. It should be connected to whatever part of the steering system the autopilot controls. Normally, this will be the vessels 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 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 rudder 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. Mount the rudder follower so that the rudder follower arm is the same height as the rudder post arm. The rudder follower is centred when the arm is directly above the cable gland. See Figure 4 and 5 for alignment details.

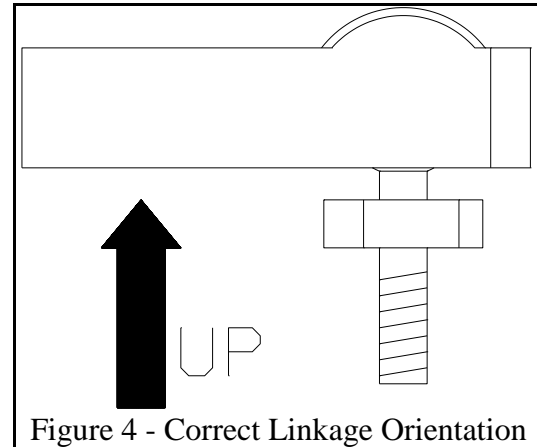


Figure 4 - Correct Linkage Orientation

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 centre 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 centred when the arm is pointing away from the cable gland and is directly over the stainless rivet in the top cover. See Figure 5 for alignment details.

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 4. Snap the rod assembly onto the ball joints. Be sure to close the release clamps on each socket. Refer to Figure 2, Figure 4 or Figure 5 and adjust the length of the rod to get the correct geometry with the rudder dead ahead.

Table I - Rudder Follower Cable Connections

Colour	Terminal	Description
White	13	+5V
Green	14	POS'N
Black	15	COM
Shield	2	GND

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 centring. 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 it is protected by hose or conduit 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 the additional length of cable. Strip the wires, and attach them to the terminals in the distribution box as shown in Table 1.

IMPORTANT

If you have installed a hydraulic pump or drive unit, there are several checks that must be done during the first few weeks of usage in order to prevent poor or dangerous steering and autopilot performance

Residual Air

After installing and bleeding your pump, residual air may be trapped in the hydraulic steering fluid. This air will gradually bleed through the header tank or the highest helm pump and the oil level will go down. Check the oil level several times during the first few weeks of use and add oil as required.

Leaking Fittings or Equipment

After installing and bleeding your pump, continuously monitor the oil level of your header tank or the highest helm pump and add oil as required. If this condition persists, it may be an indication of leakage in your steering system. Check all hydraulic steering parts, fittings and lines for leakage.

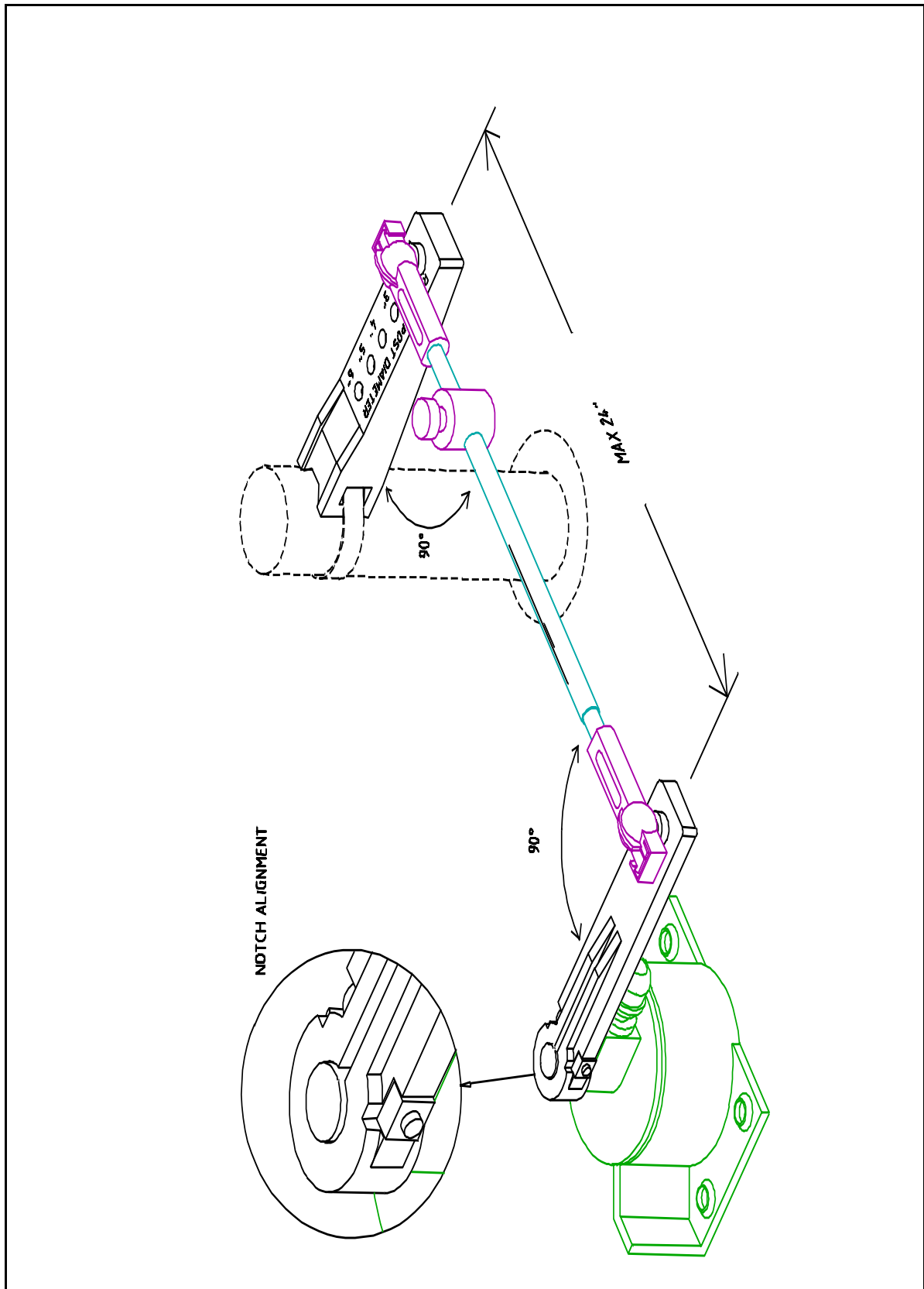


Figure 5 - Rudder Feedback correctly installed to rudder post

INSTALLATION INSTRUCTIONS

REMOTE CONTROLS

Either optional remote control can be hand-held or permanently mounted. To mount the remote control permanently, drill two holes through the mounting surface 3.5 inches (90 millimetres) apart, one above the other. Drill one more hole in the mounting surface adjacent to the watertight gland in the remote case. As the case is reversible, this may be either above or below the remote mounting location.

Run the cable to the remote control mounting location from the rear of the autopilot, and insert it into the remote control through the watertight gland. Fasten the individual wires into the terminal strip according to the wiring instructions provided with the remote control. Replace the cover. Slide the heads of two #10 stainless steel machine screws into the slots on the rear of the remote control, and lower them into the holes in the mounting surface. Spin on stainless steel lock washers and nuts to complete the installation.

To make the remote removable from its mount, drill the two holes in the mounting surface 3.0 inches (76 millimetres) apart, one above the other. Screw two #10 stainless steel screws into the mounting surface, with a gap of 0.1 inches (2.5 millimetres) between the underside of the screw head and the mounting surface. Drop the remote over the screw heads and pull it down to mount it. Lift up and out to remove the remote for handheld operation.

Run the cable to the remote control mounting location from the rear of the autopilot, and insert it into the remote control through the watertight gland. Fasten the individual wires into the terminal strip according to the wiring instructions provided with the remote control. Replace the cover.

Plug the end of the cable into the REMOTE 1 or REMOTE 2 receptacle on the rear of the autopilot. Make sure that the Dip Switch on the control circuit board of the autopilot (see figure 7) which programs that receptacle is set correctly.

If a type 101 remote control is plugged into the REMOTE 1 receptacle, Dip Switch 5 should be OFF (or OPEN).

If a type 201 or 211 remote control is plugged into the REMOTE 1 receptacle, Dip Switch 5 should be ON (or CLOSED). Dip Switch 6 should be set similarly for the type of remote control plugged into the REMOTE 2 receptacle.

INSTALLATION INSTRUCTIONS

REMOTE HEADING DISPLAYS

Up to four optional Remote Heading Displays can be run by the autopilot. These can be mounted anywhere convenient using the supplied bracket. A 4-conductor overall shielded cable is required.

Refer to the wiring diagram supplied with the Remote Heading Display to connect the cable into the autopilot distribution box.

Table II – RECOMMENDED CABLES

USE	TYPE
PILOT POWER	2 X 16 GAUGE
RUDDER DRIVE – SOLENOID VALVE	3 X 18 GAUGE
RUDDER DRIVE – CONTROL BOX	REFER TO THE INSTRUCTIONS SUPPLIED WITH THE CONTROL BOX
RUDDER FOLLOWER	3 X 18 GAUGE
REMOTE HEADING DISPLAYS	4 X 24 GAUGE W/OVERALL SHIELD
RUDDER ANGLE INDICATOR	4 X 24 GAUGE
NAV INTERFACE	2 X 24 GAUGE W/OVERALL SHIELD. SHIELD TERMINATED AT AUTOPILOT ONLY
HEADING OUTPUT (N + 1)	2 X 24 GAUGE W/OVERALL SHIELD. SHIELD TERMINATED AT AUTOPILOT ONLY
HEADING OUTPUT (BCD)	3 X 24 GAUGE W/OVERALL SHIELD. SHIELD TERMINATED AT AUTOPILOT ONLY
EXTERNAL ALARM	3 X 24 GAUGE
WATCH ALARM	4 X 24 GAUGE

NAVIGATION INTERFACE

If the autopilot is being interfaced to a navigation device with any of the NMEA 0180, 0182, or 0183 outputs, determine the type(s) of output format(s) from its data sheets.

If an option is available, select the higher numbered output format for better performance. If 0180 and 0182 formats are interspersed on the output line, the autopilot will automatically switch to use the 0182 data and ignore the 0180 data.

NMEA 0180

If the autopilot is using NMEA 0180 data to navigate, '180' will be displayed when the **TURN** key is pressed with the master select switch in the **NAV** position.

The standard baud rate for the 0180 data format is 1200 baud.

This format gives the autopilot cross track error information only. Cross track error is the distance and direction the vessel is from the line between the beginning and ending waypoints of the track.

The autopilot will use this information to make course adjustments to keep the vessel as close as possible to the track. Because the autopilot does not know the direction to the destination, there will often be one or two swings across the track as the autopilot determines the correct course to steer.

If the Nav. Device is set for automatic waypoint sequencing, the autopilot will always overshoot before locking onto the new course, as some cross track error has to build up before the autopilot can know that the Nav. Device has changed waypoints.

NMEA 0182

If the autopilot is using NMEA 0182 data to navigate, '182' will be displayed when the **TURN** key is pressed with the master select switch in the **NAV** position.

The standard baud rate for the 0182 data format is 1200 baud.

This format gives the autopilot the same cross track error information as 0180, but adds the heading from the vessel's present position to the waypoint.

The autopilot will turn to the indicated heading when the interface is engaged, and will automatically turn to the new heading when the Nav. Device sequences to a new waypoint.

It will use the Cross Track Error to make course adjustments to keep the vessel as close as possible to the track to the waypoint.

The Heading To Steer information is from the vessel's present position to the destination waypoint, so when the vessel is close to the waypoint (ie. less than 0.2 Nautical Miles), the Heading To Steer will jump, causing the vessel to wander slightly until the Nav. Device sequences to the next waypoint.

NMEA 0183

If the autopilot is using NMEA 0183 data to navigate, the three letters of the data sentence being used can be displayed by pressing the **TURN** key. Please note that the pilot must be in the **NAV** position.

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

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.

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 which contain steering or speed information. The autopilot ignores the two letter device identifier, and only looks for

the three letter sentence identifier, so it will receive information from any Nav. Device which 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 as described earlier.

Depending on the type of nav device and how it is configured, the autopilot may sound its alarm and display 'Arr' when the vessel is close to a waypoint.

The variations of NMEA 0183, which are 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 on 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 Origin to Destination, 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

NAVIGATION INTERFACE

CROSS TRACK ERROR RESPONSE

The response of the autopilot is set with the master select switch in the **NAV** position.

Press the **TURN** key, and then the green **ARROW** key to select normal (indicated by an 'n' on the right of the display), or reversed (indicated by an 'r' on the right of the display) response to cross track error.

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.

Cross Track Error contains two pieces of information; the amount of the error, and the 'sense' of the error (ie. whether the vessel is to the Left or the Right of the line between the beginning and ending waypoints). The NMEA (National Marine Electronics Association) has specified how the cross track error should be identified (ie. a (L)eft indicator in the data sentence means the vessel should steer to the left, and a (R)ight indicator meaning the opposite).

Some manufacturers, however, have reversed their cross track error identification. Because of this confusion, the response of the autopilot to cross track error can be switched from 'Normal', meaning the vessel will respond normally to the sense of the cross track error, to 'Reversed', meaning the vessel will respond the opposite way in response to the same information.

DATA OUTPUT

The autopilot can send out heading information for other external devices in a variety of formats.

In the standard autopilot, three heading output formats have been implemented. These are the '**Remote Heading Display**', '**N+1**' and '**BCD**' formats.

The Remote Heading Display format is for use with ComNav Marine Remote Heading Display repeaters.

The N+1 output is identical to the output from a Digicourse electronic compass, and has been tested with the Magnavox MX4102 Satnav equipped with the MX41D N+1 interface circuit board.

The BCD output is identical to the output from the Furuno AD-10S gyrocompass interface, and has been tested with the Furuno FSN50 Satnav equipped with the DE-FSN8-8M-1 interface circuit board.

The Remote Heading Display format is a four wire signal. Refer to the instructions accompanying the Remote Heading Displays for information on connecting them into the autopilot distribution box.

The Remote Heading Display output is selected by setting Dip Switches 3 and 4 on the autopilot control circuit board both to OFF.

The N+1 format is a two wire signal. One wire connects to TX CLOCK, terminal 22 in the autopilot distribution box. This terminal transmits a number of pulses corresponding to the vessel's heading in degrees, plus one extra pulse.

The other wire is the return, connected to COMMON, terminal 25 in the autopilot distribution box. The wire should be shielded, with the shield also connected to the COMMON terminal in the autopilot distribution box, and unterminated at the other end, to prevent the radiation of any radio noise.

The pulses are 5 volts in amplitude, transmitted at a frequency of approximately 20 KHz. The information is transmitted twice a second.

The N+1 format is selected by setting Dip Switch 3 on the autopilot Control circuit board to ON, and Dip Switch 4 to OFF.

The BCD format is a three wire signal. One wire connects to TX CLOCK, terminal 22 in the autopilot distribution box. This terminal transmits a synchronizing clock signal.

The second wire is connected to TX DATA, terminal 23 in the autopilot distribution box. This terminal transmits the vessel's heading in degrees in BCD (Binary Coded Decimal) format synchronously with the SATNAV CLOCK.

The third wire is the return, connected to COMMON terminal 25 in the distribution box. The wire should be shielded, with the shield also connected to COMMON in the autopilot distribution box, and unterminated at the other end, to prevent the radiation of any radio noise.

The clock and data pulses are 5 volts in amplitude, and the clock is transmitted at a frequency of approximately 10 KHz. The information is transmitted ten times a second.

The BCD format is selected by setting Dip Switch 3 on the autopilot control board to OFF, and Dip Switch 4 to ON.

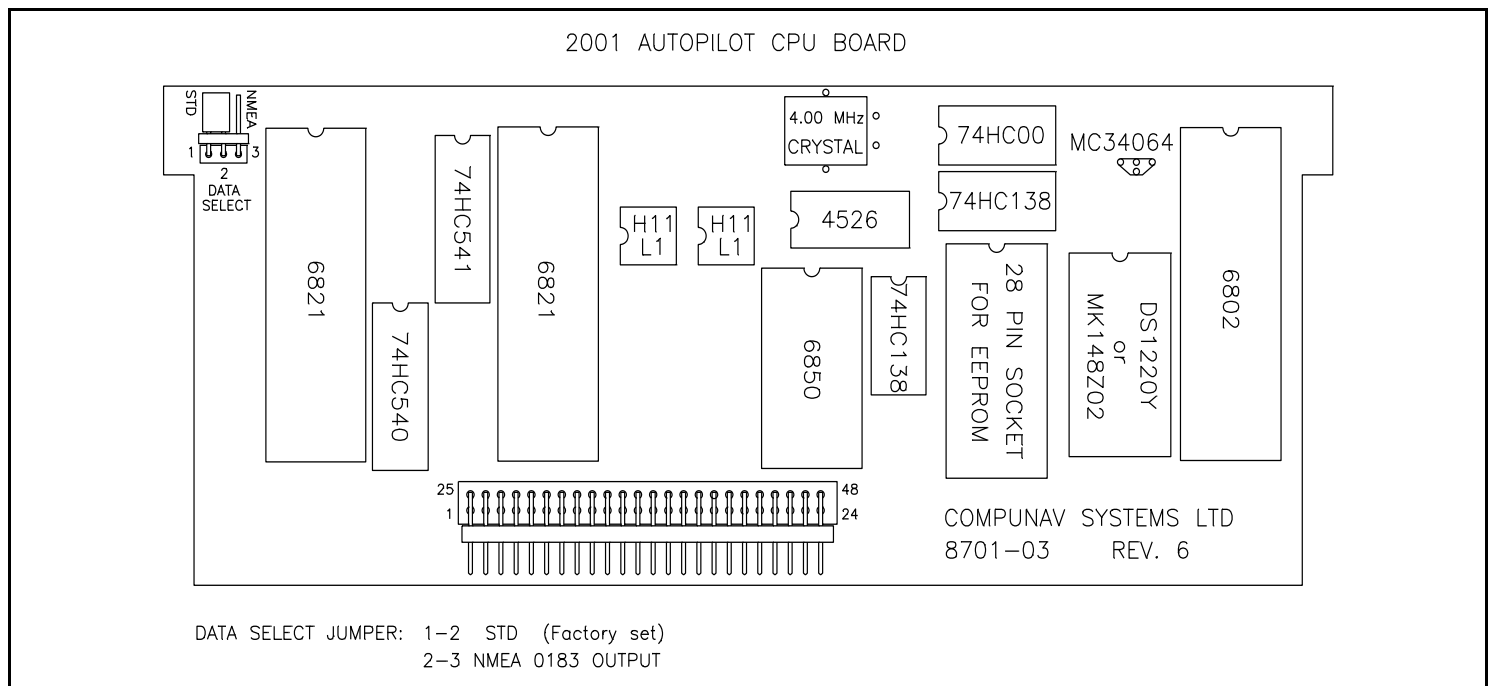
When interfacing to Furuno equipment which is compatible with the Furuno AD-10S gyrocompass interface, CLK-H corresponds to TX CLOCK, DATA-H corresponds to TX DATA and CLK-C and DATA-C both correspond to COMMON.

The NMEA 0183 data format is becoming the standard for communication between marine electronic devices. A factory modification is required to obtain this output.

The data sentences transmitted are HDM (present Magnetic Heading) and HCC (Uncorrected Compass Heading). The HDT (present True Heading) is also transmitted if the autopilot is using a gyrocompass.

The NMEA 0183 format is a two wire signal. One wire connects to TX CLOCK, terminal 22 in the autopilot distribution box. The other wire connects to COMMON, terminal 25 in the autopilot distribution box. The wire should be shielded, with the shield also connected to the COMMON terminal, and unterminated at the other end, to prevent the emission of any radio noise.

The signal is 5 volts in amplitude, and transmitted at 4800 baud. The output has enough drive to transmit to 2 standard NMEA 0183 'listeners', ie. both a Satnav and Satcom. The information is transmitted twice a second. Dip Switches 3 and 4 must be in the "closed" or "on" position.



DIP SWITCHES

The Dip Switches are used to control a number of autopilot functions. The function of the each Dip Switch is summarized in the following table:

Table III - DIP SWITCH FUNCTIONS

DIP SWITCH FUNCTIONS		
SWITCH #	OFF (OPEN)	ON (CLOSED)
1	STD WIND INTERFACE	NMEA WIND INTERFACE
2	NMEA WIND NORMAL	NMEA WIND REVERSED
3	TX PORT CONFIGURE	
4	TX PORT CONFIGURE	
5	REMOTE 1 NON-TILLER TYPE	REMOTE 1 TILLER TYPE
6	REMOTE 2 NON-TILLER TYPE	REMOTE 2 TILLER TYPE
7	REMOTE 1 NORMAL CONFIGURATION	ELECTRIC WHEEL CONNECTED TO REMOTE 1
8	NOT ASSIGNED	
9	OPERATING MODE - FACTORY PRESET	
10	OPERATING MODE - FACTORY PRESET	
11	OPERATING MODE - FACTORY PRESET	
12	OPERATING MODE - FACTORY PRESET	

Table IV - TX PORT CONFIGURE

TX PORT CONFIGURE		
DIP SWITCH	3	4
REMOTE HEADING	OFF	OFF
N+1	ON	OFF
BCD	OFF	ON
NMEA 0183	ON	ON

Further information on the Dip Switches can be found in the section of the manual corresponding to their function.

DOCKSIDE SET-UP

INTRODUCTION

It is essential that the **DOCKSIDE SETUP** procedure be performed before taking the vessel out on the water.

This procedure will be much easier to do if you have a helper, especially if you don't have a rudder angle indicator (R.A.I.).

You will need a small screwdriver such as a precision or jewellers' screwdriver for adjustments inside the pilot.

The goals of the dockside set-up are:

1. To set the limits of the rudder travel.
2. To adjust the R.A.I.
3. To make sure that the autopilot moves the rudder in the correct direction.
4. To tune the autopilot for your particular steering system.
5. To make sure that the navigation interface is properly connected.

SETTING OF RUDDER TRAVEL LIMITS

Setting of the **Rudder Gain Adjust**, inside the pilot, limits the amount of rudder travel that the autopilot allows and prevents the rudder from going hardover and stressing the steering system.

TO SET THE RUDDER GAIN ADJUST:

1. Turn the rudder hard to starboard (right) using the vessel's wheel. Turn the master select switch to **STANDBY**.
2. Turn the Rudder Gain Adjust until the red (port) front panel key lights up.

*If the green (starboard) front panel key lights up, turn the **MASTER SWITCH** off and reverse the **RUDDER POWER** and **RUDDER COMMON** wires in the **DISTRIBUTION BOX**. Turn back to **STANDBY** and the red key should be on.*

If neither key lights up, the rudder follower is incorrectly installed. Check the installation again. In particular, check that the rudder follower arm is parallel to the tiller arm. (See figure five, page 21.)

3. From hardover to starboard turn the wheel back to port about 1/16 of the total travel (e.g. 1/2 turn if the total travel from starboard to port is 8 turns).

4. Turn the **RUDDER GAIN ADJUST** until the red (port) key just turns off. Turn it no further than this point
5. Turn the rudder hard to port with the wheel. Check that the green (starboard) front panel key comes on just before the rudder reaches hard to port. *If the green key does not come on, adjust the length of the rudder follower connecting rod so that the green key turns on at the same number of turns of the wheel from midships as does the red key.*
6. Recheck to make sure that the red (port) key turns on just before the rudder reaches hard over to starboard. Recheck to make sure that the green (starboard) key turns on just before the rudder reaches hard over to port.

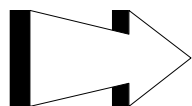
DOCKSIDE SET-UP

ADJUST RUDDER ANGLE INDICATOR (if installed)

- 1) Turn **MASTER SELECT** switch to **STBY** mode. Turn the wheel by hand. See if the rudder angle indicators show the correct direction of turn. If not **TURN PILOT OFF**. Reverse the **RAI SIG** and **RAI RET** wires at the distribution box.
- 2) Turn the wheel hard over. Turn the **RAI ADJUST** so that the indicators show hard over correctly.

CORRECT RUDDER DIRECTION

To check that the autopilot will move the rudder in the correct direction:



IMPORTANT

1. Centre the wheel.
2. Turn the **MASTER SELECT SWITCH** to **POWER STEER**.
3. Press the red (port) and green (stbd) keys alternately. Check that the rudder moves in the correct direction each time.
4. If the rudder does not move in the correct direction, reverse the **PORT OUT** and **STARBOARD OUT** wires in the distribution box.

TUNING THE AUTOPILOT FOR YOUR STEERING SYSTEM

To allow for time delays or coasting effects in the steering system, it may be necessary to adjust the **PREDICATOR MAGNITUDE** and the **DEAD BAND**. To do this, perform the following steps:

1. Turn the **MASTER SELECT SWITCH** to **PILOT**.
2. Set the adjustment screws to the positions below (*as shown in figure 6*):
 - Predictor magnitude: 1/3 turn from fully clockwise.
 - Dead band: turn fully counter clockwise.
3. Centre the rudder.
4. Set **RUDDER** and **COUNTER RUDDER CONTROLS** to zero.
6. Press the green **DODGE** key for several seconds and release it. The rudder will turn to starboard and then return to its original position.
7. If the port (red) key blinks several times as the rudder returns to its original position, the **PREDICTOR MAGNITUDE** adjust is set too high. Turn it counter-clockwise a 1/4 turn.



8. If the starboard (green) key comes on after the port key goes off, the **PREDICTOR MAGNITUDE** is set too low. Turn it clockwise a 1/4 turn.

Adjust and check the adjust position until the rudder can return to its original position without the port key blinking or the starboard key coming on at all.

Double check your work by pressing the red dodge key for several seconds and releasing it. The rudder should return to its original position without the starboard key blinking, or the port key coming on at all.

IF YOU CANNOT MAKE THE RUDDER RETURN SMOOTHLY TO IT'S POSITION:

1. Set the **PREDICATOR MAGNITUDE** fully clockwise.
2. Turn the **DEAD BAND** adjustment clockwise the minimum amount needed to stop the back and forth movement of the rudder. This type of movement is called "hunting".

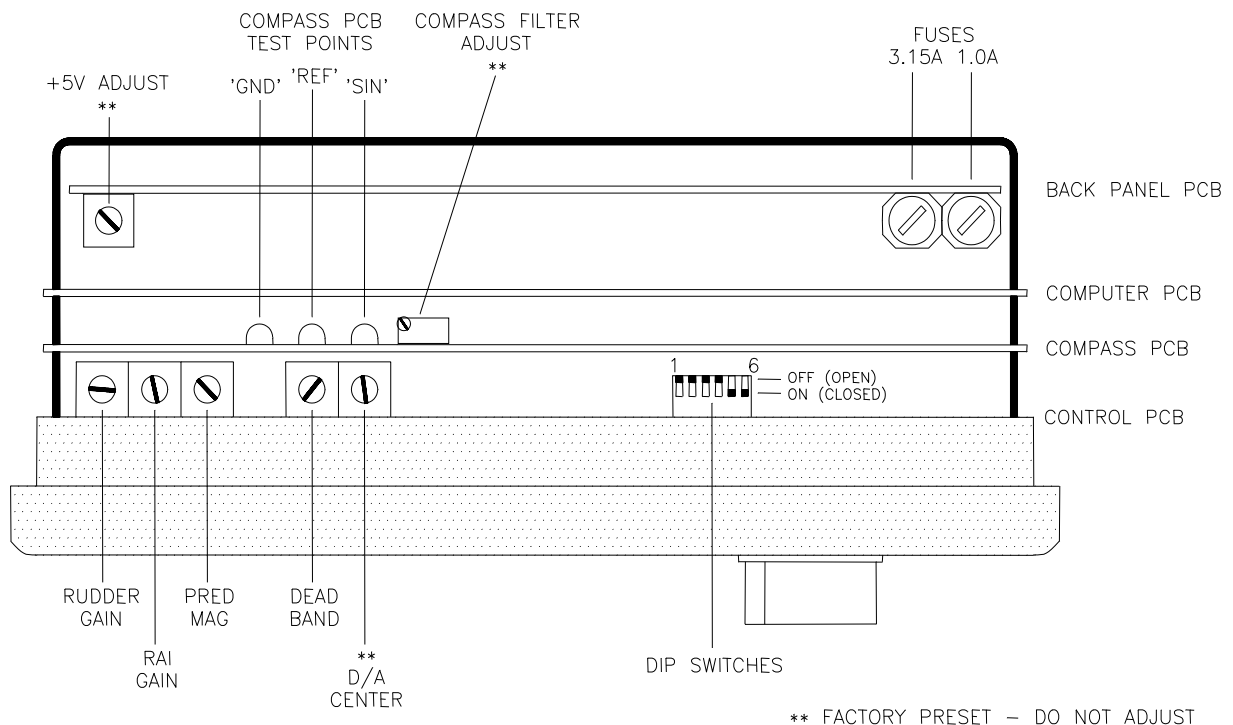


Figure 7 - AUTOPILOT INTERNAL ADJUSTMENTS

NAVIGATION EQUIPMENT INTERFACING

1. Turn on your navigation device (Plotter, Loran or G.P.S.). Wait for it to find its location and for all of its alarms to turn off.
2. Program a waypoint into the navigation device. Start it navigating towards the waypoint.
3. To use your navigation device with your Autopilot, turn the Autopilot Master Select Switch to Nav. Your navigation device will be wired to one of two Nav ports. To select the correct Nav port, press the Turn Key. The Autopilot will show which port is selected by displaying P1 or P2. To change the port selection, press the red key while the display is showing P1 or P2.

If you are not sure to which port your navigation device is connected, look in the distribution box to see where the wires coming from the navigation device are attached. Terminals 18 and 19 are Nav port 1. Terminals 20 & 21 are Nav port 2.

4. One of two things should happen:
 - a) The course shown on the display will begin to change to agree with the heading to the waypoint given by the navigation device. This shows that your wiring connections between the autopilot and the navigation device are correct.
 - b) The course shown on the display changes only a few degrees or not at all, but the autopilot does not sound any alarms. This indicates that your navigation device is probably sending information in NMEA 0180 information to your autopilot. It indicates that your wiring connections are correct.

5. If the autopilot display shows "ndEr", the autopilot is not receiving any "useable" navigation data from the navigation device. Check the following items:

- a) Check that the **SIGNAL** and **RETURN** wires are connected to the correct terminals in the distribution box.

NOTE: If the **SIGNAL** wire is in the **RETURN TERMINAL** and the **RETURN** wire is in the **SIGNAL TERMINAL** it will cause no damage to the autopilot but the data will not be read properly. To make sure that they are correct, you can exchange the positions of these wires.

- b) Check that all connections between the autopilot and the navigation device are correct.

- c) Check that the autopilot is set to the **NAV PORT** that is wired to the navigation device. See the section titled "**BASIC OPERATION**" for further details.

- d) Use the owner's manual for your navigation device to make sure that it is programmed to send information in a correct format for your pilot. This will be an NMEA language.

6. If the autopilot displays "Fd.Er", the autopilot is receiving position information which may not be accurate. Check for alarm indicators on your navigation device.

Contact your dealer or ComNav Marine for assistance if the problem persists. Please have available your pilot serial number and the make and model of your Nav device.

SEA TRIALS

1. Adjust the external controls to the following initial settings:

RUDDER	'4'
COUNTER RUDDER	'0'
YAW	'0'
TURN RATE	'6'

2. To obtain the maximum rudder gain setting that can be used on the vessel at that speed and load, in calm water, turn the master select switch to the **PILOT** position with the vessel travelling in a straight line at its normal cruising speed in calm water.

Make a 40 degree course change using the red or green **ARROW** key. Continue making 40 degree course changes while adjusting the **RUDDER** control until the vessel overshoots the correct course several times before settling onto it.

3. Continue making 40 degree course changes while slowly increasing the **COUNTER RUDDER** setting, until the vessel settles onto course with only one overshoot of 5 degrees or less. On some vessels, the **RUDDER** setting may have to be decreased by one position to get the vessel to control properly.

The **RUDDER** and **COUNTER RUDDER** controls are at the maximum combined settings that can be used on the vessel at that speed, and under the existing sea conditions.

In general, the **RUDDER** and **COUNTER RUDDER** settings will both need to be increased as the weather worsens. The higher the **COUNTER RUDDER** setting relative to the **RUDDER** setting for calm water, the less it will need to be increased in rough weather.

For example, if the vessel controls well in calm seas with the **RUDDER** control set at 4 and a **COUNTER RUDDER** setting of 2, both the **RUDDER** and **COUNTER RUDDER** settings may have to be increased to '5' in rough weather. If the vessel controls well in calm weather with a **RUDDER** setting of '4' and **COUNTER RUDDER** setting of '6', the **RUDDER** setting may have to be increased to '6' and the

COUNTER RUDDER setting increased only 1 position to '7' as the weather declines.

As the vessel's speed decreases, the rudder becomes less effective. In general, the **RUDDER** and **COUNTER RUDDER** settings will both need to be increased as the speed decreases. The higher the **COUNTER RUDDER** setting relative to the **RUDDER** setting, the less it will need to be increased at lower speeds.

To find the correct **RUDDER** and **COUNTER RUDDER** settings at different vessel speeds, or when the vessel is towing, follow the procedures outlined in sections 2 and 3 above.

Make a record of the different settings needed to control the vessel at all important speeds, loads, and weather conditions that it normally experiences.

The **YAW** is normally left at '1'. This provides 0.5 degrees of dead band on either side of the programmed course before the autopilot will begin to react. On many vessels, setting the **YAW** to '0' will cause the autopilot to work harder than necessary to hold the vessel on course. As the weather worsens, the **YAW** setting can be increased. This will result in slightly worse steering, but will reduce the amount of rudder movement, prolonging the life of the steering system.

4. Once settings for the **RUDDER** and **COUNTER RUDDER** controls have been determined, make several 40 degree course changes, and adjust the **TURN RATE** control until the vessel makes the course change at a comfortable rate.

5. If the vessel steers properly under autopilot control on some headings, but seems to wander on others, particularly heading either North or South, the problem most likely lies with on board magnetic interference to the compass. A qualified compass adjuster will be required to reduce or eliminate this interference.

In addition to normal adjustments, the compass should be compensated for deviation caused by

heeling error (particularly on steel hulled vessels), for best operation. Adjustments of this sort should only be performed by a qualified compass adjuster.

NOTE:

A potentially dangerous situation is caused by addition or movement of any magnets in the vicinity of the compass resulting in deviations different from those listed on the deviation card supplied by the adjuster.

Table III - SETTINGS CHART

VESSEL SPEED	SEA CONDITIONS	RUDDER SETTING	C/RUDDER SETTING	YAW SETTING	TURN RATE SETTING
()))))
()))))
()))))
()))))
()))))
()))))

CONTROLS

The controls consist of a five position master select switch, and a 15 position membrane keypad. The controls operate as follows:

MASTER SELECT SWITCH

OFF

All power to the autopilot is turned off. The display will be blank.

STANDBY



The left three digits of the display show the vessel's current compass heading. This is the mode the autopilot must be in to select various presets, such as compass heading offset, gyrocompass heading offset, wind angle offset, watch alarm interval select, or U-Turn function select.

POWER STEER



The left three digits of the display show the vessel's current compass heading. The vessel can be steered by using the red and green **ARROW** keys to turn the rudder port or starboard as desired.

PILOT



The vessel will steer the course indicated on the left three digits of the display (provided that the display is in the **COURSE** mode). The vessel can be brought to the desired heading by pressing either the red or green **ARROW** keys.

Pressing and releasing either key will change the heading by one degree. Pressing and holding either key will initially change the vessel's heading by one degree, and after a one/half

second delay, by ten degrees per second until the key is released. The function display will show a 'c' until the course change is completed. Pressing the **U-TURN** and then either the red or green **ARROW** key for one second will initiate a special turn (Emergency turn, Continuous turn, or U-turn; selected in **STANDBY**) in that direction. The function display will show an 'E', 'C', or 'U' until the turn is completed.

NAV



Place the master select switch in this position when the autopilot is being operated with a navigation computer (ie. Loran, Sat Nav, etc.) which has an NMEA 0180, 0182 or 0183 format output. The autopilot operates the same way as in the **PILOT** position, except that it will change its course as directed by the navigation computer to maintain a Zero Track Error. The autopilot will display 'FdEr' if there is a problem with the data it is receiving such as Low Signal To Noise Ratio, Blink Alarm, or Incorrect Cycle Selection. The autopilot will display 'ndEr' and maintain its last course if it does not receive any data from the navigation computer. The **DODGE** keys can be used as described above to avoid obstacles in the water. Press the **U-TURN** key to display which data port (1 or 2) the autopilot is looking at for data. Press the **U-TURN** key followed by the red **ARROW** key to select the other data port. Press the **U-TURN** key followed by the green **ARROW** key to change the sense of the Cross Track Error for that data port.

MEMBRANE KEYPAD

The control keys are used by pressing one of the **RUDDER**, **COUNTER RUDDER**, **YAW**, or **TURN RATE** keys. All four settings will appear on the display in corresponding positions. The setting of the control key that was pressed will be blinking. It may be changed in single steps by pressing and releasing either the INCREASE or DECREASE key. The operation of the CONTROL keys are as follows:

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. Setting the control to '0' turns the rudder control off.

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 course error. Every two position reduction in the setting cuts the amount of correction applied in half. Setting the control to '0' turns the counter rudder control off.

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, centred on the programmed course (ie. a setting of 4 will allow 2 degree's of heading deviation on either side of the programmed course, before any correction is applied).

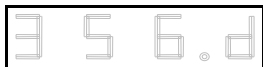
TURN RATE

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 below:

Table IV - TURN RATE CHART

TURN RATE SETTING	COURSE CHANGE RATE DEGREES PER SECOND
0	0.50
1	0.56
2	0.63
3	0.71
4	0.83
5	1.00
6	1.25
7	1.67
8	2.50
9	5.00

DODGE KEYS



The **DODGE** keys are used to dodge the vessel from its course. As long as either **DODGE** key is pressed, the rudder will turn in the direction desired until it reaches hard over. Hold both **DODGE** keys to centre the rudder and hold the vessel off course. Release the keys and the vessel will return to its course at the rate set by the **TURN RATE** control. As long as the vessel is dodged off course, a 'd' (for **DODGE**) will appear in the Function display.

DISPLAY SELECTOR

The **COMPASS** and **COURSE** keys operate only when the autopilot (ie. not one of the remotes) is in control. When the autopilot is in the **STANDBY** or **POWER STEER** modes, the vessel's actual compass course will be displayed and the LED in the **COMPASS** key will be lit. Pressing the **COURSE** key will have no effect.

When the autopilot is in the **PILOT** or **NAV** modes, the display will switch to show the vessel's programmed course, and the LED in the **COURSE** key will be lit. To view the vessel's actual compass course, press the **COMPASS** key. The display will now show the vessel actual compass course, and the LED in the **COMPASS** key will light.

Press the **COURSE** key to return the programmed course to the display. The display will automatically switch back to the **COURSE** display if any of the red or green **ARROW** keys, the **DODGE** keys, or the **U-TURN** key are pressed with the autopilot in the **PILOT** or **NAV** mode.

ALARM CLEAR

The autopilot will sound the alarm when an error condition exists. This condition will also be indicated on the display. The alarm may be silenced by touching the **ALARM CLEAR** key. The display will continue to indicate the alarm condition until it is gone. The **ALARM CLEAR** key is also used to reset the optional Watch Alarm.

GYRO (WIND) CONTROLS

The **GYRO (WIND) ON/SET** and **GYRO (WIND) OFF** keys are used to control the optional gyro-compass or wind interface. A complete description of their operation is supplied with the interface. The **GYRO (WIND) OFF** key is also used to offset the compass heading displayed by the autopilot. Place the master select switch in the **STANDBY** position and then press the **GYRO (WIND) OFF** key together with the up or down **ARROW** key to set the desired offset.

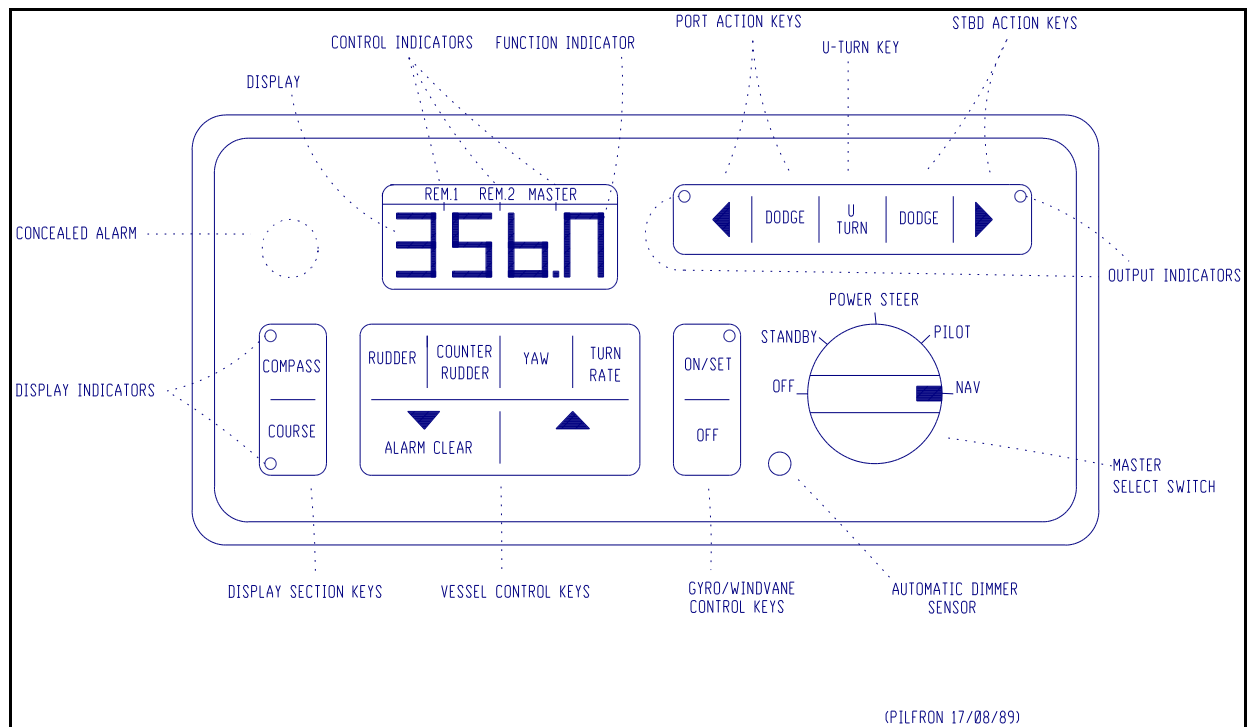


Figure 8 - AUTOPILOT FRONT PANEL

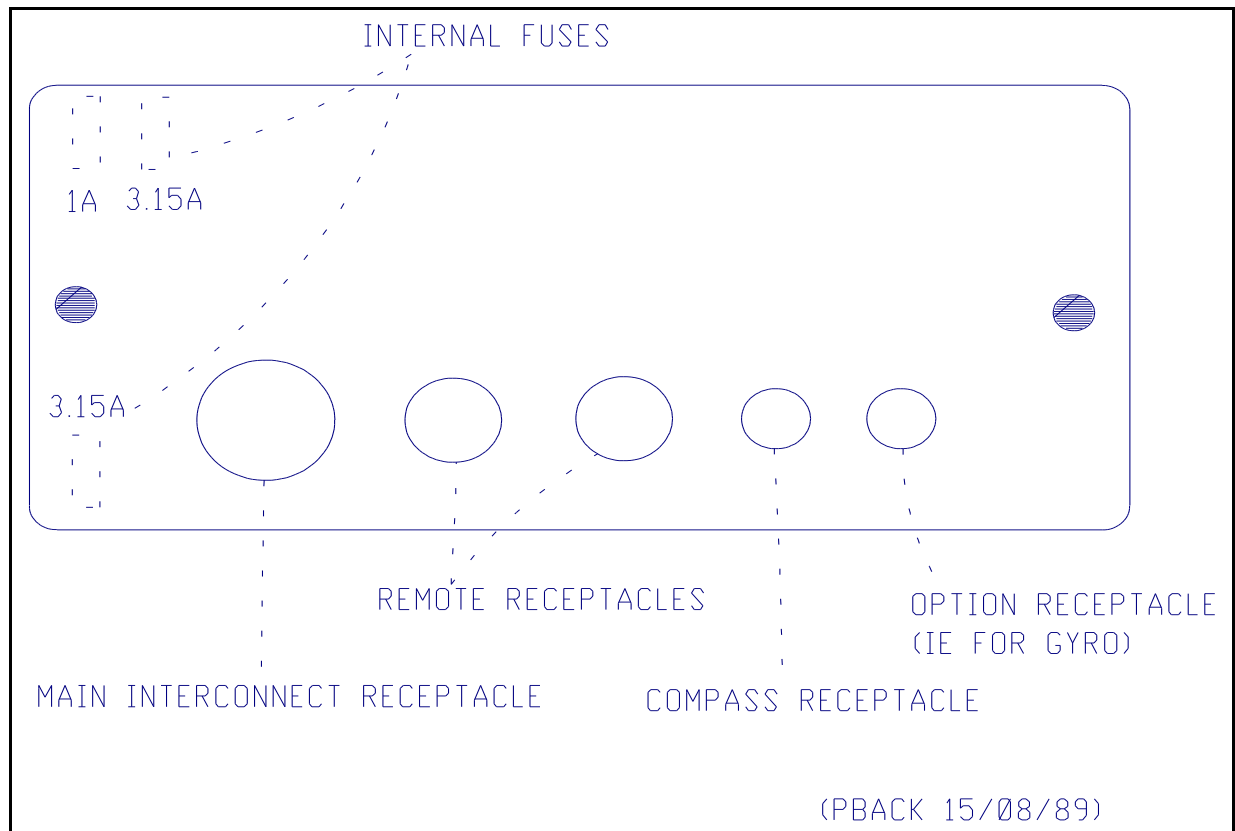


Figure 9 - AUTOPILOT REAR PANELREMOTE CONTROLS

COMNAV 101 REMOTE CONTROL

This remote control plugs into either remote receptacle on the rear of the autopilot.

If it is plugged into the REMOTE 1 receptacle, Dip Switch 5 on the autopilot control circuit board must be in the OFF or OPEN position.

If it is plugged into the REMOTE 2 receptacle, Dip Switch 6 must be in the OFF or OPEN position.

Control is taken at the remote by pressing both its pushbuttons for one second. The decimal point on all LCD displays will move to the **REM.1** or **REM.2** position, depending on which receptacle is being used.

This remote control includes a display, master select switch, pushbuttons, and a **DODGE/U-TURN** toggle switch. Its operation is identical to the operation of the autopilot except for the toggle switch.

The vessel can be dodged off course by holding the toggle switch in the **DODGE** position and pressing one of the pushbuttons. 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 rate set by the **TURN RATE** control.

To display the type of special turn currently selected, place the remote in **STANDBY**, pull the toggle switch to the **U-TURN** position and release it. Press either the red or green pushbutton to select a different type of special turn. Place the remote in **PILOT**, click the toggle switch to the **U-TURN** position and then press either the red or green pushbutton for one second to start a special turn to that side.

Place the remote in **NAV** to engage the Navigation Interface. Pull the toggle switch to the **U-TURN** position and release it to display the selected nav port and cross track error sense. Press the red pushbutton to switch to the other nav port. Press the green pushbutton to select either Normal or Inverted response to cross track error for that port.

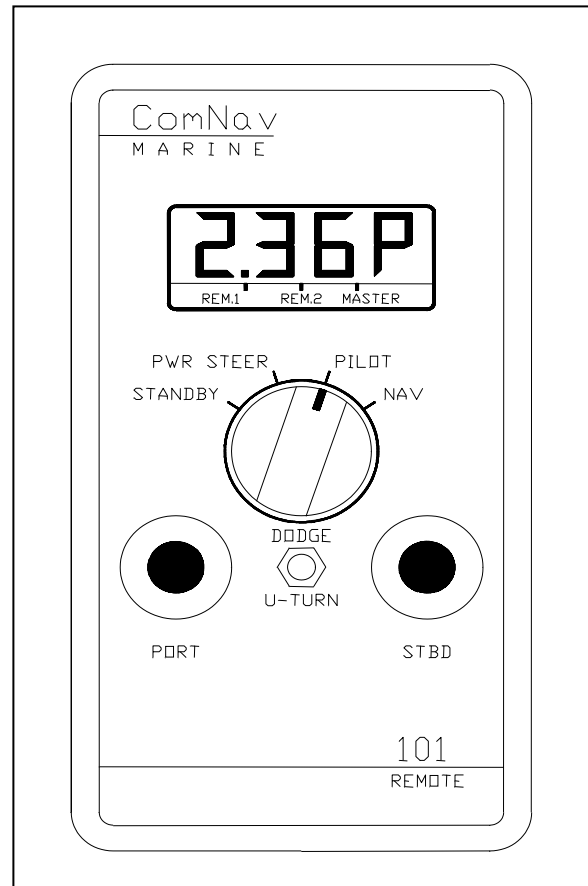


Figure 10 - ComNav 101 Remote

COMNAV 201 REMOTE CONTROL

This remote control plugs into either remote receptacle on the rear of the autopilot.

If it is plugged into the REMOTE 1 receptacle, Dip Switch 5 on the autopilot control circuit board must be in the ON position.

If it is plugged into the REMOTE 2 receptacle, Dip Switch 6 must be in the ON position.

Control is taken at the remote by pressing both its pushbuttons for one second. The decimal point on all displays will move to the **REM.1** or **REM.2** position. 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 one-degree steps, or by 10 degrees per second after holding the pushbutton for half a second.

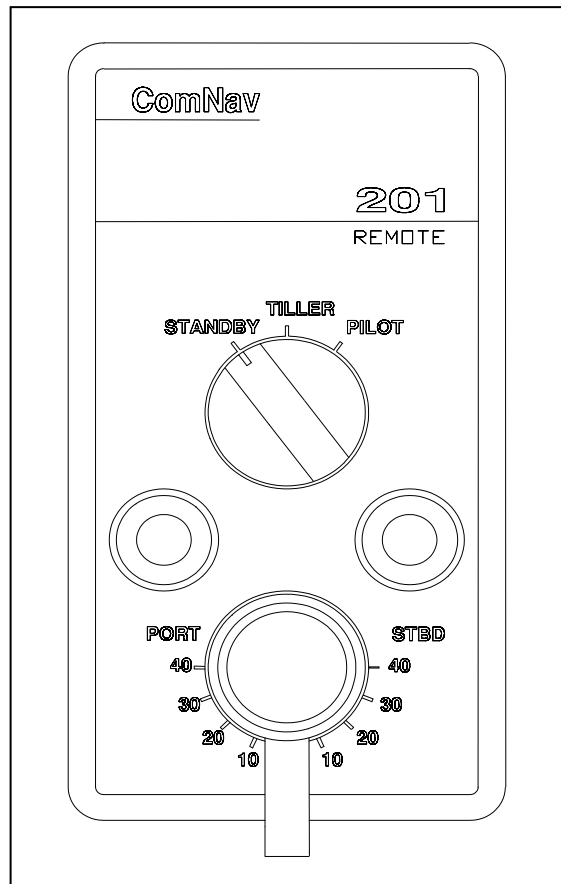


Figure 11 - ComNav 201 Remote

REMOTE CONTROLS

COMNAV 211 REMOTE CONTROL

This remote control plugs into either remote receptacle on the rear of the autopilot.

If it is plugged into the REMOTE 1 receptacle, Dip Switch 5 on the autopilot control circuit board must be in the ON position.

If it is plugged into the REMOTE 2 receptacle, Dip Switch 6 must be in the ON position.

Control is taken at the remote by pressing both its pushbuttons for one second. The decimal point on all displays will move to the **REM.1** or **REM.2** position.

The **STANDBY**, **PILOT**, AND **NAV** modes are the same as on the autopilot front panel, and the **TILLER** position permits direct control of the vessel's rudder angle, identical to the COMNAV 201 remote.

The **DODGE/U-TURN** toggle switch operates identically to the COMNAV 101 remote.

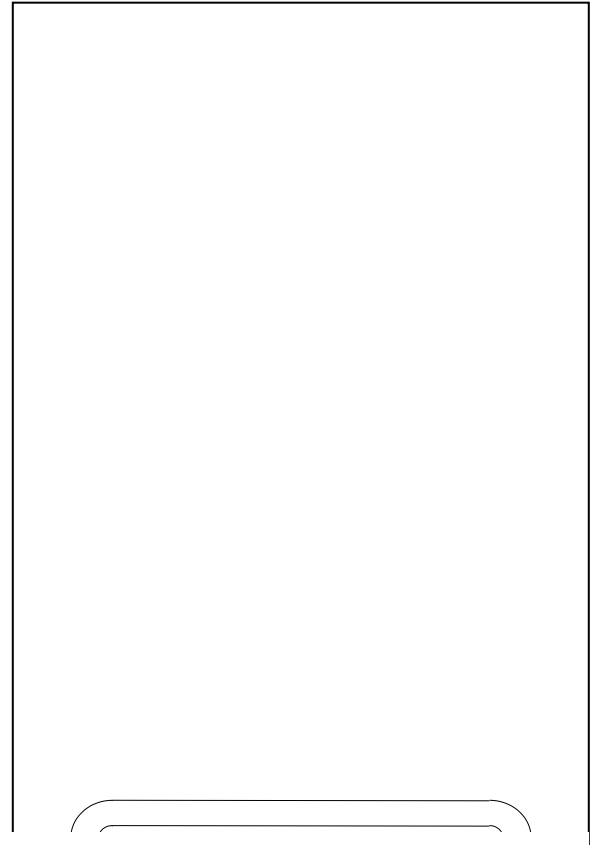
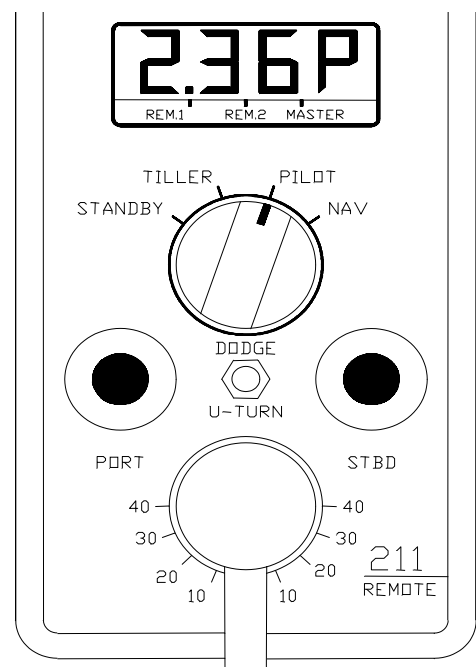


Figure 12 - ComNav 211 Remote



SPECIAL TURNS

When the autopilot is in the **PILOT** mode, pressing the **U-TURN** key together with either the red or green **ARROW** key for one second initiates the PRE-SELECTED type of special turn.

EMERGENCY TURN



The Emergency Turn is selected by placing the autopilot in the **STANDBY** mode, pressing the **U-TURN** key, followed by either the red or green **ARROW** key until the display shows 'E.trn'.

This turn is sometimes called the 'man overboard turn' or 'Williamson turn'. If the vessel's speed is not changed while the turn is in progress, it should bring the vessel about in such a way that it retraces its own path in the water.

When the second turn is complete, the vessel should be retracing its own track in the water. Pressing the **U-TURN** key and the green **ARROW** key for one second starts the same thing, only the first 90 degree turn is to starboard, and the second 270 degree turn is to port.

The speed at which the turns are performed is set by the **TURN RATE** control, and should not be changed during the turn (otherwise the vessel will not end up on its own track).



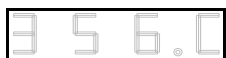
An Emergency Turn to port is initiated by placing the autopilot in the **PILOT** mode and pressing the **U-TURN** key together with the red **ARROW** key for one second. The autopilot will make a 90 degree turn to port. When that turn is complete, the autopilot will automatically make a 270 degree turn to starboard. The function indicator will change to an 'E' until both turns are complete.

CONTINUOUS TURN



The Continuous Turn is selected by placing the autopilot in the **STANDBY** mode, pressing the **U-TURN** key, followed by either the red or green **ARROW** key until the display shows 'C.trn'. This is a turn which continues endlessly until something is done to stop it.

turn at the rate determined by the **TURN RATE** control. The vessel will continue to turn until either the red or green **ARROW** keys is pressed. The function indicator will show a 'C' until the turn is stopped. The vessel will then travel in the direction indicated on the display. Pressing the **U-TURN** key and the green **ARROW** key will start a similar turn to starboard.



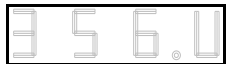
A Continuous Turn to port is initiated by placing the autopilot in the **PILOT** mode and pressing the **U-TURN** key together with the red **ARROW** key for one second. The vessel will

SPECIAL TURNS

U-TURN



The U-Turn is selected by placing the autopilot in the **STANDBY** mode, pressing the **U-TURN** key, followed by either the red or green **ARROW** key until the display shows 'U.trn'. This turn is a 180 degree turn.



A U-Turn to port is initiated by placing the autopilot in the **PILOT** mode and pressing the **U-TURN** key together with the red **ARROW** key for one second. The vessel will turn at the rate determined by the **TURN RATE** control.

Pressing the **U-TURN** key and green **ARROW** key together for one second will start a similar turn to starboard. Pressing the **U-TURN** key and the same **ARROW** key together for one second during the U-turn will increase it to a full 360 degree turn.

OPERATION

For two seconds, the first thing you will see when the autopilot is turned on is the software revision number. **Example: '02.08'**. This will tell you the version of the computer program in your autopilot.

To tell if you have the most current version of the autopilot program, call the factory with the software revision number displayed. If you do not have the latest version, we will be able to tell you how to have your autopilot updated.

The first operating mode is **STANDBY**. In this mode, the display will show you the vessel's actual compass heading. Any rudder angle indicators fitted will now show the vessel's rudder angle, and any Remote Heading Displays will also be active.

To apply a permanent offset to the displayed compass heading to make it agree with your compass, press and hold the **GYRO (WIND) OFF** key and then press the up or down **ARROW** key. Heading information will be transmitted on the Data Output port.

To reset all autopilot parameters back to factory original settings, press and hold both the up and down **ARROW** keys for one second.

To change the type of special turn (Emergency turn, Continuous turn, or U-turn) that will occur when you select a **U-TURN** in the **PILOT** operating mode, press the **U-TURN** key followed by either the red or green **ARROW** key.

The second operating mode is **POWER STEER**. In this mode, the display still shows the vessel's actual compass heading, but now the red and green **ARROW** or **DODGE** keys can be used to turn the rudder port or starboard.

You can still use the wheel if you have hydraulic steering, but the autopilot will not let you turn the rudder past the limits that were set when the autopilot was installed. The only operating mode where you can use the wheel if you have mechanical steering, is **STANDBY**.

The third operating mode is **PILOT**. When you turn the master select switch to this position, the autopilot will begin steering the vessel on the last course it was on just prior to switching to **PILOT**. It will use the last rudder angle on the vessel as the first approximation of dead ahead rudder. (This means that if you are towing a net and require 15 degrees of port rudder to make the vessel steer straight, the autopilot will hold that rudder angle when you turn to **PILOT**.)

If the rudder angle is not correct, the automatic trim function of the autopilot will find the correct dead ahead rudder angle in approximately one minute.

To change the vessel's course by one degree, press and release the red or green **ARROW** key.

To make larger course changes, press and hold the red or green **ARROW** key, and the display will move at 10 degrees per second until you release the key. The autopilot will bring the vessel around to the new course at the rate set by the **TURN RATE** control (see 4). The Function Indicator will show a 'c' until the course change is complete.

Press the **U-TURN** key, with either the red or green **ARROW** key for one second, and the vessel will make an Emergency turn, Continuous turn, or U-turn (selected in **STANDBY**) to that side at the programmed rate of turn. The Function Indicator will show a 'E', 'C' or 'U' until the turn is complete.

The **RUDDER**, **COUNTER RUDDER**, **YAW** and **TURN RATE** keys are now active. These can be adjusted by pressing the appropriate key, followed by either the up or down **ARROW** key.

When any of the four keys are pressed, the display will change to show all their settings. These are in the same order on the display as they are on the keypad. The digit corresponding to the key that you pressed will be blinking. After five seconds, the display will return to normal.

Typical values for **RUDDER**, **COUNTER RUDDER**, **YAW** and **TURN RATE** which seem to work on most vessels in the 30 to 60 foot range are 4, 4, 1, and 6 respectively. When in doubt about how to determine the settings, try these. If you make a large turn, and you see by watching the vessel's actual heading display as you come around that you overshoot the new course, try either increasing the amount of **COUNTER RUDDER** by one setting, or reducing the amount of **RUDDER** by one setting, and do it again.

If the vessel seems to stop turning before you get to the new course, and then slowly come up to it, try either decreasing the amount of **COUNTER RUDDER**, or increasing the amount of **RUDDER**.

If nothing seems to make the vessel steer properly, or it steers properly on some headings but not on others, particularly north or south, it is almost always a problem with the compass. The card may be sticking because of a worn pivot; the compass may not have been swung by a qualified compass adjuster; or the compass may not have been swung properly the first time.

On new steel vessels in particular, the magnetism of the hull can change dramatically over time, and it is not uncommon to require the compass to be swung twice in the first year. Also there is a common misconception that aluminum vessels don't require the compass to be swung because aluminum is non-magnetic. It is, but the welds where the aluminum plates are joined become magnetic because of the amount of energy injected there. For this reason, having the compass properly swung is just as important on an aluminum vessel as a steel vessel.

You can see either the programmed course or the vessels' actual heading on the display. Press the **COMPASS** key to display the vessel's actual heading. This will remain on the display until you press the **COURSE** key, or any of the red or green **ARROW** or **DODGE** keys, or the **U-TURN** key. Any of these will return the display to the programmed course.

The **DODGE** keys may be used to avoid a log or other obstacle in the water ahead. Pressing one

DODGE key will cause the vessel to make a panic turn in that direction. Pressing both **DODGE** keys when the vessel has turned far enough to miss the obstacle, will make the autopilot bring the rudder to dead ahead and hold it there.

Release the **DODGE** keys to return the vessel to the original course at the programmed turn rate when the vessel is clear of the obstacle. The Function Indicator will show a 'd' until the dodge is complete.

The next operating mode is **NAV**. If you have a Loran or other navigation computer interfaced to the autopilot, program in a waypoint, tell the computer to begin navigating towards the waypoint from the vessel's present position, and turn the autopilot master select switch to **NAV**. For one second, you will see which nav port is selected as well as the cross track error sense setting for that port.

To change the nav port, press the **U-TURN** key followed by the red **ARROW** key. To change the cross track error sense for that nav port press the **U-TURN** key followed by the green **ARROW** key.

If your interface is using either the NMEA 0182 or 0183 data format, the first thing that should happen is the course the autopilot is steering will begin to change towards the Heading to the Waypoint as indicated by the Nav. Device. The autopilot will then begin to alter its course to keep the Cross Track Error as indicated by the Nav. Device to a minimum.

WATCH THE CROSS TRACK ERROR if you are in any doubt as to whether things are working correctly. If it is being maintained at a low value (Example less than 0.02 nautical miles), everything is working.

If the vessel is wandering back and forth, but there are no alarms on the autopilot or Nav. Device, the most common thing, particularly with Loran, is poor signal quality. This can be usually attributed to either poor or no grounding of the Loran, noisy alternators on the vessel, poor antenna location, or shared data being loaded by other devices. Refer to the manual for the Nav.

Device for ideas on making improvements.

If the Nav. Device is set for automatic waypoint sequencing, the heading to steer will change when the next waypoint is selected, and the autopilot will turn the vessel to the new course.

Some things that will optimize the pilots operation are:

1.) If the heading to steer can be in degrees magnetic or degrees true, select degrees magnetic, unless you are using the optional gyrocompass interface.

2.) Course changes during automatic waypoint sequencing will be smoother if the arrival circle is set to a small value such as 0.05 nautical miles. This usually will let the autopilot bring the vessel directly onto the next track when the course change is completed.

If your interface uses the NMEA 0180 format, the autopilot does not know the direction to the waypoint, but only how far it is off the line between the beginning and end of the track and to which side. Typically, up to .10 or more nautical miles of cross track error will build up before the autopilot begins to find the heading to the waypoint. The autopilot will also probably cross the track one or two times before it finally locks onto it.

To reduce the initial wander, preset the vessel's course to the approximate heading to the waypoint using the red or green **ARROW** keys with the autopilot in the **PILOT** mode. Once the autopilot has found the track, it will perform just as well as with the NMEA 0182 or 0183 formats. However, if the Nav. Device is set for automatic waypoint sequencing, the autopilot will have to go through the cycle of finding the track again after each time the Nav. Device sequences waypoints.

You can still use the **DODGE** keys to avoid obstacles in the water. After you release the **DODGE** keys, the vessel will return to its original track, rather than its original course.

To use the remote control, leave the autopilot in the **STANDBY** mode when you go up to the flying bridge. This will leave the vessel under the

operator's control. At the flying bridge make sure that the remote switch is in the **STANDBY** mode. Press both pushbuttons on the remote control and hold them down for one second until you see the decimal point move to either the **REM.1** or **REM.2** position.

The remote controls are similar to the main control panel of the autopilot. The model 201 and 211 remotes substitute the **TILLER** mode for **POWER STEER**. The model 101 and 211 remotes have a **DODGE/U-TURN** toggle switch instead of separate pushbuttons for these functions.

Hold the toggle switch in the **DODGE** position and press a pushbutton for a panic turn. Hold the toggle switch in the **DODGE** position without pressing either pushbutton to lock the rudder at dead ahead. Release the toggle switch to return to the original course. Hold the toggle switch in the **U-TURN** position and press either pushbutton for one second to initiate a u-turn, emergency turn, or continuous turn.

To change the type of turn, place the master select switch on the remote in the **STANDBY** position. Move the toggle switch to the **U-TURN** position and release it. Select the type of turn desired by pressing and releasing either the red or green pushbutton.

If you have one loran in the wheelhouse, and a second loran on the flying bridge, the data output from the one in the wheelhouse should be wired into Nav Port 1 and the data output from the one on the flying bridge should be wired into Nav Port 2.

To use the navigation interface on the flying bridge, program a waypoint into the loran on the flying bridge, turn the master select switch on the remote to the **NAV** position, move the toggle switch to the **U-TURN** position and release it, and then press the red pushbutton until the left side of the display on the remote shows 'P2'.

If you have mechanical steering, you can disengage the clutch on the drive unit and return to hand steering by selecting the **STANDBY** mode on the model 101 or 211 remote.

When you want to go back to the main control unit, leave the remote in the **PILOT** mode so the vessel is under control. Walk back to the wheelhouse and press both the red and green **ARROW** keys; hold them down for one second, until the decimal point moves back to the **MASTER** position.

GYRO COMPASS INTERFACE

Read this section only if your autopilot has the optional gyrocompass interface.

OPERATION

To engage the gyrocompass, press the **GYRO ON/SET** key on the front panel of the autopilot. The digital heading displayed by the autopilot may be adjusted to agree with the master gyrocompass by rotating the master select switch to the **STANDBY** position, pressing and holding the **GYRO ON/SET** key and pressing the up or down **ARROW** key. In all other respects, the autopilot operates as described in the manual.

The autopilot will remember that it was in **GYRO** mode when it was turned off, and will remain in **GYRO** mode when turned on again. It will use information from the vessel's magnetic compass to make a 'best guess' at the current heading of the gyrocompass during turn on.

The alarm will sound, and the display will show 'GC.Er', if a failure of the gyrocompass occurs in a manner detectable by the autopilot (caused by all the signal lines from the gyrocompass going high or low simultaneously for at least two seconds). It will read the magnetic compass once to determine the current magnetic heading, reset the course it is steering to that heading, and change to using the magnetic compass as the heading reference.

To disengage the gyrocompass and return to control by the magnetic compass, press the **GYRO OFF** key on the front panel of the autopilot

INSTALLATION

MAKE SURE YOU HAVE THE CORRECT AUTOPILOT AND INTERFACE.

This autopilot and interface is intended for use with a gyrocompass which has either a gear driven synchro output with a 360:1, 180:1, 90:1 or 36:1 gear ratio (36:1 requires 02.06/01.15 software), or a 3, 6, or 12 steps/degree step type output. If the gyrocompass has a 1:1 synchro output (ie Sperry SR50) you need a different model of 2001 autopilot and a different interface. Contact the factory or your dealer for assistance.

No. 8 holes are provided in the bottom of the box for mounting. Position and mount the gyrocompass interface box so that it will remain dry, the terminals are accessible and the 10 foot cable supplied with it will reach the rear of the autopilot. Run a cable from the gyrocompass output to the gyrocompass interface box, bringing it inside the box through the rubber grommet or gland.

Make sure that the gyrocompass is turned off, or the output circuit in the gyrocompass is disconnected before terminating either end of this cable.

If the gyrocompass has a SYNCHRO output, only three wires (S1, S2 and S3) are required.

If the gyrocompass has a STEP output, four wires will be required (S1, S2, S3 and COMMON). The connection of the COMMON wire inside the gyrocompass depends on the type of output circuitry the gyrocompass has. If the gyrocompass has 'open collector' transistors which switch to ground you will require a POSITIVE connection of the COMMON wire. If the gyrocompass has 'open emitter' transistors which switch to positive, you will require a GROUND connection for the COMMON wire. It may be necessary to inspect the output circuit schematic of the gyrocompass to make this determination.

If you make the wrong connection of the COMMON wire, no damage will result to the interface, it simply won't work. Fasten the wires into their appropriate terminals inside the gyrocompass interface.

Set the Synchro/Step selectors J1-J5 to the appropriate position to accommodate the Gyrocompass. If the gyrocompass has a SYNCHRO output, they must all be in the SYNCHRO position. If the gyrocompass has a STEP output, they must all be in the STEP position.

Set J6 to the Gyro gear ratio. **The autopilot MUST have software version 02.06 (01.15) or higher to use the 36:1 ratio.** If the gyrocompass has a 6 Step/Degree output (very common) select the 180X ratio.

Plug the Interface output cable into the **OPTION** receptacle on the rear of the autopilot. The Interface will automatically set itself to the output voltage of the Gyro Transmitter.

With some older Sperry MK37 gyrocompasses (ie. MOD 0 or MOD 1) problems with the regulation of the 70VDC positive common can interfere with the correct operation of the interface. This is indicated by repeated GC.Er alarms on the autopilot display. To correct this problem, turn off the output from the gyrocompass, move each of the J7, J8 and J9 jumpers so they are on one pin only and retest. This should solve the problem.

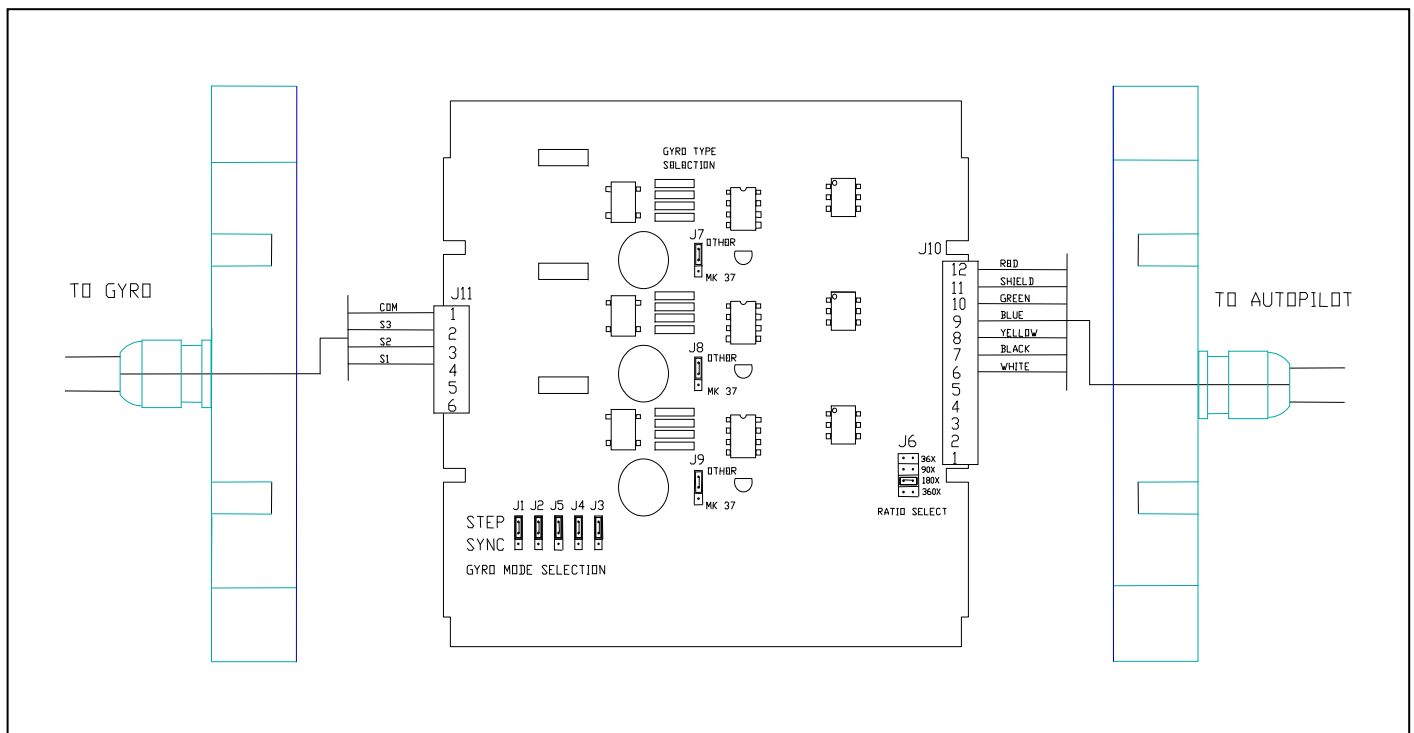


Figure 13 - Gyro Compass Interface

WIND VANE INTERFACE

Read this section only if your autopilot is equipped with the optional windvane interface.

OPERATION

Press the **WIND ON/SET** key to engage the windvane interface. The display will switch to display wind angle rather than compass heading. This display differs slightly from the compass display. In wind mode, the left most segments of the left display character are the tack indicators. When the upper segment of the character is on, the vessel is on the Port tack. When the lower segment of the character is on, the vessel is on the Starboard tack. Leading zeros are suppressed in the wind mode (ie. in compass mode, a heading of

10 degrees is displayed as 010 , while in wind mode, a wind angle of 10 degrees is displayed as 10).

If the displayed wind angle, does not agree with the actual wind angle; a permanent offset can be applied to the displayed wind angle, to bring it into agreement by pressing and holding the **WIND ON/SET** key and pressing either the up or down **ARROW** key with the autopilot in the **STANDBY** mode.

RAISING THE SAILS

With the engine running and in gear, place the autopilot (or remote control) master select switch in the **PILOT** position. Press the red or green **ARROW** key (or pushbutton) until the command wind angle is 0 degrees. The autopilot will turn the vessel until it is steering directly head to wind. Raise the sails.

Once the sails are raised, press the red or green **ARROW** key (or pushbutton) until you

see the desired tack and angle to the wind on the digital readout. The autopilot will bring the vessel around until it is at that angle to the wind. Turn off the engine and set the sails normally.

To adjust the vessel's angle to the wind, simply press the red or green **ARROW** key until you see the new desired angle, and the autopilot will bring the vessel around.

TACKING



To tack the vessel, press the **TACK/U-TURN** key (toggle switch on the remote) for one second. The vessel will turn through head to wind to the same angle on the opposite tack.

The function indicator will show a 't' for tack until the tack is completed. It is best to wait until the vessel has gone through head to wind before tacking the jib to prevent the vessel from being caught in irons.

GYBING



To gybe the vessel, press either the red or green **ARROW** key (pushbutton) to make the command heading increase to 180 degrees, and then decrease on the opposite tack to the desired wind angle.

The alarm will sound and the display will show a 'GYbe' warning once when the command wind angle equals 180 degrees to notify you that you have programmed a gybe, and again when the actual wind angle reaches 180 degrees to notify you that it is now time to gybe.

NOTES

The autopilot does not actually steer by the wind. Instead it steers by the magnetic compass, which is a much more stable source of heading information, and adjusts the compass course it is steering to make the command wind angle and the actual wind angle equal each other. This method results in much more accurate steering while engaged in the wind mode than is possible by just steering by the wind.

If you attempt to tack automatically in very light air, and the vessel gets stuck in irons, the autopilot will continue to adjust the compass course in an attempt to make the vessel come around, and will end up not knowing which way to steer the vessel. If this happens, simply move the master select switch to the **POWER STEER** or **STANDBY** position and bring the vessel onto the proper tack by hand, and then return the master select switch to the **PILOT** position.

INSTALLATION

We recommend mounting the 2001s Autopilot below decks at the nav station and mounting a 101s Remote Control (a version of the standard 101 remote designed specifically for use with the 2001s Autopilot) in the cockpit.

On large vessels an additional 101s remote may be mounted at the base of the mainmast for use during deck work. Except for the actual wind vane interface, all other installation and setup procedures are the same as for the standard 2001 autopilot.

In many cases, it is possible to tap into the wind angle information coming down the mast from an existing windvane to avoid the expense and hassle of installing another piece of equipment at the top of the mast. The wind vane must be of the type which reads over a full 360 degrees.

Most windvanes of this type have a three phase output. The autopilot is shipped configured to be connected to this type of wind vane.

Some wind vanes have a 2 phase output (ie. VDO). Two jumpers must be moved on the Compass Interface PCB inside the autopilot to adapt to this type of output (see Figure 15). This should be done by your dealer. A 10 foot cable terminated in flying leads which plugs into the **OPTION** receptacle is included. Refer to the table below for the wire colours corresponding to the S1, S2 and S3 leads (3 phase) or Sine, Reference and Cosine leads (2 phase).

Hookup information on wind vanes we know to be compatible with the autopilot are listed on the next page.

WINDVANE INTERFACE

3 Phase Outputs	2 Phase Outputs	6 Wire Cable plus Shield	5 Wire Cable plus Shield
S1	SINE	YELLOW	BLUE
S2	REFERENCE	BLUE	WHITE
S3	COSINE	GREEN	YELLOW

INSTRUMENTS WITH AN NMEA 0183 WIND OUTPUT

The autopilot must have 02.06 (01.15) software to accept NMEA 0183 wind data.

The output from the wind vane must be connected to NAV PORT 2.

Dip Switch #1 must be set to the ON or CLOSED position.

With the autopilot master select switch in the **STANDBY** position, press and hold the **WIND ON** key and press either the up or down **ARROW** key if necessary to set the wind offset to 0 degrees. If the tack indicator on the autopilot display indicates Port Tack when

it should indicate Stbd Tack, or vice versa, reverse the setting of Dip Switch #2 from its current setting.

If the autopilot does not receive any wind information it will alarm and display 'Wd.Er'. You may need to reverse the Signal and Return leads in the autopilot distribution box. The autopilot can accept either the **VWT** (True Wind Angle) or **VWR** (Relative Wind Angle). The VWR sentence has higher priority than the VWT sentence as sailing by the apparent wind reduces the amount of sail trimming necessary.

BROOKES AND GATEHOUSE

The windvane interface circuit in the autopilot is compatible with both the older potentiometer type masthead units, as well as the newer solid state masthead units from Brookes and Gatehouse.

The S1, S2 and S3 wires from the autopilot should be hooked in parallel with the RED, GREEN and BLUE wires from the masthead unit. The other wires in the cable from the autopilot are not used, and should be cut off to avoid the possibility of short circuits. Turn

on the wind instrument, place the autopilot master select switch in the **STANDBY** position, and press the **WIND ON/SET** key.

If the reading on the autopilot display is increasing when the actual wind angle is decreasing, reverse any two of the wires from the autopilot. Press and hold the **WIND ON/SET** key and press either the up or down **ARROW** key until the reading on the autopilot display is the same as the actual wind angle.

DATAMARINE WIND INSTRUMENTS

Datamarine uses an AC 3 phase synchro to transmit wind angle information from the masthead unit.

You must order the WIND VANE SYNCHRO CONVERTER (part number 93297) from ComNav to tie into a Datamarine wind vane. Information on wire colours and other hookup information is included with the synchro converter.

Additionally, the Compass Interface Circuit Board in your autopilot will need to have some jumpers moved to make it compatible with the synchro converter. Instructions on how to do this are included with the synchro converter, however, we recommend it be done by your dealer.

OCKAM WIND INSTRUMENTS

Refer to the OCKAM manual to obtain the wire colours for the S1, S2 and S3 wires from the masthead unit as the colours vary with the brand of masthead used.

Connect the S1, S2 and S3 leads from the autopilot in parallel with the S1, S2 and S3 leads from the masthead unit. The other wires in the cable from the autopilot are not used, and should be cut off to avoid the possibility of short circuits.

Turn on the wind instrument, place the autopilot master select switch in the **STANDBY** position, and press the **WIND ON/SET** key. If the reading on the autopilot display is increasing when the actual wind angle is decreasing, reverse any two of the wires from the autopilot. Press and hold the **WIND ON/SET** key and press either the up or down **ARROW** key until the reading on the

autopilot display is the same as the actual wind angle.

Alternately if you have the AUTOPILOT NMEA DRIVER MODULE and the autopilot has 02.06 (01.15) software, you may use the NMEA 0183 connection described above.

DO NOT confuse this with the Model 045 NMEA-0183 DR DRIVER MODULE which does not transmit wind angle information.

You may choose either True or Apparent wind data using Switch S2 inside the module. The interface will work with either Normal Fields or Fixed Field Width.

SIGNET WIND INSTRUMENTS

The S1, S2 and S3 wires from the autopilot should be hooked in parallel with the RED, WHITE and GREEN wires from the masthead unit. The other wires in the cable from the autopilot are not used, and should be cut off to avoid the possibility of short circuits.

Turn on the wind instrument, place the autopilot master select switch in the **STANDBY** position, and press the **WIND ON/SET** key.

If the reading on the autopilot display is increasing when the actual wind angle is decreasing, reverse any two of the wires from the autopilot. Press and hold the **WIND ON/SET** key and press either the up or down **ARROW** key until the reading on the autopilot display is the same as the actual wind angle.

WIND VANE INTERFACE

STOWE WIND MONITOR

The S1, S2 and S3 wires from the autopilot should be hooked in parallel with the GREEN, WHITE and YELLOW wires from the masthead unit. The other wires in the cable from the autopilot are not used, and should be cut off to avoid the possibility of short circuits. Turn on the wind monitor, place the autopilot master select switch in the **STANDBY** position, and press the **WIND ON/SET** key.

If the reading on the autopilot display is increasing when the actual wind angle is decreasing, reverse any two of the wires from the autopilot. Press and hold the **WIND ON/SET** key and press either the up or down **ARROW** key until the reading on the autopilot display is the same as the actual wind angle.

SWOFFER MODEL 70

The S1, S2 and S3 wires from the autopilot should be hooked in parallel with the WHITE, GREEN and BROWN wires from the masthead unit. The other wires in the cable from the autopilot are not used, and should be cut off to avoid the possibility of short circuits. Turn on the wind instrument, place the autopilot master select switch in the **STANDBY** position, and press the **WIND ON/SET** key.

If the reading on the autopilot display is increasing when the actual wind angle is decreasing, reverse any two of the wires from the autopilot. Press and hold the **WIND ON/SET** key and press either the up or down **ARROW** key until the reading on the autopilot display is the same as the actual wind angle.

VDO

The VDO windvane has a two phase Sine/Cosine output with no reference. Create a reference by using two 1K Ohm 1/4 Watt resistors as shown in Figure 14.

The jumpers on the compass circuit board will have to be moved as shown in Figure 15 to select the Sine/Cosine input; this is best done by your dealer.

CONNECTION FOR NON-2001 FLUXGATE COMPASSES

PLUG PIN NUMBERS	2001 FLUXGATE	COMNAV FUNCTION	NON-COMNAV CONNECTIONS
1	BLUE	COSINE	COSINE *
2	RED	DRIVE P1	N/C
3	BLACK	DRIVE P2	N/C
4	SHIELD	GROUND	GROUND
5	WHITE	REFERENCE	REFERENCE
6	YELLOW	SINE	SINE *
7	GREEN	+12V	+12V

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

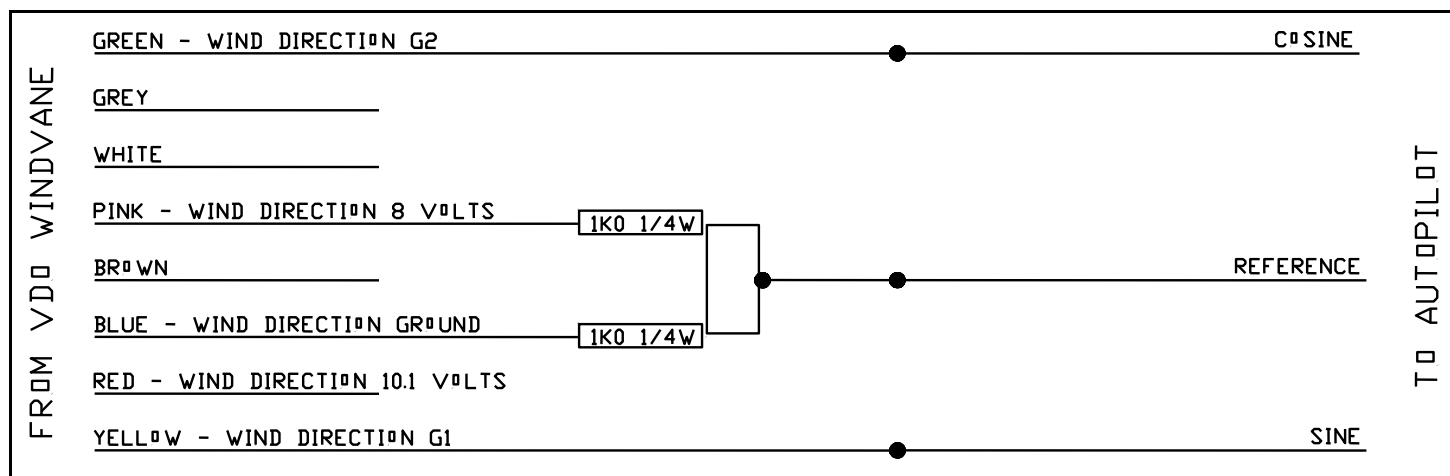


Figure 14 - VDO WINDVANE HOOKUP

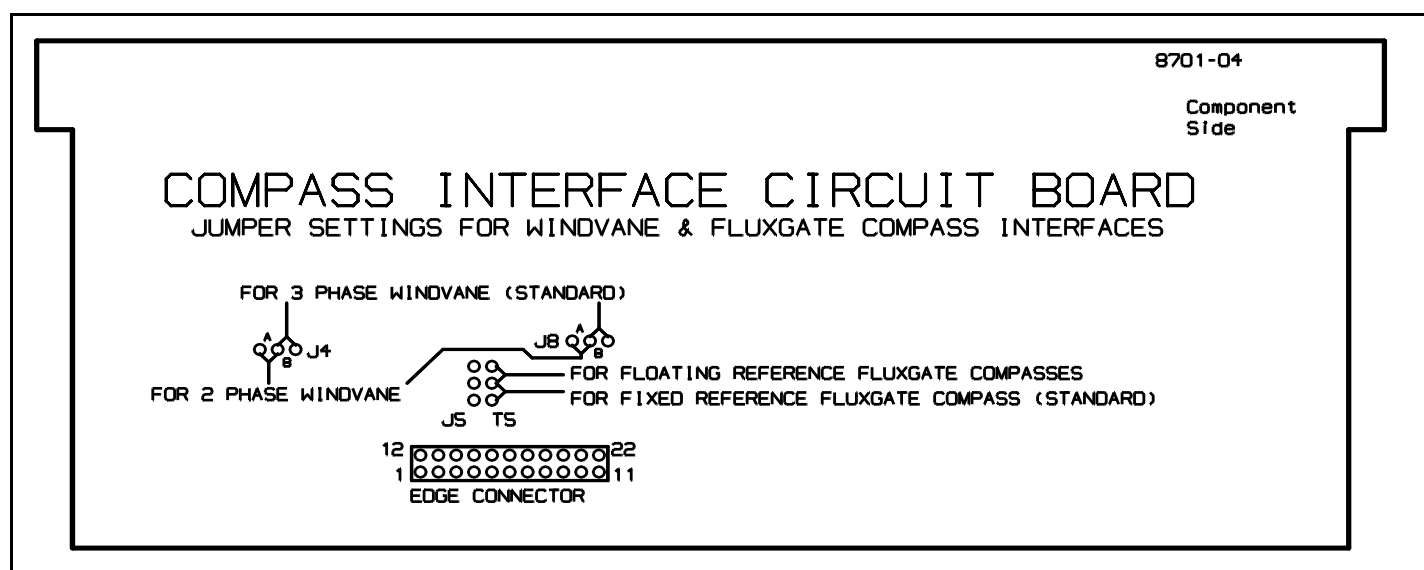


Figure 15 - COMPASS INTERFACE PCB JUMPER SETTINGS

The Sine and Cosine wires from the autopilot should be hooked in parallel with the YELLOW and GREEN wires from the masthead unit. The unused wires in the cable from the autopilot should be cut off to avoid the possibility of short circuits. Turn on the wind instrument, place the autopilot master select switch in the **STANDBY** position, and press the **WIND ON/SET** key. If

the reading on the autopilot display is increasing when the actual wind angle is decreasing, reverse the Sine and Cosine connections from the autopilot. Press and hold the **WIND ON/SET** key and press either the up or down **ARROW** key until the reading on the autopilot display is the same as the actual wind angle.

OTHER WIND INSTRUMENTS

As mentioned earlier, the autopilot is compatible with wind vanes which have a three phase DC output from the masthead unit. By moving a pair of jumpers on the Compass Interface Circuit Board (which should only be done by your dealer), the autopilot can also work with a 2 phase

(sine/cosine) output with up to a 6V reference. Less expensive windvanes which use a simple potentiometer in the masthead unit and have a dead zone, typically at head to wind, are not compatible with the autopilot.

ERROR CHECKING

The autopilot will display an error message and sound the alarm when any of the following conditions exist:

The error code 'CSEr' is displayed in a seven-segment font within a rectangular border. The 'C' is formed by the top, bottom, and left segments. The 'S' is formed by the top, bottom, and right segments. The 'E' is formed by the top, middle, and right segments. The 'r' is formed by the bottom and right segments.

Off Course Error

- The vessel has fallen more than 20 degrees off course and has remained off course for more than 30 seconds. This indicates a possible failure of the rudder follower, or more likely, the power steering system. Check for an inoperative motor drive, blown breaker to the motor, jammed four-way-valves, etc..

The error code 'FCEr' is displayed in a seven-segment font within a rectangular border. The 'F' is formed by the top, middle, and left segments. The 'C' is formed by the top, bottom, and left segments. The 'E' is formed by the top, middle, and right segments. The 'r' is formed by the bottom and right segments.

Faulty Compass Data Error

- The computer is receiving data which cannot be true heading information from the compass interface circuit board. The autopilot is operable in non-autopilot modes only.

The error code 'FdEr' is displayed in a seven-segment font within a rectangular border. The 'F' is formed by the top, middle, and left segments. The 'd' is formed by the bottom, middle, and right segments. The 'E' is formed by the top, middle, and right segments. The 'r' is formed by the bottom and right segments.

Faulty Data from Nav. Device Error

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

The error code 'FPEr' is displayed in a seven-segment font within a rectangular border. The 'F' is formed by the top, middle, and left segments. The 'P' is formed by the top, middle, and right segments. The 'E' is formed by the top, middle, and right segments. The 'r' is formed by the bottom and right segments.

Front Panel Error

- One or more of the keys on the front panel is stuck in the closed position. The autopilot can be used by pressing **ALARM CLEAR**, however, some functions may not work properly. The remote controls should operate normally. The front panel should be replaced.

The error code 'FrSt' is displayed in a seven-segment font within a rectangular border. The 'F' is formed by the top, middle, and left segments. The 'r' is formed by the bottom and right segments. The 'S' is formed by the top, bottom, and right segments. The 't' is formed by the top, middle, and right segments.

Full Reset

- If the test of the permanent memory indicated that one or more of the bytes of data stored were not correct but the RAM memory chip passed the memory test, a number of controls are reset to pre-determined values. These include the RUDDER, COUNTER RUDDER, YAW, and TURN RATE controls. The function of the autopilot is not impaired.



Gyrocompass Input Error

- This alarm is triggered if all three input lines from the gyrocompass go high or low simultaneously, and do not return to normal within two seconds. The autopilot will switch back to the magnetic compass, steering the heading that the magnetic compass was on at the time of the gyrocompass failure. This ensures that the vessel will continue steering a straight course. If the gyrocompass returns to normal operation, the heading on the autopilot must be reset to match the master gyrocompass heading. This alarm is only applicable to autopilots fitted with the optional universal gyrocompass interface.



Faulty Interrupt in U8 on Computer circuit board

- The autopilot has detected a fault with the 6821 I/O chip part number U8. Normal operation of the autopilot should still be possible, but caution should be exercised until the autopilot can be returned to an authorized service centre to have the fault rectified.



Faulty Interrupt in U9 on Computer circuit board

- The autopilot has detected a fault with the 6821 I/O chip part number U9. Normal operation of the autopilot should still be possible, but caution should be exercised until the autopilot can be returned to an authorized service centre to have the fault rectified.



No Compass Data Error

- The computer is not receiving any data from the compass. Check that the compass is plugged into the autopilot. The autopilot is operable in non-autopilot modes only (ie. **STANDBY** or **POWER STEER**). Check that the autopilot is programmed for the correct type of compass (see **DOCKSIDE SETUP** for information).

ERROR CHECKING



No Data from Nav. Device Error

The autopilot is not receiving any recognizable data from the Nav. Device. This could be because **1)** the Nav. Device is not programmed correctly; **2)** the Nav. Device is not putting out any data; **3)** there is a problem with the cabling between the Nav. Device and the autopilot (ie. broken or reversed wires); or **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 started.



Faulty Output Error

- The autopilot is not operable. Both the Port and Starboard outputs are on simultaneously. This can be caused by internal failure of the autopilot, or by problems in the cabling leading to the rudder angle indicators, or in the rudder angle indicators themselves. Try disconnecting the rudder angle indicators in the autopilot distribution box. If the problem does not go away, there is something wrong with the autopilot that will require servicing.



Permanent Memory Error

- The autopilot is not operable. The portion of RAM memory chip used for permanent data storage tested faulty.



Prom Memory Error

- The autopilot is not operable. The memory chip, which contains the autopilot program, tested faulty.



Temporary Memory Error

- The autopilot is not operable. The portion of RAM memory chip used for temporary data storage tested faulty.

If any of these alarm conditions occur, and cannot be easily rectified, return the autopilot to an authorized service centre for servicing.

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 centre for servicing.

1. The autopilot does not turn on.

a) Check for power reaching the distribution box. Check the main fuse or breaker panel.

b) Check that the main interconnect cable is properly plugged into the rear of the autopilot.

c) Check the PILOT fuse. If it is blown, replace it with a 5 X 20 mm 1.0 amp fuse. One spare fuse of this value has been included with the autopilot. Make sure the power leads are not reversed before using the spare fuse.

2. The autopilot does not turn on, but the alarm sounds continuously.

Check for a short circuit between +5V and ground. 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 lies with the cabling to that external device, or the external device itself (ie. a control box, the rudder follower, the External Alarm, the remote heading display, etc.).

If the problem does not go away after disconnecting all the leads, then there is something wrong with the autopilot. Return it to the factory or an authorized service centre for servicing.

3. The autopilot turns on, but does not turn the rudder.

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

b) Check for a possible short in the output cable to the rudder drive. 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 master select switch on the autopilot is in

PROBLEM SOLVING

3. cont...

POWER STEER or higher mode. Check that the voltage on the PORT OUT and STBD OUT lines drop to less than 1.5 volts when their respective keys are pressed. The red and green PORT and STBD LED's should come on in the distribution box when the respective red or green **ARROW** key is pressed with the autopilot in the **POWER STEER** mode. If all is correct, the problem is not in the autopilot.

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

d) Check both OUTPUT fuses. If either of them is blown, replace it with a 5 X 20 mm 3.15 amp fuse. Two spare fuses of this value have been included with the autopilot.

4. The rudder turns hard over to one side.

a) Check the rudder follower for correct operation.

b) Check the rudder follower cable for short or open circuits.

c) Check the rudder drive for correct operation (ie. sticking relays, sticking solenoid valves, etc.).

d) If the rudder appears to move normally with the autopilot in **POWER STEER**, but goes hard over with the autopilot in **PILOT**, recheck the rudder follower and rudder drive connections in the distribution box for correct hookup as described in the DOCKSIDE SETUP section of this manual.

5. The autopilot turns on, but does not operate properly.

a) Turn the master select switch to **OFF** and then to **STANDBY** to restart the computer program.

b) Check the voltage in distribution box for a minimum of 10.0 VDC between PILOT PWR and PILOT COM.

c) Check for problems in the cables leading to the remote controls by unplugging them from the rear of the autopilot.

6. The displayed compass heading does not follow the actual compass heading properly.

a) Check that the compass cable is properly plugged into the rear of the autopilot.

b) Check for any compensating magnets, particularly heeling magnets, that are placed too close to the flux-gate sensor.

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

7. The autopilot steers normally on some courses, but not on others, particularly north or south.

The problem most likely lies with poor compass adjustment. Contact a compass adjustor 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 this may make the compass dangerously inaccurate, particularly if it is used as a steering compass.

8. The autopilot steers poorly on all courses.

a) Check that the internal controls, especially the Dead Band potentiometer, are set correctly. If the autopilot requires the Dead Band potentiometer to be more than 1/8th of a turn from fully counter-clockwise to get proper rudder position control, either the rudder speed is too fast, or there is a problem with the vessels steering system, particularly with either the mounting for the hydraulic ram, or worn rudder shaft bushings. Other problems may include excessive amounts of air in the steering, or excessive play in mechanical steering.

b) Watch the card on the autopilot compass to make sure that it follows the vessel 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.

9. The remote control doesn't work at all.

Check very carefully that the wires are inserted into the terminal block in the remote control in the correct order, and not in reversed order.

10. The remote control doesn't work in POWER STEER or TILLER mode.

Check that the Dip Switches on the autopilot control circuit board are set properly. Dip Switch 5 should be OFF if a type 101 remote is plugged into the REMOTE 1 receptacle on the rear of the autopilot, or ON if it is a type 201 or 211 remote. Dip Switch 6 should be OFF if a type 101 remote is plugged into the REMOTE 2 receptacle on the rear

of the autopilot, or ON if it is a type 201 or 211 remote.

PROBLEM SOLVING

11. The rudder doesn't always move even though the Port or Starboard output LED is lit on the autopilot front panel.

The autopilot is using a CT1T Type 1 Control Box, either as part of a CP1H Hydraulic Pumpset, or a CP1L Hydraulic Linear Actuator, or with an existing reversing electric drive system.

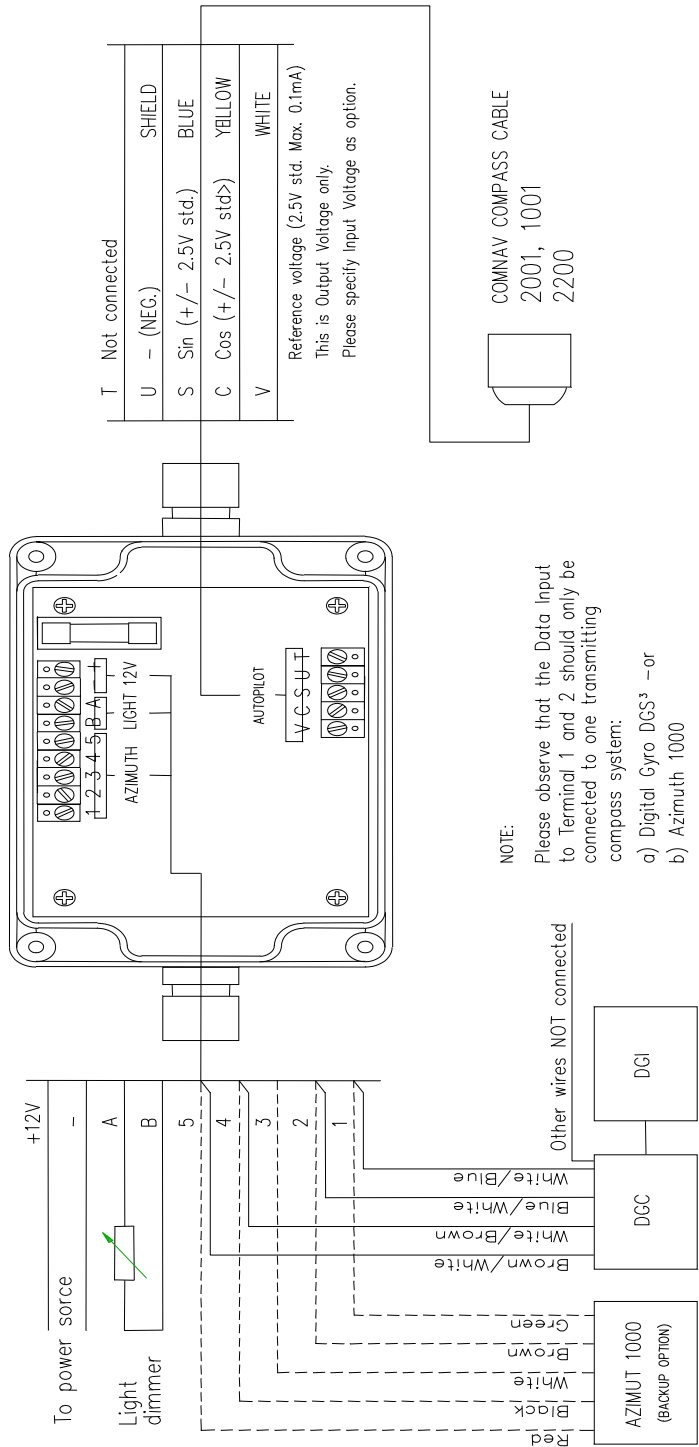
a) Recheck all the connections between the autopilot and the control box, making sure that none are reversed.

b) Remove the cover of the **CT1T** Type 1 Control Box and check the setting of the minimum speed potentiometer for too low a minimum speed.

ADDENDUM A

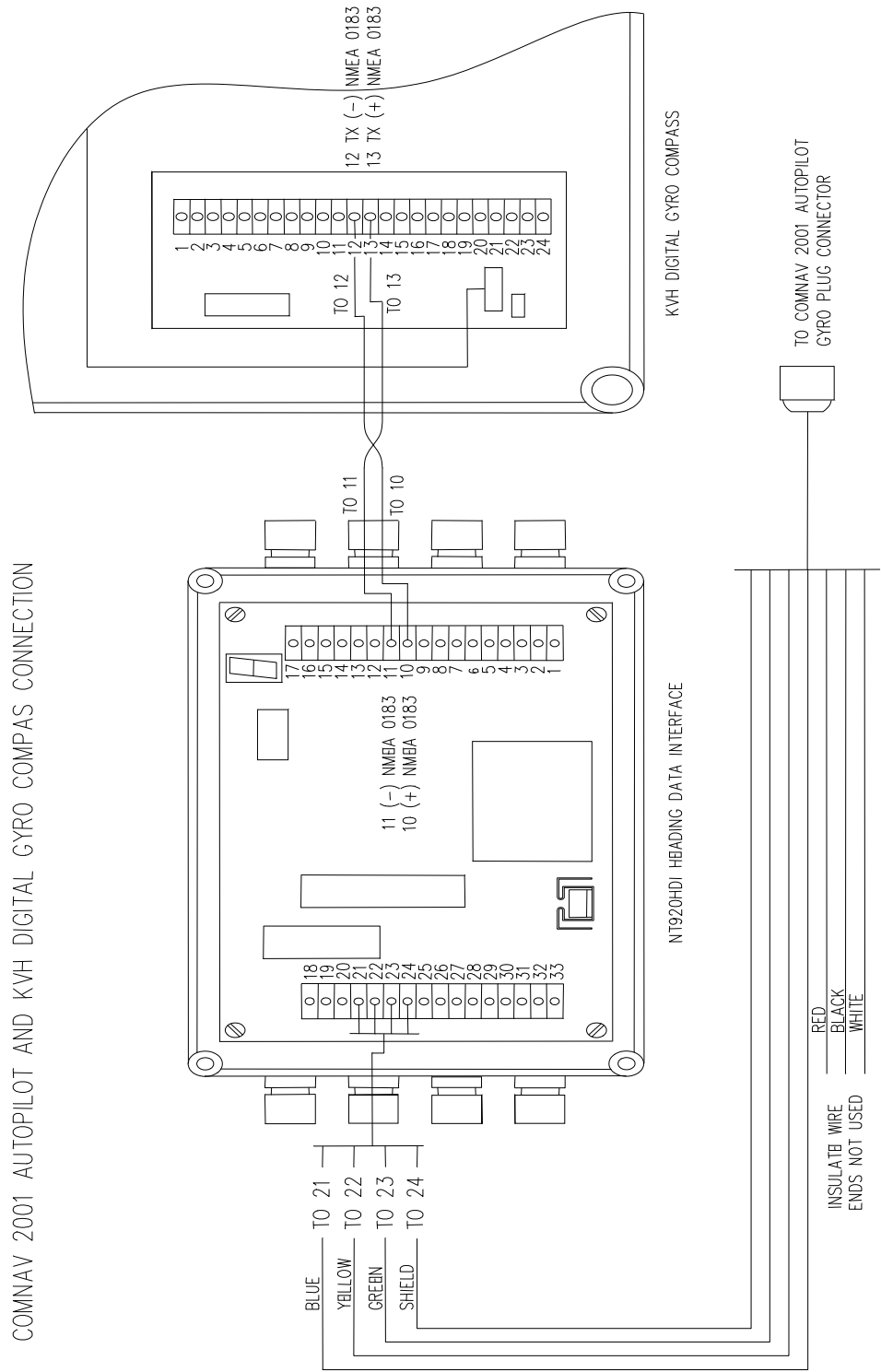
Connecting a 1001F, 2200F or 2001F Autopilot System to a KVH AGDC DIGITAL GYRO COMPASS

INTERFACE TYPE K-INT1 (Input: NMEA 0183, Output: Sine/Cosine)



ADDENDUM B

Connecting a 2001G, 2001GF, 2001GFC, 2001G1, 2001G1F, or
2001G1FC Autopilot system to a KVH AGDC DIGITAL GYRO COMPASS



ADDENDUM D

Autocomp for 2001 Autopilots.

Tools Required: Medium size Slot Screwdriver.
 2001 Installation and Operation Manual.

The Autocomp procedure for 2001 Autopilots is detailed below. The procedure assumes that you have read the 2001 Installation and Operation Manual, and are familiar with the operation of the various controls on the Autopilot Head. Note that the procedure given here differs from the “Dockside Setup” in the Autopilot manual because the Autopilot manual does not take into consideration the presence of a Heading Rate Stabilizer.

1. Start with the Autopilot power turned “off”.
2. Gently loosen the nylon screw on the top of the Heading Rate Stabilizer that is labeled AUTOCOMP. It is necessary to loosen the screw a couple of turns. *Do not remove the screw all the way.*
3. Turn the Autopilot “on”. The display will lock on to an arbitrary heading.
4. Slowly turn the vessel in complete circles. During the turn the heading on the autopilot will remain locked (frozen).
5. Continue turning the vessel until the autopilot display starts to follow the heading changes. It normally takes about 2 ½ circles to come to this stage. Once the autopilot heading starts to respond to the heading change, the autocomp for the Rate Stabilizer is complete. If unsuccessful after 3 ½ turns, the fluxgate compass may need to be relocated.
6. After successful Autocomp, turn the Autopilot “off”.
7. Retighten the AUTOCOMP ACCESS screw. It must be screwed in all the way until the shoulder of the screw-head is completely flush with the face of the unit’s label. Do not over-tighten as this will strip the threads from the screw.
8. Switch the Autopilot on to Standby and check the reading on the display. If the heading displayed on the Autopilot does not match with a reference compass then use the “compass offset function” of the autopilot to synchronize the displayed heading to that of the reference.
9. Turn the Autopilot “off” and then “on” in the normal Standby mode. Check that the compass heading is reading correctly on the display.

This completes the Heading Rate Stabilizer Autocomp procedure for the 2001 Autopilot.

MANUAL CHANGES

DECEMBER 31, 1996

1) PAGE 20 - A STERNER, MORE DETAILED WARNING WAS GIVEN REGARDING RESIDUAL AIR AS WELL LEAKING FITTINGS AND EQUIPMENT.

2) PAGE 17 - WARNING ADDED ABOUT ATTAINING A 10 TO 15 SECOND H.O. TIME.

FEBRUARY 19, 1997

1) PAGE 28 - ADDED DRAWING SHOWING 2001 CPU BOARD LAYOUT

MARCH 17, 1997

1) PAGE 4, 5 & 6 - NEW WARRANTY POLICY

JUNE 20, 1997 - CORRECTED PAGE 67 DRAWING (TERMINALS 10 & 11 REVERSED)

Feb. 2002 – Converted to Microsoft Word. Removed information on Watch Alarms, Updated warranty agreement.