

**Modification to be performed on a Neco Drive Unit
17DR8/35DR8 in order to fit it to an autopilot able to
control solenoid valves.**

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Introduction

The Neco drive consists of a DC motor of the kind where the static magnetic field is produced by both a Shunt and a Series Coil; the only way to invert its rotation is by reversing the relative directions of the static and rotor magnetic fields i.e. by keeping the polarity of the coils fixed and inverting the current to the Armature (via the brushes). This would be easily accomplished if there was only the Shunt Coil which is powered directly from the battery but it is less immediate for the Series Coil which, as its name specifies, is connected in series with the Armature.

The best way to control the turning direction is by using part of the circuitry already present inside the waterproof Relay Box on top of the Neco Drive Unit (DU hereafter). The original circuit (see Figure 1) is essentially made by two changeover relays that take care of powering and inverting the current to the Armature while keeping the current direction in the Series Coil unaffected and short-circuiting the Armature when not powered. The Shunt Coil is paralleled to the Clutch Solenoid and its polarity is kept fixed. The Shunt Coil is powered all the time the autopilot is active, even when the motor is not turning; its function is to act as an electromagnetic brake when the two changeover relays short-circuit the Armature of the motor. The two changeover relays are driven by the final transistors of the Neco Control Unit (CU hereafter) while the Clutch/Shunt coils are powered directly by the CU main switch.

The modification.

The solenoid output of any autopilot will match what the transistors inside the Neco CU do. The clutch control output of commercial autopilots may or may not match the Neco Clutch/Shunt requirements; the latter issue is easily dealt with an additional relay.

Of the four cables originally entering the DU (see Figures 2, 3 and 4), only two must remain: Cable 5 (Two Core, 40/0076) (see the following point 2) and Cable 6 (Two Core, 70/0076). These cables are necessary to power the DU and are connected to the electrical circuit of the boat through the main switchboard. Cable 4 (3 Core) and Cable 2 (8 Core) should be completely detached from the DU 16-terminal block and the open passages left in the box should be plugged.

1) Additional relay needed to control the Clutch and the Shunt coil. It must be a high power DC relay (12V/15A switching specification or better), activated at 12V. Possible choices are OMRON G8P-1C4P 12DC or Tyco Electronics VF4-11F13 but any good automotive high power relay may work; the minimum requirement configuration is SPST NO (single pole, single throw, normally open). It is important that all connectors are isolated from ground and the absorption of the coil is as little as possible (approx 100mA). Find a proper way to accommodate the relay either inside the original Neco Relay Box or close to it. If it cannot be fitted inside the Relay Box check that it is well protected from moisture. The two coil terminals (DU5) and (DU6) must be connected to the autopilot central unit Clutch Output while the two switched terminals are to be connected to the DU as depicted in Figure 4: terminals Nr. 7 and Nr. 9 of the 16-terminal block (Figure 2). Be sure to use only the Common Terminal and the Normally Open Contact of the relay if it is not SPST-NO (check its datasheet). Voltage polarity is NOT important in any connection of this relay.

2) The 2A Fuse placed in the Neco Relay Box (second from left in the Figures 2, 3 and 4) must be taken off in order NOT to send the electrical negative of the boat to that part of the circuit. (This is in accordance with the indication given by Raymarine “CAUTION” in Figure 8 but it is a good practice for any autopilot). In fact it is a good idea to disconnect and insulate the wire carrying the negative from the boat electric circuit to the terminal Nr. 1 of the 16-terminal block of the DU (Blue wire of Cable 5, Figure 3). Notice that the negative of the boat electrical circuit is also carried to terminal Nr. 3 of the 16-terminal block; this connection, that does not feed back to the autopilot Central Unit but is necessary for the functioning of the motor, must remain.

3) The rudder feedback which is placed on the side of the DU needs some attention because the potentiometer is not able to perform whole turns without breaking and causing possible damage to the motor.

It is possible to keep the end switches working but the original 500 Ohm potentiometer is useless as all autopilots are provided by their own rudder reference. The only way to avoid breaking the potentiometer would be to keep it aligned with the rudder so that its central position still coincides with zero rudder angle. If you are not sure to be able to achieve this then next choice will be to extract the whole potentiometer/end-switches assembly (Figure 6) completely from behind the cuplike lid on the side of the DU (Figure 7). In this case the original Neco end-switches will not be present but the new autopilot will take care of the rudder limits through its electronics (note that all autopilots do this by default so the Neco end-switches are just a possibly unnecessary additional security). Be sure to fit the lid back into its position after extracting the assembly and plug the cable passage.

There is a thick cable with 7 wires (cores) from the rudder reference assembly to the terminal blocks inside the Neco Relay Box (Figure 7). The cable should be extracted and the open passage plugged. Of the 7 cores of such cable, the three that go from the potentiometer to terminals 14-15-16 of the 16-terminal block (Red, Green and Blue) should be disconnected and discarded. The other four need taking care of as explained in what follows.

There is a Brown wire connected to terminal 12 and a Violet connected to terminal 13 of the 16-terminal block (Figure 3)(12/16 and 13/16 respectively); a Black wire and a Yellow wire connected to the D and E terminals of the 12-terminal Relay Connector Block under the Fuse Board (Figure 4)(D/12 and E/12 respectively). Having now removed the feedback/end-switches assembly (Figure 6) with the resulting loss of continuity between 12/16 and D/12 and between 13/16 and E/12, the proper connection must therefore be restored inside the DU (Figure 5) with two short wires similar to the ones discarded: the first connected between 12/16 and D/12, and the second between 13/16 and E/12. (Note: the color coding of the cables was taken from several original Neco pages; although unlikely, some discrepancies in the color may exist and should be checked carefully).

Having reached this point it is possible to proceed with the installation of the new autopilot which includes in most cases a Control Display, a Processor Unit, possibly a Junction Box, a Compass, and a Rudder Reference. At the end of the series of figures addressed in the present part, several additional chapters with instructions relating to different autopilot brands are included.

An additional note on 24 and 32 volt units.

The Neco engineers devised a way to match boats with different voltage system with the least changes in their autopilots. Namely they used different coils within the motors depending on voltage, but same relays and same Control Unit with a few added components to lower the voltage only when needed.

In particular:

- 1) the Armature, Series and Shunt coils are “voltage conscious” depending on 12, 24 and 32 V. In this way they are fed directly by the main power lines.
- 2) the Clutch coil is also “voltage conscious” in the 12 or 24 V units. In a system at 32 V the clutch is still at 24 V but an additional resistor 15 Ohm/15 watt is connected in series to lower the voltage. The modification of a 32 V system must take into account this point but the resistor should already be there within the original Relay Box.
- 3) the CU, which is powered by cables coming from the Relay Box and has a voltage regulator inside, needs a voltage input strictly not exceeding 16 V. This is accomplished by the addition of one or two Zener diodes within the Relay Box. The Zener diode breakdown voltage is 8.2 V for the 24 V system and 16.4 V (or two 8.2 V in series) for the 32 V system. The Zener is placed inside the Relay Box on a metal bracket close to the 16-terminal block and it is connected to the terminals 10 and 11 (polarity conscious). This point is not relevant to the modification explained in this paper because the new autopilot “brain” will not be powered by the Neco Drive Unit.
- 4) the relay coils are at 12 V in all the cases because a resistor (68 Ohm/10W for the case at 24 V or 120 Ohm/10 W for 32 V) is connected in series on the negative common branch of both relays. One could ask why the voltage at the exit of the Control Unit should be lowered again: this is due to the positive-common configuration of the CU electronics. If in performing the modification proposed in this paper the relays are changed with units at a different voltage, this point should be taken into account. On the other hand, if the original relays are used, the appropriate resistor is already there. One should only take into account this point if the voltage exiting the new autopilot control lines does not match the original which was the same of the main power.

Acknowledgments.

I am grateful to M.Bennett for his helpful comments and suggestions. He contributed to find and correct errors in the first drafts of this note.

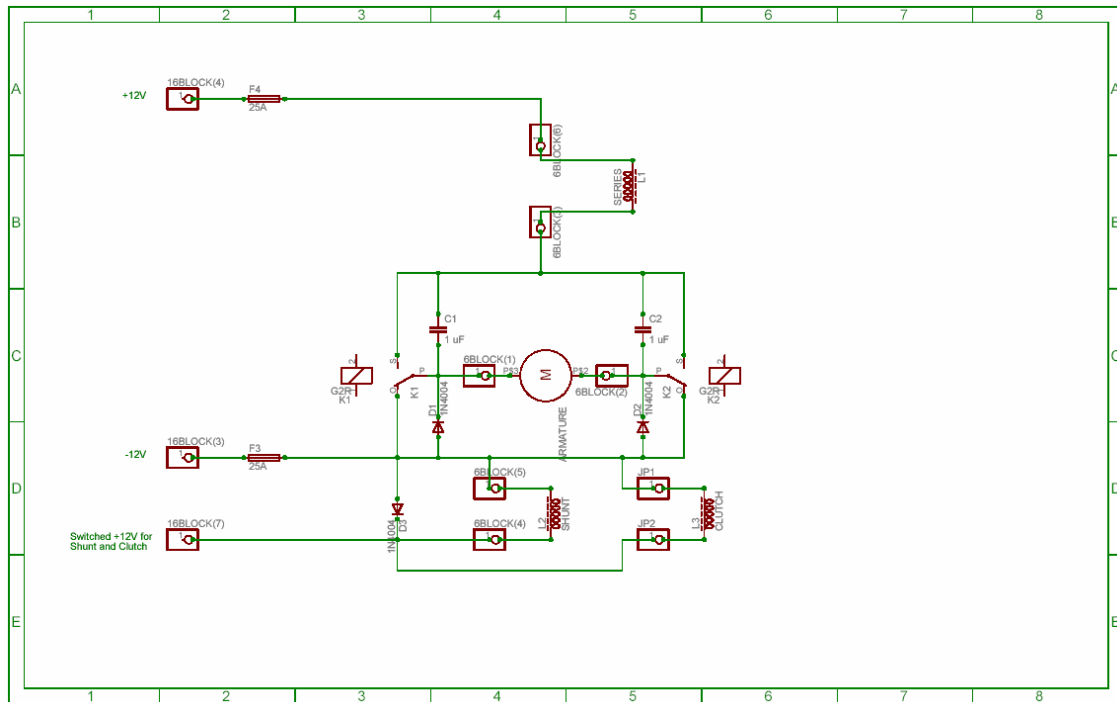


Figure 1. Electrical scheme of the circuit that controls the reversing of the Shunt/Series DC Neco Drive. The motor turning direction depends on which relay is activated. If both relays are deactivated (as in the figure), the Armature poles are both grounded and the Series Coil is not powered.

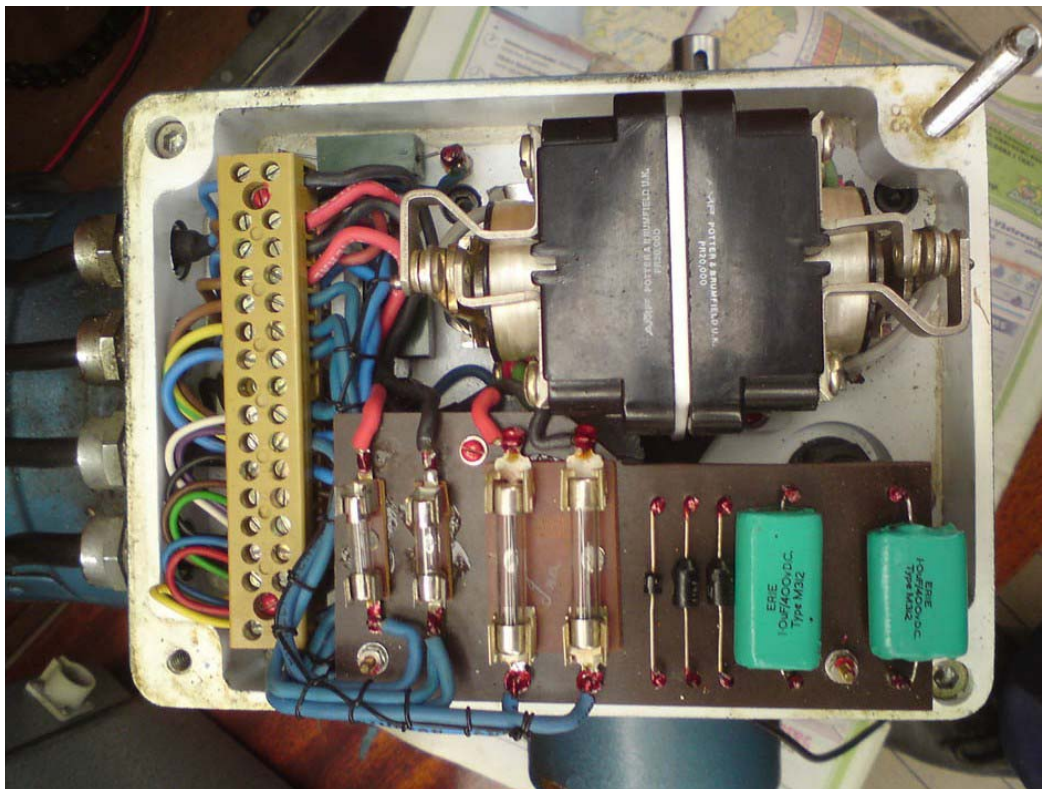


Figure 2. Picture of the open Neco Relay Box. Left: the 16-terminal block. Center-top: the two black relay bodies fixed shoulder-to-shoulder. Center-bottom: the fuse board which hides the relay connector block.

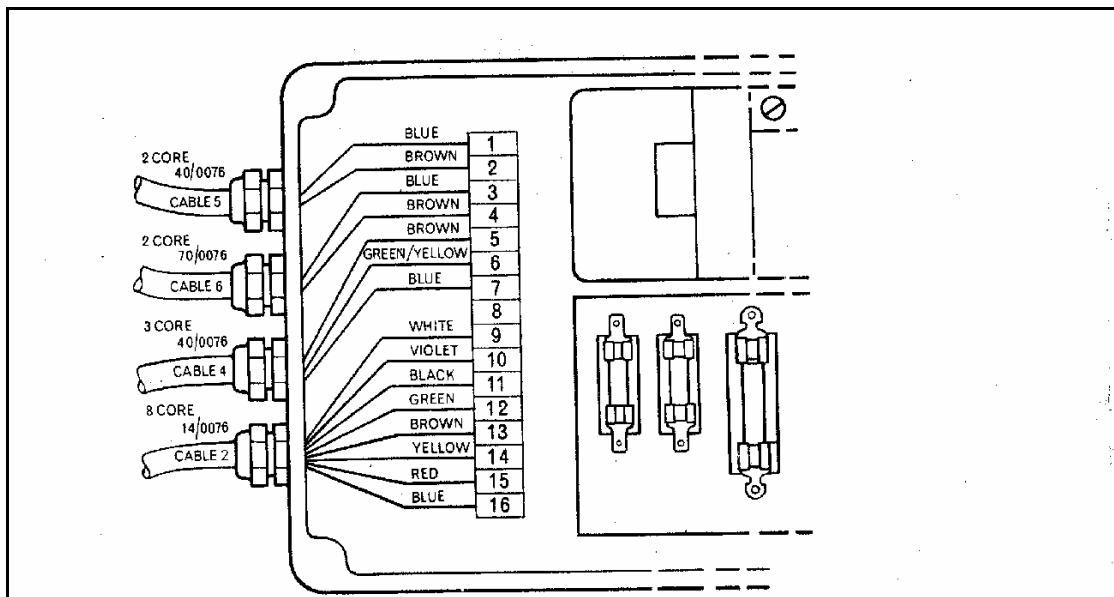


Figure 3. Particular of the Neco Relay Box (extracted from the Neco Manual).

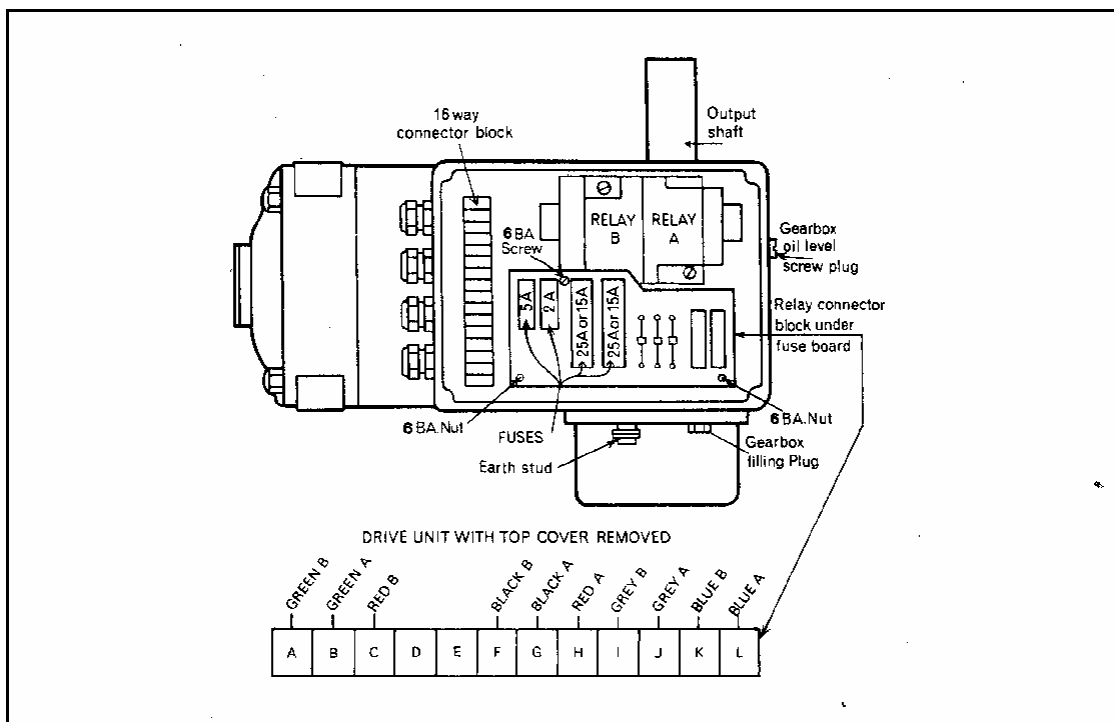


Figure 4. Neco Drive Unit and Relay Box (extracted from the Neco Manual).

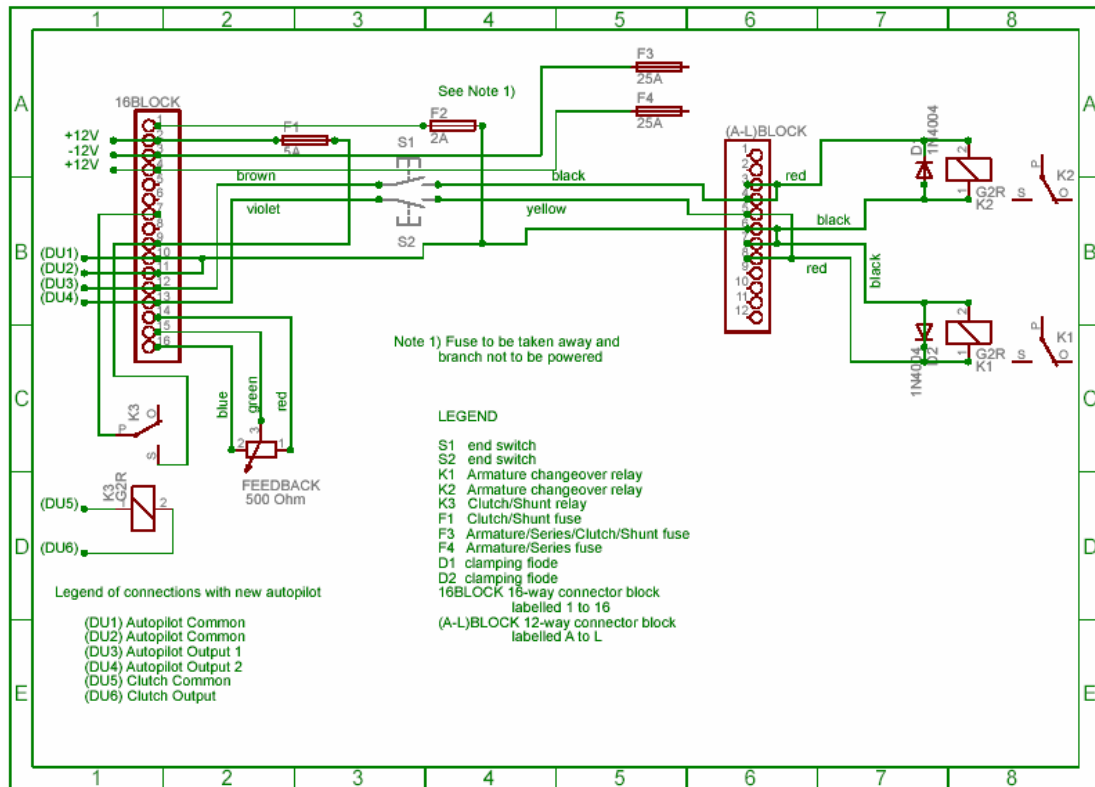


Figure 5. Electrical scheme of the relevant connections inside the Neco Relay Box where changes are to be carried out. Parts of the circuit present in the Neco Relay Box but not indicated in this scheme must not be modified to avoid compromising its functioning.



Figure 6. Neco rudder feedback and “end-switches” assembly (photograph by N.Kassel).

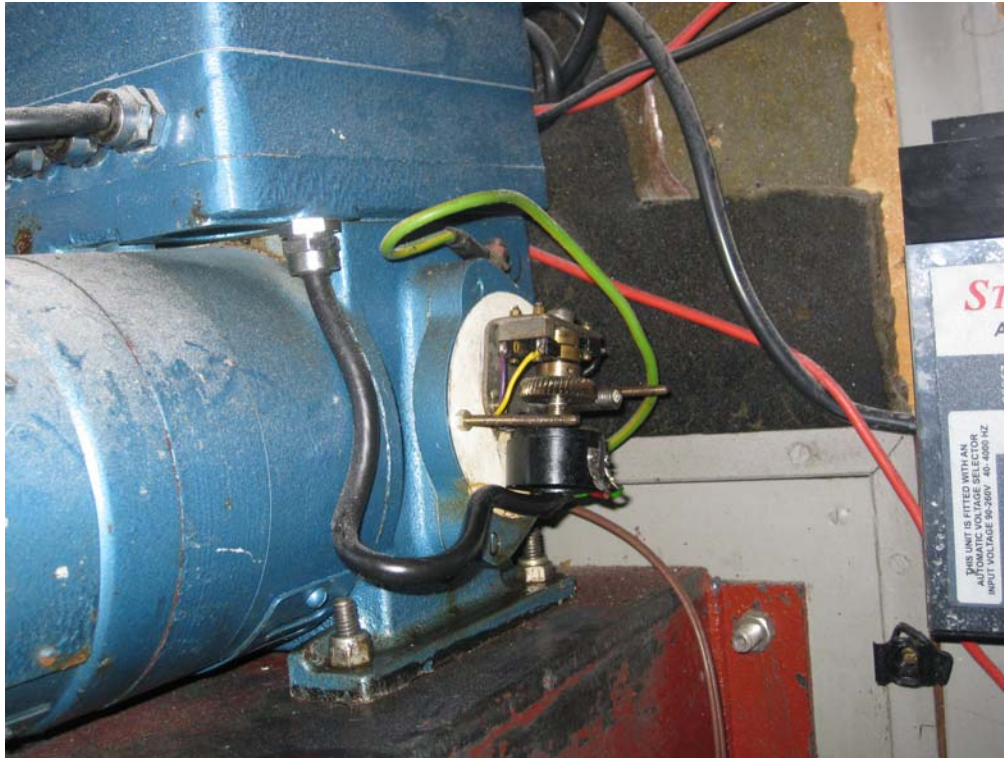


Figure 7. Position of the rudder feedback assembly on the side of the Drive Unit. The black 7-core cable from the feedback assembly to the Relay Box is clearly visible (photograph by N.Kassel) .

Notes for connecting a Neco Drive Unit (DU) to a Raymarine Type 150/400 Autopilot System (AP hereafter).

Regarding the control of the motor through relays, we follow what is suggested by Raymarine (Figures 8 and 9) for connecting its AP to “spool valves” (solenoids are electrically identical to relays).

The “Drive Motor Outputs” terminals MOTOR(A) and MOTOR(B) (AP, figure 9) are to be connected to (12/16)(defined also as DU3) and (13/16) (also DU4) of the 16-terminal block inside DU, Figure 3. Polarity is important for a correct rudder control but, unfortunately, the right choice must be checked according to a final test while in function: there is a 50% chance to find the right configuration at first shot. If the rudder corrections performed by the autopilot are in the wrong direction the link from MOTOR(A) and MOTOR(B) to 12/16(DU3) and 13/16(DU4) shall be crossed.

The terminals (10/16) (DU1) and (11/16) (DU2) of the 16-terminal block inside DU, Figure 3, are to be connected to the two “Drive solenoid return inputs” SOLENOID(-) of AP, Figure 9. Polarity is not important in this case.

Notice that the clamping diodes required by Raymarine across the solenoids are already present within the DU, therefore additional diodes are not necessary.

The “Drive clutch outputs” of the AP, Figure 10, are to be connected to (DU5) and (DU6) of DU, Figure 5 i.e. to the coil terminals of the newly fitted relay. Polarity is NOT important. If there is a voltage selector for the clutch, (only Type 400) it must be set to 12V.

Other manufacturers' drive units

If you are connecting another manufacturer's drive unit, refer to the specifications (on *page 45*) for information on the course computer's drive motor, drive clutch and drive solenoid terminals. Connect the drive unit to these terminals as necessary.



For more information, contact the drive unit manufacturer.

Connecting spool valves

If the drive has spool valves, connect them to the motor and solenoid terminals on the course computer as shown below. The course computer provides a negative ground for the spool valves even when it is switched off.

CAUTION:

Do NOT connect the solenoid return cables to boat's negative ground, as this will bypass the current protection devices inside the course computer.

Figure 8. (extracted from the Raymarine manual)

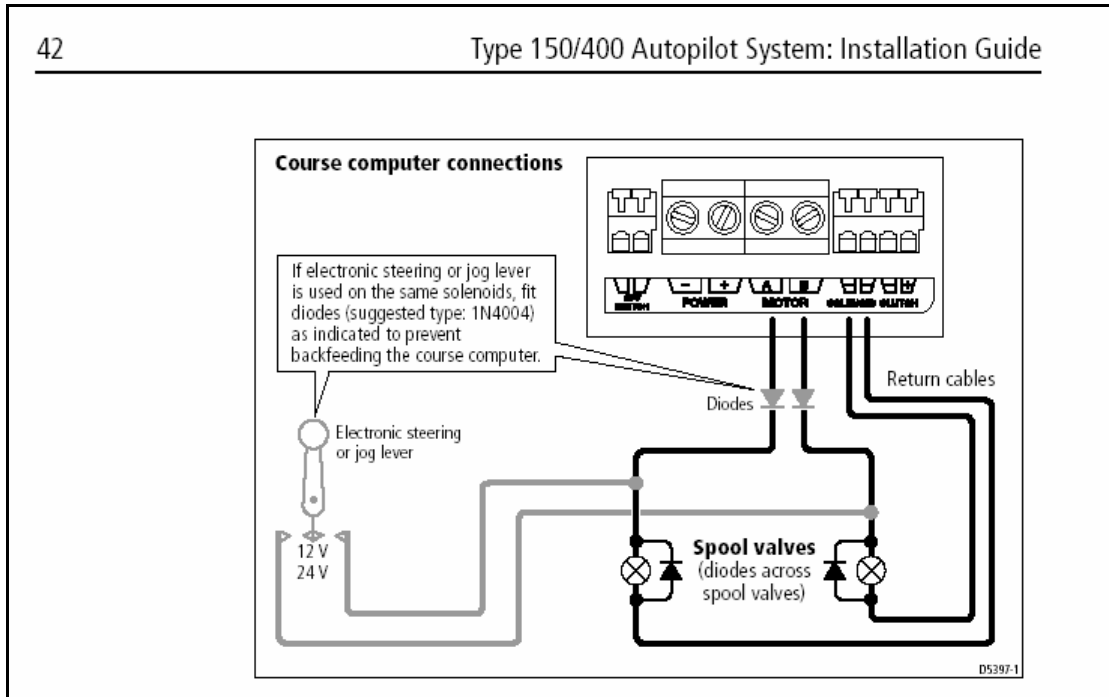


Figure 9. (extracted from the Raymarine manual)

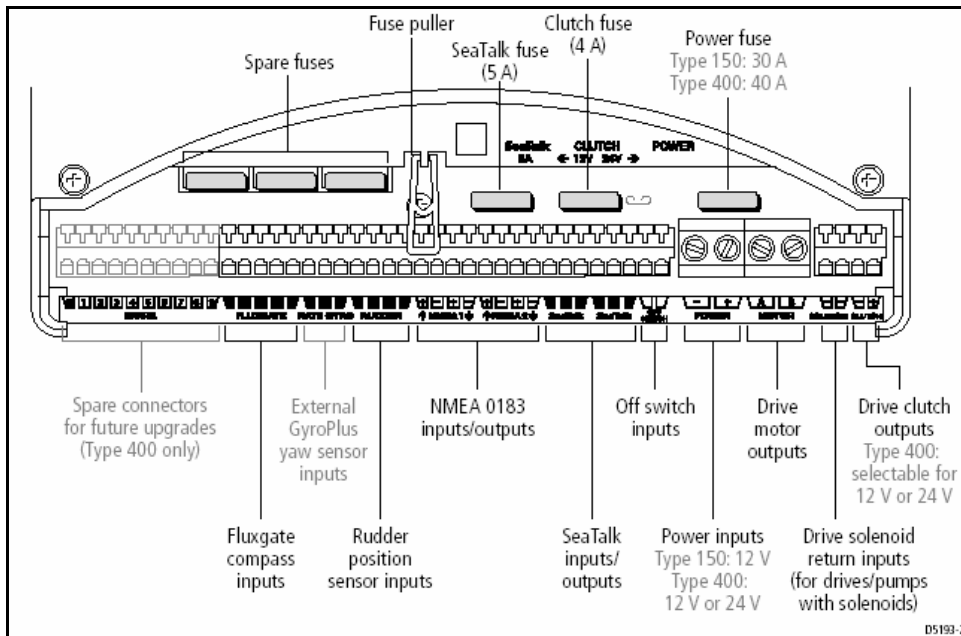


Figure 10. (extracted from the Raymarine Manual)

Notes for connecting a Neco Drive Unit (DU) to a Simrad AP22 Autopilot (AP22 hereafter).

Regarding the control of the motor through relays, we follow what is suggested by Simrad (Figure 11) for connecting its AP22 to a “solenoid valve” (solenoids are electrically identical to relays).

The terminals “Sol.-Motor” TB3 and TB4 (AP22, Figure 11) are to be connected to (12/16)(defined also as DU3) and (13/16) (also DU4) of the 16-terminal block inside the Neco Relay Box, Figure 3. Polarity is important for a correct rudder control but, unfortunately, the right choice must be checked according to a final test while in function: there is a 50% chance to find the right configuration at first shot. If the rudder corrections performed by the autopilot are in the wrong direction the link from TB3 and TB4 to 13/16(DU4) and 12/16(DU3) shall be crossed.

The terminals (10/16) (DU1) and (11/16) (DU2) of the 16-terminal block of the Neco Relay Box, Figure 3, are both to be connected to “Sol. gnd” TB5 of AP22, Figure 11.

Although no specific indication is given by Simrad and clamping diodes never appear in their schematics, we believe that the clamping diodes should be unsoldered (or clipped) from the original Neco relays.

The “Drive engage” TB6 + and TB6 - of the AP22, Figure 11, are to be connected to (DU5) and (DU6) of DU, Figure 5 i.e. to the coil terminals of the newly fitted relay. Polarity is NOT important.

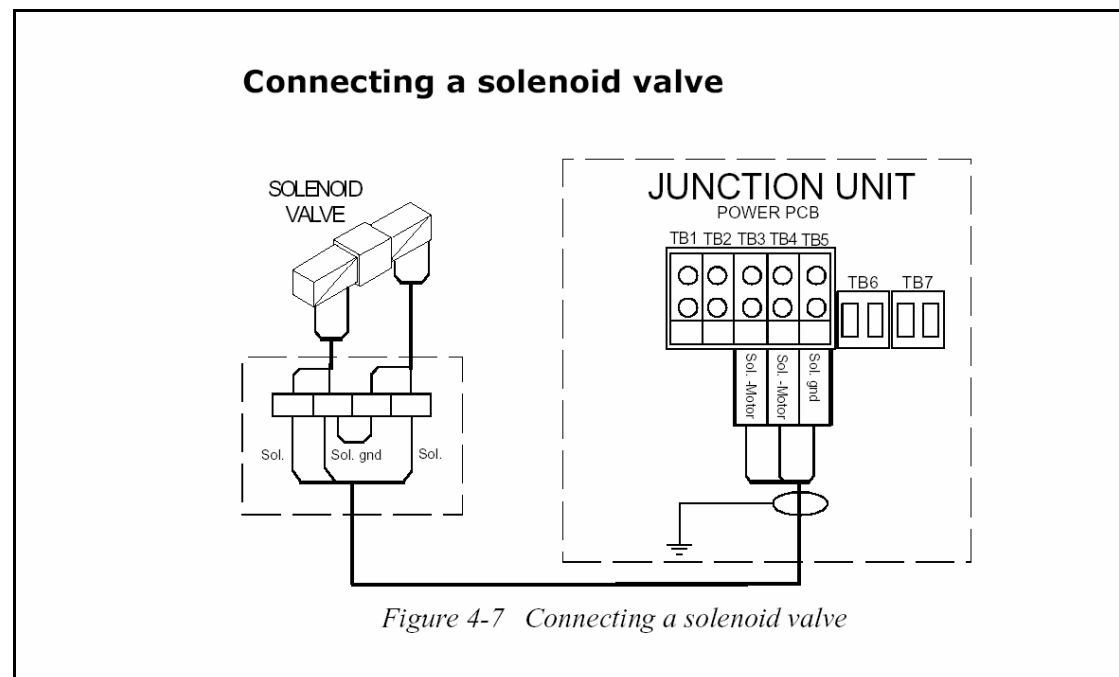


Figure 11. (extracted from the Simrad Manual)

Notes for connecting a Neco Drive Unit to a Geonav/Navicontrol autopilot (GEO hereafter).

Regarding the control of the motor through relays, we follow what is suggested by Geonav (Figure 12) for connecting its GEO to a “RELAYS SYSTEM”.

The terminals “LEFT +” 1/TB11 and “RIGHT +” 3/TB11 (GEO, Figure 12) are to be connected to (12/16)(defined also as DU3) and (13/16) (also DU4) of the 16-terminal block inside the Neco Relay Box, Figure 3. Polarity is important for a correct rudder control but, unfortunately, the right choice must be checked according to a final test while in function: there is a 50% chance to find the right configuration at first shot. If the rudder corrections performed by the autopilot are in the wrong direction the link from 1/TB11 and 3/TB11 to 13/16(DU4) and 12/16(DU3) shall be crossed.

The terminals (10/16) (DU1) and (11/16) (DU2) of the 16-terminal block of the Neco Relay Box, Figure 3, are to be connected to “LEFT -“ 2/TB11 and “RIGHT -“ 4/TB11 of GEO, Figure 12. Polarity is not important in this case.

Notice that GEONAV discourages the use of clamping diodes across the solenoids therefore the diodes should be unsoldered (or clipped) from the original Neco relays.

The “MOTOR RELAY” “+” and “-“ 5/TB11 and 6/TB11 of the GEO, Figure 12, are to be connected to (DU5) and (DU6) of DU, Figure 5 i.e. to the coil terminals of the newly fitted relay. Polarity is NOT important.

Still GEONAV suggests to connect a 50-100Ohm/25W resistor between the R.MOTOR terminals as in Figure 12.

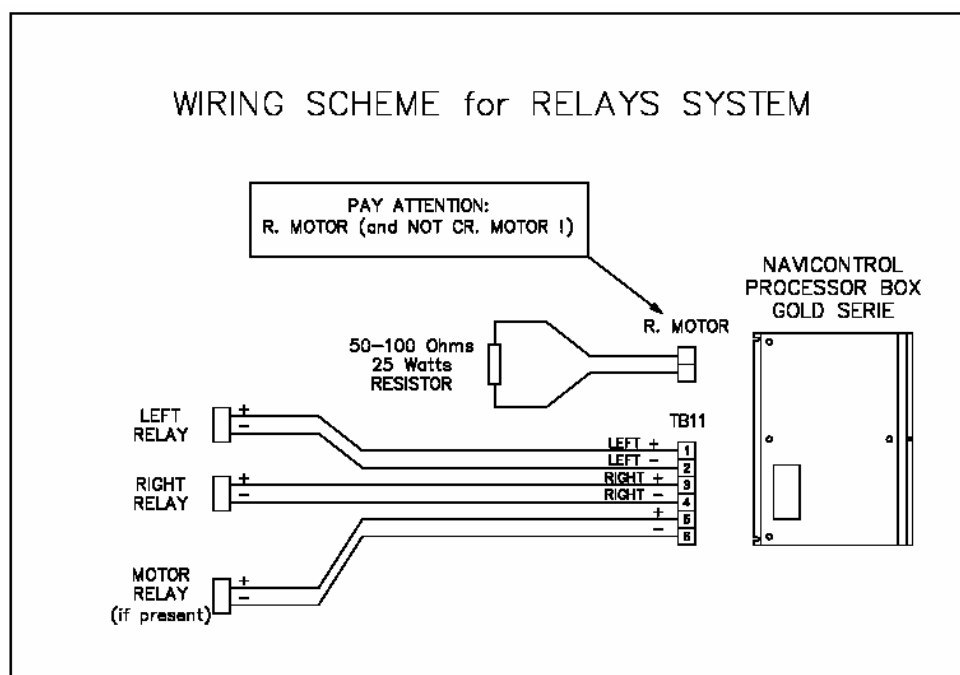
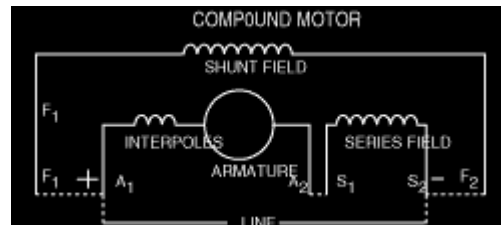


Figure 12. (Source: GEONAV/NAVICONTROL)

Appendix

Compound-Wound DC Motors - A combination of the shunt wound and series wound types combines the characteristics of both. Characteristics may be varied by varying the combination of the two windings. These motors are generally used where severe starting conditions are met and constant speed is required at the same time



When comparing the advantages of the series and shunt motors, the series motor has greater torque capabilities while the shunt motor has more constant and controllable speed over various loads. These two desirable characteristics can be found in the same motor by placing both a series field and shunt field winding on the same pole. Thus, we have the compound motor.

The compound motor responds better to heavy load changes than a shunt motor because of the increased current through the series field coils. This boosts the field strength, providing added torque and speeds.

If a shunt coil is added to a series motor at light loads (when a series motor tends to over speed) the added shunt field flux limits the top speed, eliminating self-destruction.

Common uses of the compound motor include elevators, air compressors, conveyors, presses and shears. Compound motors can be operated as shunt motors by disconnecting the series field. Many manufacturing process lines are designed this way. The reason being that, most off the shelf motors are compound motors, and the series field can always be connected later to provide additional torque, if needed.

Compound motors can be connected two ways, cumulatively and differentially. When connected cumulatively, the series field is connected to aid the shunt field, providing faster response than a straight shunt motor. When connected differentially, the series field opposes the shunt field. Differentially connected compound motors are sometimes referred to as "suicide motors," because of their penchant for self destruction. If perhaps, the shunt field circuit were to suddenly open during loading, the series field would then assume control and the polarity of all fields would reverse. This results in the motor stopping, and then restarting in the opposite direction. It then operates as an unloaded series motor and will destroy itself. Differentially connected motors can also start in the opposite direction if the load is too heavy. Therefore, it is seldom used in industry