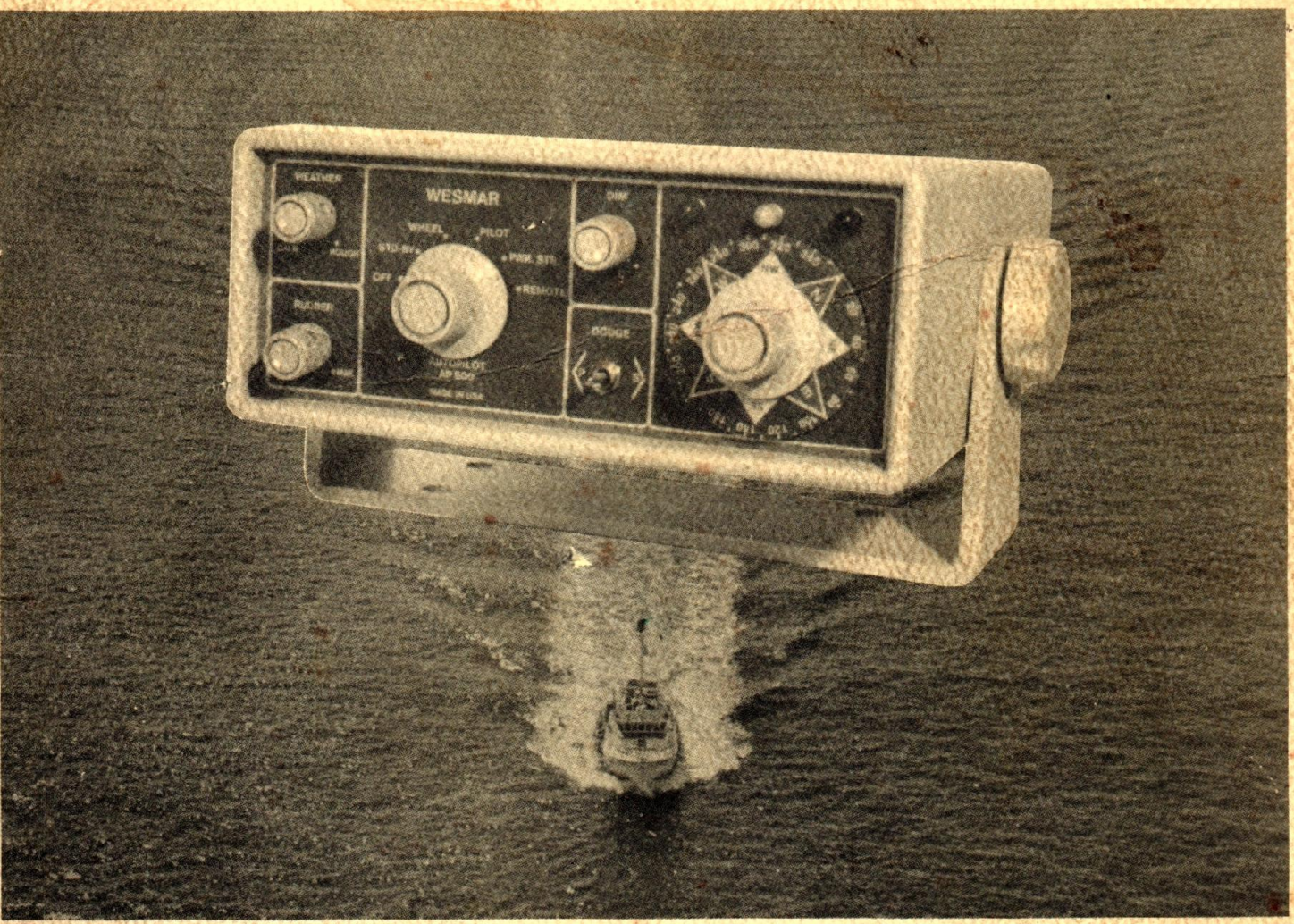
Sea Mart P-1301

WESMAR AP900



Autopilot Owner's Manual

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FORM SDN1423-1176

We at WESMAR wish to thank you for choosing our product. For eleven years WESMAR has been successfully designing and manufacturing marine electronic equipment for commercial fishing vessels, salvage boats, deep sea submersibles, research ships, and search and rescue vessels. All of this experience has gone into the development of your AP900 Autopilot. We believe that you have purchased the most advanced autopilot on the market today.

You should read this manual COMPLETELY before attempting to install or operate your WESMAR Autopilot.

NOTE: Never leave the helm unattended. WESMAR's AP900 does many things for you and your boat, but protecting your vessel from dangerous situations is not one of them. No amount of electronic equipment will ever replace the most important source of safety, you the pilot.

Always steer your vessel manually (Autopilot in STD-BY) when moving in the vicinity of other vessels, near land masses, or under steel bridges.

PROPRIETARY NOTICE

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Schematics

1.0 GENERAL DESCRIPTION

This manual contains detailed information concerning the AP900 Autopilot designed and manufactured by WESMAR. The first section, Description, provides an overview of the system, its uses and function. Each module is pictured and briefly discussed. The following three sections contain complete Installation, Calibration and Operation instructions. Also contained in the manual are Dockside Checkout and Sea Trial sections. The Service Instructions section includes information on maintenance, spare parts, replacement procedure, and a troubleshooting guide. System specifications and schematics can be found in the final section.

This is indeed an all-purpose manual! Keep it close at hand, and refer to it often.

1.1 SYSTEM MODULES

The AP900 Autopilot system is comprised of 6 distinct modules (pieces) of equipment and Interconnecting Cables:

Control Console - Contains most of the system's electronics on three removable printed circuit boards. All the controls to effectively operate the Autopilot appear on the Console. A dust cover, trunnion bracket, and trunnion knobs are also included.

Saturable Core Sensor (Compass) - Consists of an electronic compass and mounting bracket. The Sensor senses the magnetic heading of the vessel.

Rudder Position Transducer - Consists of a feedback transducer assembly, feedback arm, and connecting rod with swivels. The Transducer senses rudder angle and transmits this information to the Control Console.

Interconnecting Matrix - Serves as a junction center for all modules of the AP900 Autopilot. The basic modules are attached to the Matrix by means of cables.

Servo Driver - Takes the small electronic signal from the Control Console and amplifies it to sufficient power to drive the Servo Motor clockwise or counterclockwise. (Several different models are available so that the Autopilot can be adapted to various steering systems.)

Servo Motor - Converts the amplified electrical information into mechanical motion of the rudder.

Interconnecting Cables - Used to connect each of the Autopilot modules to the Matrix.

1.2 APPLICATION

The AP900 Autopilot is a cost- and space-saving Autopilot system, designed primarily for vessels in the 28 to 60 foot (8 to 18 m.) range, although it can be modified to steer smaller or even much larger vessels. The AP900 is used on pleasure craft as well as fishing vessels throughout the world. A tested system, the AP900 incorporates the latest design techniques and electronic CMOS components. The AP900 has been kept as compact as possible; it is easily operated and easily maintained. Thus, the AP900 saves space as well as reduces installation and maintenance costs. Optional equipment is available to tailor the Autopilot to each operator and vessel. The Autopilot can be adjusted to most makes of steering systems -- cable, rod, electric, hydraulic, or any combination of these systems. The operator can choose manual or automatic steering, using the function control selector on the console panel. In the remote mode, the entire system can be operated by the Remote Hand Control.

1.3 SYSTEM FUNCTION

At the AP900 Control Console the operator "dials in" a desired course heading and switches the FUNCTION switch to PILOT. The AP900 Saturable Core Sensor senses the heading of the vessel and compares this heading signal to the dialed in course signal. Should the heading of the vessel be different from the dialed in course, a "course error" signal will be generated in the sense amplifier board (AP900-4016) within the Control Console.

With the rudder at amidships, the "course error" signal generated in the sense amplifier is compared to the "rudder position" signal sent from the Rudder Position Transducer (RPT). This comparison takes place in the control amplifier board (AP900-4017). The "course error" signal causes an imbalance in the control summing circuits, generating proportional and trigger signals. The proportional and trigger signals are sent to the Servo Driver where they are amplified. This signal is then sent to the Servo Motor. The Servo Motor moves the rudder in the direction to bring the vessel onto course. The amount of rudder applied is controlled by the Rudder Position Transducer. As the Servo Motor moves the rudder, the RPT produces a DC signal to balance the "course error" signal, thus stopping rudder movement.

As the vessel responds to the applied rudder it starts to come onto the desired course. As the vessel turns, the "course error" signal starts to diminish. This decrease in "course error" produces a reverse imbalance in the control amplifier board, causing the same chain of events to re-occur, except that the rudder is removed instead of applied. The Servo Motor will always move the rudder the correct amount so as to produce a balance between "course error" and "rudder position" signals.

With the vessel on the "dialed in" heading, the "course error" will be zero. With no "course error," the Servo Motor will have returned the rudder to amidships, and a balanced condition will exist at the summing junction on the control amplifier board. Should either signal change due to course change or rudder movement, the imbalance will cause the same chain of events to reoccur.

By adjusting the WEATHER and RUDDER controls on the AP900 Console front panel, the operator can choose the amount of rudder applied and width of course error allowed. In this way, the Autopilot can be "tuned" to the steering characteristics of the vessel, as well as prevailing weather conditions.

1.4 DESCRIPTION OF MODULES

The basic AP900 Autopilot system contains six distinct modules. The function of each of these modules, and of the accessories available, is described below.

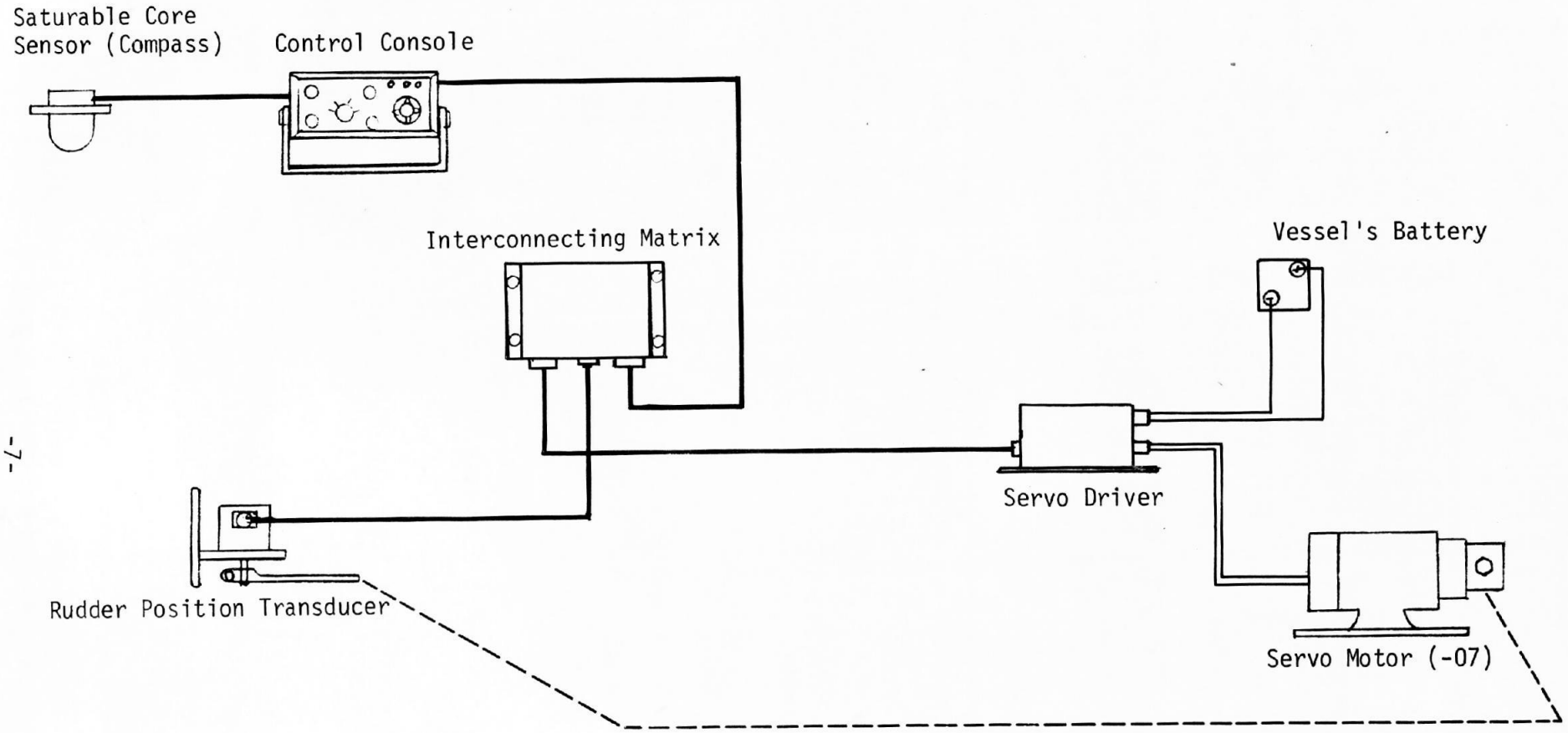


FIGURE 1. BLOCK DIAGRAM OF AP900 AUTOPILOT SYSTEM WITH A HYDRAULIC SERVO MOTOR (-07)

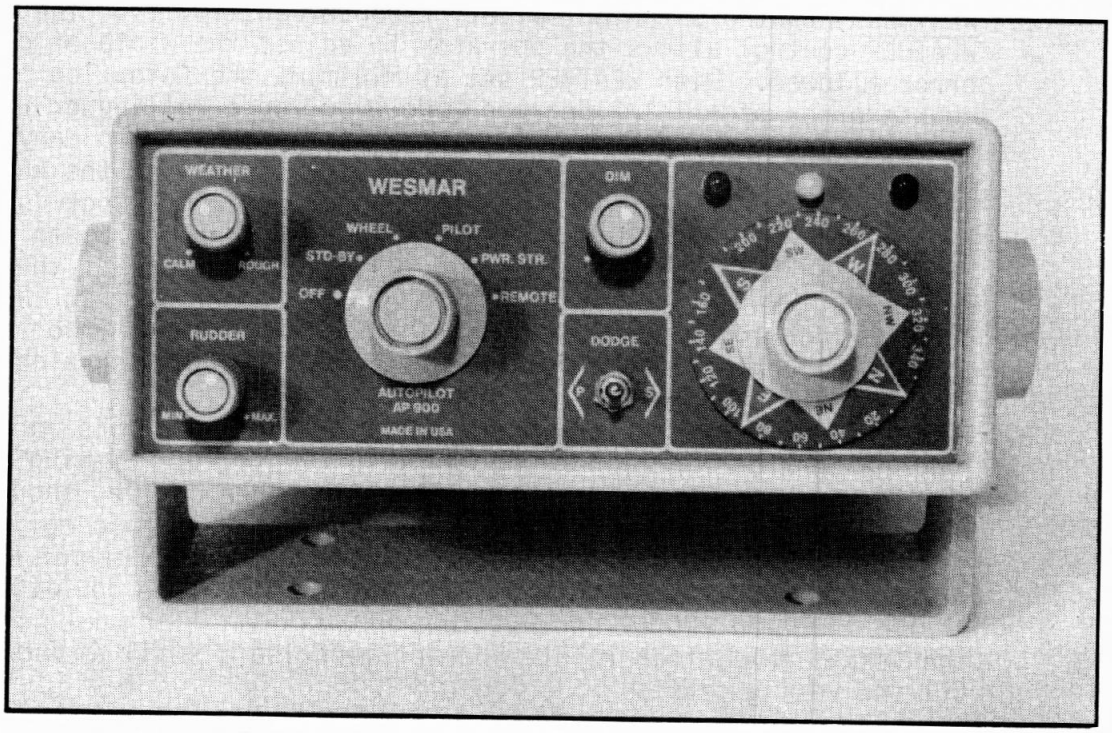


FIGURE 2. CONTROL CONSOLE, FRONT PANEL

1.4.1 Control Console

The Control Console contains 90% of the system's electronics. All controls necessary to operate the Autopilot are on the backlighted Console panel. The function of the six controls is explained below:

1. FUNCTION switch - Allows the operator to select from 6 modes of operation:

   a. OFF: Power is off. Autopilot is non-functional.

   b. STD-BY: Autopilot automatically turns COURSE SET DIAL to heading being manually steered. The COURSE SET DIAL also acts as a compass repeater.

   c. WHEEL: DC power is on; the course sensing circuits are the only active circuits. The operator can use this mode to "steer by lights." Dial in a course and set the WEATHER control (explained below). Manually steer the vessel so that the yellow light remains lit, indicating that the vessel is on course. Should the red light come on, apply port rudder until the yellow light is again lit. Should the green light be lit, apply starboard rudder.

   d. PILOT: Autopilot is automatically steering the vessel on the preset course.

   e. PWR.STR. (Power Steer): In this mode, the Autopilot will hold the rudder at any position desired. The vessel can thus be steered electronically by pressing the DODGE switch either port or starboard.

   f. REMOTE: In this mode all control is transferred from the Control Console to the Remote Hand Control.

2. WEATHER - Controls the Autopilot response sensitivity. The WEATHER control allows the operator to adjust the width of course error allowed. With WEATHER set at minimum, the Autopilot corrects course error of ± 1 1/2 degrees. However, on a rolling or rough sea this degree of accuracy is impractical, causing too many course adjustments and unnecessary strain on your vessel and the Autopilot. In this situation, turn the WEATHER toward maximum, clockwise. At this setting, the Autopilot will correct course error up to ± 10 degrees and the course "made good" will be an average of the vessel's movements. In general, the WEATHER should be set so that the yellow function light will be lit 50 - 60% of the time. In other words, the red and green function lights will blink occasionally.

3. RUDDER - Controls the amount of applied rudder. This is an important control function which keeps the vessel from yawing. Should the vessel's rudder be small and non-responsive, should the vessel have dead rudder, be in a following sea, or just moving slowly, RUDDER can be increased clockwise toward maximum, allowing more rudder to be applied for a fixed off-course deviation. Always turn the RUDDER control towards maximum, clockwise, until the vessel yaws, then rotate counterclockwise a small amount until the yawing ceases.

4. DODGE - Can be used to dodge objects or for electronic steering. The DODGE switch is activated when the FUNCTION switch is set on PILOT or PWR.STR. In the PILOT mode, press the DODGE switch either starboard or port, and the rudder will be applied until you release the switch, or until a limit switch is activated. Once the switch is released, the vessel will return to the original preset course. In the PWR.STR. mode, rudder is applied in the direction the DODGE switch is pressed. When the switch is released, however, the vessel will not return to the original course. In this manner, you can electronically steer your vessel for docking, circling a school of fish, or picking up crab pots.

5. COURSE SET DIAL - Sets the desired course. In the STD-BY mode, the COURSE SET DIAL will automatically turn to the course heading being steered manually, thereby setting the course for the Autopilot. In other modes, the operator must dial in the desired course.

6. DIM - Varies the intensity of function lights and backlighting. This feature allows easy use of the Autopilot at night.

1.4.2 Saturable Core Sensor (Compass)

The "saturable core" magnetic compass senses the earth's magnetic field electromagnetically. Since the compass uses no floating discs or moving parts, it can respond instantly to changes in direction. The Sensor is permanently housed in a waterproof sealed enclosure. The sensing element is internally mounted on a four-way gimbal to compensate for a full 70 degrees pitch and roll.

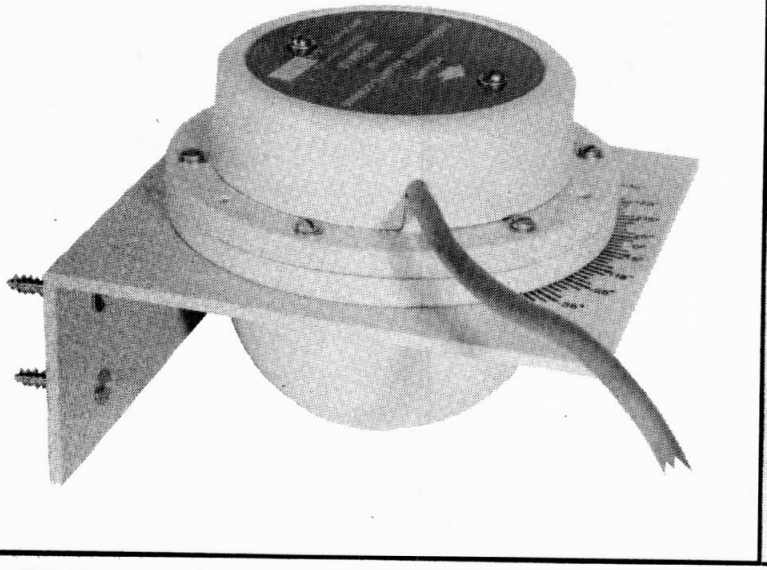


FIGURE 3. SATURABLE CORE SENSOR (COMPASS)

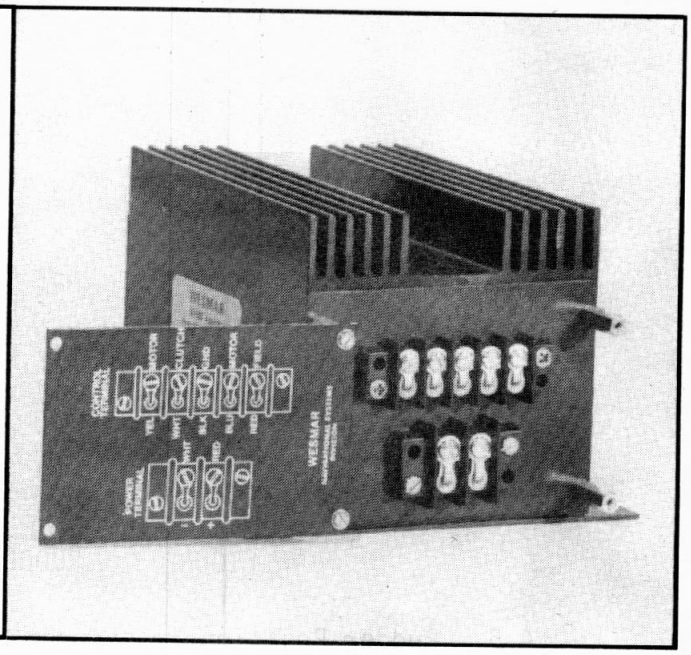


FIGURE 4. SERVO DRIVER

1.4.3 Servo Driver

All autopilot systems require a Servo Driver and Servo Motor to convert the electronic logic information to mechanical action. The Servo Driver takes the small electronic signal from the Control Console and amplifies it to sufficient power to drive the Servo Motor clockwise or counterclockwise. WESMAR Servo Drivers can be connected to existing competitive Servo Motors.

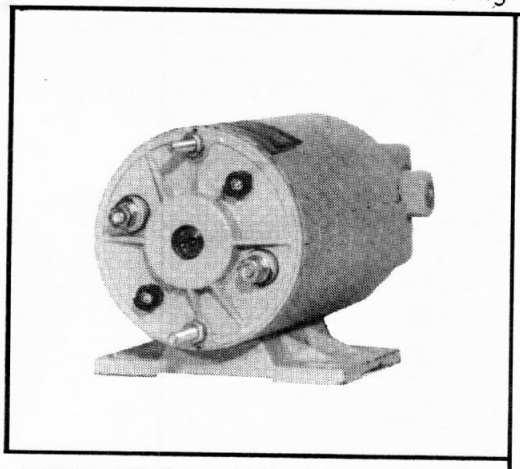


FIGURE 5. SERVO MOTOR, HYDRAULIC (-07)

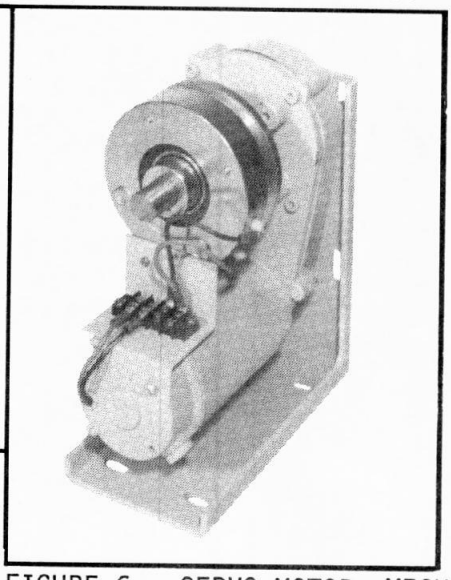


FIGURE 6. SERVO MOTOR, MECHANICAL (-06)

1.4.4 Servo Motor

The Servo Motor receives, via an interconnecting cable, the electronic signal from the Servo Driver and converts it to mechanical or hydraulic torque to move the rudder port or starboard. WESMAR Servo Motors can be used with mechanical, hydraulic, or engine-driven power steering. The -06 mechanical Servo Motor, capable of applying 20 ft. lbs. of torque at 22 RPM, is small in size and can be mounted in any plane. WESMAR's -07 hydraulic Servo Motor system can be teed into the existing hydraulic lines, and has a bi-directional gear pump with built-in lock valves, relief valves, and replenishing valves. The hydraulic Servo Motor can be used with balanced or unbalanced cylinders. Pressure relief valves can be adjusted from 0 up to 3000 PSI. All units are set at the factory to release at 850 PSI.

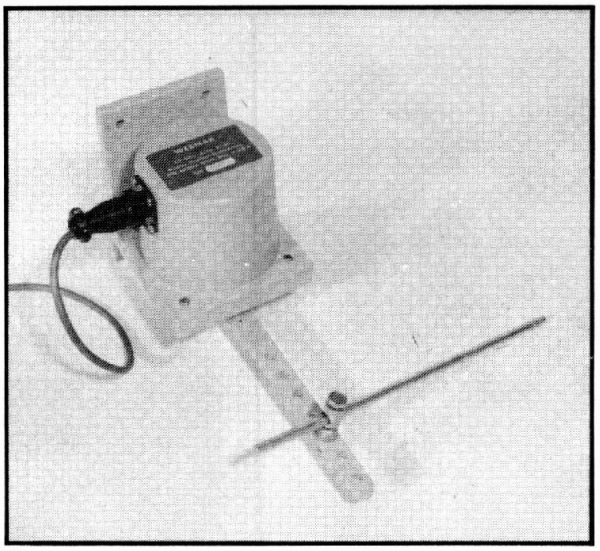


FIGURE 7. RUDDER POSITION TRANSDUCER

1.4.5 Rudder Position Transducer

The Rudder Position Transducer, installed in the lazarette area near the rudder, continually transmits a proportional DC signal, indicating the rudder angle to the Control Console. The Transducer is mechanically connected to the rudder shaft by means of a feedback arm and rod. Two safety limit switches contained within the Transducer limit the rudder angle during Autopilot operation. In this way, the vessel's steering system is protected from damage.

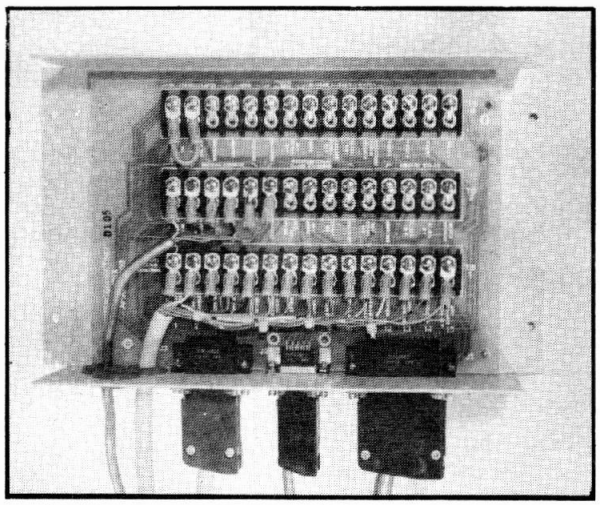


FIGURE 8. INTERCONNECTING MATRIX

1.4.6 Interconnecting Matrix

The Interconnecting Matrix serves as a junction center for all modules of the AP900 Autopilot. The basic modules of the Autopilot plug into connectors provided on the Matrix. Accessories connect into the Matrix via terminal posts.

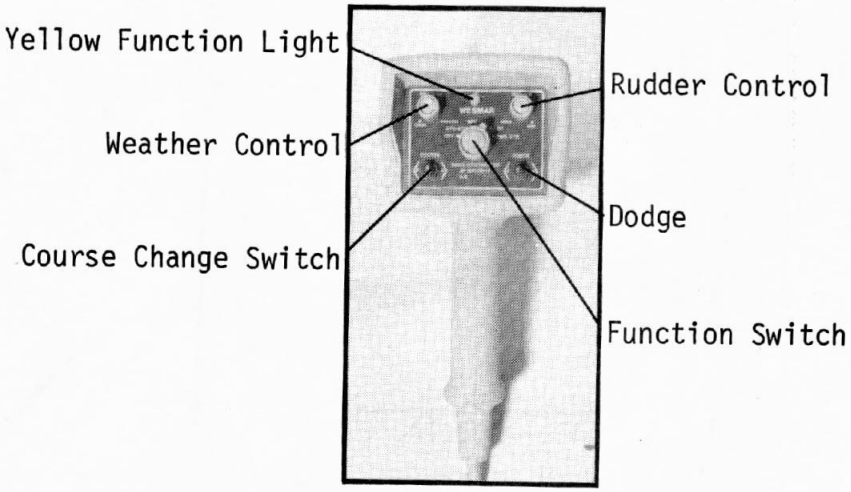


FIGURE 9. REMOTE HAND CONTROL

1.4.7 Remote Hand Control (AP-0125)

The Remote Hand Control (RHC) is a complete remote Autopilot station with the same controls as the Control Console. This unit consists of the water-proof hand held control attached to a 25-foot cable, a control hanger, and a 25-foot bulkhead cable. The bulkhead cable connects a bulkhead connector to the Interconnecting Matrix. The other cable may be plugged into the bulkhead connector when remote control is desired.

The same controls are available on the RHC as on the Control Console. A FUNCTION switch offers the same modes of operation (OFF, STD-BY, WHEEL, PILOT, PWR.STR.). RUDDER, WEATHER, DODGE and COURSE CHANGE controls are all provided, and are operated the same way as the controls on the Control Console, as explained in OPERATION, Section 4.1, page 58.

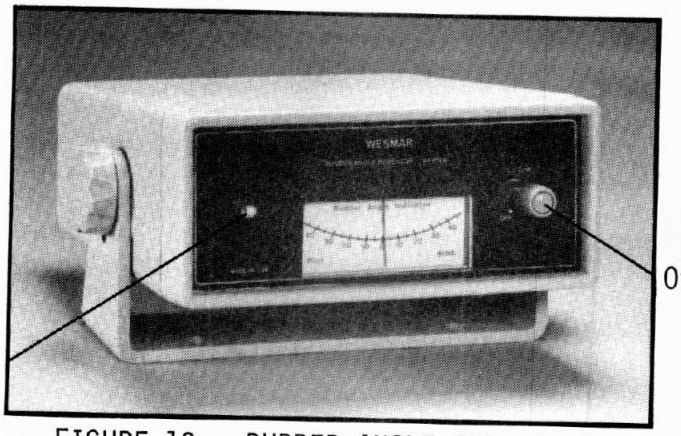


FIGURE 10. RUDDER ANGLE INDICATOR

1.4.8 Rudder Angle Indicator (AP-0128)

The Rudder Angle Indicator shows the direction and angle of the rudder on a meter whenever the Autopilot is on. The console is connected to the Matrix and backlighted for night operation.

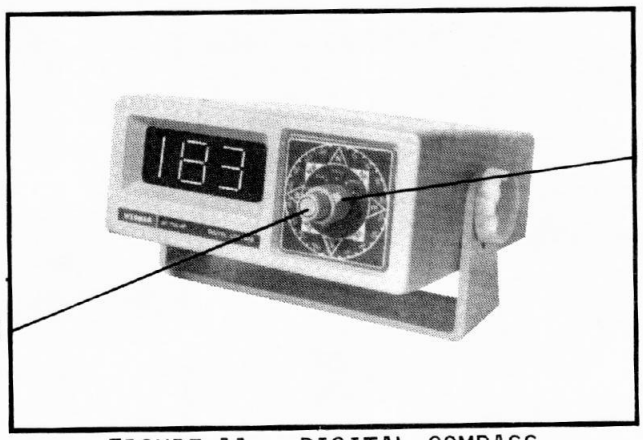


FIGURE 11. DIGITAL COMPASS

1.4.9 Digital Compass (DC700/AP)

The WESMAR DC700/AP Digital Compass was designed as an optional part of the AP900 Autopilot system. Features of the Digital Compass include digital read-out of course heading, stop-watch, elapse timer, and a memory device for holding heading information during temporary maneuvers.

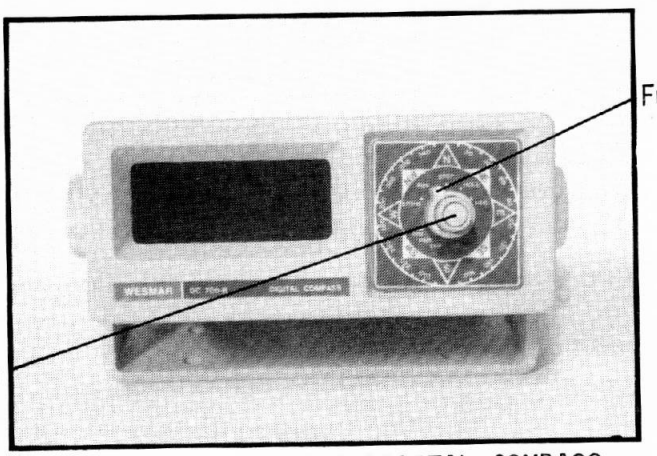


FIGURE 12. REMOTE DIGITAL COMPASS

1.4.10 Remote Digital Compass (DC700/R)

The Remote Digital Compass offers all of the features of the DC700/AP. The DC700/R is connected to the DC700/AP by cable, and is useful on vessels with more than one wheel.

1.4.11 Voltage Regulator (AP900-5006)

The basic voltage used in the AP900 Console and accessories is 12VDC. If the vessel's batteries are 24 or 32VDC, or 110VAC, a Voltage Regulator must be used to supply 12VDC at 2.5 amp to the system. The Autopilot's Servo Driver and Servo Motor operate from the vessel's batteries. (The Voltage Regulator looks exactly like the Servo Driver, only it is much heavier than the Driver.)

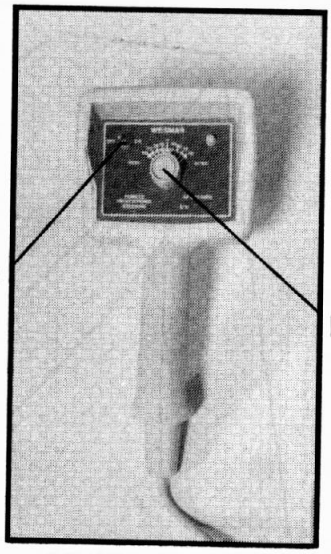


FIGURE 13. REMOTE PROPORTIONAL CONTROL

1.4.12 Remote Proportional Control (AP-0126)

The hand held Remote Proportional Control (RPC) allows the operator to electronically position the vessel's rudder while at a remote station. The degree of rudder movement is directly proportional to the degrees indicated on the RPC panel.

2.0 INSTALLATION INSTRUCTIONS

Read all sections of this manual before installing any equipment. Installation of the AP900 Autopilot will be easier once you have become familiar with the function and location of each module of the system. An overview of the whole system with suggestions for locating each module on a vessel can be found in Figure 14 on the next page.

Installation of the AP900 Autopilot generally takes 8 to 10 hours. Allow yourself plenty of time for careful work. Although the AP900 Autopilot can be installed by one person, you may find it more convenient to have assistance.

FOLLOW ALL INSTALLATION INSTRUCTIONS PRECISELY!

Read all instructions pertinent to each module BEFORE beginning installation of that module.

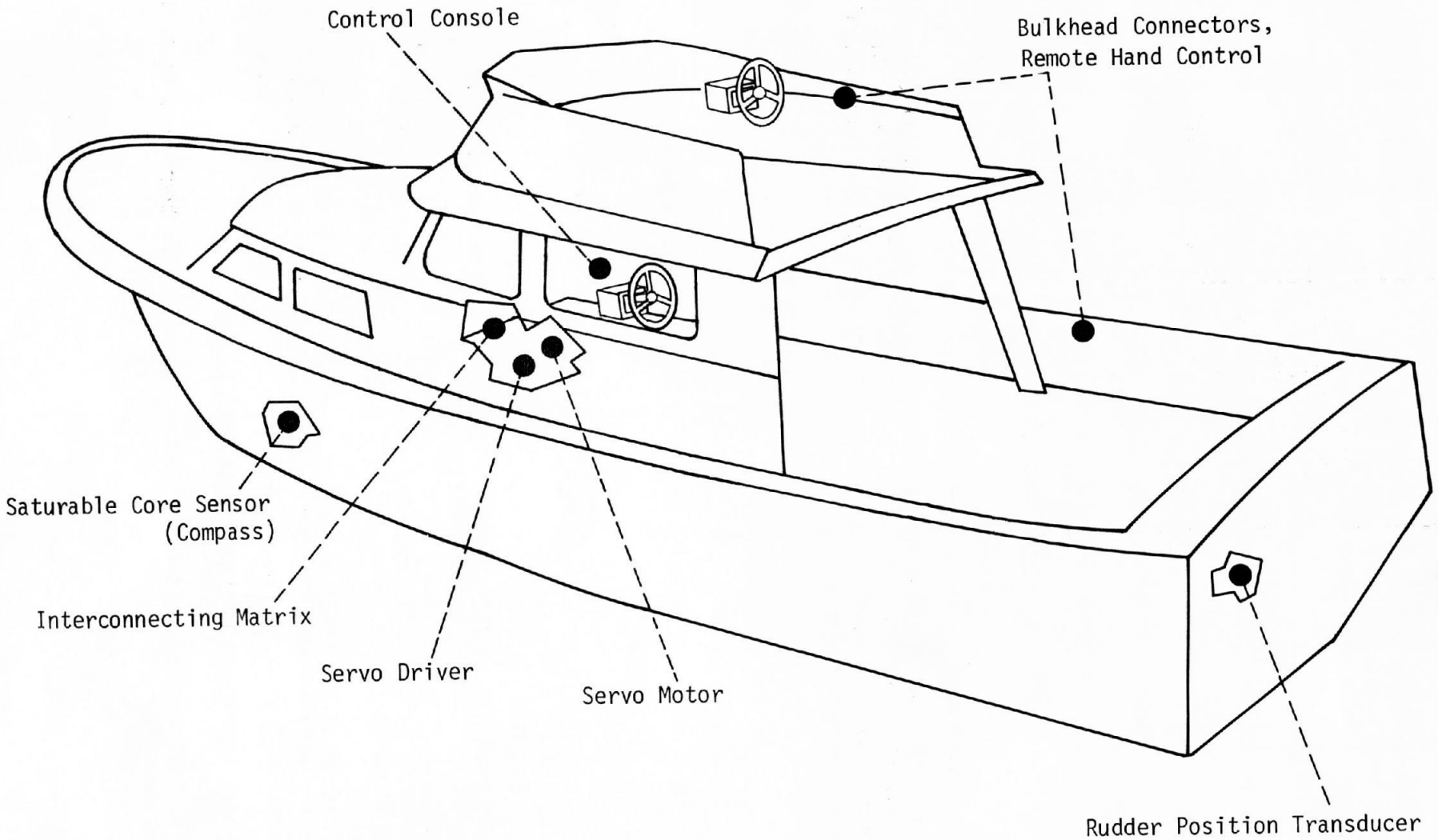


FIGURE 14. SUGGESTED LOCATIONS FOR AUTOPILOT MODULES

2.1 GENERAL WIRING INSTRUCTIONS

Individual wiring instructions are included in each module's section. However a general wiring rule should be noted at this point. Because the marine environment is always harsh on wiring and electrical connections, the following wiring procedure is strongly recommended. Wiring done otherwise will void warranty.

Do the following for each module wire going into the Matrix:

1. Determine the correct length of wire needed and cut.
2. Strip end of wire 1/4 inch back.
3. Use a spade-type lug, for 18-22 size wire, to fit a 4-6 size stud.
4. Crimp and solder the wire onto the lug.
5. Attach the wire to the Matrix as directed in each module section.

2.2 TOOLS AND PARTS NECESSARY FOR INSTALLATION (NOT PROVIDED WITH AP900)

The following is a general list of tools and hardware that will aid in the installation of your AP900 Autopilot.

TOOLS

1. Vacuum tube voltmeter - 20 meg ohm input with 0.5VDC scale.
2. Small phillips screwdriver.
3. Medium phillips screwdriver.
4. Small slotted screwdriver.
5. Medium slotted screwdriver.
6. 8-inch crescent wrench.
7. .050 allen wrench.
8. .064 allen wrench.
9. Small hammer.
10. Small set punch.
11. #7/32 drill.
12. 1/4-20 tap.
13. Small side cutters.
14. Crimping tool (VACO #1900) (For installation of AP900 Accessories).

15. Solder (Accessories).

16. Soldering iron (Accessories).

17. Small round file (Remote Hand Control).

18. Tube cutter (Reed TC-10) (hydraulic steering systems).

19. Jumper wire with clip leads.

HARDWARE (NOT PROVIDED WITH AP900)

1. Large bolts or lag bolts (1/4-20 x 1 1/2 inch bolts) - 4 ea. (For mounting Servo Motor).

2. One length of #41 roller chain (mechanical Servo Motor).

3. #41 sprocket (mechanical Servo Motor). (For correct size, see Table 1, page 25.)

4. #41 connecting link (mechanical Servo Motor).

5. "Tees" (hydraulic Servo Motor). (Size determined by size of lines.) - 3 ea.

6. One length of pressure hose to connect reservoir to replenishing port on pump (hydraulic Servo Motor).

7. Two lengths of pressure hose to connect pump to lines going to cylinder (hydraulic Servo Motor).

8. Miscellaneous cable ties - approximately 20 ea.

9. #6 screws or bolts (Remote Hand Control and Remote Proportional Control) - 4 ea.

10. #6 screws or bolts (Interconnecting Matrix and Servo Driver) -8 ea.

11. #18-20 lugs (installed on wires from accessories to Matrix) - approximately 15 - 21 ea.

12. #16 wires (Voltage Regulator) - 3 ea.

13. One small tube of RTV Silicone Rubber.

2.3 CONTROL CONSOLE INSTALLATION

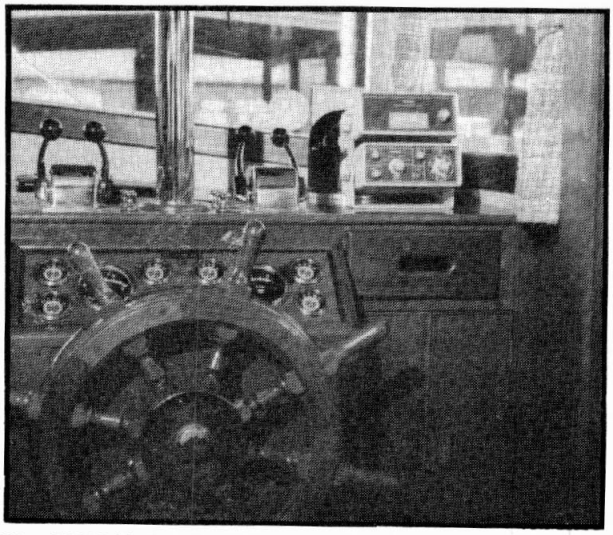


FIGURE 15. CONTROL CONSOLE, INSTALLED IN TRUNNION MOUNT WITH RAI ON TOP

2.3.1 Location

The Control Console should be located in the wheelhouse, near the wheel and steering compass. Avoid installing the Control Console in areas which are very damp, or where the temperature is likely to exceed 120 degrees F. (49 degrees C.). The Control Console can be mounted recessed, on a bulkhead, overhead, or on the main console, as shown in Figures 15, 16, and 17. A trunnion mount is also provided.

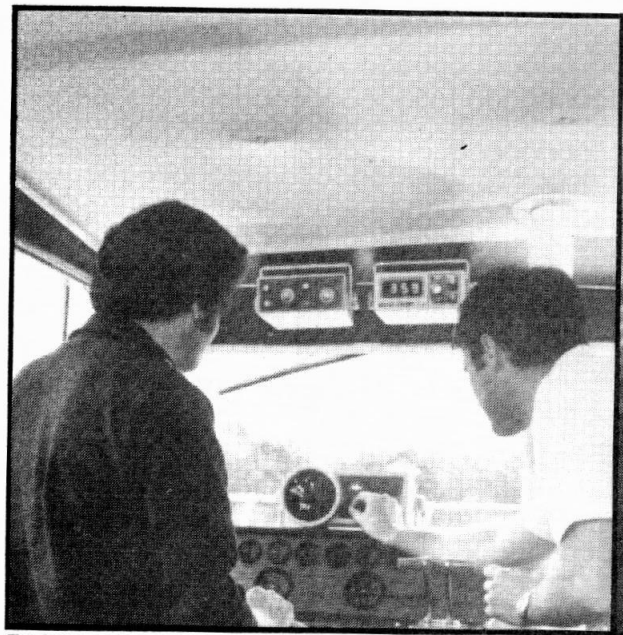


FIGURE 16. CONTROL CONSOLE, OVERHEAD

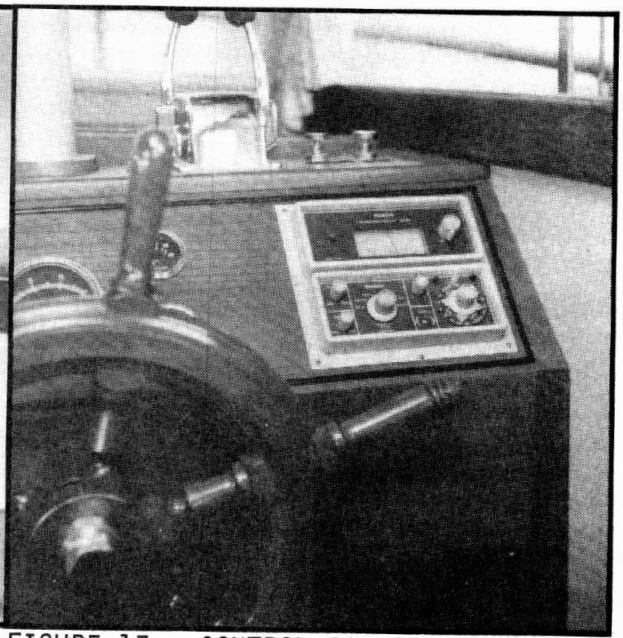


FIGURE 17. CONTROL CONSOLE, RECESSED

2.3.2 Installation Instructions

1. Secure the trunnion mount to the selected location with the provided screws or stainless steel bolts (not provided). Place the Console in the trunnion mount and tighten the trunnion knobs. The Console or trunnion mount should not be used as a bracket or handhold.

2. Connect the 25-foot connector cable (AP900-4420) to the connector on the rear of the Control Console, as shown in Figure 18. Secure the cable with the 2 screws provided on the cable plug.

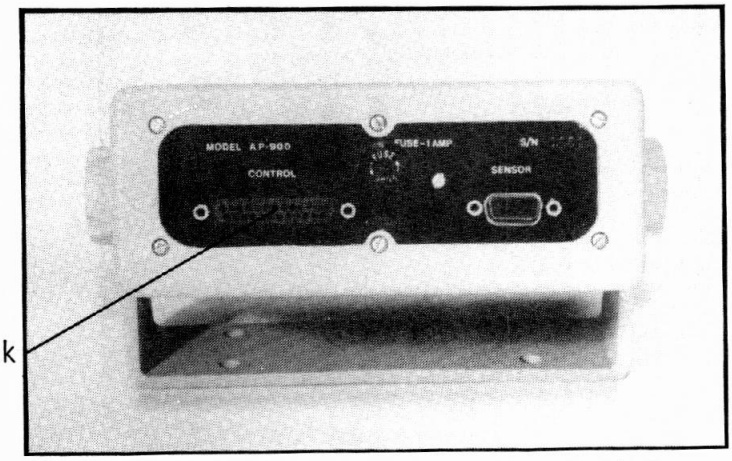


FIGURE 18. BACK OF CONTROL CONSOLE

3. Route the other end of the control cable to the site where the Interconnecting Matrix will be, using the shortest and most direct route. Keep the cable as far as possible from power cables, other electronic equipment, unshielded antennas, and high power signal cables. Route the cable neatly, securing it to existing cables or to bulkheads with cable ties.

2.4 SATURABLE CORE SENSOR (COMPASS) INSTALLATION

2.4.1 Location

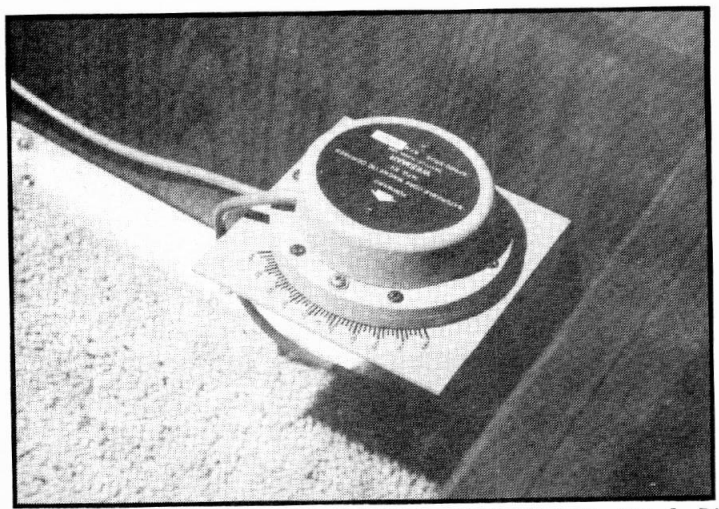


FIGURE 19. SATURABLE CORE SENSOR, INSTALLED ON A BULKHEAD

Possible locations for the Saturable Core Sensor include lockers, cupboards, and bulkheads, as shown in Figure 19. The installation site must be free from any magnetic interference. Any large DC conductors within 3 feet of the Sensor must be paired (+ and - wires twisted together). On steel vessels it may be necessary to install the Sensor on the mast to overcome strong magnetic interference. If possible, the Sensor should be on the keel line and in the center of vessel movement. The location should be relatively free from vibration.

2.4.2 Installation Instructions

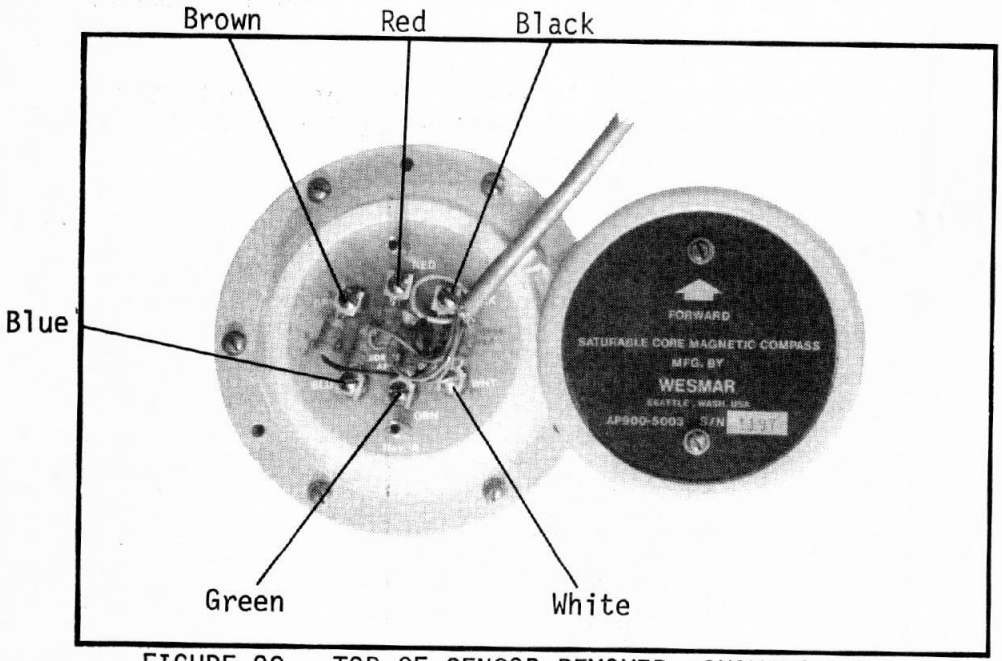
1. Secure the Sensor mounting bracket with 4 brass (preferably chrome-plated brass) screws (provided) or bolts.

2. The mounting bracket does not have to line up with the vessel's keel line, however the ARROW ON THE SENSOR MUST BE ALIGNED WITH THE KEEL LINE OF THE VESSEL. When you are sure the Sensor's arrow lines up with the vessel's keel line, then secure the Sensor in its mounting bracket using the 3 brass bolts (provided).

3. Connect the AP900-4418 Sensor cable into the back of the Control Console. Route the cable to the Sensor. Keep the cable as far as possible from power cables, other electronic equipment, unshielded antennas, and signal cable.

4. Remove the top of the Sensor and connect the 6 wires in the cable to the Sensor as shown in Figure 20. FOLLOW GENERAL WIRING INSTRUCTIONS, page 16.

5. Replace cover.



Ohmmeter Readings

Brn & Red - 18 Ohm

Blu & Grn - 18 Ohm

Blk & Wht - 4.5 Ohm

FIGURE 20. TOP OF SENSOR REMOVED, SHOWING WIRING

2.5 INTERCONNECTING MATRIX INSTALLATION

2.5.1 Location

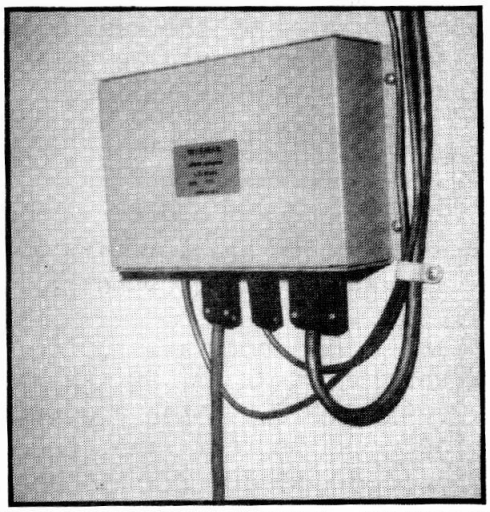


FIGURE 21. INTERCONNECTING MATRIX, INSTALLED ON A BULKHEAD

The Matrix serves as an interconnecting and wiring terminal for the AP900 Autopilot System. Although normally located in the engine room, the Matrix can be located anywhere in the vessel. See Figure 21.

2.5.2 Installation Instructions

1. Attach the Matrix to a bulkhead or firewall using wood screws or bolts.

2. Attach the Control Console cable to the Matrix, as illustrated in Figure 22. Secure in place with small bolts (provided).

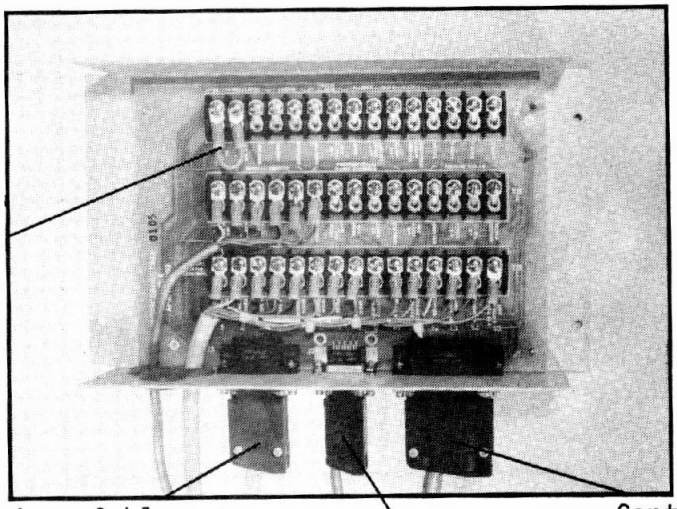


FIGURE 22. INTERCONNECTING MATRIX, WIRED

3. If the vessel has a 12VDC battery, remove the cover from the Matrix and make sure that a jumper wire is between TB3-1 and TB3-2 (Figure 22, page 21).

4. If the battery is of any other voltage, remove this jumper wire and install a Voltage Regulator (AP900-5006), as described in Section 2.12, page 35.

2.6 RUDDER POSITION TRANSDUCER (AP900-5003) INSTALLATION

2.6.1 Location

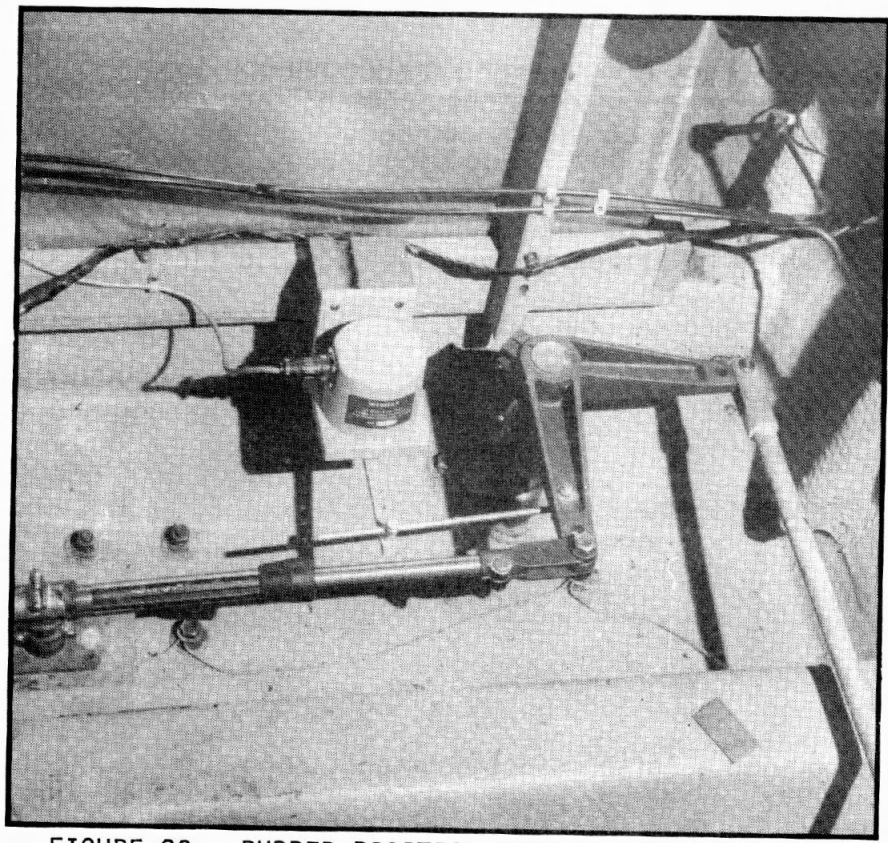
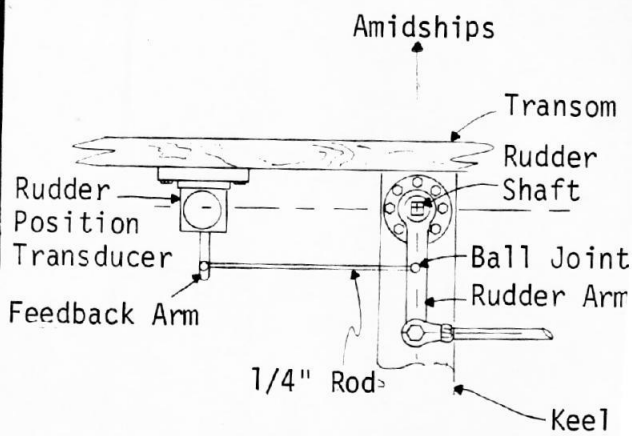


FIGURE 23. RUDDER POSITION TRANSDUCER, INSTALLED

FIGURE 24. DIAGRAM OF RUDDER POSITION TRANSDUCER, SHOWING PARALLELOGRAM LINKAGE



The Rudder Position Transducer (RPT) is always located in the lazarette area of the vessel, near the rudder stock and quadrant. The RPT is mechanically connected to the rudder arm or quadrant by means of a parallelogram linkage as shown in Figure 24. The shaft of the RPT should point down and be the same distance out from the transom as the rudder shaft. The arm of the RPT should be approximately the same height from the hull as is the rudder arm or quadrant. For a picture of a typical installation, see Figure 23.

2.6.2 Installation Instructions

1. Once the RPT has been positioned, secure it with 3 wood screws or bolts (not provided).

2. Slide the RPT feedback arm over the transducer shaft and tighten the bolt and nut provided. They need only be finger tight at this point.

3. Remove from the feedback arm 1 ball joint and prepare to mount it on the rudder arm or quadrant.

4. Referring to Figure 24 , drill and tap a 1/4 inch 20-thread hole where the ball joint is to be installed. Install the ball joint.

5. Connect the 1/4 inch rod (provided) between the ball joint on the quadrant and the ball joint on the RPT rudder arm, making sure both arms are parallel.

6. Turn the ship's wheel hard-over to hard-over slowly, and monitor the rudder movement throughout the whole cycle. The RPT arm and rudder arm should remain parallel at all times.

7. Connect Cable AP900-4422, the feedback cable, to the connector on the RPT, then route the cable to the Interconnecting Matrix. Tie the cable to existing cables or attach it by means of cable ties.

8. Attach the cable to the Interconnecting Matrix, as illustrated in Figure 22, page 21. Secure in place with small bolts provided.

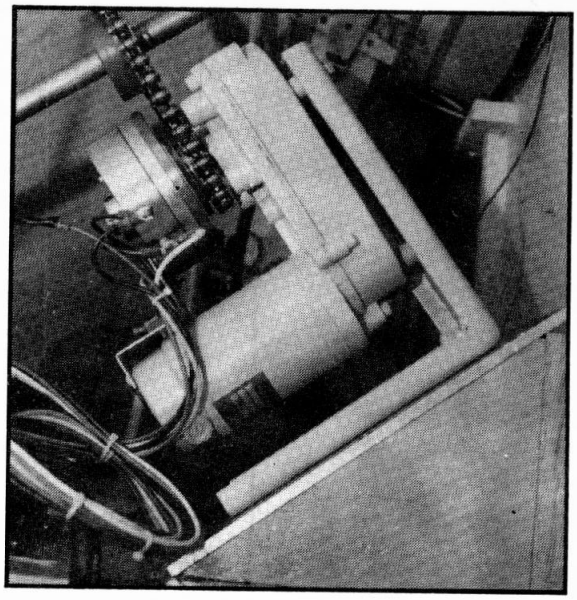
2.7 SERVO MOTOR - MECHANICAL (AP900-06) INSTALLATION

2.7.1 Location

The Servo Motor is provided with a large mounting bracket for mounting the unit overhead, on the deck, or on any plane. If a bracket or shelf is used, it should be strong enough to not flex under full load. The Servo Motor assembly is weather-resistant, not waterproof, so it should be located where it will not be submerged or continually splashed.

The mechanical Servo Motor should be installed in a location where the sprocket on the Servo Motor is in line with a sprocket (not provided) on the steering wheel shaft. The complete unit should be accessible for preventative maintenance. See Figures 25a, 25b and 26.

FIGURE 25a. MECHANICAL SERVO MOTOR INSTALLED ON CUSTOM-MADE INCLINED MOUNT, TO ALIGN WITH STEERING SHAFT.



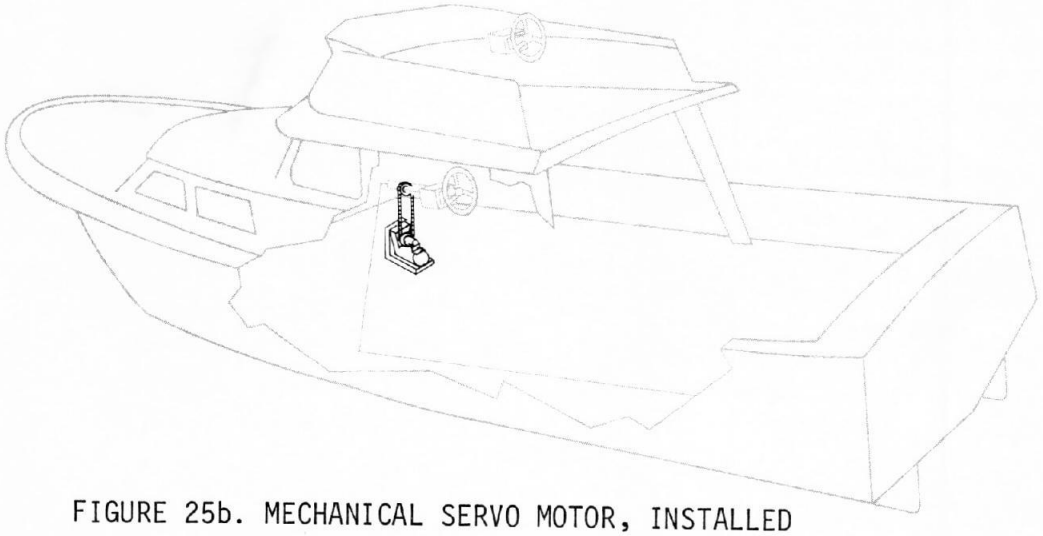


FIGURE 25b. MECHANICAL SERVO MOTOR, INSTALLED

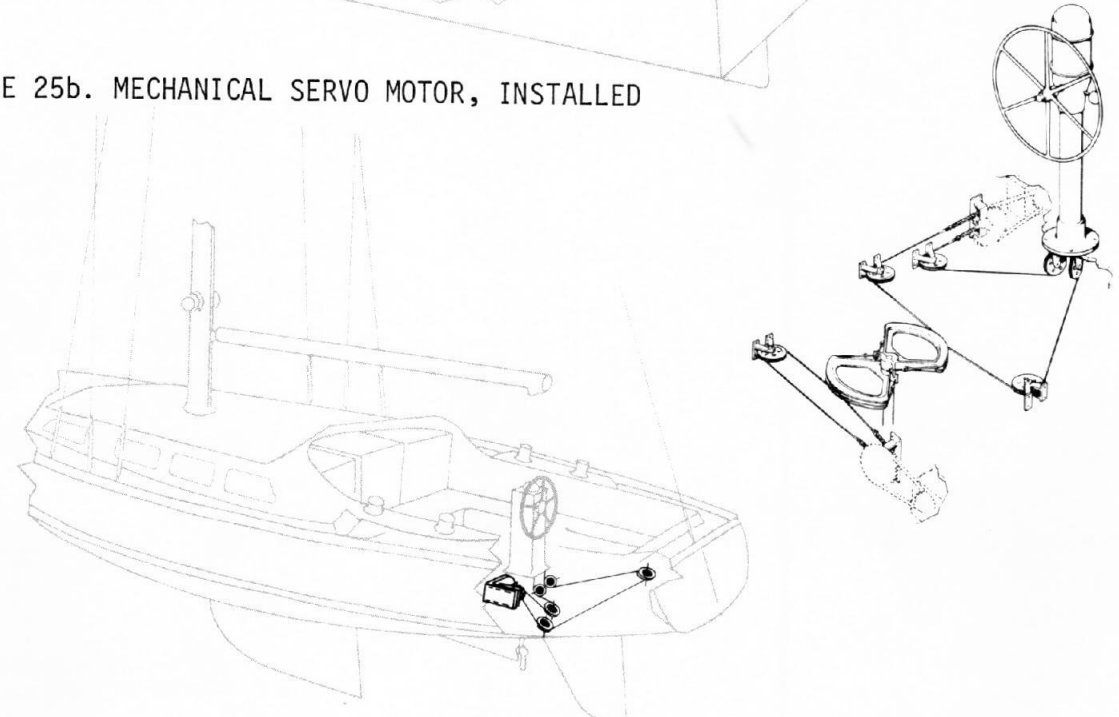


FIGURE 26. MECHANICAL SERVO MOTOR, IN A SAILBOAT

2.7.2 Installation Instructions - Sprocket on Pilot Wheel Shaft

1. Unless already present, a sprocket must be installed on the pilot wheel shaft. The following chart is a general guideline for selecting the correct sized sprocket.

TABLE 1.

Steering Wheel Turns Hard-over to Hard-over	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	7
Steering Wheel Sprocket Size, #41 (Number of Teeth)	35	32	29	26	24	22	20	18	16	5

Speed of rudder movement is determined by the size of the sprocket at the pilot wheel. For proper Autopilot operation, rudder speed should be between 8 and 20 seconds hard-over to hard-over (about 15 seconds is best). For a large hard-to-steer vessel slower rudder speeds can be obtained by installing a larger sprocket at the pilot wheel, thus increasing the delivered torque but decreasing pilot performance.

2. It is advisable that the required torque be determined. To determine torque:

   a. Tie one end of a cord to a spoke on the pilot wheel, then the other end to a spring fish scale.

   b. Pull the free end of the fish scale at a right angle from the point of attachment to the wheel. When the wheel just starts to move, read the load indicated on the fish scale.

   c. Repeat this procedure 4 times to determine the average load.

   d. Multiply the average load (in pounds) by the distance (in inches) between the center of the wheel and the point where the cord is attached.

   e. Next multiply the results by 3 to obtain the torque (in inch pounds) required to steer the vessel under the worst conditions.

   If this figure exceeds 200 inch pounds (torque delivered by Servo Motor), install a larger sprocket which will deliver the required torque. NOTE: Should your vessel require over 1,000 inch pounds of torque, you should contact the factory to get a higher torque delivering Servo Motor assembly.

2.7.3 Installation Instructions - Mechanical Servo Motor

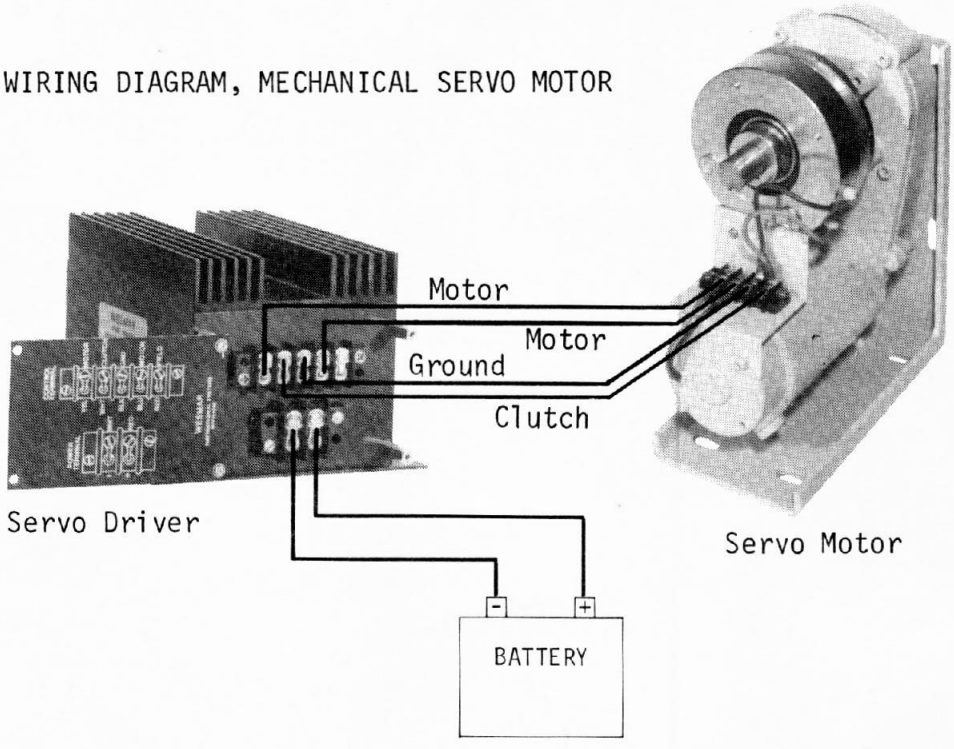
1. Align the Servo Motor sprocket and pilot wheel sprocket and connect the two sprockets with #41 roller chain (not provided).

2. Secure the Servo Motor with lag bolts or stainless steel bolts (not provided).

3. Be sure each sprocket is secured by a setscrew and keyway. Enough slack should exist in the chain to prevent possible binding, but excessive slack will decrease Autopilot control and cause defective steering.

4. Connect 4 of the 5 wires in the end of cable AP900-4425 to the Servo Motor as shown in Figure 27. Discard the red wire. (The other end of the cable will be connected to the Servo Driver after it is installed.)

FIGURE 27. WIRING DIAGRAM, MECHANICAL SERVO MOTOR



2.8 SERVO MOTOR - HYDRAULIC (AP900-07) INSTALLATION

To connect the Hydraulic Servo Motor into your steering system, you must cut and modify the existing hydraulic lines. When adding "tees" and hoses into the existing hydraulic system, use ONLY high quality fittings and double wire braid pressure hose with machine attached fittings. (These are not supplied as part of the installation because of varied line sizes.) Use standard tube fittings of the flare-type, not compression-type.

2.8.1 Cutting Instructions

Be sure to cut the lines with a standard wheel-type cutter. DO NOT USE A HACKSAW. A hacksaw produces small filings and chips which are impossible to remove from the lines. These chips or filings will damage the steering system.

2.8.2 Location

The Hydraulic Servo Motor may be located anywhere on the vessel where it can conveniently connect into the vessel's hydraulic steering lines parallel with the helm lines. See Figure 28.

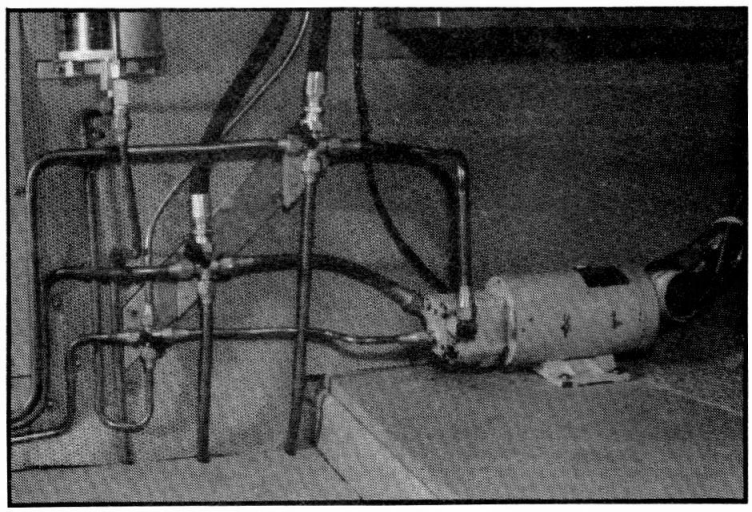


FIGURE 28. HYDRAULIC SERVO MOTOR, INSTALLED

2.8.3 Installation Instructions

1. If the vessel's hydraulic system is the type that will "motor" when subject to hydraulic pressure, a second lock valve must be added between the helm(s) and the Servo Motor. Refer to Figure 29 for a typical installation.

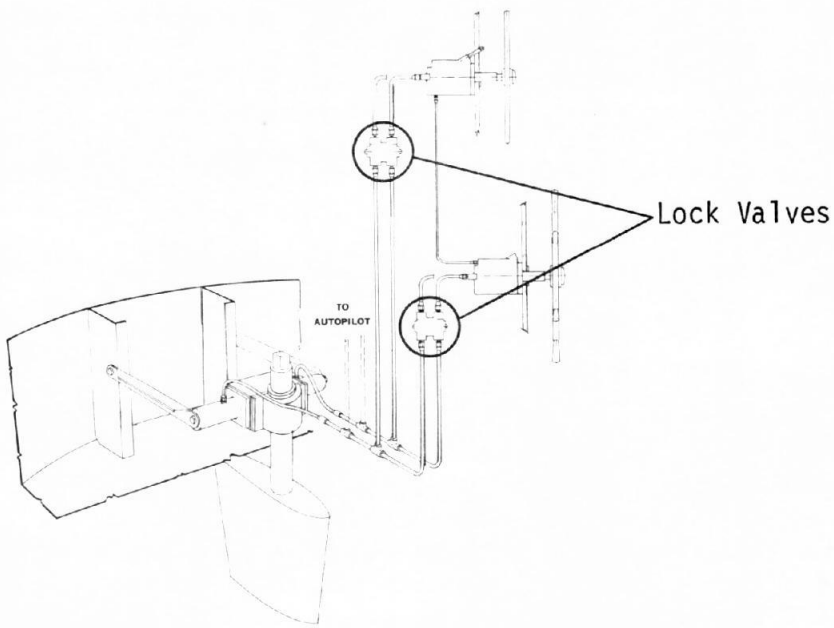


FIGURE 29. HYDRAULIC SYSTEM WITH TWO LOCK VALVES

2. Begin installation of the hydraulic Servo Motor by draining the steering system sufficiently so that minimum fluid is lost when the lines are cut.

3. Cut the lines on the steering system as shown in Figure 30. FOLLOW CUTTING INSTRUCTIONS, Section 2.8.1, page 27.

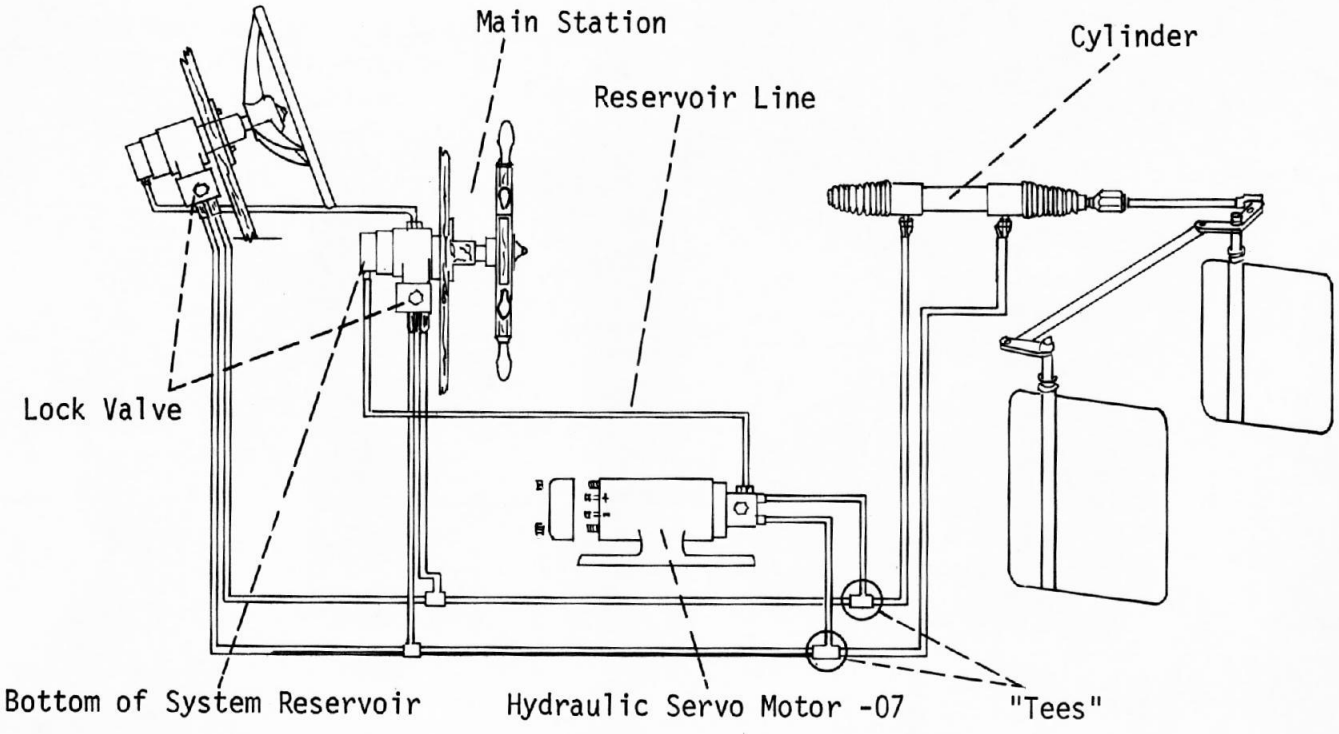


FIGURE 30. DIAGRAM OF HYDRAULIC SYSTEM WITH CUTS AND "TEES"

4. Insert "tees" into the lines and connect to the output ports of the Servo Motor. It does not matter which lines connect to which port, since the motor rotation can be reversed, as discussed in CALIBRATION, Section 3.3 Step 13, page 48.

5. Be sure that all pipe thread connections are sealed with a good sealing compound.

6. Fill the hydraulic system with the fluid drained in Step 2.

7. MAKE SURE THE SERVO MOTOR PUMP BLEED LINE IS CONNECTED TO BOTTOM OF THE SYSTEM RESERVOIR. See Figure 30.

8. IMPORTANT: Once the unit has been installed and fitted, loosen one of the hose connections at the cylinder and turn the wheel hard-over until it is difficult to turn, building pressure to force all air out of the lines. Once air bubbles (which look like foam) stop flowing, tighten the hose connection. Repeat in the opposite direction. Continue repeating this process until no air bubbles escape. Be sure to keep the reservoir full at all times.

IMPORTANT NOTE: In hydraulic steering systems, all the air must be bled from the system if the Autopilot is to perform properly. Air left in the system will cause the rudder to move after the Autopilot has ceased applying corrective rudder. As the compressed air moves the rudder, a yawing situation will occur, which cannot be corrected by adjusting the RUDDER control at the Control Console.

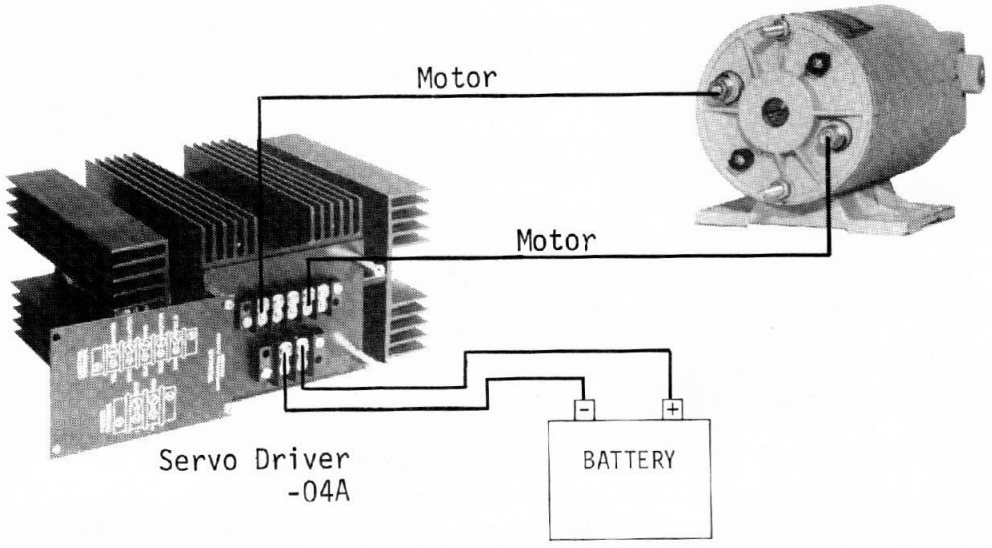


FIGURE 31. WIRING DIAGRAM, HYDRAULIC SERVO MOTOR

9. Crimp two large lugs onto the blue and yellow wires in the end of cable AP900-4425. Connect these lugs to the Servo Motor as shown in Figure 31.

10. Remove the remaining wires in the cable and discard.

2.9 SOLENOID INSTALLATION

2.9.1 Location

In the case of an engine-driven hydraulic steering system, a 4-way Solenoid is installed "in series" between the hydraulic pump and the helm steering unit.

2.9.2 Installation Instructions

Some hydraulic lines must be cut and "tees" and hoses used to make the connections. When adding "tees" and hoses into the existing hydraulic system, use ONLY high quality fittings and double wire

braid pressure hose with machine attached fittings. (These are not supplied as part of the installation because of varied line sizes.) OBSERVE CUTTING INSTRUCTIONS, Section 2.8.1, page 27.

1. Begin installation of the Solenoid by draining the steering system sufficiently so that minimum fluid is lost when the lines are cut.

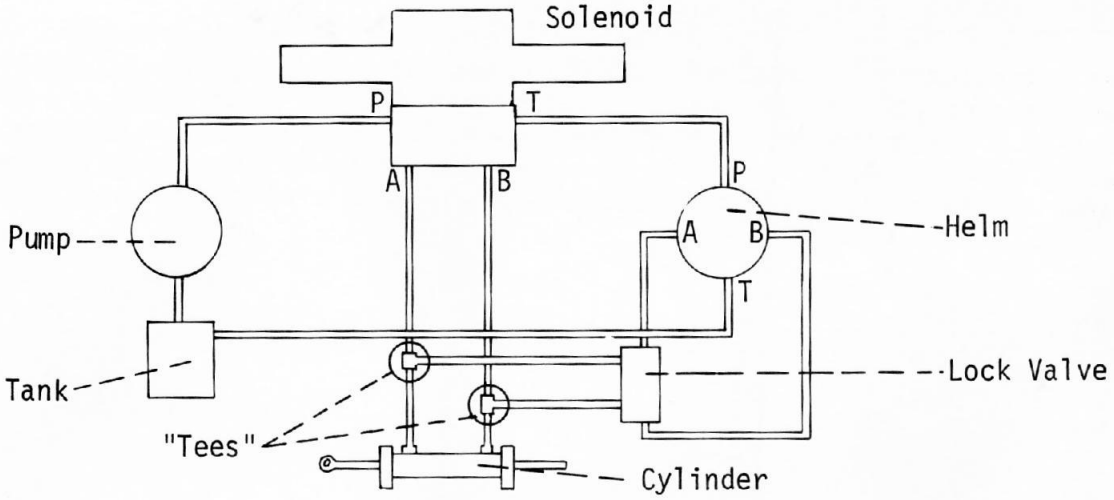


FIGURE 32. DIAGRAM OF SOLENOID INSTALLATION

2. Cut the pressure line coming from the pump to the helm and connect the pump side of the line into the "P" port of the Solenoid valve. See Figure 32.

3. Connect the helm side of the line to the "T" port of the Solenoid valve.

4. Cut the two lines going from the steering helm to the rudder. Insert "tees". Connect the "A" port of the valve to one of these lines, and the "B" port of the valve to the other line.

5. Fill the steering system with the fluid drained in Step 1.

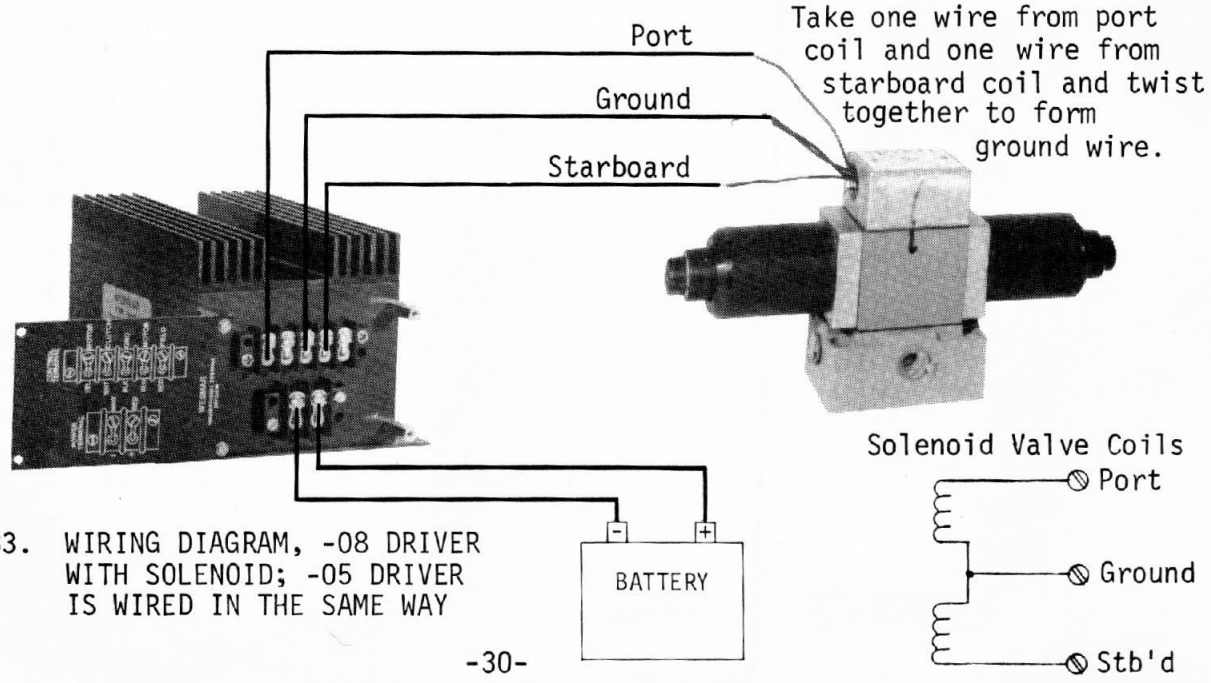


FIGURE 33. WIRING DIAGRAM, -08 DRIVER WITH SOLENOID; -05 DRIVER IS WIRED IN THE SAME WAY

6. BE SURE TO BLEED ALL AIR FROM THE STEERING SYSTEM, AS EXPLAINED ON PAGE 29, Section 2.8.3, Step 8.

7. Wire the Solenoid to the Servo Driver, as shown in Figure 33, page 30.

2.10 SERVO DRIVER INSTALLATION

The Autopilot system receives its DC power from the Servo Driver, which must be connected to the vessel's battery source, as shown in Figure 33 on page 30. Since the Servo Motor draws considerable current under heavy loads, large power cables must be used to connect the battery to the Driver. Refer to the table below to determine the size of wire needed.

Table 2.

	2ft	4ft	6ft	8ft	10ft	12ft	14ft	18ft	20ft	22ft	24ft	30ft	40ft	50ft
12V	16	14	14	10	10	8	8	6	6	6	4	4	2	2
24V	16	14	14	12	12	12	10	10	10	8	8	6	6	6
32V	16	16	14	14	14	14	12	12	10	10	10	8	8	8

2.10.1 Location

The selected Servo Driver should be installed within three feet of the Servo Motor. The Driver is usually mounted securely to a bulkhead allowing air convection up and through the fins of the Driver. Refer to Figure 34.

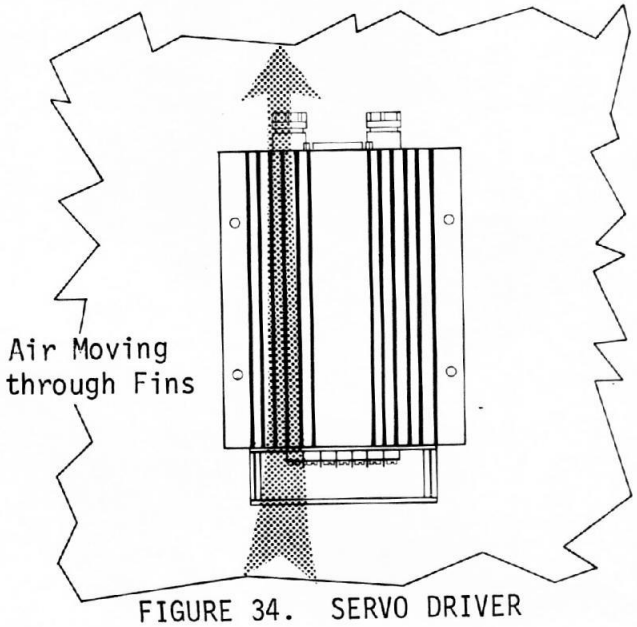


FIGURE 34. SERVO DRIVER

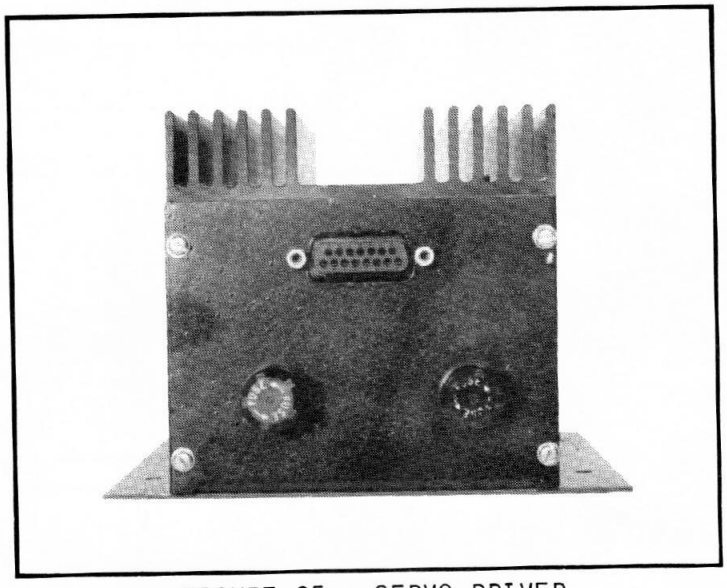


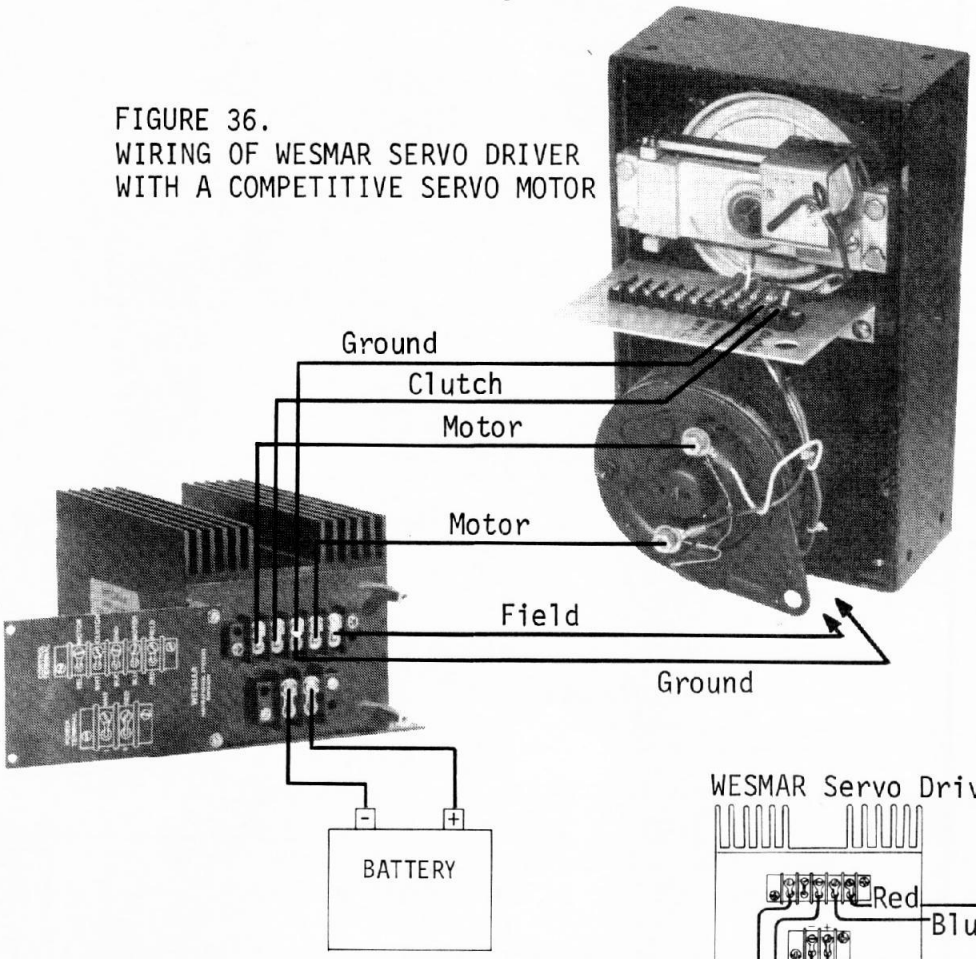
FIGURE 35. SERVO DRIVER

2.10.2 Installation Instructions

1. Secure the Driver into place with 4 wood screws, metal screws, or bolts (not provided).

2. Connect the AP900-4425 cable from the Servo Motor to the terminals in the Servo Driver. If a mechanical Servo Motor has been installed, See Figure 27. If a hydraulic Servo Motor was installed, see Figure 31. For instructions on connecting a WESMAR Servo Driver to a competitive Servo Motor, see Figure 36. For information on connecting a WESMAR Servo Driver with a Wagner Power Pack, see Figure 37.

FIGURE 36.
WIRING OF WESMAR SERVO DRIVER
WITH A COMPETITIVE SERVO MOTOR



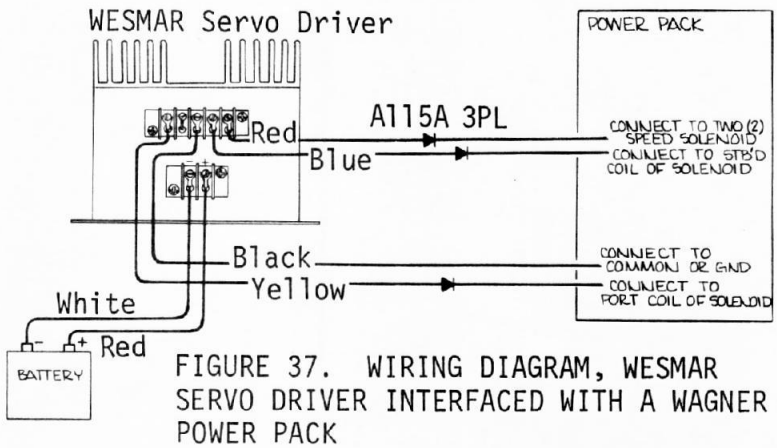


FIGURE 37. WIRING DIAGRAM, WESMAR SERVO DRIVER INTERFACED WITH A WAGNER POWER PACK

3. Connect one end of Cable AP900-4419 to the cable jack on the Servo Driver, shown in Figure 35, page 31. Secure in place with the 2 supplied screws.

4. Route the other end of the cable to the Interconnecting Matrix. Attach the cable to the Matrix, as illustrated in Figure 22, page 21. Secure in place with small bolts provided.

5. To connect the battery to the Driver, first REMOVE THE FUSES FROM THE SERVO DRIVER. Then connect the DC power leads to the Driver. OBSERVE POLARITY.

ACCESSORIES

2.11 REMOTE HAND CONTROL (AP900-0125) INSTALLATION

The Remote Hand Control (RHC) consists of a hand held controller with a 25-foot cable attached, a control hanger, and a 25-foot bulkhead cable.

2.11.1 Location

The bulkhead cable (AP900-4426) will be mounted first. Select a location on the flying bridge, aft deck, pilothouse, or bow.

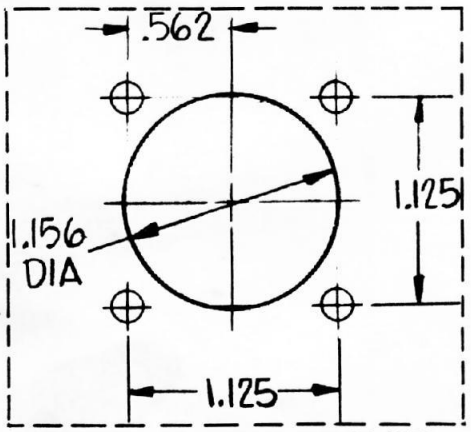


FIGURE 38. RHC TEMPLATE

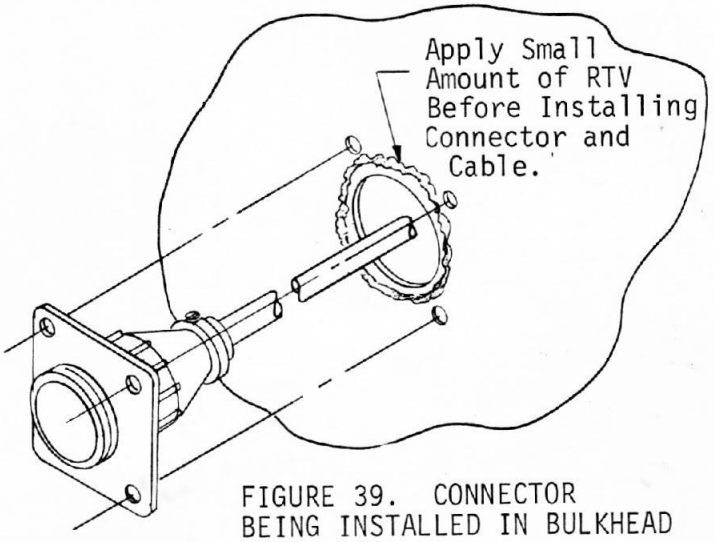


FIGURE 39. CONNECTOR BEING INSTALLED IN BULKHEAD

2.11.2 Installation Instructions

1. Referring to Figure 39, drill 5 holes in the bulkhead. To aid in locating the hole pattern, a template is provided above (Figure 38). Insert the bulkhead cable and the connector through the holes and secure, using 2 wood screws or bolts (not provided).

2. Neatly route the cable to the Interconnecting Matrix.

3. Cut the cable to the desired length. (Longer lengths can be ordered.)

4. Route the cable through one of the grommets on the Matrix. Refer to Figure 40, page 34 for instructions on wiring the RHC into the Matrix. Follow the General Wiring Instructions on page 16, Section 2.1.

5. Do not yet plug the RHC into bulkhead connector.

6. Mount the RHC hanger near the bulkhead connector. Secure with 2 wood screws or stainless steel bolts (not provided). See Figure 41.

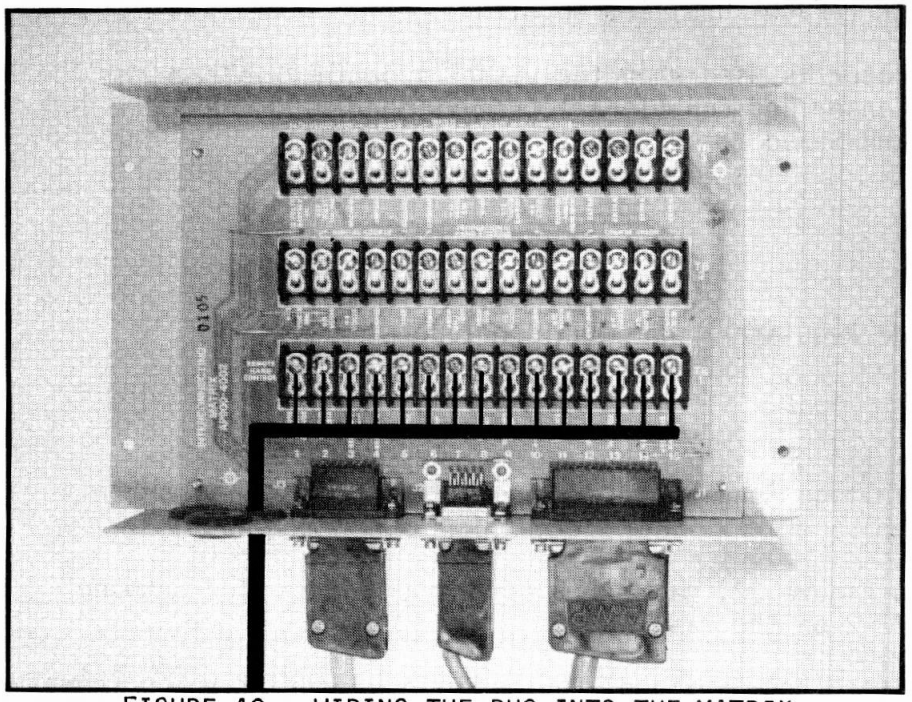


FIGURE 40. WIRING THE RHC INTO THE MATRIX

TABLE 3.

TB-1	COLOR
1	Grn/Blk
2	White
3	Black
4	Red
5	Blk/Wht
6	Blue
7	Blue/Blk
8	Green
9	Grn/Wht
10	Blue/Wht
11	Orn/Blk
12	Wht/Blk
13	Red/Wht
14	Red/Blk
15	Orange

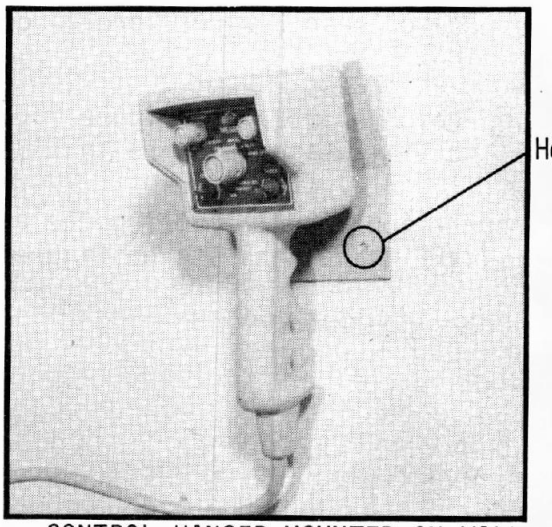


FIGURE 41. CONTROL HANGER MOUNTED ON WALL, WITH RHC

2.11.3 Additional RHC bulkhead connectors may be installed throughout the vessel (flying bridge, stern, bow, pilothouse, allowing the operator to control the vessel from any remote station.

Additional bulkhead cables must be wired into the Matrix in the same manner as a single cable, described in INSTALLATION, Section 2.11.2, Step 4, page 33.

NOTE: Only one RHC can be plugged in and operated at any one time.

2.12 VOLTAGE REGULATOR (AP900-5006) INSTALLATION

The WESMAR Voltage Regulator is used when the vessel's battery voltage is other than 12VDC. The Sensor and Console electronics operate on 12VDC, while the Servo Driver and Servo Motor operate on the same voltage as the battery.

2.12.1 Location

Mount the Voltage Regulator near the Interconnecting Matrix.

2.12.2 Installation

1. Secure the Voltage Regulator in place with 4 wood screws or bolts (not provided).

2. Referring to Figure 22, page 21, remove the jumper wire between TB3-1 and TB3-2 on the Matrix.

3. Connect 3 wires (not provided) to the Voltage Regulator, as shown in Figure 42.

4. Route these 3 wires through one of the grommets in the Matrix to TB3.

5. Again referring to Figure 42, attach one wire to TB3-1, one wire to TB3-2, and one wire to TB3-3.

2.12.3 Instructions for installing the AP900-5006 Voltage Regulator (115VAC to 12VDC operation) are on Figure 43, page 36.

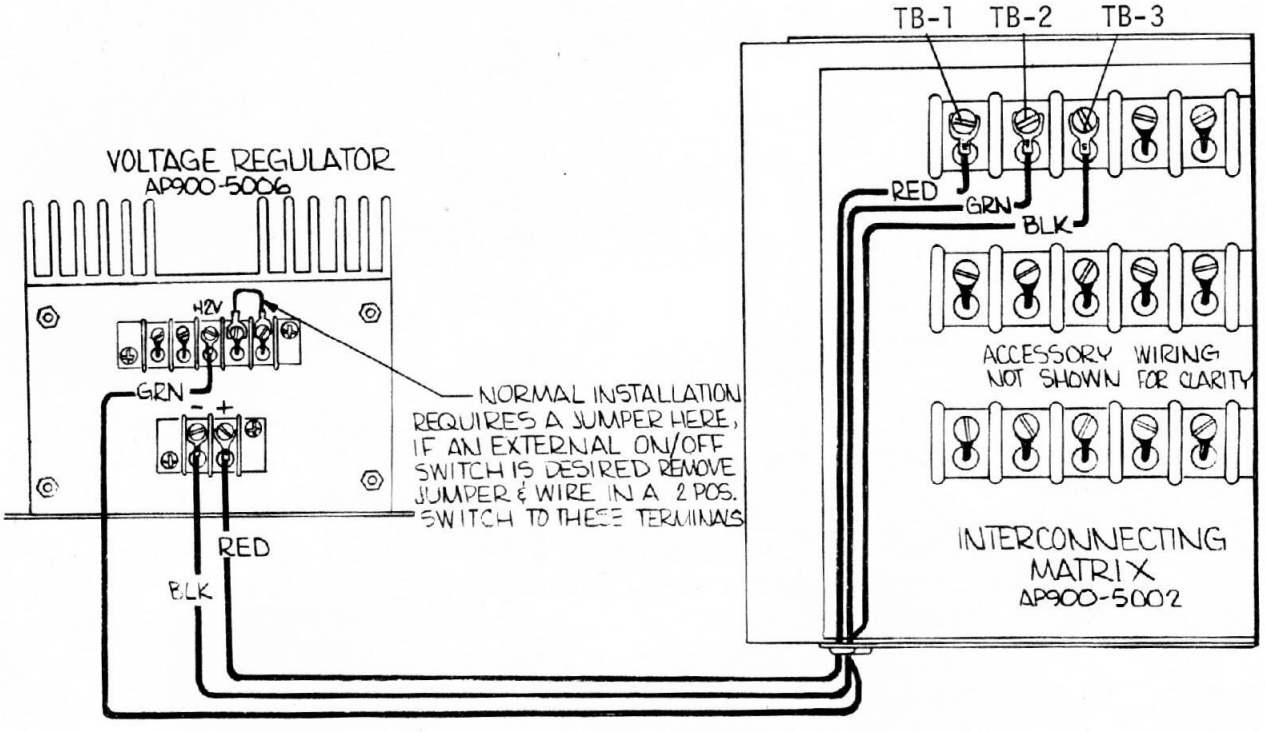


FIGURE 42. WIRING VOLTAGE REGULATOR TO MATRIX

2.13 RUDDER ANGLE INDICATOR (AP-0128) INSTALLATION

2.13.1 Location

The Rudder Angle Indicator (RAI) should be located where it can be viewed from the pilothouse. Avoid areas where the temperature is likely to exceed 120 degrees F. (49 degrees C.). The front panel is splash-resistant, not waterproof, so locate the RAI where it won't be exposed to direct moisture such as rain, or sprayed water during boat washings. The RAI can be mounted on a bulkhead, overhead, countertop, or wall.

2.13.2 Installation Instructions

1. Secure the trunnion mount to the selected location with the provided wood screws or stainless steel bolts (not provided). Place the console in the trunnion mount and tighten the trunnion knobs. The console or trunnion mount should not be used as a bracket or handhold.

2. Connect the supplied interconnecting cable (AP900-4428) to the rear of the RAI console panel by inserting the plug into the TRANSDUCER jack, shown in Figure 44. Neatly route the opposite end of the cable to the Interconnecting Matrix. (NOTE: When using the RAI with AP900 installation, do not connect a separate 12VDC to the jack on the rear of the RAI. The AP900 supplies power through the TRANSDUCER jack.)

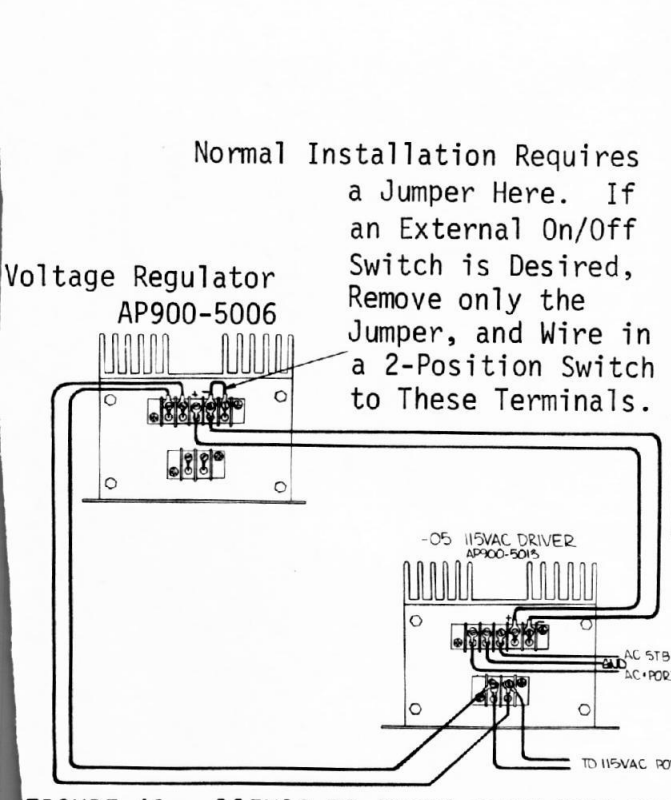


FIGURE 43. 115VAC TO 12VDC REGULATOR WIRING DIAGRAM

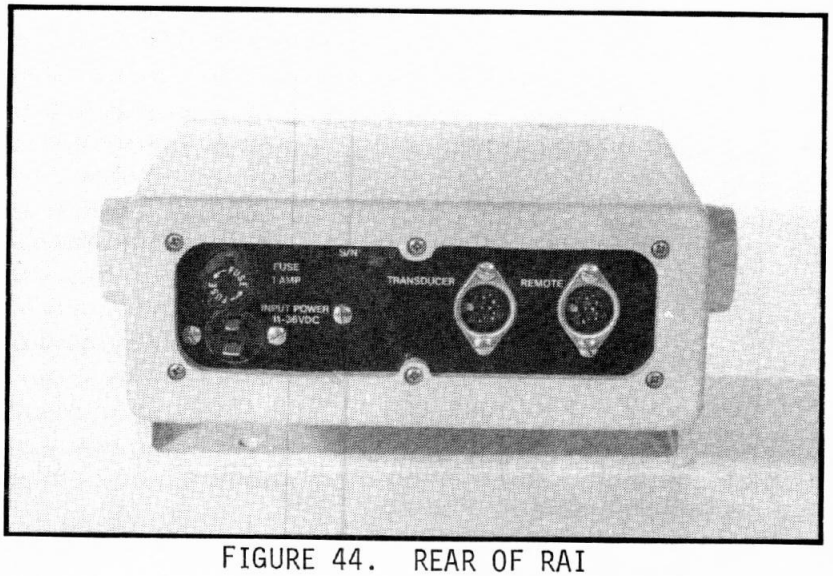


FIGURE 44. REAR OF RAI

3. Remove the Interconnecting Matrix cover. Place the cable through one of the grommets on the Matrix.

4. Referring to Figure 45, wire the cable into the Matrix. Follow the General Wiring Instructions on page 16, Section 2.1. Replace Matrix cover.

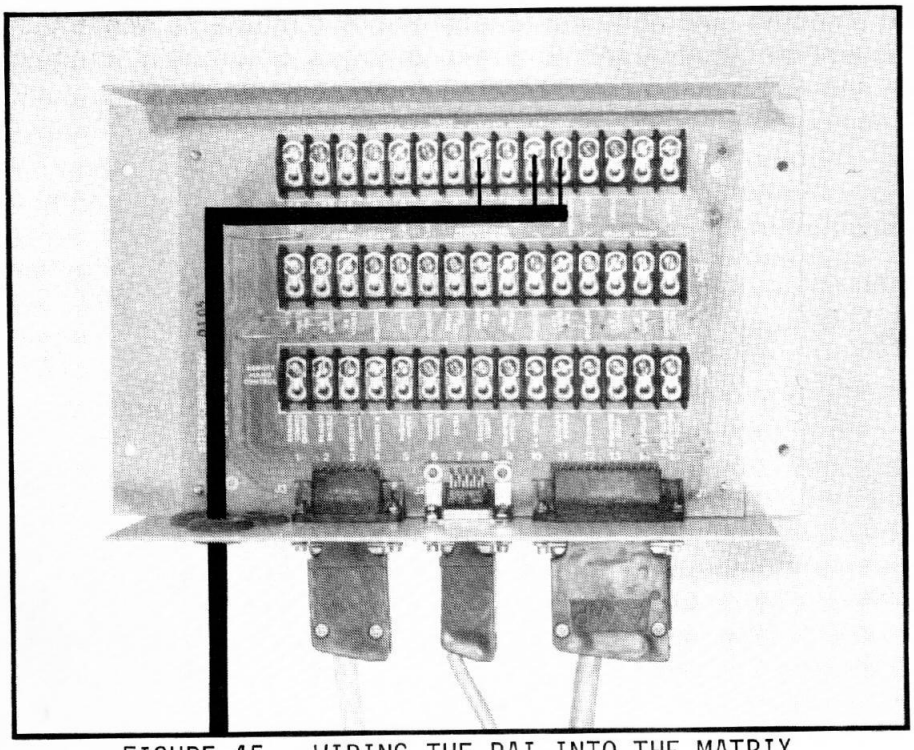


FIGURE 45. WIRING THE RAI INTO THE MATRIX

TABLE 4.

TB-3	COLOR
8	Black
10	Red
11	Green or White

2.13.3 A second, third, or more RAI's may be installed as desired. Installation and calibration of additional RAI's are the same as discussed in INSTALLATION, 2.13, page 36, and CALIBRATION, 3.5, page 54.

It is also possible to connect an RAI into the rear of a previously installed RAI instead of into the Matrix. To do this:

1. Modify cable AP900-4423 (provided with the RAI) as shown in the schematic drawing AP900-4429, Section 8.0 TECHNICAL APPENDIX/SCHEMATICS.

2. Plug one end of the cable into the REMOTE jack on the back of the previously installed RAI. Plug the other end of the cable into the TRANSDUCER jack on the back of the second RAI (Figure 44, page 36).

3. Any number of RAI's can be added in this manner.

2.14 DIGITAL COMPASS (DC700/AP) INSTALLATION

2.14.1 Location

The display console should be located within easy view of the wheel and AP900 Console. Avoid areas where the temperature is likely to exceed 120 degrees F. (49 degrees C.). The front panel of the Digital Compass is splash-resistant, not waterproof, so place the console where it won't receive direct moisture. The Digital Compass can be mounted on a bulkhead, overhead, dash, or wall.

2.14.2 Installation Instructions

1. Secure the trunnion mount to the selected location with the provided wood screws or stainless steel bolts (not provided). Place the console in the trunnion mount and tighten the trunnion knobs.

2. Referring to Figure 36, plug the interconnecting cable DC700-4405, into the SENSOR jack at the back of the Digital Compass. Secure with the 2 supplied bolts.

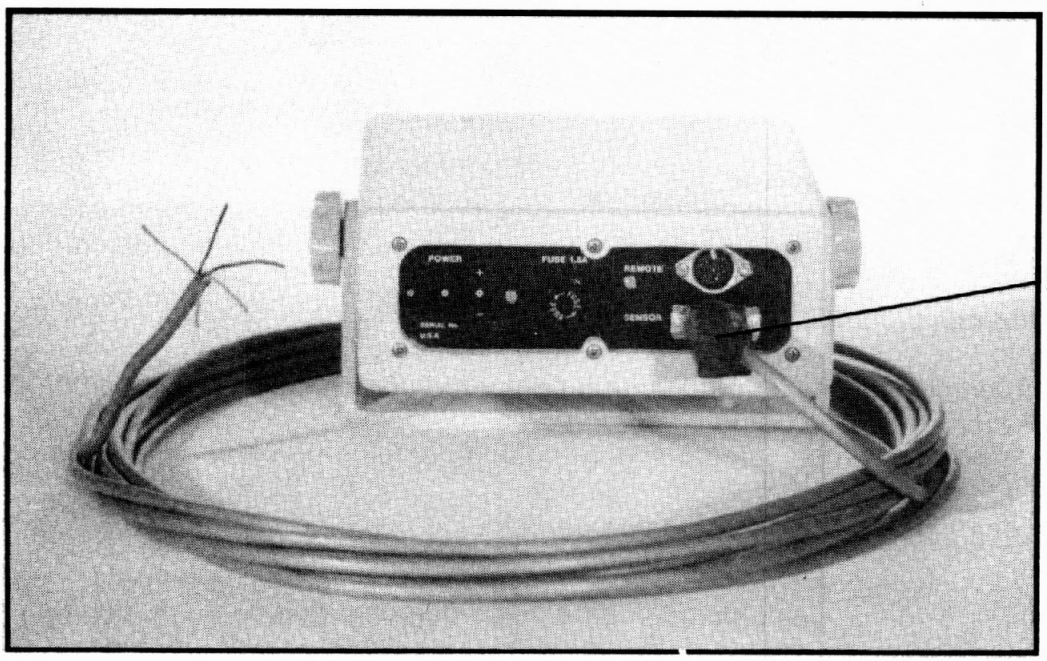


FIGURE 46. BACK OF DIGITAL COMPASS

3. Neatly route the remaining cable to the Interconnecting Matrix. Keep the cable away from large cable groups, such as power equipment cable, unshielded antennas, or signal cables.

4. Remove the Matrix cover and place the cable through one of the rubber grommets on the Matrix.

5. Referring to Figure 47, wire the cable into the Matrix. Follow the General Wiring Instructions on page 16, Section 2.1. Replace Matrix cover.

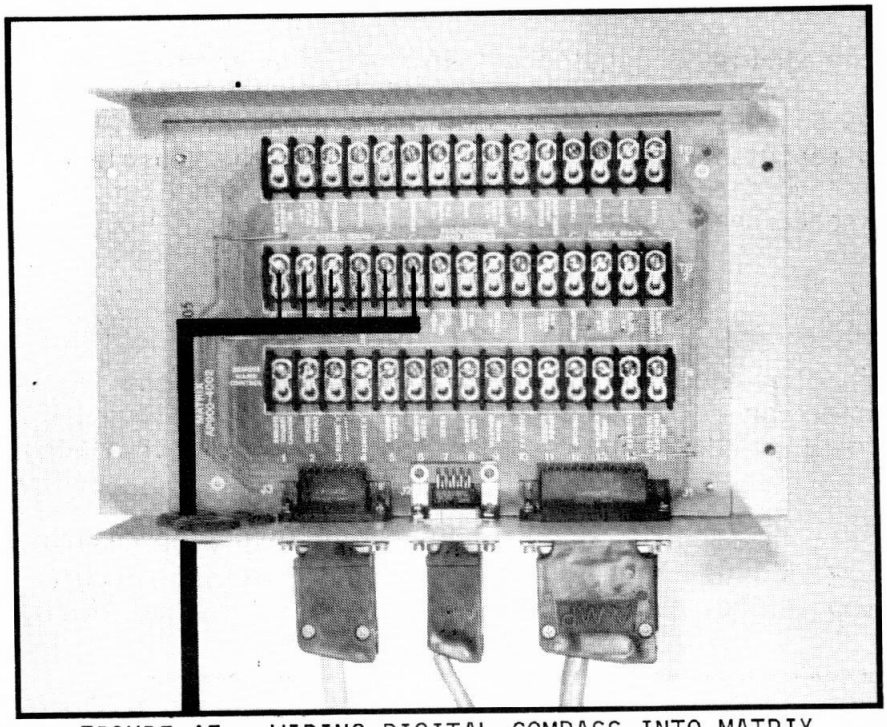


FIGURE 47. WIRING DIGITAL COMPASS INTO MATRIX

TABLE 5.

TB-2	COLOR
1	White
2	Brown
3	Green
4	Black
5	Red
6	Blue

2.15 REMOTE DIGITAL COMPASS (DC700/R) INSTALLATION

The DC700/R consists of a display console, trunnion mount, dust cover, and interconnecting cable.

2.15.1 Location

Avoid locating the display console in areas where the temperature is likely to exceed 120 degrees F. (49 degrees C.). The front panel of the Remote Digital Compass is splash-resistant, not waterproof, so place the console where it won't receive direct moisture. The Remote Digital Compass can be mounted on a bulkhead, overhead, dash, or wall.

2.15.2 Installation

1. Secure the trunnion mount with wood screws (provided) or stainless steel bolts (not provided).

2. Connect interconnecting cable DC700-4404 (provided) into the jack on the back of the DC700/R console (Figure 48, page 40). Secure with 2 screws provided.

3. Neatly route the cable to the DC700/AP console. Keep the cable as far as possible from power cables, other electronic equipment, unshielded antennas, and signal cables.

4. Plug the end of the DC700-4404 cable into the REMOTE jack on the rear of DC700/AP (Figure 49.)

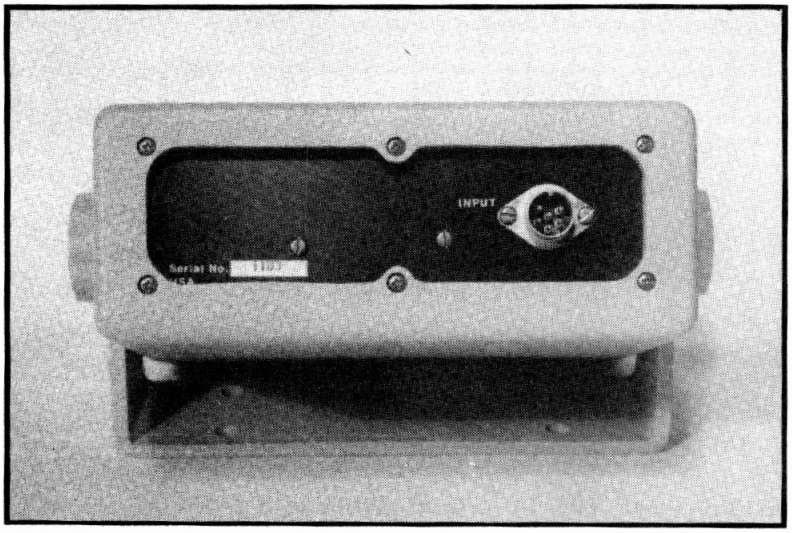


FIGURE 48.
BACK OF DC700/R
REMOTE DIGITAL COMPASS

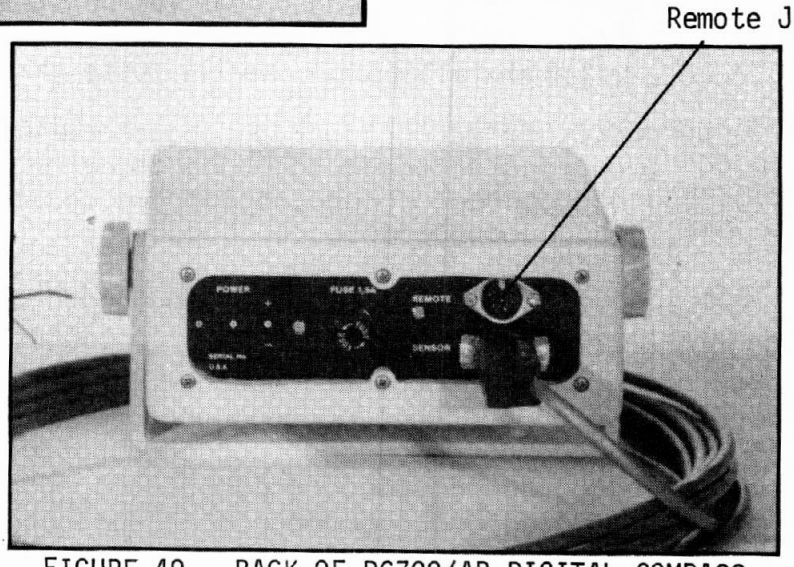


FIGURE 49. BACK OF DC700/AP DIGITAL COMPASS

2.16 REMOTE PROPORTIONAL CONTROL (AP-0126) INSTALLATION

The Remote Proportional Control (RPC) consists of the hand held controller with a 25-foot cable attached, control hanger, and a 25-foot bulkhead cable (AP900-4427).

2.16.1 Location

The bulkhead cable has a bulkhead connector on one end to attach to a central location, such as a flying bridge, aft of cabin, or on a bulkhead. (More than 1 bulkhead connector can be installed and wired into the Matrix. Only one RPC can be plugged in and operated at any one time.)

2.16.2 Installation Instructions

1. Using the template provided in Figure 51, drill 5 holes. Insert the cable through the holes and secure the connector (Figure 39, , page 33), using wood screws or stainless steel bolts (not provided.)

2. Mount the control hanger near the bulkhead connector, using 2 screws or bolts (not provided). (See Figure 41, page 34 for a similar installation.) Neatly route the cable to the Matrix.

3. Remove the Matrix cover and insert the cable through one of the grommets. Referring to Figure 50, wire the cable into the Matrix. Follow General Wiring Instructions on page 16, Section 2.1. Replace Matrix cover.

4. Do not yet plug RPC into bulkhead connector.

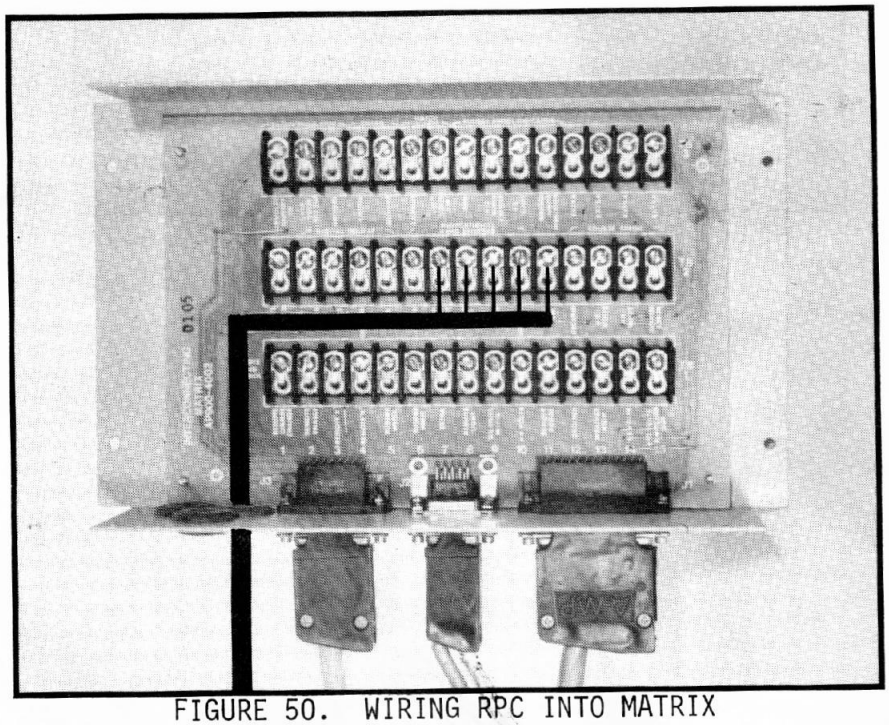


FIGURE 50. WIRING RPC INTO MATRIX

TABLE 6.

TB-2	COLOR
7	Green
8	Black
9	Red
10	White
11	Orn/Brn

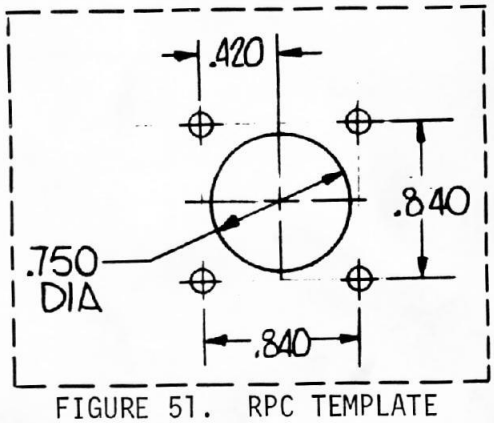


FIGURE 51. RPC TEMPLATE

3.0 CALIBRATION

Once the installation of the AP900 Autopilot and accessories has been completed, the system must be calibrated.

IN ORDER TO AVOID ANY DAMAGE TO THE AUTOPILOT CAUSED BY MISWIRES, SHORTS, OR VOLTAGE PROBLEMS, CHECK BATTERY VOLTAGE AND POLARITY BEFORE BEGINNING CALIBRATION. REFER TO FIGURE 52 for correct polarity. If the battery is not 12VDC, a Voltage Regulator must be installed as described in Section 2.12, page 35.

DO NOT INSERT FUSES AT THIS POINT.

Any damage, especially damage to electronic modules, resulting from non-observance of the above instructions, will not be covered under the warranty.

Follow all calibration instructions PRECISELY.

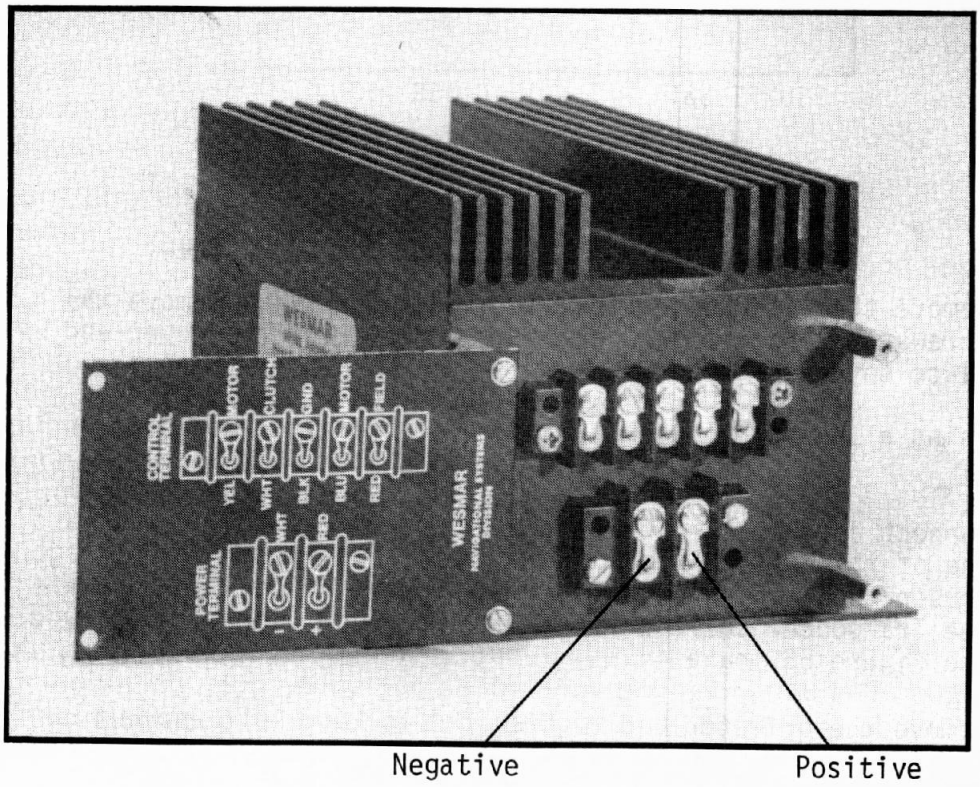


FIGURE 52. SERVO DRIVER

3.1 RUDDER POSITION TRANSDUCER (RPT) CALIBRATION

1. Determine rudder amidships. Rudder amidships is not necessarily the position with the rudder parallel with the keel line; it is the rudder position that steers the vessel on a straight course. Manually position the rudder to amidships.

2. Position the feedback arm on the RPT to form a parallelogram to the vessel's rudder arm as shown in Figure 23, page 22.

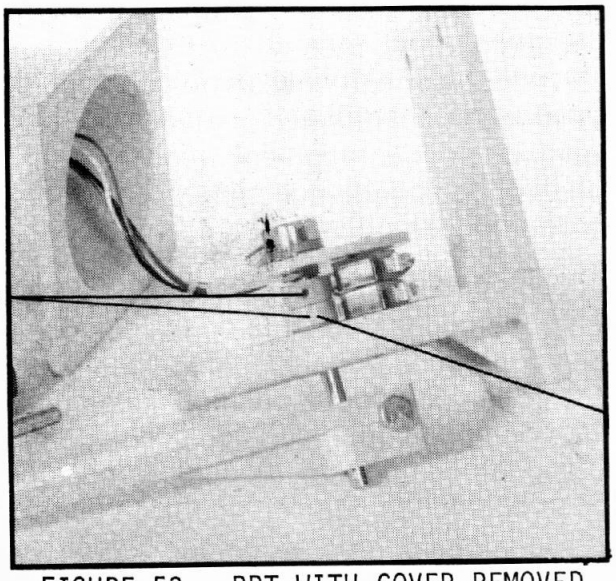


FIGURE 53. RPT WITH COVER REMOVED

3. Remove the interconnecting cable from the RPT. Remove the 4 screws that hold the cover on the RPT. Lift the cover and place to one side.

4. Using a .050 allen wrench, loosen both limit cams shown in Figure 53.

5. Connect an ohmmeter across the wiper (center leg of pot) and one of the outside legs of the pot, shown in Figure 54, page 44. Loosen the locking nut. Using a slotted screwdriver, rotate the Transducer shaft until a reading of 500 ohms is achieved. See Figure 55, page 44.

6. Remove the ohmmeter and tighten the locking bolt and nut on the feedback arm. Make sure not to move the Transducer shaft, since the RPT is now electronically sensing amidships.

7. Manually rotate the vessel's wheel hard-over port. Return the wheel starboard approximately 10 degrees rudder toward amidships.

8. Using the .050 allen wrench, rotate the lower cam until the large portion of the cam just engages the limit switch to produce a "click". Rotate the cam back and forth to a point where the cam just engages the plunger on the limit switch to "open" the switch. Tighten the cam in this position. See Figure 53.

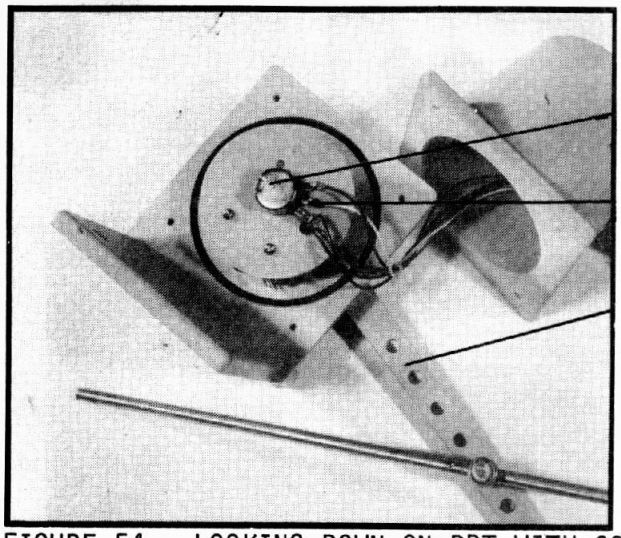


FIGURE 54. LOOKING DOWN ON RPT WITH COVER REMOVED

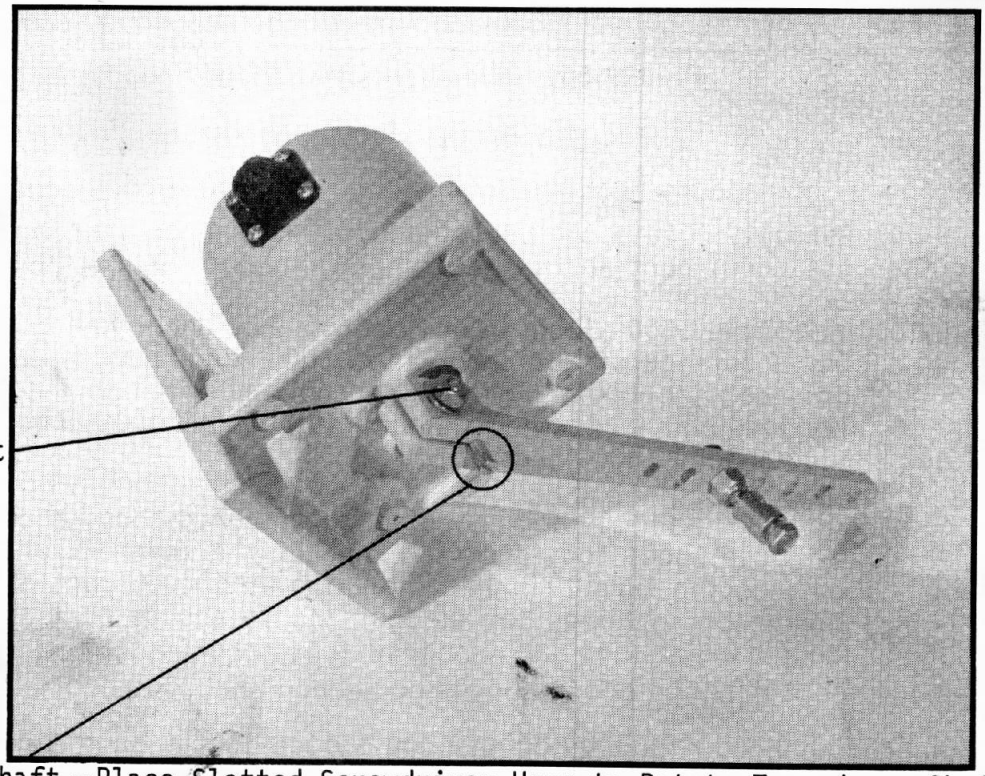


FIGURE 55. RPT, SHOWING TRANSDUCER SHAFT

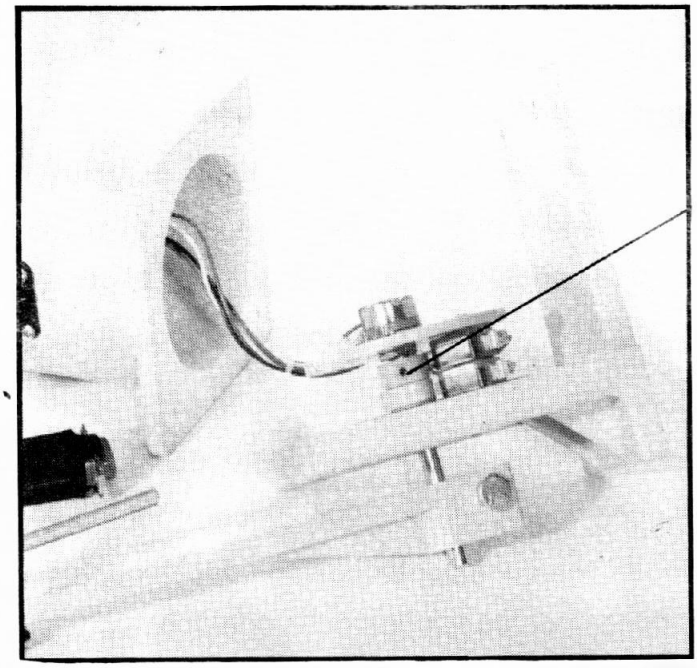


FIGURE 56. RPT WITH COVER REMOVED

9. Manually rotate the vessel's wheel hard-over starboard. Return the wheel port approximately 10 degrees toward amidships.

10. Using the .050 allen wrench, rotate the upper cam until the large portion of the cam just engages the limit switch to produce a "click". Rotate cam back and forth to a point where the cam just engages the limit plunger to "open" the switch. Tighten cam in this position.

11. Rotate the wheel of the vessel toward amidships, then gradually turn the wheel toward port. Monitor the movement of the limit cam, making sure that it is turning in the correct direction. Rotate the wheel as far as possible to ensure that the cam will make contact with the limit switch approximatley 10 degrees before port hard-over.

12. Check starboard limit cam and switch in the same manner.

13. Replace RPT cover, but do not attach screws.

14. Reconnect disconnected rudder cable to RPT cover plug.

15. Check movement of the vessel's rudder and the RPT feedback arm to assure that the RPT cable doesn't catch on any moving parts.

3.2 ORIENTATION OF SATURABLE CORE SENSOR (COMPASS)

1. Review installation of the Saturable Core Sensor assuring that the arrow on the Sensor is aligned with the keel line of the vessel.

3.3 CONTROL CONSOLE CALIBRATION

1. Turn the FUNCTION switch on the Control Console to OFF position.

2. Replace both fuses that were removed from the Servo Driver, INSTALLATION, Section 2.10.2, Step 5, page 33.

3. Remove Control Console from case, exposing the 3 printed circuit boards and calibration points.

4. Position the wheel so the rudder is amidships. Rotate the COURSE SET DIAL to approximate heading of steering compass. Turn WEATHER and RUDDER controls fully counterclockwise.

5. Connect a voltmeter, black or ground lead to TP8 (GND). Attach the red lead (positive lead) to TP7 (+4.0VDC) on mother board. Refer to Figure 57 for test point locations.

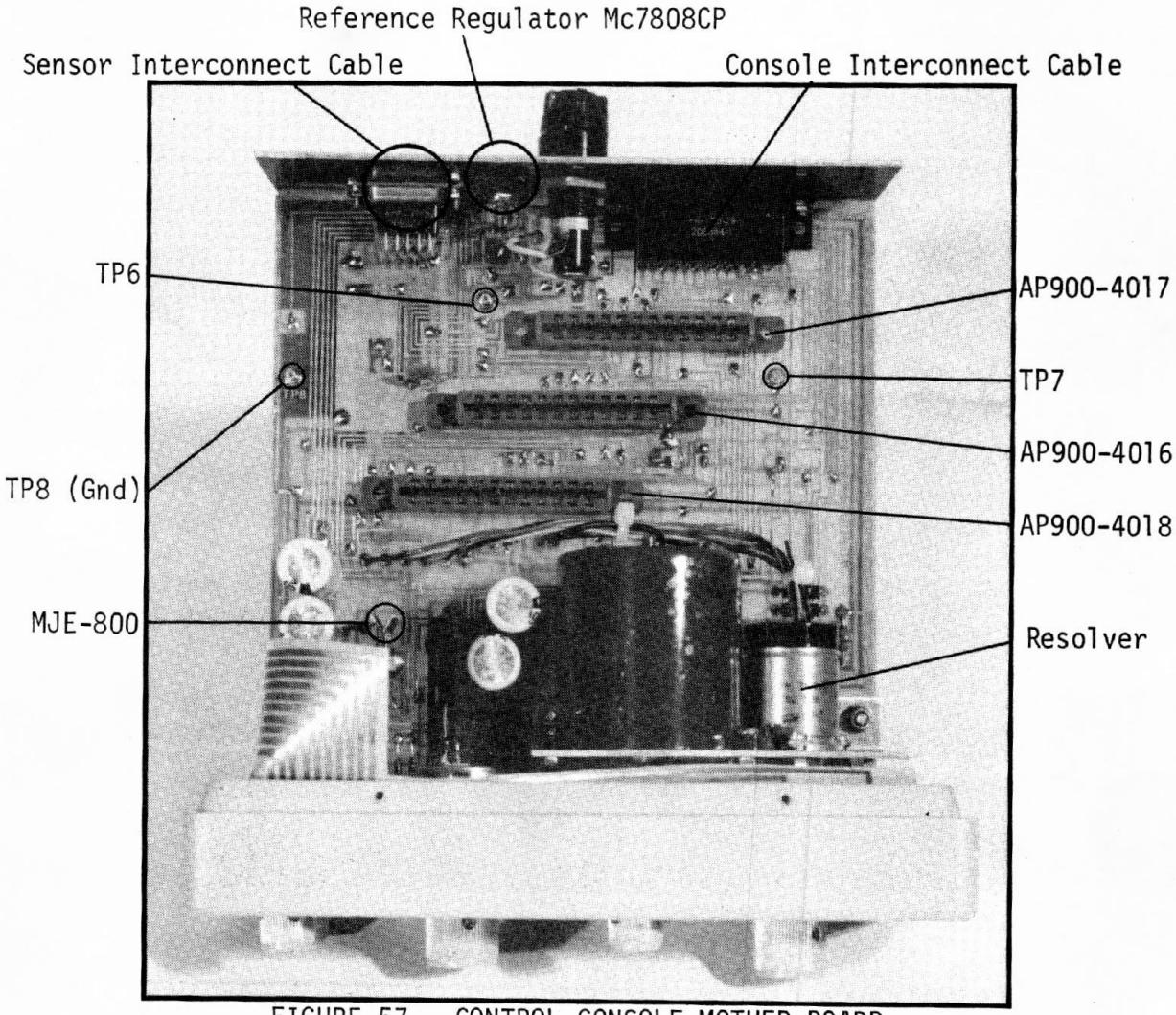


FIGURE 57. CONTROL CONSOLE MOTHER BOARD

6. While observing the voltmeter, turn the FUNCTION switch to the STD-BY mode. The voltmeter should read approximately 4.0 VDC. If you read something greater or much less, turn Autopilot OFF and refer to TROUBLESHOOTING, Number 32.

7. If voltage is correct, check TP6 for approximately 8.0 VDC. If both TP7 and TP6 show the correct voltage, proceed.

8. While in the STD-BY mode of operation, rotate the COURSE SET DIAL clockwise. As soon as you stop turning the dial, release it, and the Autopilot should return the dial back to the original heading. At this point, the yellow light should come on. Should the COURSE SET DIAL "hunt" back and forth about the yellow light, adjust R227 on AP900-4018 (Figure 58) to stop "hunt." If the COURSE SET DIAL does not turn to a position at which the yellow light comes on, increase gain pot R227 (AP900-4018) (Figure 58) until the dial rotates to a yellow light. If this function does not operate correctly, refer to TROUBLESHOOTING, Numbers 30 and 31.

9. Rotate the COURSE SET DIAL counterclockwise, and repeat the calibration described in Step 8 above.

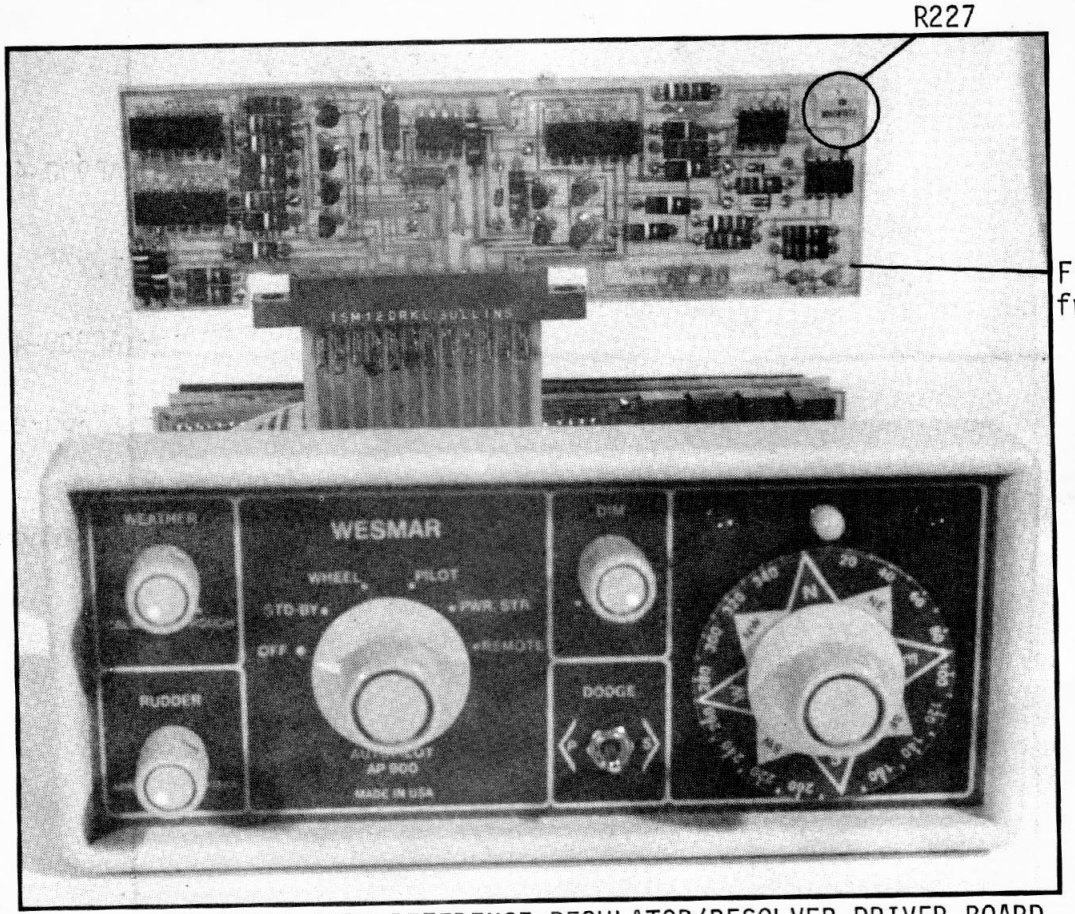


FIGURE 58. AP900-4018 REFERENCE REGULATOR/RESOLVER DRIVER BOARD

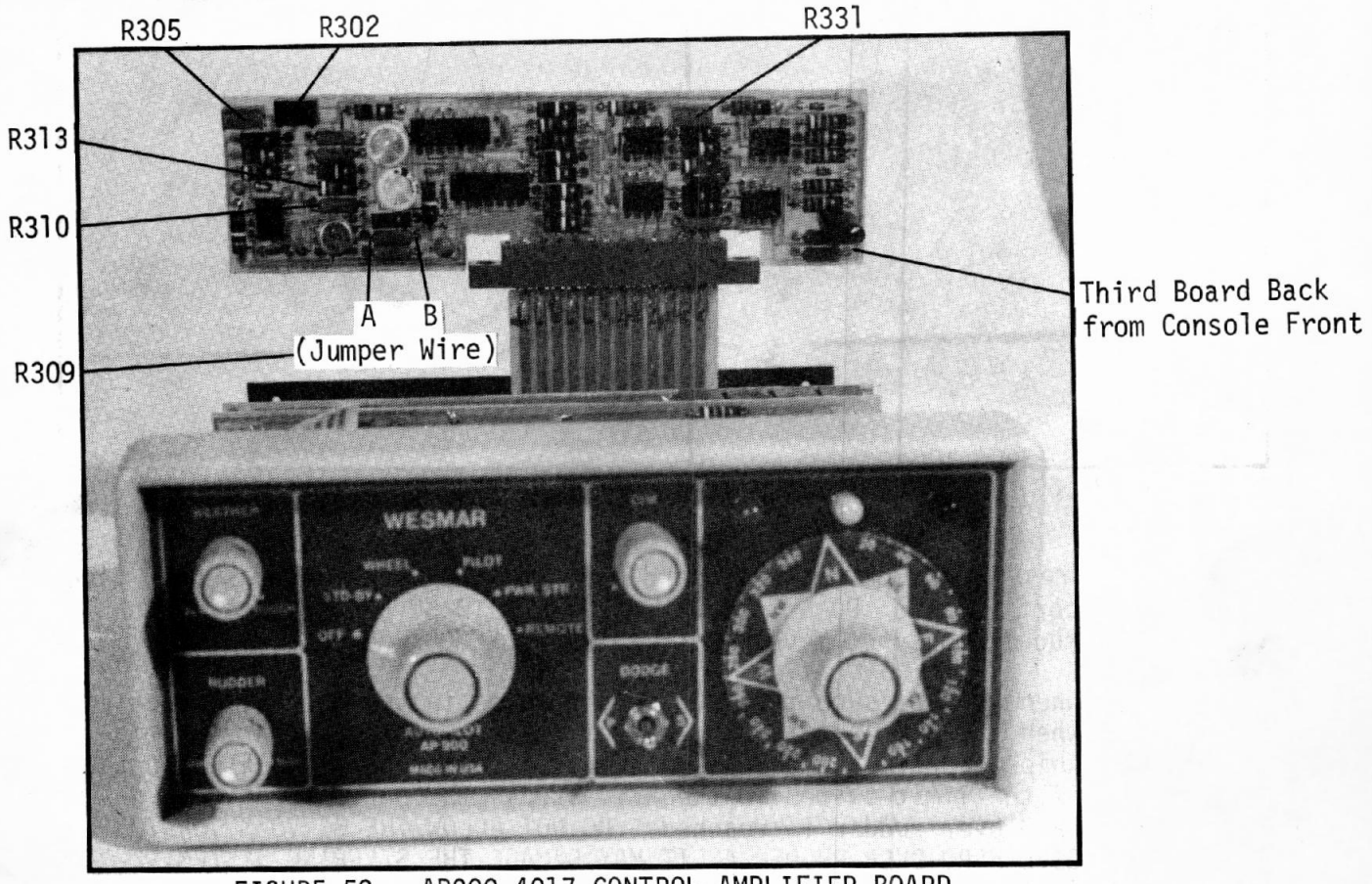


FIGURE 59. AP900-4017 CONTROL AMPLIFIER BOARD

10. Rotate the FUNCTION switch to the WHEEL mode. Place a jumper wire between A and B on the Control amplifier circuit board AP900-4017, as shown in Figure 59. Make sure the rudder is AMIDSHIPS.

11. Connect the voltmeter ground lead to TP7 (4.0 VDC), positive lead to the resistor junction R313 as shown in Figure 59. Observing the voltmeter, adjust R302 for a null or zero volts on the 1 volt scale of meter.

12. Rotate the wheel so the rudder moves 5 degrees to port or starboard. Monitor the voltmeter -- it should read between 500mv and 575mv change. If the meter reads differently, adjust R305 (Figure 59) on the AP900-4017 circuit board until the correct reading is obtained.

13. With rudder amidships, rotate FUNCTION switch to PWR. STR. mode. In this position the Servo Driver and Servo Motor are programmed to hold the rudder at a fixed angle. Press the DODGE switch toward starboard. DO NOT ALLOW THE RUDDER TO GO HARD-OVER. If the rudder goes port, reverse the motor wires on the Servo Driver. Refer to Figure 60, page 49. Should a problem develop, refer to TROUBLESHOOTING, Numbers 10, 11, 12, 13, 14, or 34.

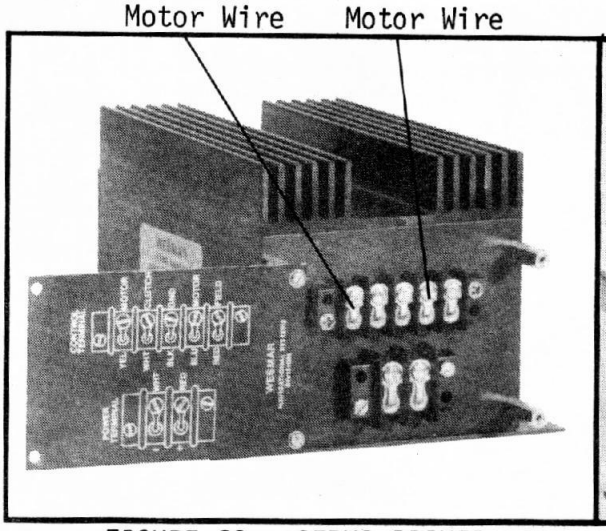


FIGURE 60. SERVO DRIVER

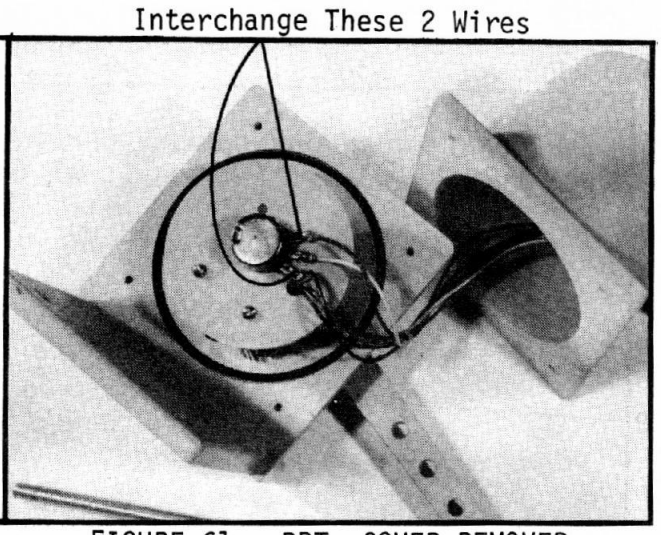


FIGURE 61. RPT, COVER REMOVED

14. Press the DODGE switch toward port and the Servo Motor should give port rudder. DO NOT ALLOW THE RUDDER TO GO HARD-OVER. If the rudder does not move, refer to TROUBLESHOOTING, Number 34.

15. When you are sure that the rudder moves in the correct direction when the appropriate DODGE is given, return the rudder to amidships. Press the DODGE switch to starboard, and CAREFULLY note if the limit switch in the RPT "stops" the Servo Motor before hard-over rudder is reached. DO NOT ALLOW THE SERVO MOTOR TO GIVE HARD-OVER RUDDER AS IT MAY DAMAGE THE STEERING SYSTEM. If the limit switch doesn't stop rudder travel approximately 10 degrees short of hard-over, re-adjust the cams as directed on page 45, Step 10. It may be necessary to use the other cam to stop rudder travel.

16. Check the port limit switch in the same manner.

17. Set WEATHER and RUDDER controls on the Console to 8 o'clock and return rudder to amidships. Turn the FUNCTION switch to PILOT. If the rudder attempts to go hard-over in either direction, TURN PILOT OFF. Then:

    A. Check calibration of 3.3 Step 12, page 48.

    B. Interchange the wires on RPT sensor, Figure 61.

18. With rudder at amidships, again turn FUNCTION switch to PILOT. The Autopilot should now attempt a null condition. The yellow function light should remain on and the rudder should be amidships.

19. While in PILOT mode, remove the jumper wire (installed in 3.3 Step 10, page 48) between points A and B on the AP900-4017 amplifier circuit board, Figure 59, page 48. Note that when the jumper wire is removed, the Autopilot will slowly give rudder, to port or starboard. This is a normal function when at dockside. The automatic synchronizer is trying to null out any error signals. This automatic feature becomes operational when an unequal rudder thrust or drag is present, or when there is wind on the bow. Should the vessel yaw while underway, either re-install the jumper wire or remove resistor R310, Figure 59, page 48.

20. With FUNCTION switch in PILOT, and WEATHER and RUDDER controls set fully counterclockwise, check to see if the red and green function lights flash back and forth. If they do, there is a "hunt" condition which is caused by air in the hydraulic lines, or play in the mechanical steering system. Check both possibilities and eliminate the causes. If you are unable to eliminate the "servo loop slop" in this manner, reduce the loop gain by re-adjusting R305 on the AP900-4017 circuit board. (Figure 59, page 48.)

21. Check Autopilot operation by pressing the DODGE switch to the starboard for a few seconds and then releasing; the rudder should return to amidships. Likewise, press the DODGE switch port and release. The rudder should return to amidships.

22. Turn the FUNCTION switch to PWR.STR. Press DODGE switch to port and note the direction of travel. If correct, switch to PILOT. Rudder should return to amidships.

23. The AP900 Autopilot has a 1 1/2 degree course sense angle. To check the course sense angle, start with the FUNCTION switch in WHEEL position. Rotate the WEATHER control fully counterclockwise. Turn the COURSE SET DIAL until the yellow light is on. Then turn the COURSE SET DIAL clockwise, noting the heading indicated on the dial when the yellow light is on. Turn the dial until a red function light comes on. Note the heading, and rotate the dial counterclockwise. The red light should go out, the yellow light flash on, then the green light should illuminate. Note this heading also. The COURSE SET DIAL should move approximately 3 degrees maximum between the flashing of the red and green lights. If the COURSE SET DIAL moves more than 1 1/2 degrees in either direction before the yellow function light extinguishes, then the course sense angle is incorrect and calibration is necessary, as described in Step 24 immediately following.

24. To calibrate the Course Error Signal, connect a voltmeter, positive lead to J2-F on the AP900-4016 amplifier board, Figure 62, page 51. Connect the negative lead (black) to TP7 (4.0 VDC) on the mother board. Set voltmeter to 1 volt range. Turn the FUNCTION switch to WHEEL mode. Rotate COURSE SET DIAL until a zero (0 VDC) reading is on the meter. At this point the yellow function light should be lit. Note the exact course on the dial, and then rotate COURSE SET DIAL exactly 10 degrees. The meter reading should change approximately 500mv, or 50mv per degree of course error. If the voltage is not between 500mv and 575mv, adjust R131, Figure 62, page 51, until the correct voltage is read.

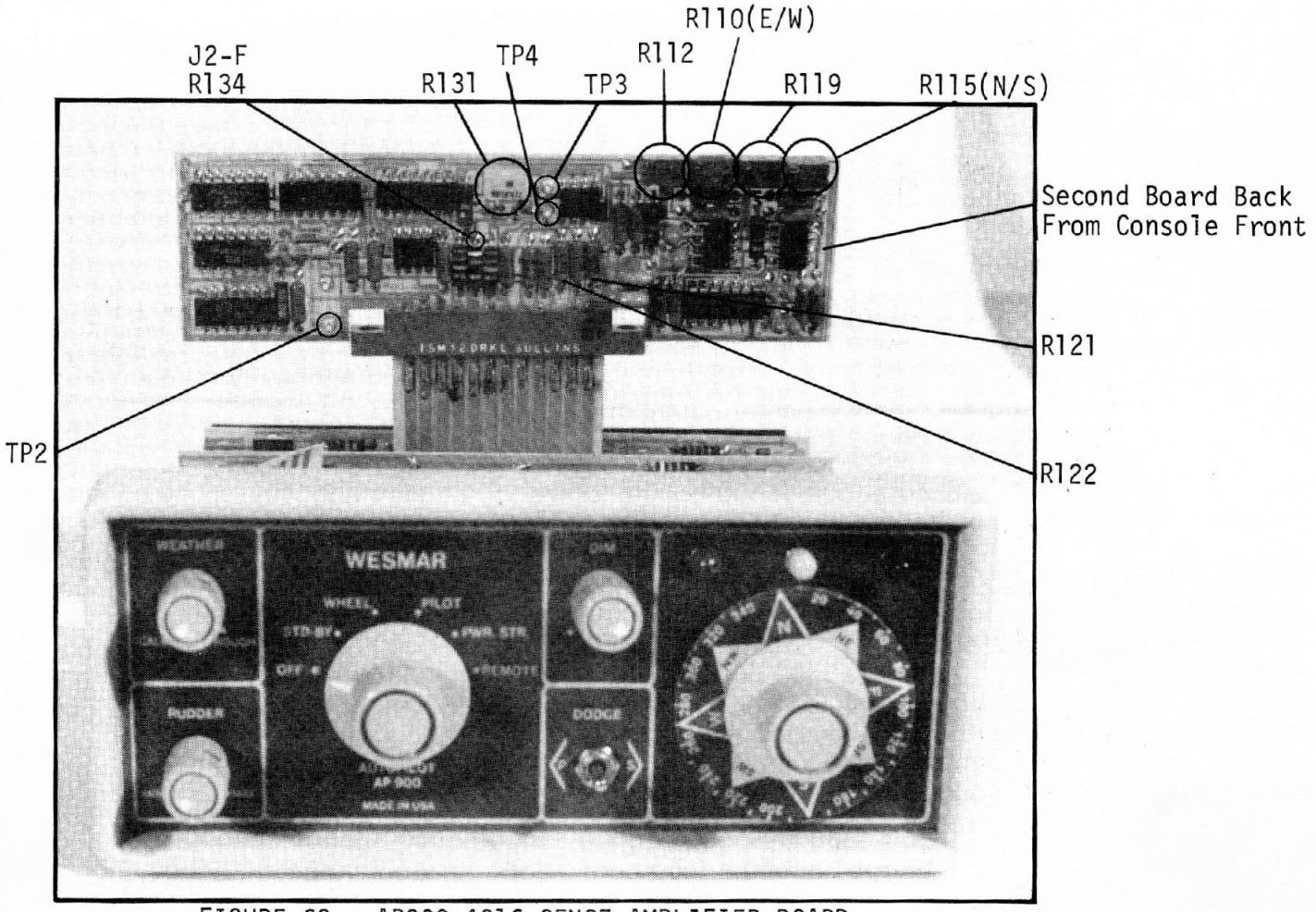


FIGURE 62. AP900-4016 SENSE AMPLIFIER BOARD

25. Check calibration of COURSE SET DIAL while at dockside. Set FUNCTION switch to WHEEL mode, WEATHER control fully counter-clockwise. Rotate the COURSE SET DIAL so yellow function light is lit. Using a standard mechanical compass, determine the exact direction in which the keel line points. If the compass reading agrees with the COURSE SET DIAL heading, then go to Step 27.

26. To calibrate COURSE SET DIAL, remove the course set knob using a 1/16 inch allen wrench. While in the WHEEL mode, WEATHER control turned fully counterclockwise, and yellow light lit, hold the dial and loosen the locking nut. Then hold the bushing and rotate the COURSE SET DIAL until it reads the same heading as the magnetic compass. Holding the bushing and the dial, tighten the locking nut and replace the knob. Re-check to see that the COURSE SET DIAL agrees with the mechanical compass reading.

27. This completes the calibration of the Autopilot Control Console. Replace the console in its enclosure.

28. Make sure the Rudder Position Transducer cover is on and tighten screws.

3.4 SATURABLE CORE SENSOR (COMPASS) CALIBRATION

The AP900-5003 Saturable Core Sensor has been calibrated to a known standard at the factory. This enables the Sensor to indicate precise headings when not disturbed by any strong magnetic fields. When properly installed on wood, fiberglass, or aluminum boats, the SENSOR WILL GENERALLY REQUIRE NO RECALIBRATION. On steel or ferro-cement boats, the Sensor may have to be calibrated.

1. To calibrate the Sensor, secure the vessel to the dock. Using a separate magnetic compass, mark on the Sensor mounting bracket 0 degrees (magnetic north), 45 degrees, 90 degrees, and 135 degrees. Loosen the Sensor in its mounting bracket, so that the Sensor can be rotated in its bracket during calibration.

2. Remove the AP900 Control Console from its enclosure, leaving both the Sensor cable and Matrix cable connected. Slide the panel forward to expose the AP900-4016 circuit board. Refer to Figure 62, page 51.

3. Rotate the Sensor in its mount until the arrow on the Sensor cover is aligned with the mark indicated 0 degrees (magnetic north).

4. Attach the ground lead of a voltmeter to TP7 (Figure 57, page 46). Attach the positive lead to resistor junction R122 (Figure 62, page 51). Set the meter to .5 VDC range.

5. Turn the Console FUNCTION switch to WHEEL mode. Adjust R115 (Figure 62, page 51) on the AP900-4016 circuit board for a null or zero volts.

6. Manually rotate the Sensor in the mounting bracket to 90 degrees (east).

7. Connect the positive lead of the voltmeter to resistor junction R121 (shown in Figure 62, page 51).

8. With the FUNCTION switch in WHEEL mode, adjust R110 for a null or zero volts.

9. Repeat steps 3 and 5.

10. Repeat steps 6 and 8.

11. Rotate the Sensor to 0 degrees (magnetic north).

12. Calibrate the COURSE SET DIAL, as shown on page 51, Steps 25 and 26, until the dial reads 0.

13. Turn the FUNCTION switch to WHEEL mode and rotate the COURSE SET DIAL to zero degrees. WEATHER control must be fully counter-clockwise to Calm. Yellow light must be lit.

14. Rotate the Sensor to 45 degrees.

15. Turn the FUNCTION switch to STD-BY mode. The COURSE SET DIAL should move close to a 45 degree reading.

16. Observing the dial, adjust R119 (Figure 62, page 51) until the COURSE SET DIAL reads exactly 45 degrees.

17. Rotate the Sensor manually to 135 degrees.

18. Adjust R112 until the COURSE SET DIAL reads 135 degrees.

19. Check the calibration of cardinal points. Minor adjustments of R115 north and south, R110 east and west may be necessary to obtain greater accuracy.

20. Check the calibration of inter-cardinal points. Minor adjustments of R119 and R112 may be necessary to obtain greater accuracy.

21. Replace the Control Console into its enclosure and secure with 8 screws.

22. Secure the Sensor in its mounting bracket.

3.5 SENSOR CALIBRATION ON STEEL VESSELS

1. To calibrate the Sensor on a steel vessel, tie a bow line around a piling so the vessel can swing around it. With the Autopilot in STD-BY, steer the vessel to each of the headings on the chart below, using a calibrated mechanical compass or known sightings as the reference. Note the reading on the COURSE SET DIAL for each heading. Should any of the readings be off more than 20 degrees, it may be necessary to install a compensating magnet near the Sensor.

REFERENCE	0	45	90	135	180	225	270	315
READING								

SENSOR CALIBRATION CHART

2. If <u>all</u> readings are greater than the reference, or <u>all</u> readings are less than the reference, note the heading at which there is the <u>smallest</u> difference between the reference and the COURSE SET DIAL. Turn the vessel to this heading, then rotate the Sensor until the COURSE SET DIAL reads the same as the reference. Proceed with Sensor calibration, Steps 4 through 11 on page 52.

3. A sea trial is necessary after Sensor calibration. On most steel vessels a 1" x 1/4" rod healing magnet housed in a brass tube must be installed. Position the magnet approximately 5" below the exact center of the Sensor, red side up. While in PILOT mode, steer a north course. Should the vessel yaw, bring magnet closer to the bottom of the Sensor. Once yawing stops, secure the magnet. Now steer an easterly and southern heading. Autopilot should steer normally. If the vessel yaws on these headings, magnet is too close or too large. Try a smaller magnet, reset on a north heading, and repeat sea trial until yawing stops.

3.6 RUDDER ANGLE INDICATOR (RAI) CALIBRATION

1. With the RAI console mounted and the interconnecting cable inserted into the TRANSDUCER jack on the rear panel, turn the console on.

2. Turn the FUNCTION switch on the AP900 Control Console to WHEEL. Rotate the vessel's wheel to exact amidships position.

3. To calibrate the RAI, take the RAI console out of its enclosure by removing 8 screws. Pull the RAI partially out of the enclosure, exposing the 2 adjustment pots shown in Figure 63. Check to make sure the rudder is amidships. Adjust "zero" pot on RAI circuit board for a 0 meter reading. Turn the wheel starboard until the rudder is approximately 35 degrees angle. Adjust GAIN pot on RAI circuit board for a 35 degree meter reading.

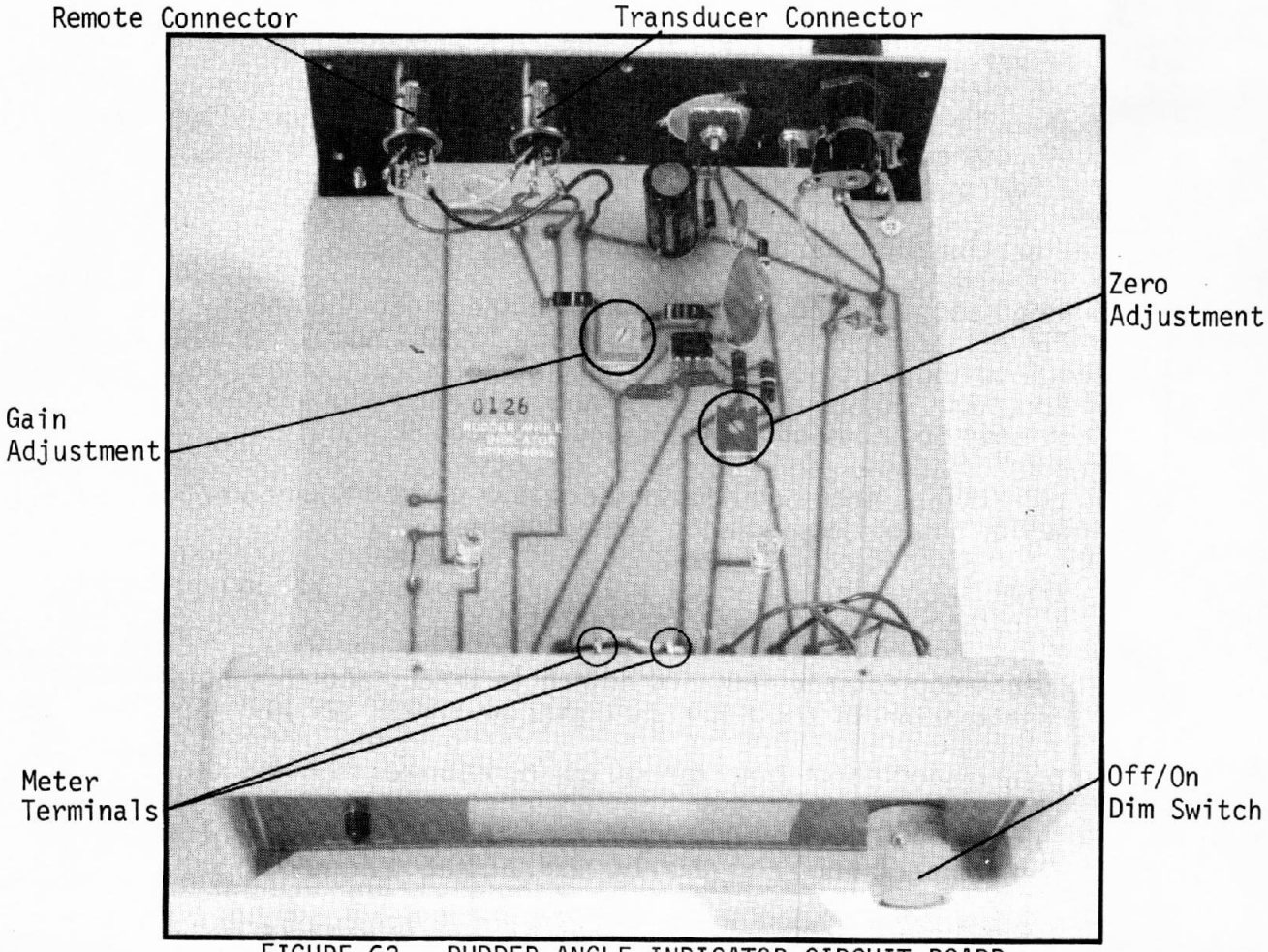


FIGURE 63. RUDDER ANGLE INDICATOR CIRCUIT BOARD

4. At this point make sure the meter needle swings in the correct direction. If the meter reads in the port direction, TURN THE RAI OFF. Then simply switch the 2 wires coming from the circuit board up to the meter terminals. BE SURE RAI IS TURNED OFF when making this change (Figure 63).

5. This completes the calibration of the RAI. Replace the RAI in its enclosure.

3.7 DIGITAL COMPASS CALIBRATION

There are several ways to calibrate the DC700/AP Digital Compass:

A. The most accurate method is to tie up to a dock which you are sure runs north/south or east/west. This can be checked by sighting with an accurate magnetic compass. Secure the vessel to the north/south dock, pointing north, and proceed with the calibration.

B. Another method involves securing the vessel to any dock. Using a magnetic compass and protractor mark 0, 45, 90, and 135 degrees on the top of the Sensor mounting bracket. Loosen the Sensor in its mounting bracket. With this method, the Sensor is rotated in its bracket during calibration.

C. A third method allows calibration while the vessel is underway. By referring to charts of local water, the ship's compass, or known landmarks, you can determine correct directions for reference. Select an area where there is sufficient area to maneuver. Because of vessel movement, this method is the least accurate.

Regardless of calibration method used, it is critical that when 0 degrees, 45 degrees, 90 degrees, or 135 degrees is being used as a reference, the arrow on the Sensor cover must be pointing in that direction.

Specific calibration instructions follow:

1. No adjustments are necessary within the Digital Compass itself. All calibrations are made within the AP900 Control Console. Remove the Control Console from its enclosure. Leave the cables attached. Slide the panel forward to expose the AP900-4016 circuit board as shown in Figure 64, page 56.

2. IMPORTANT. Make sure the arrow on top cover of the Saturable Core Sensor is in line with the keel line.

3. Align the vessel's keel on a 0 degree heading. (If using method B, rotate the Sensor in its bracket.)

4. Turn AP900 Console FUNCTION switch to WHEEL. At this point, pay no attention to the function lights or COURSE SET DIAL position.

5. Turn the DC700/AP FUNCTION switch to HEADING.

6. Turn the DC700/AP to ON position, increasing DIM control until the digital display is easily read.

7. Using a small screwdriver, adjust R115 on AP900-4016 board for a 0 degree reading on DC700/AP (Figure 64, page 56).

8. Untie the vessel and move to the end of the dock. Align the vessel's keel to an east, 90 degree heading. Secure the vessel. (If using method B, rotate the Sensor in its bracket.)

9. Again using a small screwdriver, adjust R110 for 90 degree reading on DC700/AP digital display (Figure 64, page 56).

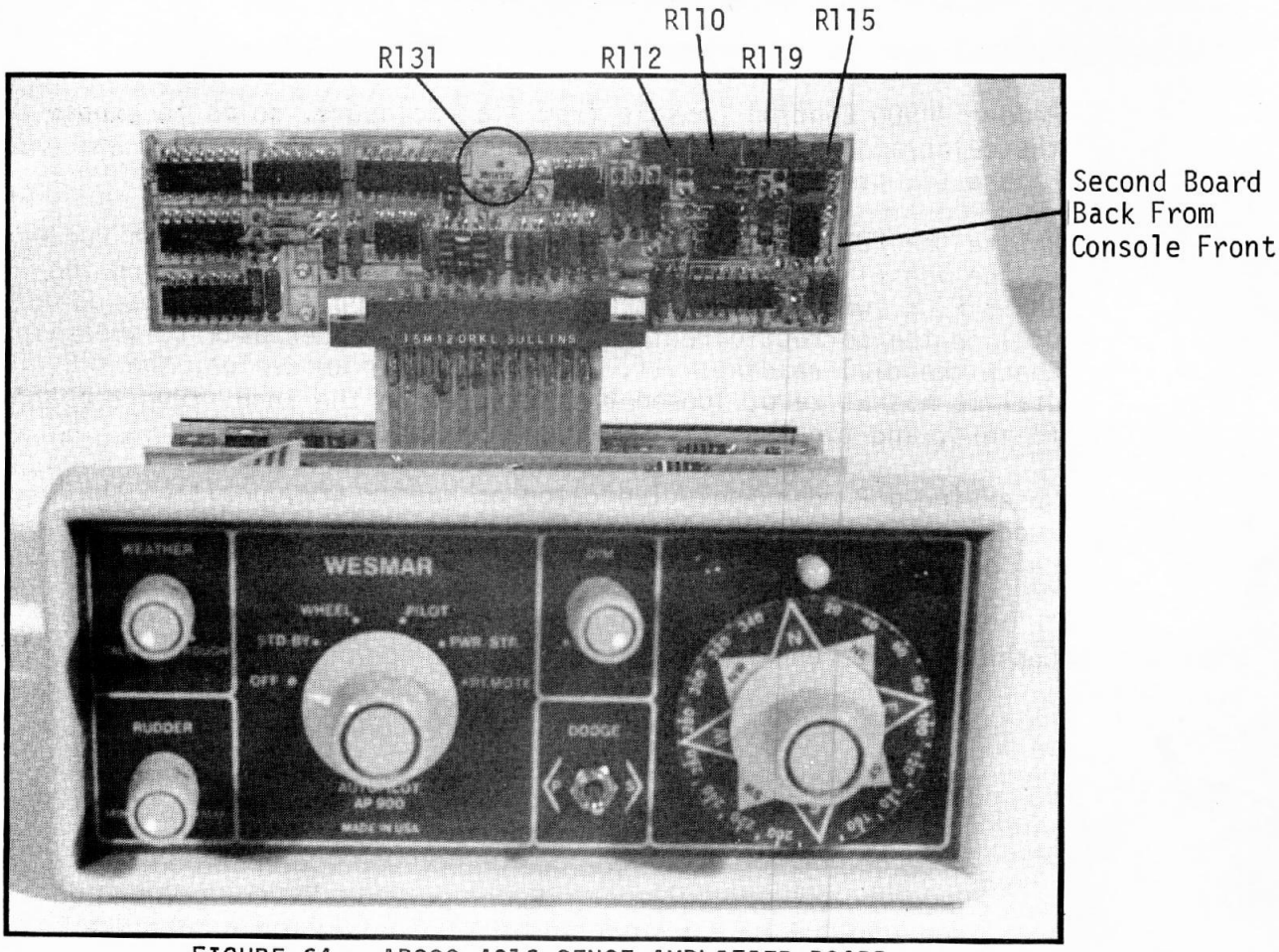


FIGURE 64. AP900-4016 SENSE AMPLIFIER BOARD

10. Untie the vessel and secure on a 45 degree heading. (If using method B, rotate the Sensor in its bracket.)

11. Using a small screwdriver, adjust R119 for 45 degree reading on DC700/AP digital display.

12. Untie the vessel and secure on a 135 degree heading. (If using method B, rotate the Sensor in its bracket.)

13. Using a small screwdriver, adjust R112 for a 135 degree heading.

14. Recheck Steps 3 and 7.

15. Recheck Steps 8 and 9.

16. This completes the calibration of the DC700/AP. Reinstall AP900 Console in its enclosure.

3.8 REMOTE PROPORTIONAL CONTROL (RPC) CALIBRATION

1. Install and plug in RPC.

2. Remove AP900 Control Console from its enclosure, so as to expose the calibration pot R331 on the AP900-4017 circuit board. See Figure 59, page 48.

3. Rotate the FUNCTION switch to PWR. STR. mode. Position the rudder of the vessel to amidships. Set the RPC dial to zero. Turn the RPC OFF/ON switch to ON. Should rudder be applied, turn the RPC dial in the correct direction to bring the rudder back to amidships. Check the dial reading. If, with the rudder amidships, the RPC dial is not at zero, loosen the setscrew on the knob, turn the knob to zero, and tighten.

4. Observing a Rudder Angle Indicator or rudder arm, position the rudder at 35 degrees. Adjust the R331 so that the angle of the rudder and the angle on the RPC dial agree.

5. This completes the calibration of the RPC. Replace the Control Console in its enclosure.

4.0 OPERATION

The proper operation of the AP900 Autopilot and accessories is discussed below. Be sure to read this section completely and carefully before attempting to operate your Autopilot. If after reading this section you still have some doubts or questions, ask your dealer or call WESMAR for an explanation BEFORE using the Autopilot.

4.1 CONTROL CONSOLE OPERATION

The Control Console contains seven controls. The operation of each control is described below:

4.1.1 FUNCTION Switch - Used to select the desired operating mode of the Autopilot and accessories.

OFF: In this mode of operation the Autopilot is non-functional and DC power to the complete system is off.

STD-BY: When this mode of operation is selected, the AP900 Console automatically rotates the COURSE SET DIAL to read the course heading being manually steered. The Autopilot is "standing by," ready to take over. To operate, set the WEATHER and RUDDER controls as described below. Then manually steer the vessel to the desired heading, waiting for the yellow light to come on. Turn the FUNCTION switch to PILOT. The AP900 will now automatically steer the vessel on the desired heading.

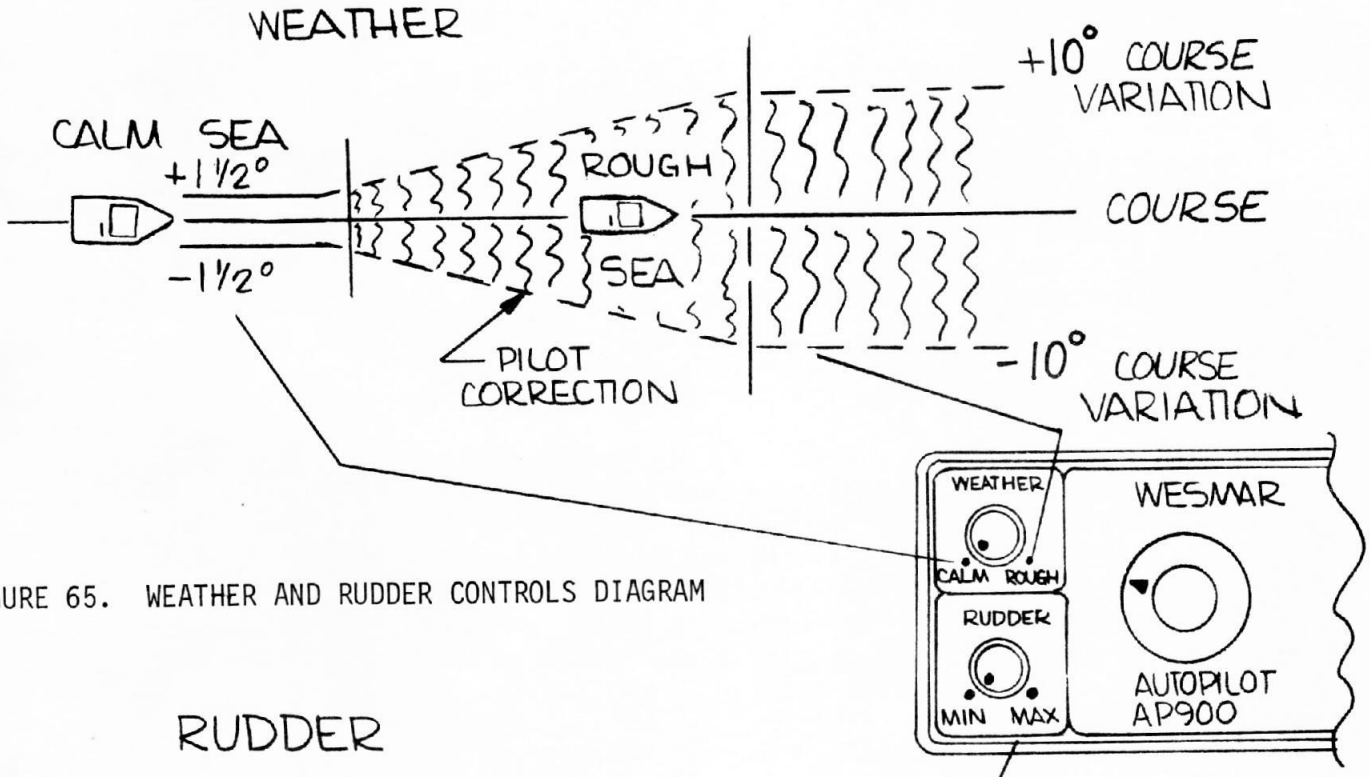
WHEEL: Steer-by-lights mode. To use this mode, set the COURSE SET DIAL to the desired course. Adjust WEATHER control, as explained below. The yellow light will be lit when the vessel is on course. If the red light becomes lit, turn the wheel to port until the yellow light comes back on. Counter with starboard rudder to maintain a steady yellow light. If the green light comes on, apply starboard rudder until the yellow light is lit again.

PILOT: While in the PILOT mode, all sensing and control circuits are activated, and the Autopilot is steering the vessel on the course "set in" by the COURSE SET DIAL. In this mode of operation, the operator can change course by dialing in the course desired. The vessel may also be dodged to the port or starboard by simply pressing the DODGE switch to port or starboard. Rudder will be applied as long as the DODGE switch is pressed, or until a limit switch is activated. When the DODGE switch is released, the vessel will return to its original course.

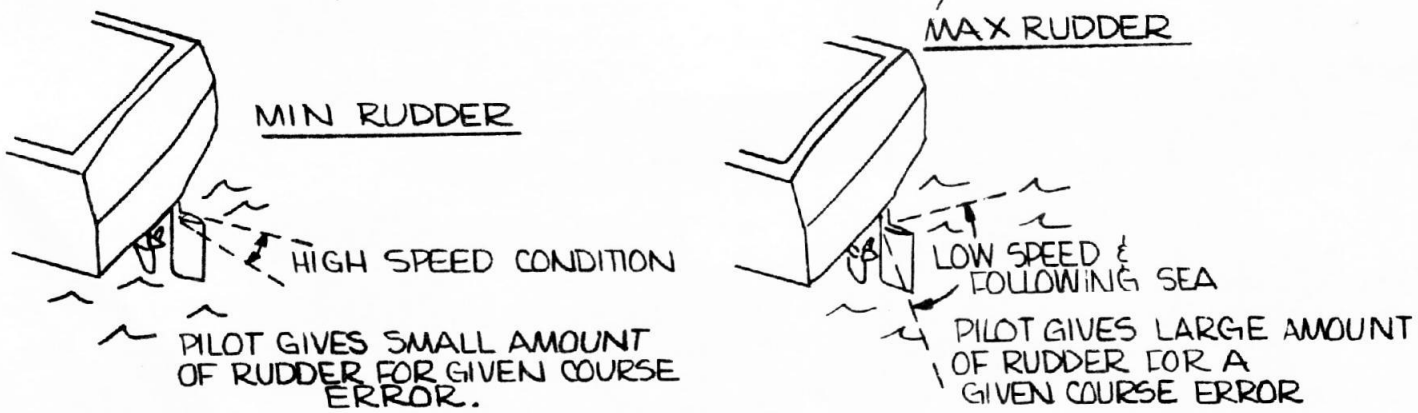
PWR.STR. (Power Steer): In this mode of operation the Autopilot will hold the rudder at any position desired. This is essentially an electric steering mode. Change course and rudder angle by pressing the DODGE switch.

REMOTE: The REMOTE mode transfers Console control to the Remote Hand Control when it is plugged in.

4.1.2 WEATHER - Used in different sea conditions to set the degree of course error allowed. When the WEATHER is set to minimum, or counterclockwise, the degree of course deviation is narrow, approximately ± 1 1/2 degrees; with the control set to maximum, the degree of course error allowed is ± 10 degrees. For a calm sea, set the WEATHER to minimum. For a rolling or rough sea, turn the WEATHER clockwise to open the course width. In this condition, the course "made good" will be an average of the vessel's movement. The WEATHER should be set so that the yellow function light will be lit through a normal oscillation of the vessel's bow. In other words, the red and green function lights will blink occasionally. Set the WEATHER control so that a yellow light is maintained approximately 50 - 60% of the time. See Figure 65.



IGURE 65. WEATHER AND RUDDER CONTROLS DIAGRAM



4.1.3 RUDDER - Controls the amount of rudder applied for a specific off-course deviation. If the vessel is under-steered and yaws off course, turn the RUDDER control clockwise until the correct amount of rudder is applied. Should the Autopilot be over-steering the vessel, causing an uncontrolled yaw, turn the RUDDER control counterclockwise until the vessel stops yawing.

4.1.4 DODGE - The DODGE switch is activated when the FUNCTION switch is set on PILOT or PWR.STR., and can be used to dodge objects or to electrically steer the vessel. In the PILOT mode, if the DODGE is pressed either port or starboard, the rudder will be applied until DODGE is released or a limit switch is activated. Once DODGE has been released, the vessel will return to the original course. When the DODGE switch is pressed in the PWR.STR. mode, rudder is again applied, but when the switch is released the vessel will not be returned to the original course. This is useful because it allows you to "electronically" steer your vessel for docking, circling a school of fish, or picking up crab pots.

4.1.5 COURSE SET DIAL - Used to "set in" the course heading desired. The course may be "set in" automatically in STD-BY, or dialed in by the operator in any other mode of operation.

4.1.6 DIM - Varies the intensity of the function lights and back panel lighting. This allows easy use of the Autopilot at night.

4.1.7 FUNCTION LIGHTS - Show how the Autopilot is functioning and aid in setting the WEATHER and RUDDER controls. The lights can also be used in troubleshooting. In addition, with the Autopilot in WHEEL mode, the lights will guide the operator to manually steer a straight course. In this "steer-by-lights" situation, when the yellow light is lit the vessel is on course. When the red light flashes on, the operator should apply port rudder until the yellow light is again lit. When the green light comes on, apply starboard rudder.

ACCESSORIES

4.2 REMOTE HAND CONTROL (RHC) OPERATION

The easily operated RHC is fully activated and usable ONLY when the FUNCTION switch on the AP900 Control Console is turned to the REMOTE mode. The function of each control on the RHC is explained below:

4.2.1 FUNCTION switch - Controls the various operating modes of the RHC.

OFF: Power remains on at the AP900 Control Console. The RHC is non-functional.

STD-BY: When in this mode of operation, the COURSE SET DIAL on the AP900 Control Console is rotated to read the course heading being manually steered. The Autopilot is "standing by," ready to take over. To operate, set the WEATHER and RUDDER controls as described below. Then manually steer the vessel to the desired heading, waiting for the yellow light. With the yellow light on, turn FUNCTION switch to PILOT. The AP900 will now automatically steer the vessel on the desired heading.

WHEEL: Steer-by lights mode. Turn FUNCTION switch to STD-BY, then manually steer to the desired course. Rotate FUNCTION switch to WHEEL mode. Adjust WEATHER control, as explained below. The yellow light will be lit when the vessel is on course. When the yellow light goes out, manually steer the vessel back on course, using a steering compass to find the correct heading. When the vessel is back on course, the yellow light will flash on again.

PILOT: While in the PILOT mode, all sensing and control circuits are activated, and the Autopilot is steering the vessel on the course "set in". In this mode of operation, the operator can change course by pressing the COURSE change switch. The vessel may also be dodged to the port or starboard by simply pressing the DODGE switch to port or starboard. Rudder will be applied as long as the DODGE switch is pressed, or until a limit switch is activated. When the DODGE switch is released, the vessel will return to its original course.

PWR.STR. (Power Steer): In this mode of operation the Autopilot will hold the rudder at any position desired. This is essentially an electric steering mode. Change course and rudder angle by pushing the DODGE switch.

4.2.2 WEATHER - Used in different sea conditions to set the degree of course error allowed. When the WEATHER is set to minimum, or counterclockwise, the degree of course deviation is narrow, approximately ± 1 1/2 degrees; with the control set to maximum, the width of course error allowed is ± 10 degrees. For a calm sea, set the WEATHER to minimum (Calm). For a rolling or rough sea, turn the WEATHER clockwise to open the course width. In this condition, the course "made good" will be an average of the vessel's movement. The WEATHER should be set so that the yellow function light is lit 50 - 60% of the time. See Figure 65, page 59.

4.2.3 RUDDER - Controls the amount of rudder applied for a specific off-course deviation. If the vessel is under-steered and yaws off course, turn the RUDDER control clockwise until the correct amount of rudder is applied. Should the Autopilot be over-steering the vessel, causing an uncontrolled yaw, turn the RUDDER control counterclockwise until the vessel stops yawing.

4.2.4 DODGE - The DODGE switch is activated when the FUNCTION switch is set on PILOT or PWR.STR., and can be used to dodge objects or to electrically steer the vessel. In the PILOT mode, if the DODGE

is pressed either port or starboard, the rudder will be applied until DODGE is released or a limit switch is activated. Once DODGE has been released, the vessel will return to the original course. When the DODGE switch is pressed in the PWR.STR. mode, rudder is again applied, but when the switch is released the vessel will not be returned to the original course. This is useful because it allows you to "electronically" steer your vessel for docking, circling a school of fish, or picking up crab pots.

4.2.5 COURSE - Operational only when the RHC is in PILOT mode, the COURSE change switch allows the operator to change the preset course heading from the remote station. By pressing COURSE switch to port, the COURSE SET DIAL on the AP900 Control Console will rotate toward port, and the heading of the vessel will be changed to port. To change the vessel's heading to starboard, press the COURSE switch to starboard.

4.2.6 YELLOW FUNCTION LIGHT - This light indicates when the system is nulled, or, in other words, when the vessel is on course. The yellow light on the RHC is lit when the yellow light on the AP900 Control Console is on.

4.3 RUDDER ANGLE INDICATOR (RAI) OPERATION

The operation of RAI is simple. Turn OFF/ON DIM control to ON and fully clockwise. The green "on" light should be lit. The meter on the RAI will indicate the angle of the rudder. To dim the backlight for night use of the RAI, rotate the DIM control counterclockwise.

4.4 DIGITAL COMPASS (DC700/AP) OPERATION

Turn the AP900 Control Console FUNCTION switch to any mode but OFF, thereby applying power to the DC700/AP and the Autopilot. Turn the DC700/AP FUNCTION switch to HEADING, then turn OFF/ON DIM knob to ON and continue rotating clockwise to increase the lighting intensity until the digital display is clearly visible. The digital readout displayed on the panel is the present course or heading of the vessel. The function of the two controls is explained below:

OFF/ON/DIM - Supplies power to the Digital Compass, when the Autopilot is on. On the same control is the DIM function, which varies the brightness of the digital display.

FUNCTION - Controls the many functions of the Digital Compass, as explained below:

HEADING: In this mode of operation the heading or course of the vessel is digitally displayed in degrees.

HOLD: Holds the last reading displayed on the readout. Can be used to remember the last heading before temporary or evasive vessel movements. A secondary function of HOLD is to clear the timer circuits (STOP, RUN, STORE). Whenever you are using STOP, RUN

or STORE and you wish to reset to zero and resume counting, you must first switch to HOLD and then back to RUN.

RUN: A timer within the DC700/AP counts in one-second increments from 0 to 9 minutes 59 seconds, then resets and starts over. The elapsed time appears as a digital display of minutes and seconds.

STOP: When the Digital Compass FUNCTION switch is rotated from the RUN mode to STOP, the displayed time is "held" on the readout, and the internal counter is stopped. When the FUNCTION is switched back to RUN, the timer resumes counting from where it left off.

STORE: This mode of operation is used as an elapsed time counter. When the FUNCTION switch is turned from RUN to STORE, the displayed time is "held" on the digital display, but the internal timer continues counting. When the FUNCTION is switched back from STORE to RUN, the total elapsed time is then displayed. Useful for measuring time from point A to B to C, etc.

4.5 REMOTE DIGITAL COMPASS (DC700/R) OPERATION

In order to operate the Remote Digital Compass, first turn the FUNCTION switch on the AP900 Control Console to any mode except OFF. Then turn the Digital Compass (DC700/AP) ON. Next turn the Remote Digital Compass FUNCTION switch to HDG, then rotate the DIM/PWR OFF switch clockwise to increase the lighting intensity until the digital display is clearly visible. The digital readout displayed on the panel is the present course or heading of the vessel. The function of the two controls is explained below:

DIM/PWR OFF - Turns the DC700/R on and regulates the brightness of the digital display.

FUNCTION - Controls the various DC700/R functions, as explained below:

HDG (Heading): The heading of the vessel is displayed in degrees.

HOLD: This mode holds the last heading displayed on the readout. Can be used to remember the last heading before temporary or evasive vessel movements. A secondary function of HOLD is to clear the timer circuits (STOP, RUN, STORE). Whenever you are using STOP, RUN or STORE and you wish to reset to zero and resume counting, you must first switch to HOLD and then back to RUN.

RUN: In this mode a timer counts in one-second increments from 0 to 9 minutes, 59 seconds, then resets and starts over. The elapsed time appears on the digital display. To reset, switch to HOLD, then back to RUN.

STOP: When FUNCTION is rotated to STOP from the RUN mode, the displayed time is held on the readout and the timer is stopped. When switched back to RUN, the timer resumes counting where it left off.

STORE: Another timer function. When FUNCTION is turned to STORE from RUN, the displayed time is held on the readout, but the timer continues counting. When the FUNCTION is switched back from STORE to RUN, the total elapsed time is then displayed. Useful for measuring elapsed time from point A to B to C, etc.

4.6 REMOTE PROPORTIONAL CONTROL (RPC) OPERATION

The RPC allows the operator to electronically position the vessel's rudder at any desired angle while at a remote station. To operate:

1. Turn the FUNCTION switch on the AP900 Control Console to PWR.STR.
2. Rotate RUDDER POSITION dial on the RPC to 0 degrees.
3. Turn OFF/ON switch to ON. The yellow light on the RPC will light, indicating that the RPC is on and has power.
4. By rotating the RUDDER POSITION dial on the RPC to 20 degrees port, the rudder will move 20 degrees, changing the vessel's heading to port.
5. Any desired rudder angle can be dialed into the RPC in this manner.
6. To return control back to the Autopilot, the ON/OFF switch on the RPC MUST be OFF.

5.0 DOCKSIDE CHECKOUT

Once the Autopilot has been installed and calibrated, the Dockside Checkout should be performed to ensure proper operation of the Autopilot. These procedures should also be completed whenever the Autopilot will be used, before casting off. After the engines have been started, and while they are warming-up, perform the following:

1. Set WEATHER control to 8 o'clock.
2. Turn the FUNCTION switch to STD-BY mode. The COURSE SET DIAL wil rotate until the heading of the vessel is programmed into the Console.
3. The yellow function light will light when the heading is dialed in.
4. Rotate the FUNCTION switch to the WHEEL mode.
5. Rotate the COURSE SET DIAL back and forth over the heading and note that both red and green function lights come on. Turn back to the original heading and the yellow light.
6. Turn the FUNCTION switch to PWR.STR. mode, then press the DODGE switch to port and observe that port rudder is applied. Press DODGE to starboard and note the rudder movement. Using the DODGE switch, return the rudder to amidships.

7. Set the RUDDER control at 9 o'clock.

8. Turn the FUNCTION switch to PILOT mode. The Autopilot may apply rudder until a null condition is achieved. Press DODGE switch to port and starboard, noting that the rudder is returned to amidships when the DODGE switch is released.

9. Rotate the COURSE SET DIAL 5 degrees each side of the heading and note that the Autopilot is applying rudder.

10. Rotate the FUNCTION switch to STD-BY.

11. This completes the dockside test of the Autopilot.

6.0 SEA TRIAL

Following installation, calibration, and dockside checkout, a sea trial must be made to make sure that the rudder has been set to amidships and that the autopilot is performing properly.

1. Set FUNCTION switch on STD-BY, WEATHER at 8 o'clock, RUDDER at 8 o'clock, DIM on fully bright (Daytime).

2. Cast off and steer to a desired heading. Note that the COURSE SET DIAL is tracking the heading being steered.

3. Steer a straight course.

4. Rotate FUNCTION switch to the PILOT mode of operation. NOTE: When switching to the PILOT mode, the Autopilot should apply very little or no rudder. Should the AP900 apply rudder and change course heading, re-calibrate R305 (AP900-4017 Control Console circuit board) as described in CALIBRATION, 3.3 Step 12, page 48. The operator should be able to switch from STD-BY to PILOT with little or no rudder movement. Underway adjustment of R305 may allow a more accurate calibration.

5. While in PILOT mode of operation, set WEATHER fully counterclockwise (Calm sea) and note control of vessel. The Autopilot should correct any $\pm$ 1 1/2 degree of course deviation.

6. Again while in PILOT mode, set RUDDER fully counterclockwise. Vessel may show some signs of under-steering, depending on the speed of travel. Rotate RUDDER clockwise until the vessel shows signs of being over-steered. Adjust RUDDER control for proper steering and note setting.

7. In PILOT mode of operation, rotate COURSE SET DIAL clockwise 10 degrees and note that the Autopilot changes course 10 degrees to the port. Check in opposite direction.

8. Press DODGE switch and note that rudder is applied while in PILOT mode. When DODGE switch is released, the vessel should return to previous heading.

9. Set FUNCTION switch to PWR. STR. Press DODGE switch to port. The vessel should return to port. Rudder should be applied until the DODGE switch is released. Check the DODGE to starboard in the same manner.

10. Rotate FUNCTION switch to REMOTE mode and check the operation of the Remote Hand Control as described in OPERATION.

7.0 SERVICE INSTRUCTIONS

7.1 MAINTENANCE OF THE AP900 SYSTEM

Preventative maintenance should be performed every 6 months to ensure that your AP900 system is in proper operating condition.

Points to check are:

1. Check all plug and jack connections, making sure they are clean and tight. Spray with WD40 every month.

2. Check all terminal wiring connections in Interconnecting Matrix making sure they are secure.

3. On mechanical steering systems check that the drive chain is sufficiently tight and oiled.

4. On hydraulic steering systems make sure all hydraulic connections are tight and not leaking. Also check fluid level.

5. Check the seals within the Rudder Position Transducer, making sure no condensation has accumulated inside the Rudder Position Transducer.

6. Check rudder linkage to rudder arm making sure ball joints are tight and greased.

7. Check Remote Hand Control bulkhead connector making sure no pins are bent or corroded.

8. Check all remote accessories for secure wiring and proper operation.

9. Check gold-plated card edges on the plug-in circuit boards inside the AP900 Control Console, making sure they are clean and free from any foreign substances.

10. Check AP900 electronic Sensor, making sure mounting screws are tight so Sensor cannot vibrate or turn.

11. Remove top cover on Sensor. Check to see that screws are tight on each lug and that no corrosion is present.

12. Perform dockside checkout as explained on page 64.

If all the above steps are periodically followed, your AP900 should remain a reliable second hand aboard your vessel.

Remember to use the provided dust covers when your WESMAR equipment is not in use.

7.2 TROUBLESHOOTING INDEX

1. Course Set Dial will not automatically null to course heading in STD-BY.
2. No power. Fuses not blown.
3. Blown fuse in Servo Driver.
4. Blown fuse in Master Control Console.
5. Steady red light in Control Console.

6. Steady green light on Console.
7. Steady yellow light on Console.
8. Red and green lights blinking.
9. Both red and green lights on.
10. Rudder moving in wrong direction.

11. Rudder going hard-over to port.
12. Rudder going hard-over to starboard.
13. Rudder goes port but not starboard.
14. Rudder goes starboard but not port.
15. Rudder will not return to amidships.

16. Erratic steering while underway.
17. Excessive yaw.
18. Slipping Servo Motor clutch.
19. Unable to narrow course width.
20. No Weather adjustment.

21. No Rudder adjustment.
22. Rudder response slow or erratic.
23. No red function light.
24. No green function light.
25. No yellow function light.

26. No back lights or function lights.
27. In PILOT mode, red, yellow, green lights blinking.
28. Course Set Dial rotates in PILOT mode.
29. Unable to zero rudder feedback circuit.
30. Course Set Dial hunts when in STD-BY.

31. Course Set Dial will not null yellow light when in STD-BY.
32. TP7 not reading +4 VDC.
33. TP6 not reading +8 VDC.
34. Rudder will not move to port or starboard in either PILOT or PWR.STR.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
1. Course Set Dial will not automatically null to course heading in STD-BY mode.	Resolver Drive Motor in Control Console not turning.	No drive signal to motor. Check for approximately 6 volts across motor with red light lit, STD-BY mode.	If voltage is present; defective motor. Replace Resolver Drive Motor. If voltage is not present, replace AP900-4018 board.
	Resolver Drive Motor turning. Reducer not turning.	Broken Drive Belt.	Replace Drive Belt with National #124.
		Reducer binding on panel.	Loosen mounting bracket and realign.
		Dial rubbing on panel.	Loosen Reducer (2 setscrews); move forward.
		Course Set knob binding on Dial.	Loosen and move forward.
2. No power. Fuses not blown.	Power input lines.	Corroded connection.	Clean & replace, coat.
		Broken power wire.	Replace with correct size.
	Vessel's battery.	Boat's battery low.	Replace or recharge.
	Circuit breaker.	Boat's circuit breaker is off.	Turn on.
	Servo Driver.	Servo Driver cable loose.	Tighten.
		Servo Driver cable has open wire.	Replace cable.
	Control Console.	Console interconnect cable defective.	Replace cable.
		Console Function switch defective.	Repair or replace Console.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
3. Blown fuse in Servo Driver.	Driver power fuse blown.	Short in Driver.	Replace Driver.
		Too heavy torque load.	Change steering ratio.
		Short in Servo Motor.	Check resistance and replace Servo Motor.
	Console power fuse blown.	Possible short in Console.	Remove each circuit board, one at a time, substituting a spare board until the malfunctioning board is identified. Replace board.
		Possible short in accessories.	Eliminate each accessory one by one until defective unit is found. Repair or replace.
4. Blown fuse in Control Console.	8.0 VDC regulator.	Defective. Check for 8.0 VDC at TP-6.	Replace Regulator if defective.
	Reference regulator board AP900-4018.	Defective reference regulator or component. Unplug and check TP-6 voltage for 8.0 VDC.	Replace 4018 board, or repair defective component.
5. Steady red light on Console.	Control amplifier board AP900-4017.	Defective AR4.	Repair AR4 or replace AP900-4017 board.
		Defective AR6.	Repair AR6 or replace AP900-4017 board.
	Sense amplifier board AP900-4016.	Course error signal positive with reference to TP-7 (4.0 VDC).	Repair or replace AP900-4016 board.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
6. Steady green light on Console.	AP900-4017 board.	Defective AR4.	Replace AP900-4017 board.
		Defective AR6.	Replace AP900-4017 board.
	Sense amplifier board AP900-4016.	Course error signal negative with reference to TP-7 (4.0VDC). Turning Course Set Dial will not affect signal.	Repair or replace AP900-4016 board.
7. Steady yellow light on Console.	Sense amplifier AP900-4016 board.	Loss of course error signal.	Replace AP900-4016 board.
	Control amplifier AP900-4017.	Defective AR6.	Repair or replace 4017 board.
	Reference regulator AP900-4018.	Defective Q_1, Q_4 or U_1 on 4018 board.	Repair or replace 4018 board.
	Reference regulator board AP900-4018.	Defective logic function.	Replace AP900-4018 board.
8. Red and green lights blinking.	Sensor.	Open primary - S/B 4.5 ohms resistance. See Figure 20, page 20.	Replace Sensor.
		Open sine winding.	Replace Sensor.
		Open cosine winding.	Replace Sensor.
	Interconnect cable.	Loose connector.	Check and tighten both ends.
		Broken wire.	Repair or replace cable.
	AP900-4017.	Loss of drive signal.	Replace AP900-4017 board.

SYMPTOM	AREA OF MALFUNCTION	ROBABLE MALFUNCTION	CORRECTIVE ACTION
9. Both red and green lights on.	Control amplifier AP900-4017.	Defective AR6.	Replace AP900-4017 board.
10. Rudder moving in wrong direction.	Servo Motor.	Motor wires reversed.	Reverse per page 48, Step 13.
11. Rudder going hard-over to port.	Servo Driver.	Defective starboard transistor.	Replace Servo Driver.
	Control amplifier AP900-4017.	Defective AR6 comparitor.	Replace AP900-4017 board.
	Sense amplifier AP900-4016.	Course error signal positive with reference to TP-7 (4.0VDC) causing system to give only port rudder.	Repair or replace AP900-4016. board.
12. Rudder going hard-over to starboard.	Servo Driver.	Defective drive transistor.	Replace Servo Driver.
	Control amplifier AP900-4017.	Defective AR6 comparitor.	Replace AP900-4017 board.
	Sense amplifier AP900-4016.	Course error signal negative with reference to TP-7 (4.0VDC) causing system to give only starboard rudder.	Repair or replace AP900-4016 board.
13. Rudder goes port but not starboard.	Servo Driver.	Defective starboard drive circuit.	Replace Servo Driver.
	Rudder Position Transducer.	Starboard limit switch open; defective.	Replace limit switch.
		Starboard limit cam moved to engage switch.	Recalibrate per page 45, Step 10.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
14. Rudder goes starboard but not port.	Servo Driver.	Defective port drive circuit.	Replace Servo Driver.
	Rudder Position Transducer.	Port limit switch open.	Replace limit switch.
		Port limit cam moved to engage switch.	Recalibrate per page 43, Step 8.
15. Rudder will not return to amidships.	Control amplifier AP900-4017.	Loss of feedback signal.	Replace AP900-4017 board.
		Defective rudder synchronizer.	Replace AP900-4017 board.
16. Erratic steering while underway.	AP900-4018 board.	Noise on 4.0 VDC.	Replace 4018 board or isolate noise problem.
	Battery.	Weak battery.	Recharge or replace battery.
	Servo Driver (Proportional).	Defective AR_2.	Replace AR_2 or Servo Driver.
17. Excessive yaw.	Rudder Control.	Too much rudder being applied causing an oversteering condition.	Turn Rudder Control CCW until yaw diminishes.
		Not enough rudder being applied causing an understeering condition.	Turn Rudder Control CW until yaw diminishes.
	Weather Control.	Not enough sensitivity; vessel drifts too far off course.	Turn Weather Control CCW.
	Rudder of vessel.	Dead rudder. No effect when Autopilot gives rudder. Happens even during manual steering.	Add shingle to rudder for more rudder response.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
18. Slipping Servo Motor clutch.	Mechanical Servo Motor.	Excessive load on drive motor assembly.	Change gearing.
		Oil spilled on clutch face.	Replace clutch.
		Binding in steering system.	Repair.
19. Unable to narrow course width.	Control amplifier AP900-4017 bd.	Defective U_1.	Repair or replace AP900-4017 board.
	Control Console.	Defective rudder pot.	Replace rudder pot.
	Remote Hand Control	Defective cable wiring or weather pot.	Replace Remote Hand Control.
20. No WEATHER adjustment.	Control amplifier AP900-4017 board.	Defective AR_4.	Replace AP900-4017 board.
		Defective U_1.	Replace AP900-4017 board.
	Control Console.	Defective WEATHER Control.	Replace Console.
	Remote Hand Control.	Defective cable or defective component.	Replace Remote Hand Control.
21. No RUDDER adjustment.	Control amplifier AP900-4017 board.	Defective AR_1.	Replace AP900-4017 board.
		Defective U_1.	Replace AP900-4017 board.
	Control Console.	Defective RUDDER Control.	Replace Console.
	Remote Hand Control.	Defective cable or defective component.	Replace Remote Hand Control.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
22. Rudder response slow or erratic.	Servo Driver.	Defective AR_1.	Replace Driver.
		Defective AR_2.	Replace Driver.
		Defective Drive circuit.	Replace Driver.
	Control amplifier AP900-4017 bd.	Defective AR_4.	Replace AP900-4017 board.
23. No red function light.	Reference regulator AP900-4018 bd.	Defective Q_1.	Replace AP900-4018 board.
	Control amplifier AP900-4017 bd.	Defective AR_6.	Replace AP900-4017 board.
	Control Console.	Defective bulb.	Replace bulb.
24. No green function light.	Reference regulator AP900-4018 bd.	Defective Q_4.	Replace AP900-4018 board.
	Control amplifier AP900-4017 bd.	Defective AR_6.	Replace AP900-4017 board.
	Control Console.	Defective bulb.	Replace bulb.
25. No yellow function light.	Reference regulator AP900-4018 bd.	Defective Q_2.	Replace AP900-4018 board.
		Defective U_1.	Replace AP900-4018 board.
	Remote Hand Control.	Defective Q_3.	Replace AP900-4018 board.
		Defective bulb.	Replace bulb.
	Control Console.	Defective bulb.	Replace bulb.
26. No back lights or function lights.	Control Console.	No dim voltage. Defective Q_4 MJE800.	Replace drive transistor.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
27. In PILOT mode red, yellow, green lights blinking.	Sensor.	Loose wire in compass head.	Tighten.
		Broken sense wire.	Replace Sensor.
		Broken interconnecting cable.	Repair or replace cable.
		Loose connector at rear of Control Console.	Tighten.
	Control Console.	Defective AP900-4016 sensor bd.	Replace AP900-4016.
28. Course Set Dial rotates in PILOT mode.	Reference regulator board, AP900-4018.	Logic function defective.	Replace AP900-4018 board.
29. Unable to zero rudder feedback circuit.	Control amplifier board AP900-4017.	AR_1 defective.	Replace AP900-4017 board.
30. Course Set Dial hunts when in STD-BY.	Reference regulator board, AP900-4018.	Faulty adjustment of R227.	Adjust as per page 47, Step 8.
31. Course Set Dial will not null yellow light when in STD-BY.	Sense amplifier board, AP900-4016.	Defective AR_4 course error signal.	Replace Sense amplifier board, AP900- 4016.

SYMPTOM	AREA OF MALFUNCTION	PROBABLE MALFUNCTION	CORRECTIVE ACTION
32. TP7 not reading +4.0 VDC.	Control Console.	Defective 8.0 VDC Regulator.	Replace MC7808 Voltage Regulator.
		Short on AP900-4018 board.	Replace AP900-4018 board.
		Short on AP900-4017 board.	Replace AP900-4017 board.
		Short on AP900-4016 board.	Replace AP900-4016 board.
33. TP6 not reading +8.0 VDC.	Control Console.	Defective 8.0 VDC Regulator.	Replace MC7808 cp Voltage Regulator.
		Blown fuse.	Determine cause and replace.
		Incorrect battery voltage.	Check battery voltage against system voltage.
34. Rudder will not move to port or starboard in either PILOT or PWR.STR.	Rudder Position Transducer.	Defective interconnecting cable.	Replace cable.
		Loose interconnecting cable.	Tighten.
		Defective limit switch.	Replace limit switch.
	Servo Driver.	Defective power transfer relay.	Repair or replace power transfer relay.

7.3 SPARE PARTS KIT

The following is a list of the available spare parts included in the Spare Parts Kit. It is suggested that individuals planning an extended cruise procure a Space Parts Kit before embarking. WESMAR Service Dealers should keep a Spare Parts Kit on hand at all times.

SPARE PARTS KIT

1. AP900-4016 Sense Amplifier Printed Circuit Board (PCB) - 1 ea.
2. AP900-4017 Control Amplifier PCB - 1 ea.
3. AP900-4018 Power Regulator/Resolver PCB - 1 ea.
4. JK 811-120-210-AT Amber light - 1 ea.
5. JK 811-120-210-RT Red light - 1 ea.
6. JK 811-120-210-GT Green light - 1 ea.
7. Fuse 20 Amp - 2 ea.
8. Fuse 15 Amp - 1 ea.
9. Fuse 2 Amp - 2 ea.
10. #7367 Lamp (Backlight) - 2 ea.
11. AP900-4011 Card Extender - 1 ea.

7.4 PROCEDURE FOR RETURNING AP900 FOR REPAIR

For prompt service and quick return of your AP900 equipment, complete the following steps exactly:

1. Always refer to the MODEL, SERIAL NUMBER on rear of consoles (front panel of hand controls) and your WARRANTY NUMBER in all correspondence and include them in shipping container when returning your AP900 equipment.
2. Type or print a complete description of malfunction and under what conditions it occurs. Include this information in shipping container when returning your AP900 equipment.
3. Enclose a RETURN SHIPPING ADDRESS, typed or very legibly printed.
4. Return your AP900 equipment to WESMAR prepaid. Equipment sent collect will not be accepted.

8.0 TECHNICAL APPENDIX/SCHEMATICS

Technical Specifications

Schematics

8.1 AP900 AUTOPILOT

Operating Voltage	12, 24, 32 VDC, and 110 VAC
Power Source	Vessel's source or battery
Power Consumption (no load)	Maximum 1.8A (mechanical at 12 VDC)
Power Consumption (loaded)	Maximum 18.0A (mechanical at 12 VDC)
Type of Steering	Mechanical, hydraulic
Torque Output (mechanical)	20 ft/lbs.
RPM at full load (mechanical)	22 RPM
GPM (gallons per minute)(hydraulic)	.4 GPM
Maximum Sensitivity	±1.5 degrees
Minimum Sensitivity	±10 degrees
Operating Range	0 to 50°C.
Sensing System	Saturable Core
Environment	Splashproof
Clutch (mechanical only)	Electro-magnetic
Controls and Readout	a. Function Switch (Six Positions) 1. OFF 2. STD-BY 3. WHEEL 4. PILOT 5. PWR.STR. 6. REMOTE b. Weather c. Rudder d. Dim e. Dodge f. Course Set
Accessories	a. Digital Compass b. Remote Hand Control c. Remote Proportional Control d. Rudder Angle Indicator e. Voltage Regulator f. Remote Digital Compass

8.2 RELAY SERVO DRIVER -02 OPTION

Operating Voltage..... 12, 24, 32 VDC

Power Source..... Vessel's source or battery

Type of Switch..... Double pole, double throw, ARC suppressed relays

Maximum Current Draw..... 20 Amps

Operating Temperature..... 0^{o} C. to $+70^{o}$ C.

Storage Temperature..... -55^{o} C. to + 95^{o} C.

Environmental:

Shock..... Mil-E-I method 1041
Vibration..... Mil-E-I method 1041
Moisture..... 85% humidity @ 40^{o} C.

Dimensions..... 9" wide x 11" high x 5" deep

Weight..... 7 lbs.

8.3 PROPORTIONAL SERVO DRIVER -03 OPTION ON 2186

Operating Voltage..... 12, 24, 32 VDC

Power Source..... Vessel's source or battery

Type of Switch..... P.W.M. solid-state proportional drive. Variable speed full time drive.

Maximum Current Draw..... 20 amps

Operating Temperature..... 0° C. to +70° C.

Storage Temperature..... -55° C. to +95° C.

Environmental:

Shock..... Mil-E-I method 1041
Vibration..... Mil-E-I method 1041
Moisture..... 95% humidity @ 40° C.

Dimensions..... 5" wide x 4" high x 6.5" deep

Weight..... 6 lbs.

8.4 SOLID STATE DC DRIVER -04 OPTION

Operating Voltage..... 12, 24, 32 VDC

Power Source..... Vessel's source or battery

Type of Switch..... Solid-state transistorized

Maximum Current Draw..... 20 Amps

Operating Temperature..... 0^{o} C. to $+70^{o}$ C.

Storage Temperature..... -55^{o} C. to $+95^{o}$ C.

Environmental:

Shock..... Mil-E-I method 1041
Vibration..... Mil-E-I method 1041
Moisture..... 85% humidity @ 40^{o} C.

Dimensions..... 9.5" wide x 4" high x 6.5" deep

Weight..... 7 lbs.

8.5 SOLID-STATE AC DRIVER -05 OPTION

Operating Voltage..... 110 VAC

Power Source..... Vessel's power system

Type of Switch..... Solid-state TRIAC

Maximum Current Draw..... 20 amps

Operating Temperature..... 0^{o} C. to $+70^{o}$ C.

Storage Temperature..... -55^{o} C. to $+95^{o}$ C.

Environmental:

Shock..... Mil-E-I method 1041
Vibration..... Mil-E-I method 1041
Moisture..... 95% humidity @ 40^{o} C.

Dimensions..... 5" wide x 4" high x 6.5" deep

Weight..... 5 lbs.

8.6 MECHANICAL SERVO MOTOR -06 OPTION

Operating Voltage	12, 24, 32 VDC
Power Source	Vessel's battery
Current Full Load	12 VDC, 18 ± 3.0 amps 24 VDC, 11 ± 2.0 amps 32 VDC, 8 ± 1.5 amps
Current No Load	1.8 amps (clutch energized)
Rated Output Torque	240 inch pounds
RPM Full Load	22 RPM
Dimensions	4.5" wide x 10.5" high x 8.0" deep
Approximate Vessel Size	28 to 60 feet
Weight	38.0 lbs.
Mounting	Any plane

8.7 HYDRAULIC SERVO MOTOR -07 OPTION

Operating Voltage	12, 24, 32 VDC and 110 VAC
Power Source	Vessel's power source
Current Full Load	12 VDC, 18 ± 3.0 amps 24 VDC, 11 ± 2.0 amps 32 VDC, 8 ± 1.5 amps
Current No Load	1.0 amp
GPM (gallons per minute)	.4 GPM
Full Load	1000 PSI with Pressure Relief Valve
Dimensions	5.0" wide x 5.5" high x 12.0" deep
Approximate Size of Vessel	30 to 65 feet
Weight	36.0 lbs.
Mounting	Any plane

8.8 4-WAY SOLENOID VALVE -10 OPTION

Rated Flow Capacity	12-1 7 GPM @ 3000 psi
Maximum Operating Pressure	3000 psi
Maximum Tank Line Back Pressure	1000 psi
Fluid Loss	3 cu. in./min. per port @ 3000 psi
Recommended Fluid	SAE No. 10 Hydraulic Oil
Aniline Point	104° C. $\pm$ 2° C.
Maximum Operating Temperature	60° C. (oil)
Mounting	Unrestricted
Response	Less than .025 sec. from center to one side
Maximum Cycle Rate	80 cyc./min.
Weight	3 lbs.
Operating Voltage	12, 24, 32 VDC, 110 VAC
Power Consumption	DC coils: $\frac{12 \text{ watts}}{\text{voltage}}$
	AC coils: (110 VAC 60 hz.)
	inrush 1.22 amps
	hold .26 amps
	wattage 7.00 amps

8.9 REMOTE HAND CONTROL (AP-0125)

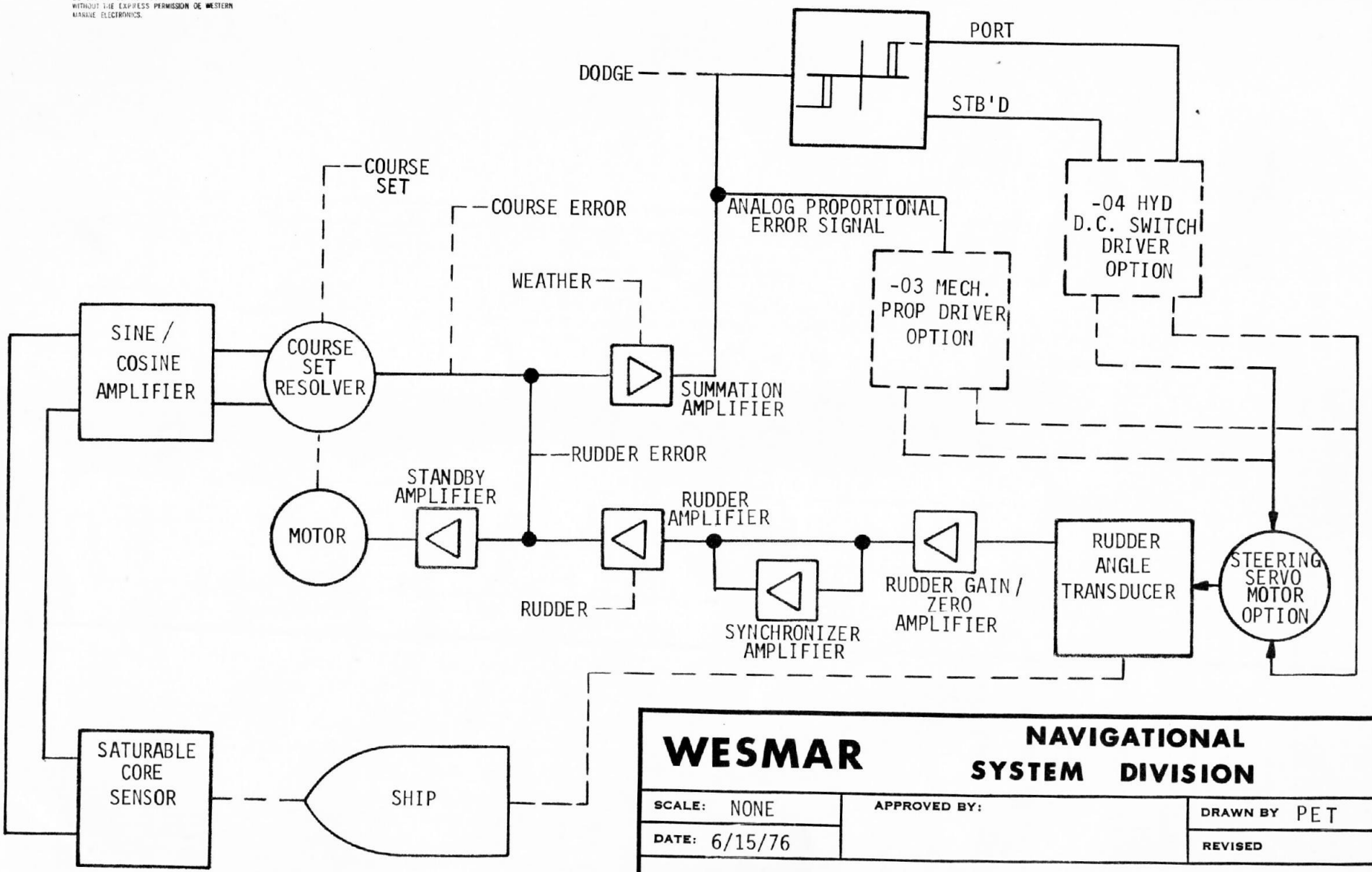
Controls	Weather Rudder Dodge Course Change Pilot Function Selector (5 positions) 1. OFF 2. STD-BY 3. WHEEL 4. PILOT 5. PWR.STR.
Environment	Waterproof
Cable	25-foot cable - with bulkhead connector for quick change to auxiliary remote locations. (Note: Should you wish to operate your Autopilot from another location, just unplug hand control; AP900 will automatically switch into PWR.STR. mode; move to your new location, reconnect, and you have total control at your fingertips.)
Dimensions	3.5" x 2.5" x 3.5" with handle
Weight	2.0 lbs.

8.10 REMOTE PROPORTIONAL CONTROL (AP-0126)

Controls	a) Off/On b) Rudder Positioner
Angle Deviation	0 $\pm$ 40 degrees rudder
Environment	Waterproof
Cable	25-foot cable, fitted with quick release connector
Dimensions	3.5" x 2.5" x 3.5" with handle
Weight	2.0 lbs.

8.11 DIGITAL COMPASS (DC700/AP)

Operating Voltage	12 VDC
Power Source	AP900 Autopilot
Power Consumption	500 ma.
Accuracy	± 1 degree
Operating Temperature	0^{o} C. to $+70^{o}$ C.
Storage Temperature	-55^{o} C. to $+95^{o}$ C.
Compensation	Internal electronic compensation
Display	3-segment digital display
Controls	a. DIM OFF/ON b. Function: HEADING HOLD RUN STOP STORE
Rear Connections	a. Input -- Signal from Interconnecting Matrix b. Output -- Signal to repeater station
Accessories/Options	Auxiliary repeater stations

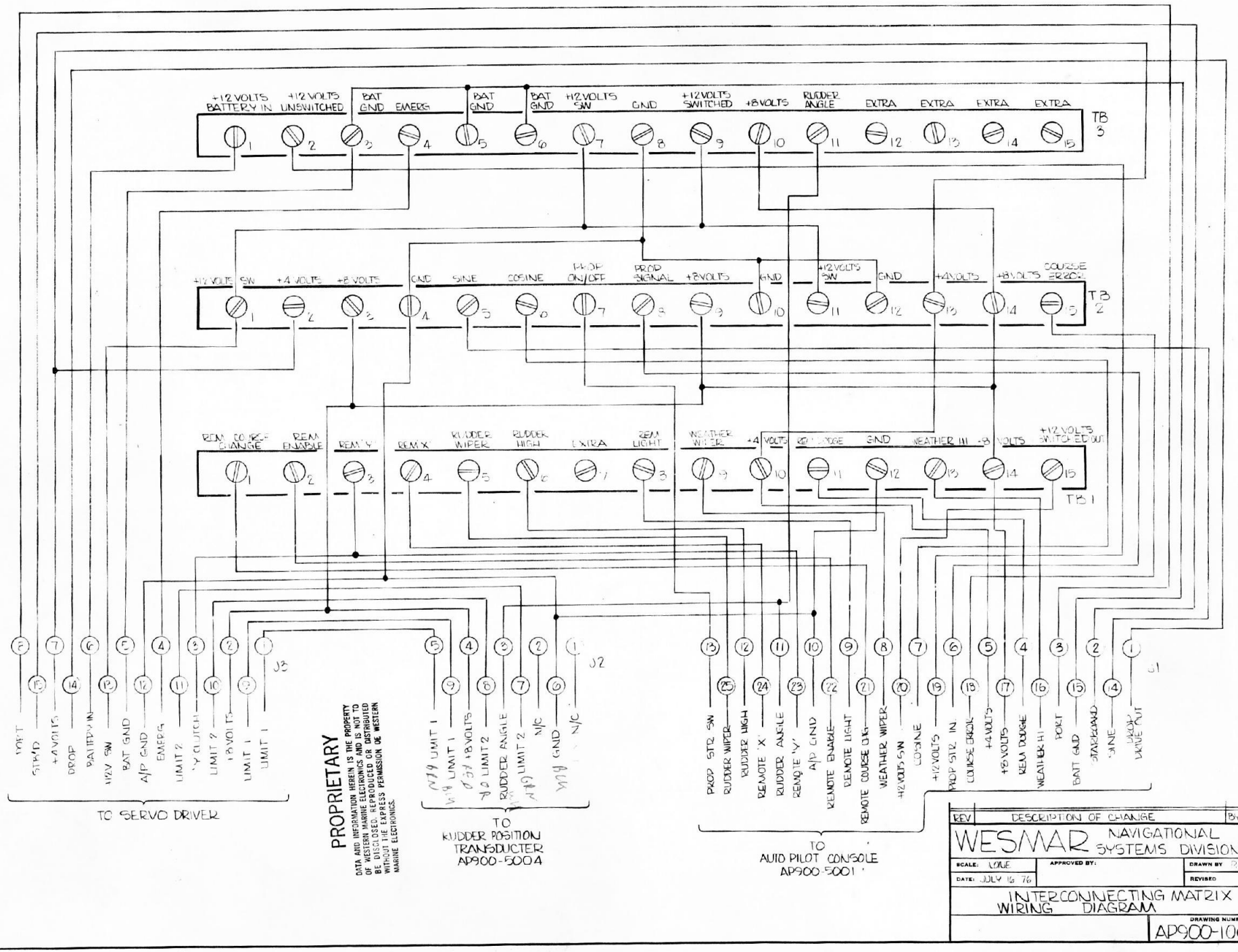


WESMAR NAVIGATIONAL SYSTEM DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY PET
DATE: 6/15/76		REVISED

AP900 BLOCK DIAGRAM

DRAWING NUMBER
AP900-1500



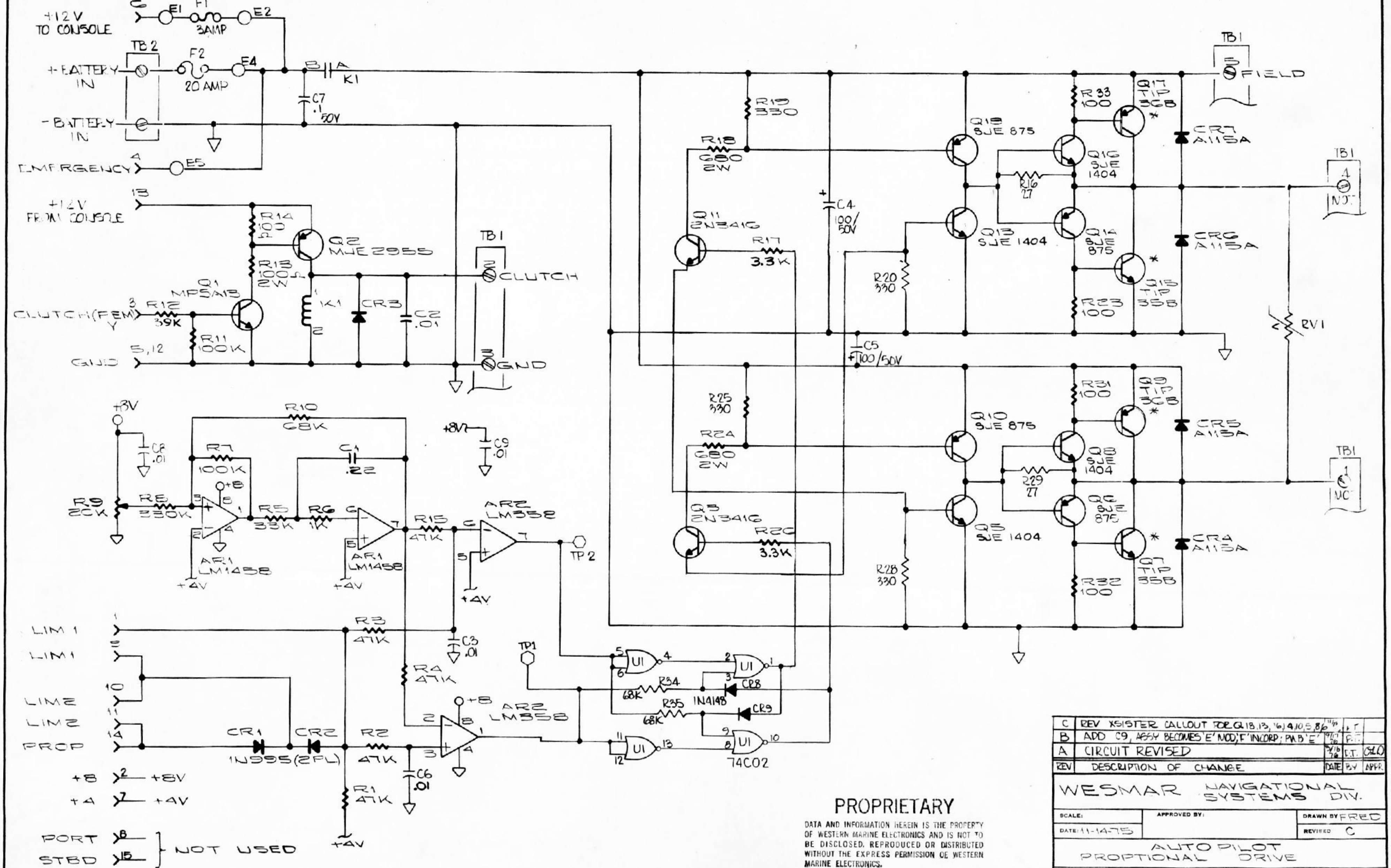
REV	DESCRIPTION OF CHANGE	BY	DATE

WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY: RET
DATE: JULY 16 76		REVISED:

INTERCONNECTING MATRIX WIRING DIAGRAM

DRAWING NUMBER AP900-1002



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REV	DESCRIPTION OF CHANGE	DATE	BY	APPR.
C	REV XSISTER CALLOUT FOR Q18,13,16,14,10,5,8,6			
B	ADD C9, ASSY BECOMES 'E' MOD; 'F' INCORP; P/N B 'E'		B.T.	
A	CIRCUIT REVISED		B.T.	

WESMAR NAVIGATIONAL SYSTEMS DIV.

SCALE: | APPROVED BY: | DRAWN BY FRED

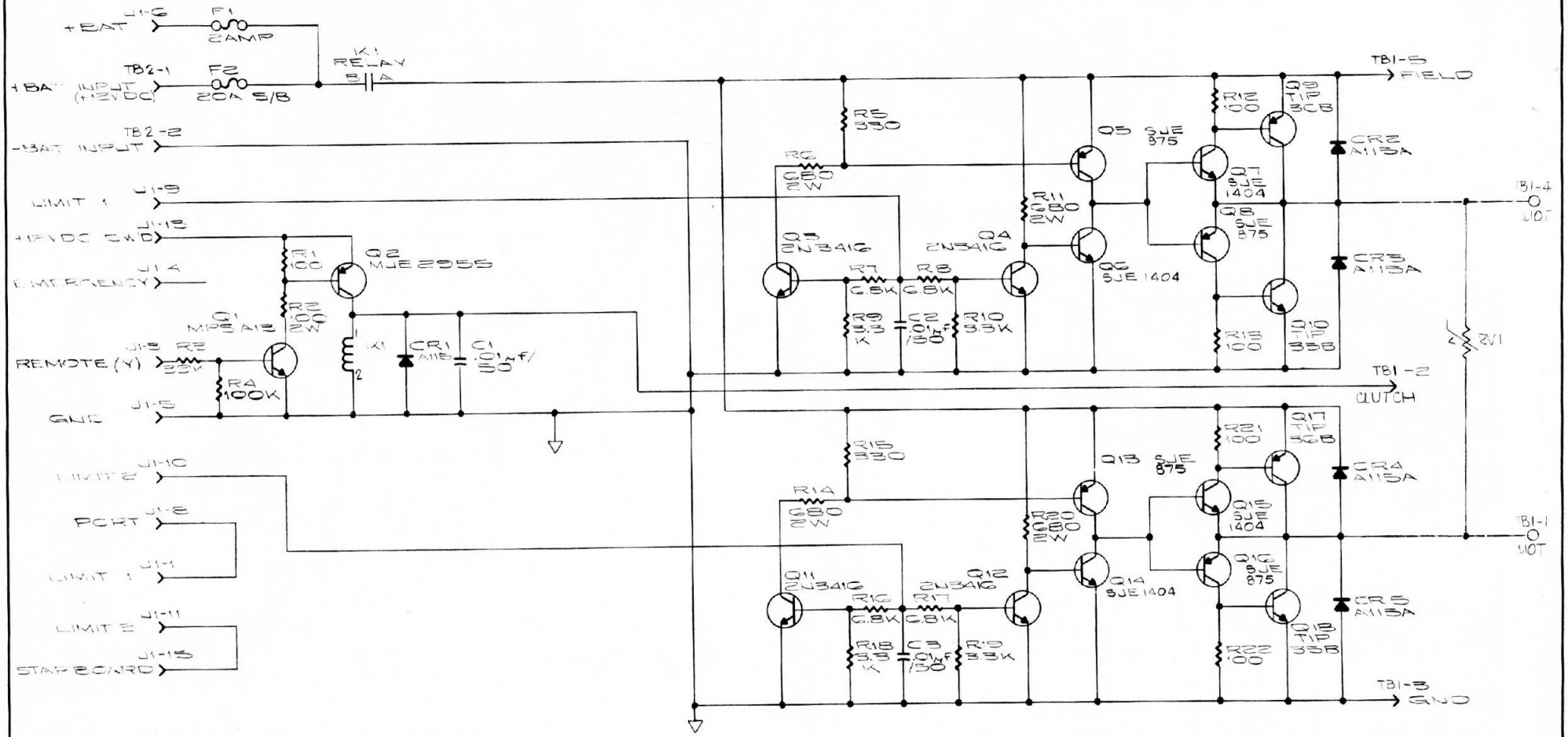
DATE 11-14-75 | REVISED C

AUTO PILOT PROPTIONAL DRIVE

SHEMATIC

DRAWING NUMBER AP300-1004

18X24 PRINTED ON NO. 1000H CLEARPRINT



REV	DESCRIPTION OF CHANGE	BY	DATE
B	REV TITLE & NSTER CALLOUT FOR Q 7,8,5,6,13,14,15,16	PT	11/76
A	ADDED RV1	PT	4/76

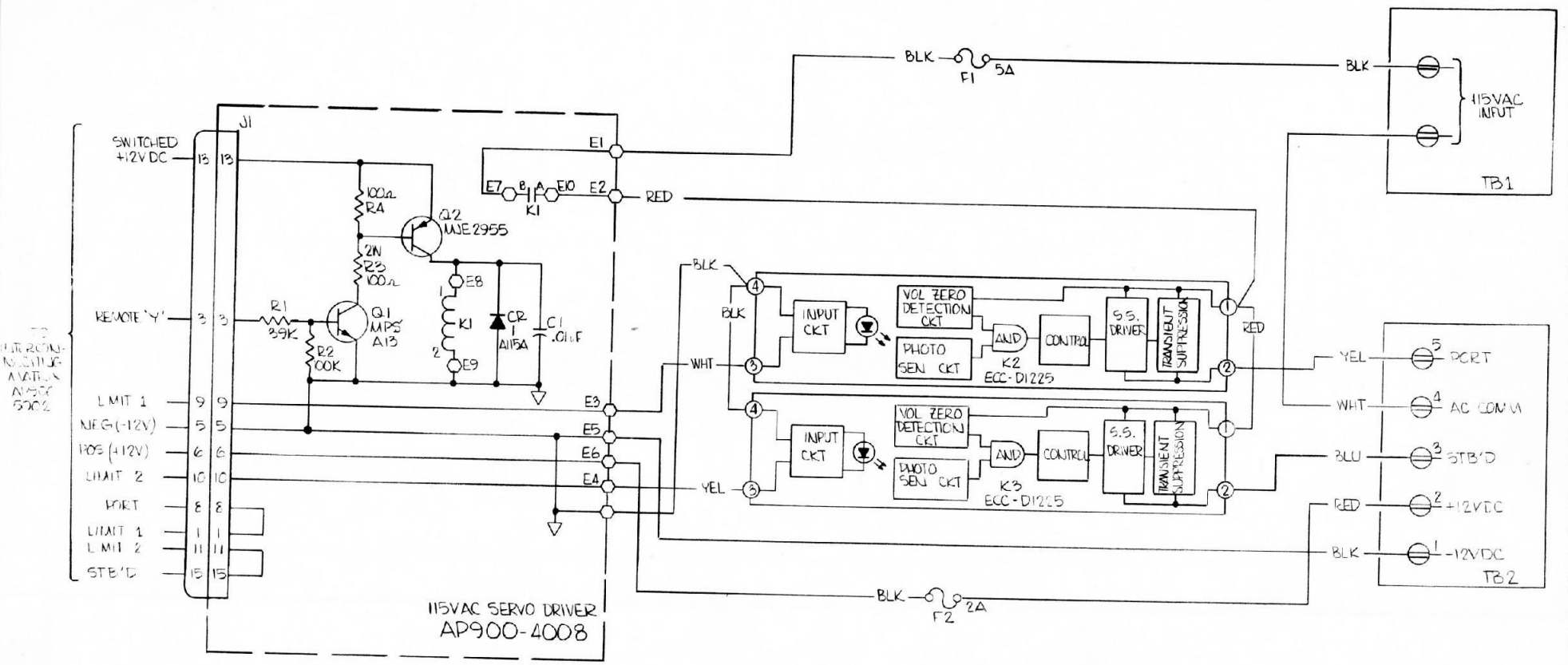
WESMAR NAVIGATIONAL SYSTEMS DIV.

SCALE:	APPROVED BY:	DRAWN BY: FRED
DATE: 11-14-75		REVISED B

+12VDC SOLID STATE SOLENOID DRIVER

SCHEMATIC -08 OPTION

DRAWING NUMBER AP900-1005



REV	DESCRIPTION OF CHANGE	BY	DATE

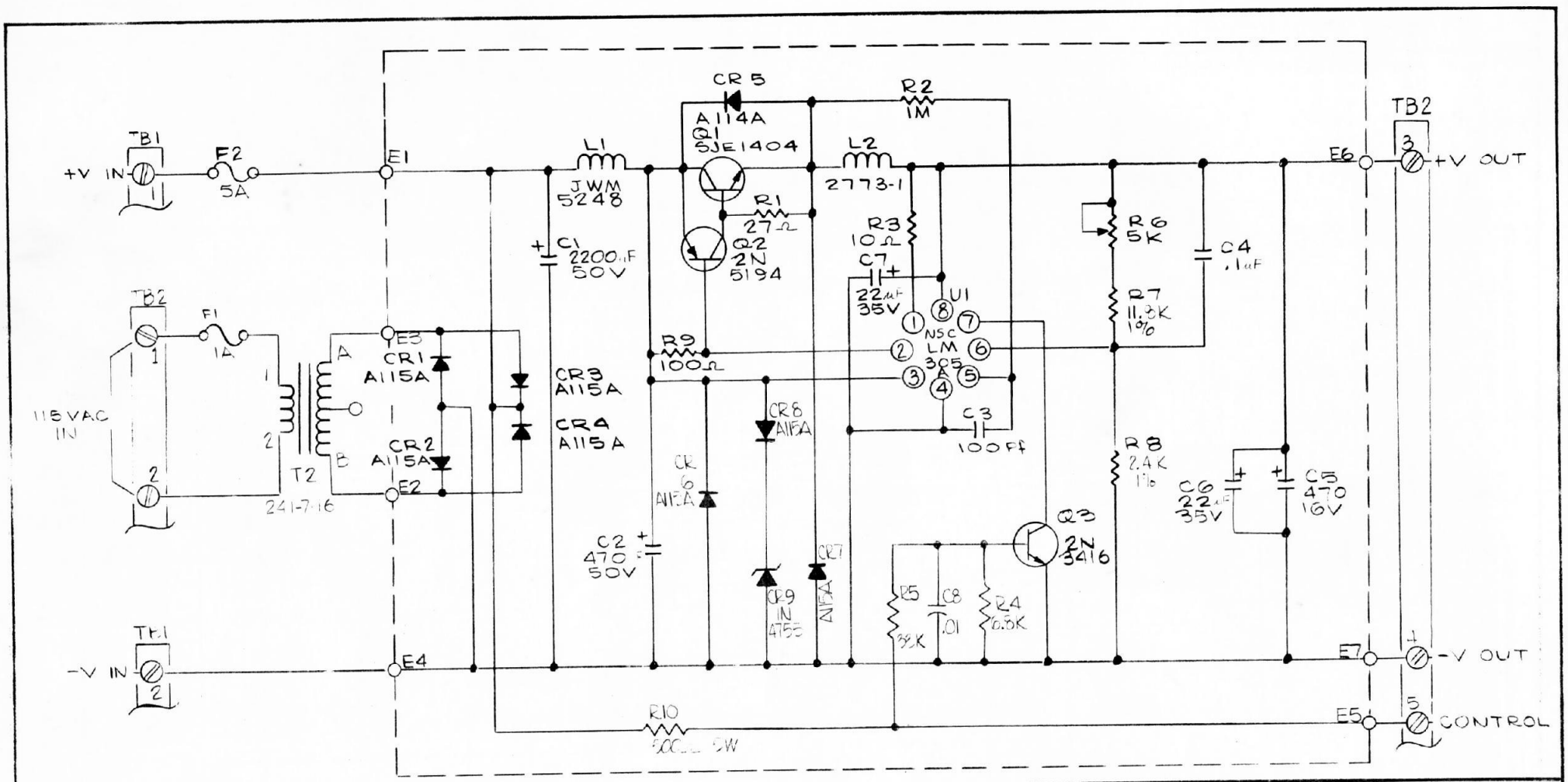
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.
DATE: 5-12-6		REVISED

115VAC SERVO DRIVER

SCHEMATIC

DRAWING NUMBER AP900-1008



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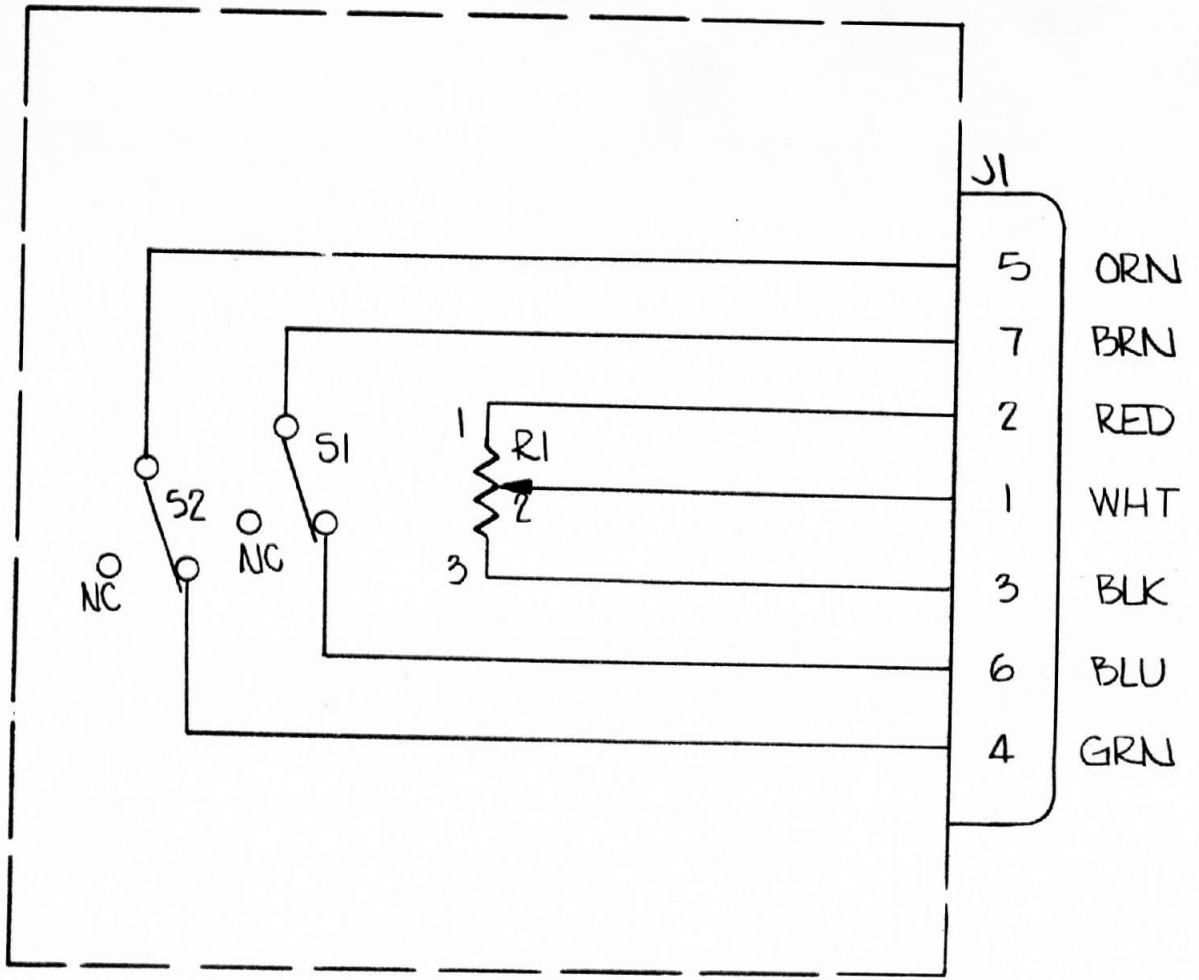
WESMAR	NAVIGATIONAL SYSTEMS DIVISION
SCALE: NONE	DWN N.O.
DATE 3-23-76	REV
VOLTAGE REGULATOR	
	AP900-1009



REV	DESCRIPTION OF CHANGE

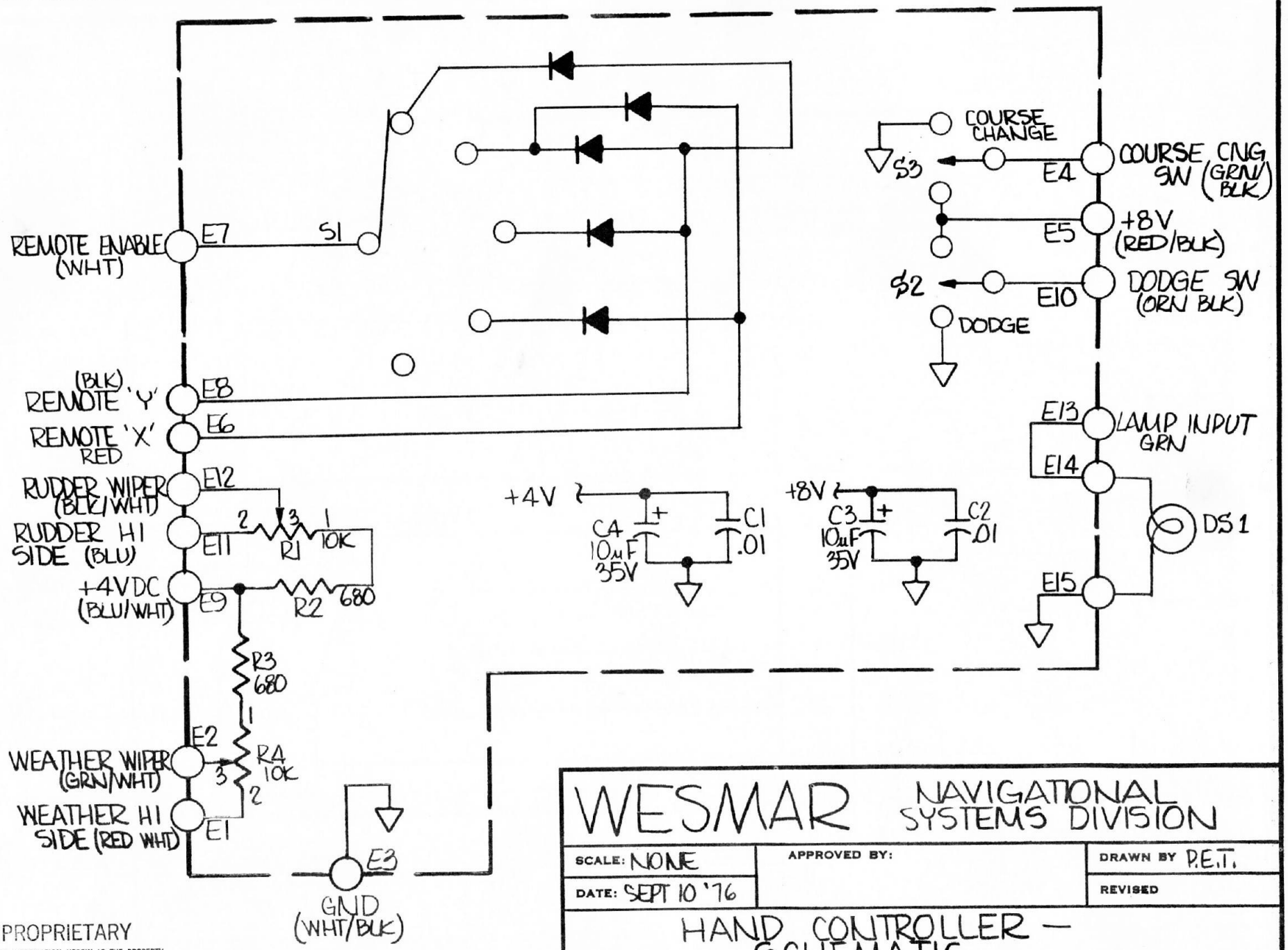
WESMAR NAVIGATIONAL SYSTEM DIVISION

SCALE: FULL	APPROVED BY:	DRAWN BY P.E.T.
DATE: 7-14-76		REVISED

RUDDER POSITION XDUCER SCH

DRAWING NUMBER
AP900-1011

8½X11 PRINTED ON NO. 1000H CLEARPRINT



PROPRIETARY

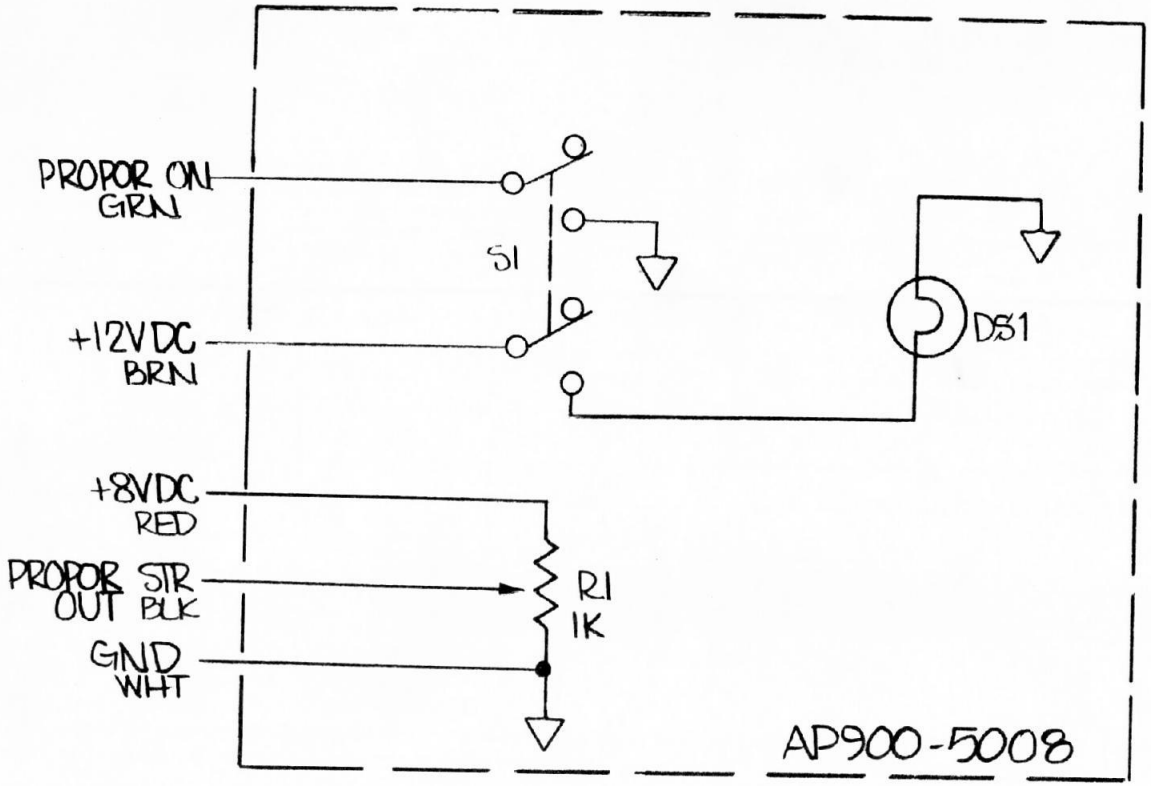
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: SEPT 10 '76		REVISED

HAND CONTROLLER — SCHEMATIC

DRAWING NUMBER

AP900-1012

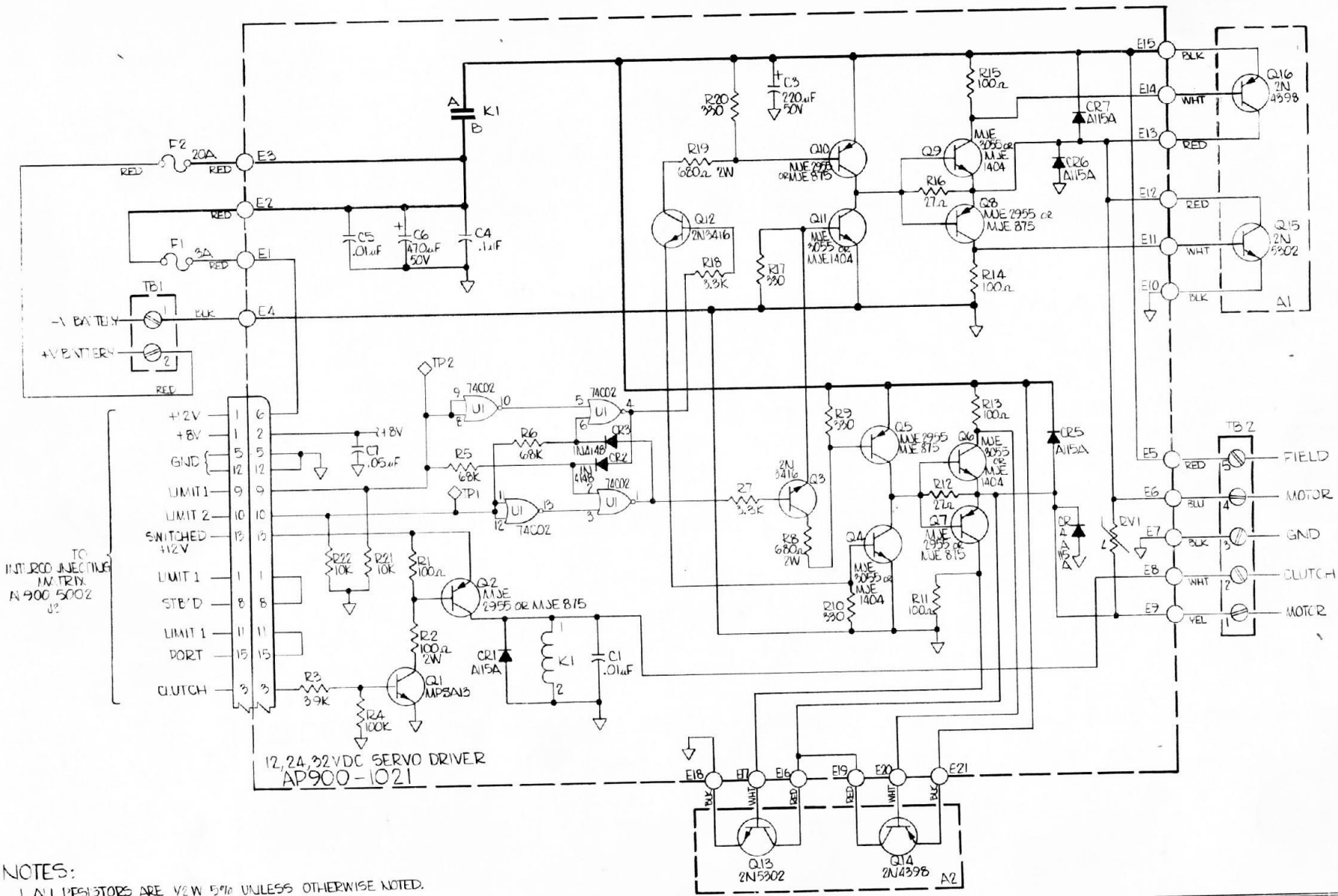


WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: 9-13-76		REVISED

PROPOPTIONAL STEERING HAND CONTROLLER - SCHEMATIC

DRAWING NUMBER AP900-1015



NOTES:

1. ALL RESISTORS ARE 1/2W 5% UNLESS OTHERWISE NOTED.

REV	DESCRIPTION OF CHANGE	BY	DATE

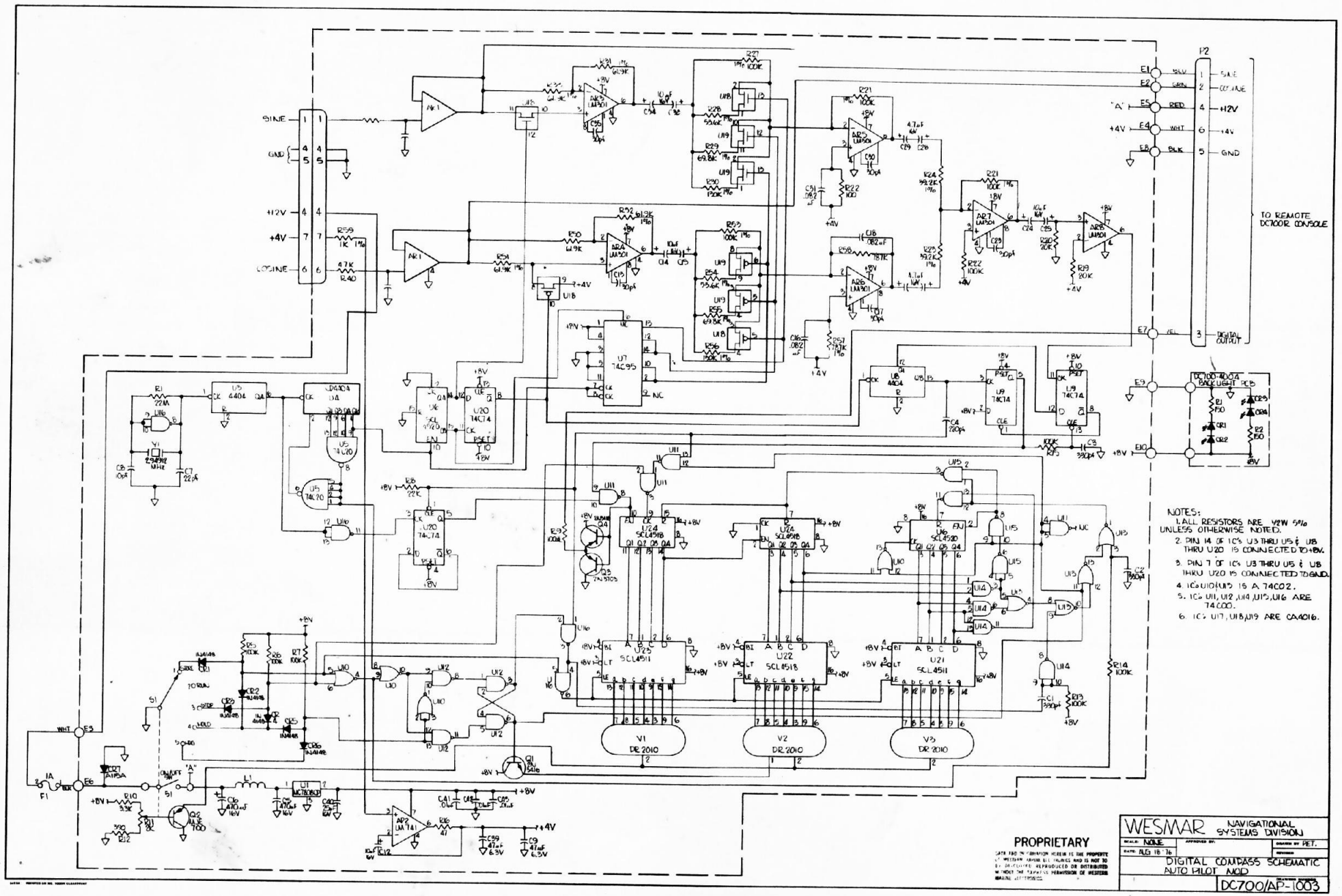
WESMAR NAVIGATIONAL SYSTEMS DIVISION

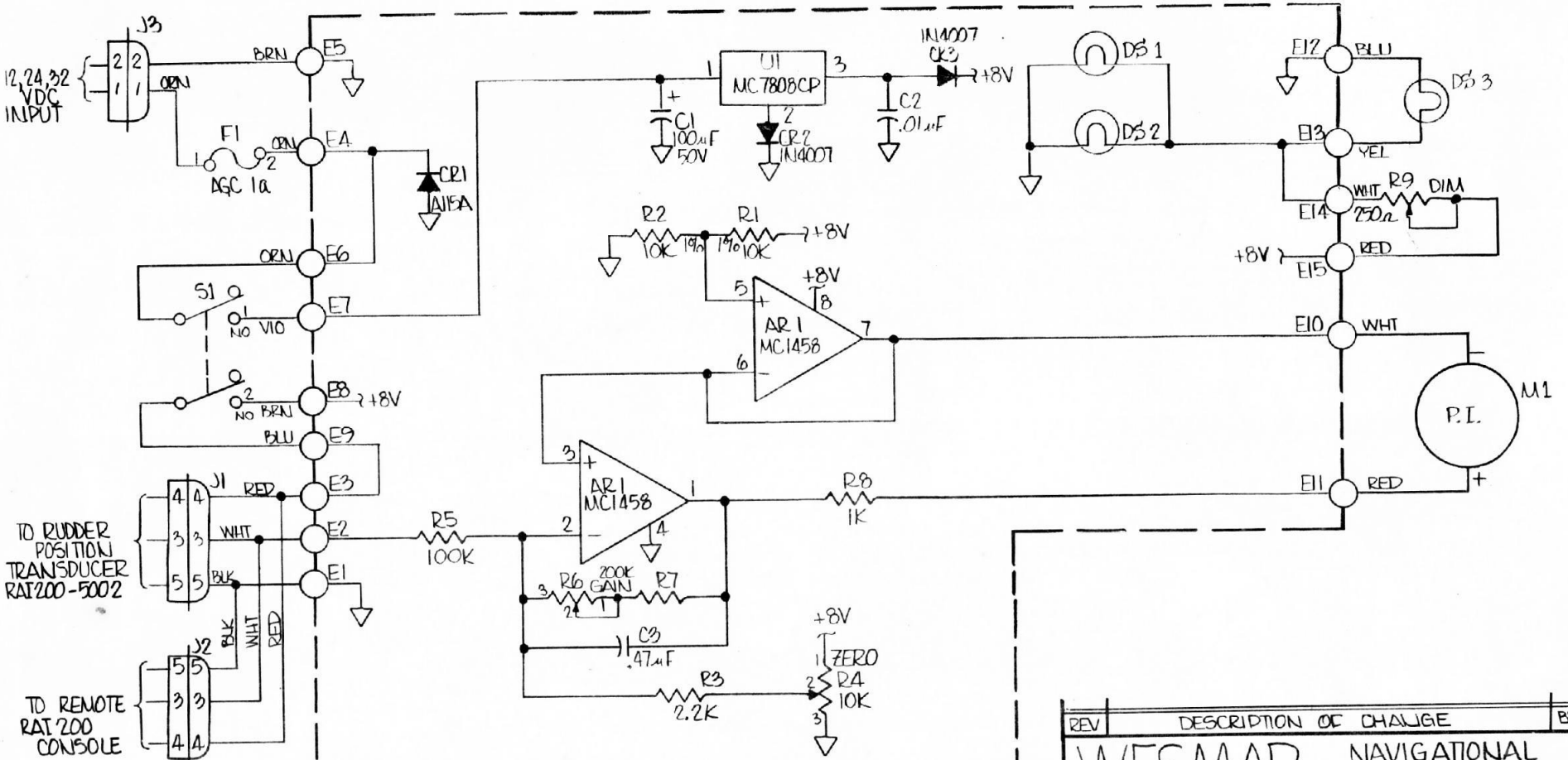
SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: 8-29-76		REVISED

12,24,32 VDC SERVO DRIVER SCHEMATIC

-04A OPTION

DRAWING NUMBER AP900-1021


SINE
GND
+12V
+4V
COSINE
TO REMOTE DC100R CONSOLE
SYNC
COMMON
RED +12V
WHT +4V
BLK GND
DIGITAL OUTPUT
DC100-4004A BACKLIGHT PCB
NOTES:
1. ALL RESISTORS ARE .25W 5% UNLESS OTHERWISE NOTED.
2. PIN 14 OF IC's U3 THRU U5 & U8 THRU U20 IS CONNECTED TO +8V.
3. PIN 7 OF IC's U3 THRU U5 & U8 THRU U20 IS CONNECTED TO GND.
4. IC's U10/U15 IS A 74C02.
5. IC's U11, U12, U14, U15, U16 ARE 74C00.
6. IC's U17, U18, U19 ARE CA4016.
PROPRIETARY
WESMAR NAVIGATIONAL SYSTEMS DIVISION
DIGITAL COMPASS SCHEMATIC AUTO PILOT MOD
DC700/AP-1003



PROPRIETARY

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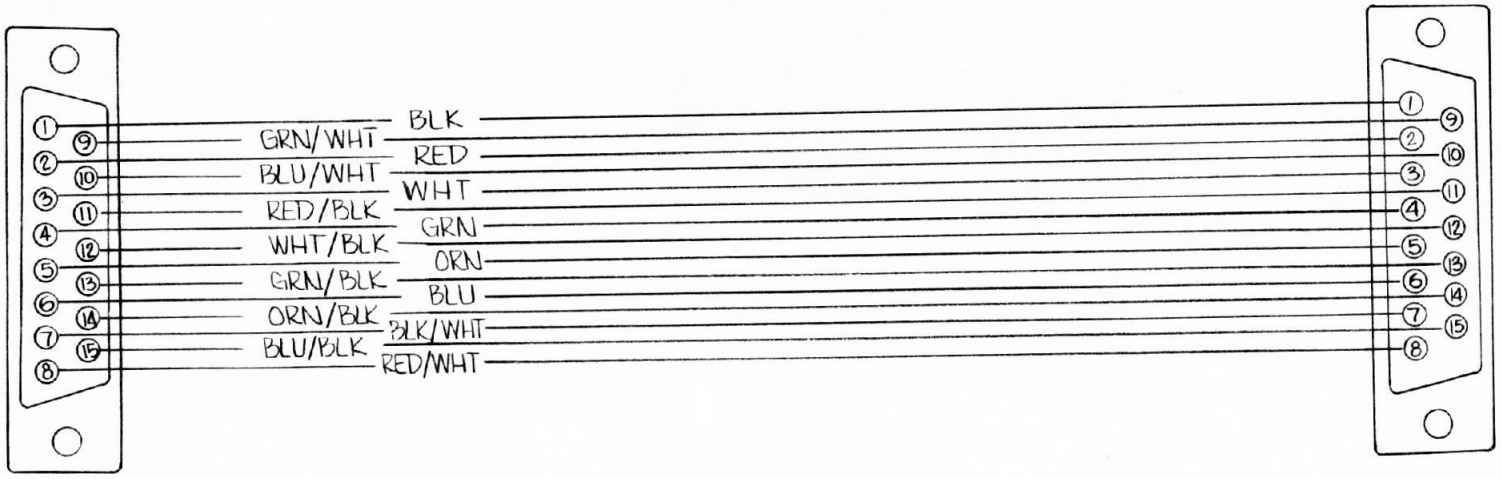
REV	DESCRIPTION OF CHANGE	BY	DATE

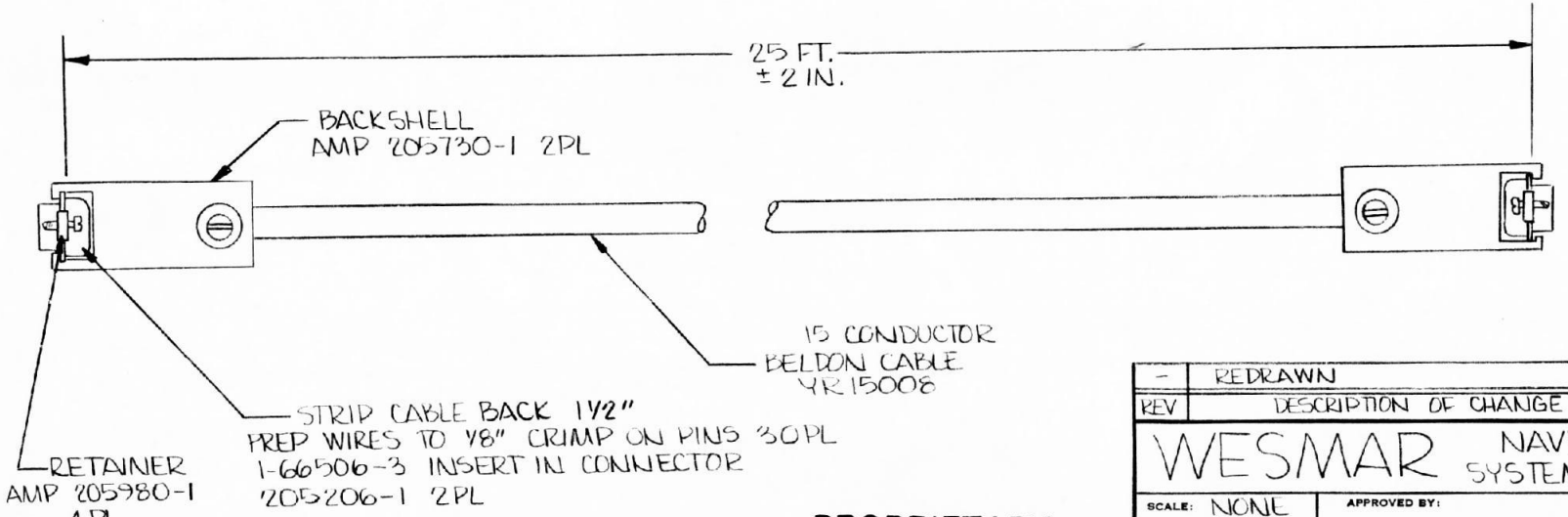
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: 9-20-76		REVISED

RUDDER ANGLE INDICATOR - SCH

DRAWING NUMBER RAI 200-1001





PROPRIETARY

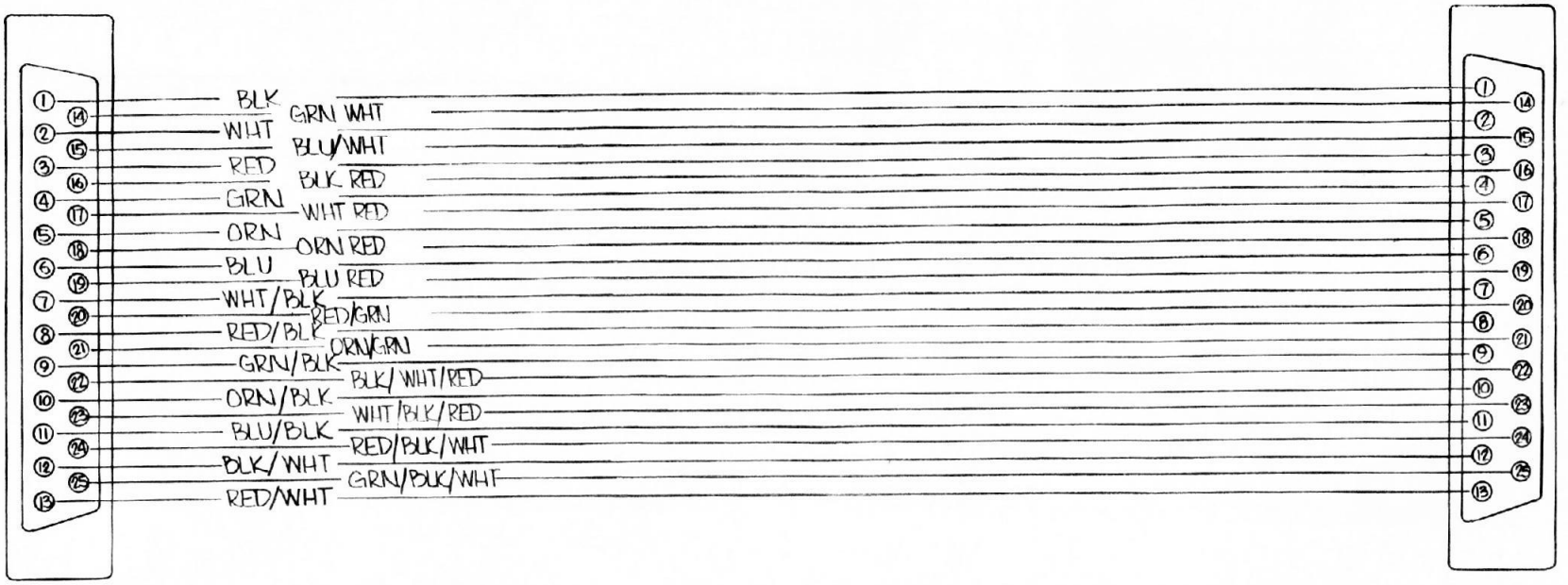
REV	DESCRIPTION OF CHANGE	BY	DATE
-	REDRAWN	P.T.	6-23-6

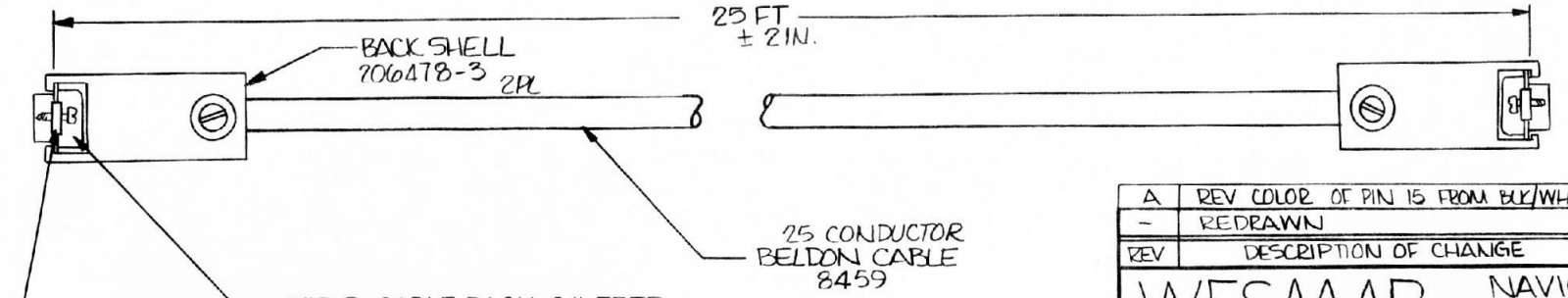
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.T.
DATE: 6-23-6		REVISED

CABLE ASSEMBLY
DRIVER INTERCONNECTION

DRAWING NUMBER
AP900-4419





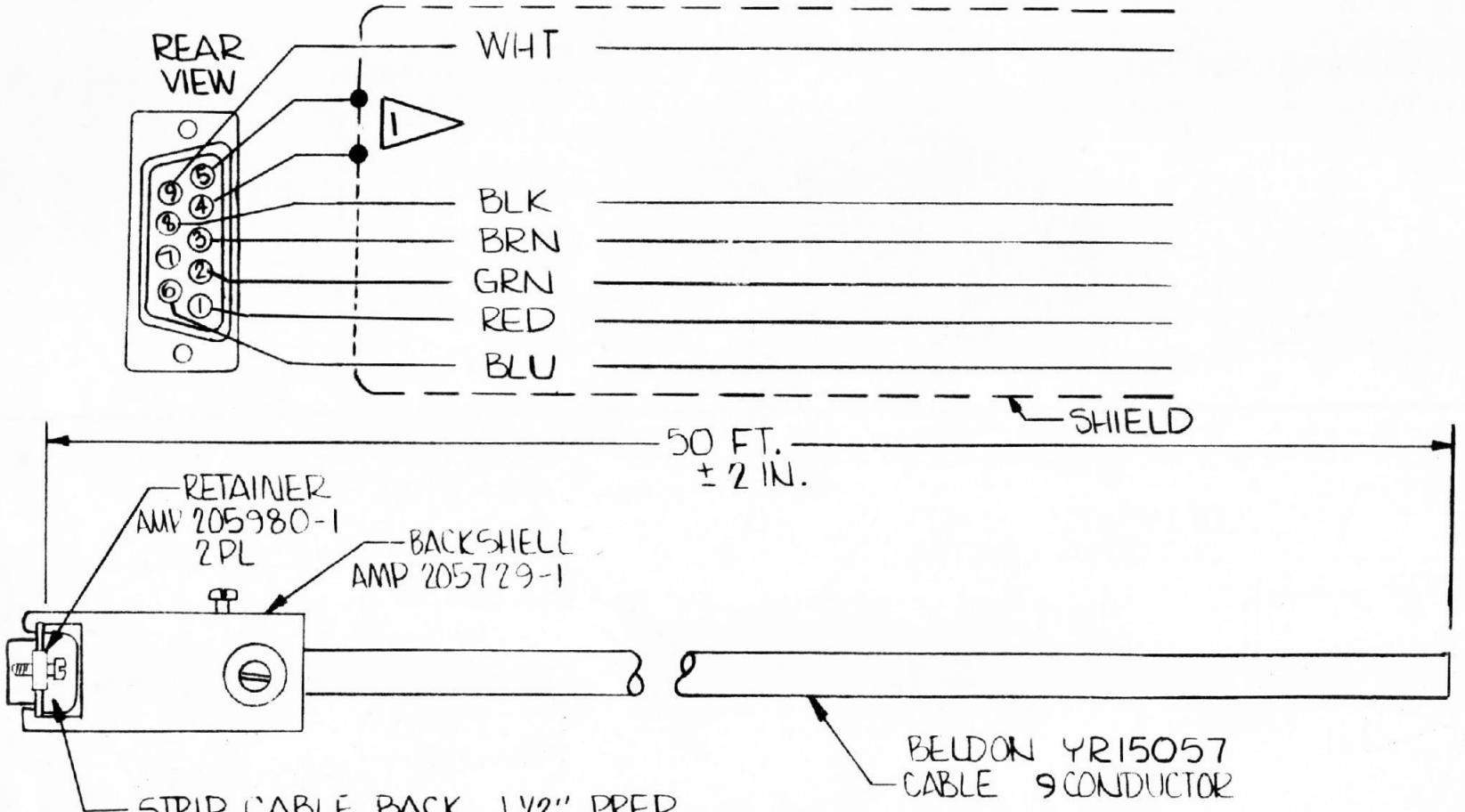
REV	DESCRIPTION OF CHANGE	BY	DATE
A	REV COLOR OF PIN 15 FROM BLK/WHT	P.E.T.	9-3-6
–	REDRAWN		

WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.T.
DATE: JUNE 25 '96		REVISED A

CABLE ASSEMBLY
CONSOLE TO MATRIX INTERCONNECT

DRAWING NUMBER
AP900-4420



1 PINS 4&5 ARE SOLDERED TO CABLE SHIELD, WIRE COLOR USED IS OPTIONAL.

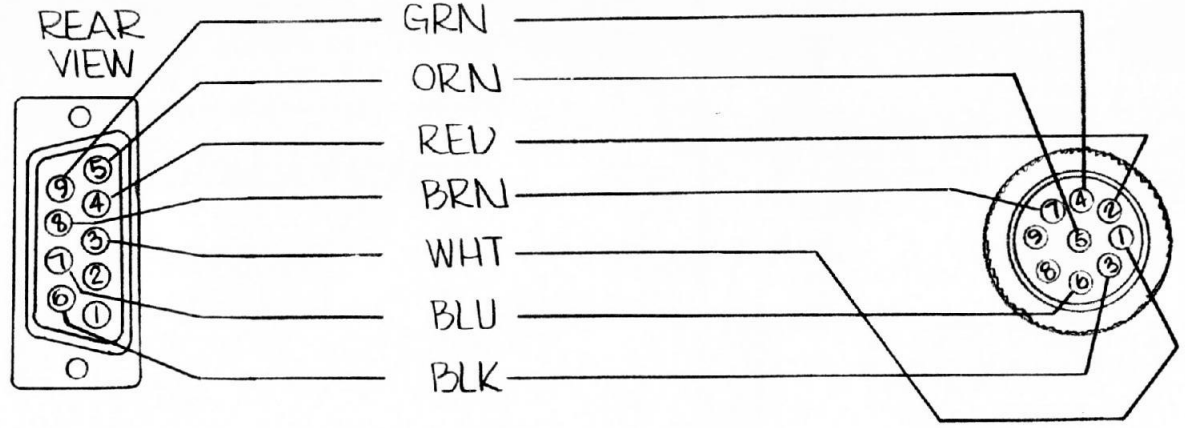
REV	DESCRIPTION OF CHANGE	BY	DATE
A	REDRAWN WITH CHANGE		

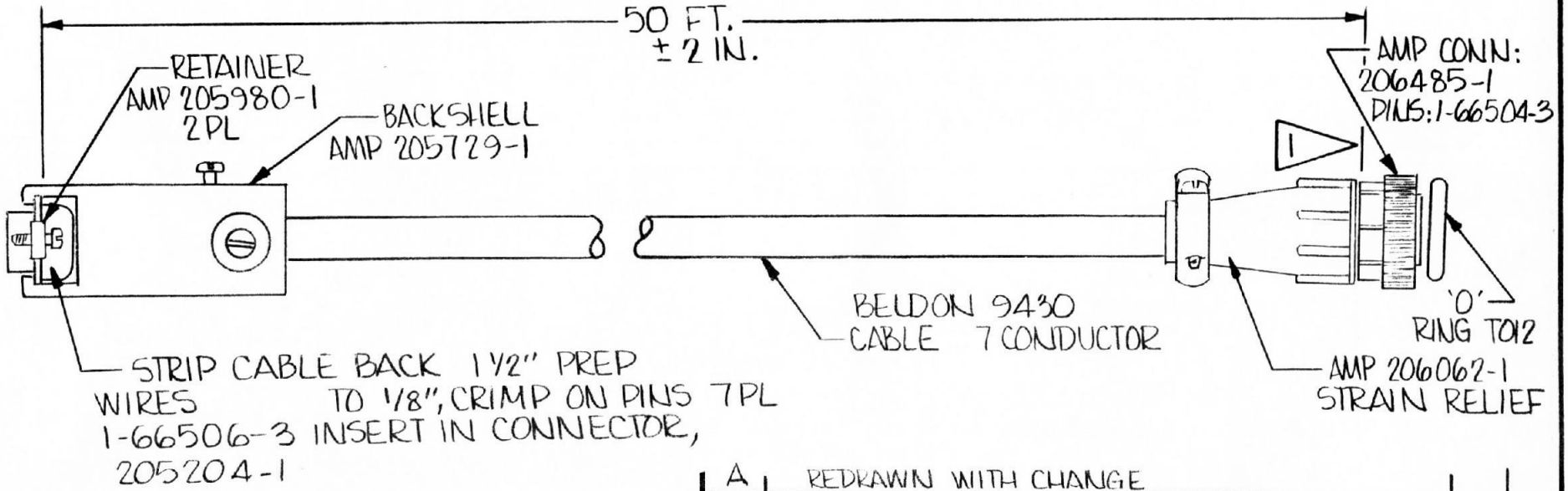
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY PET.
DATE: JUNE 18 '76		REVISED A

CABLE ASSEMBLY MAGNETIC SENSOR

DRAWING NUMBER AP900-4421





REV	DESCRIPTION OF CHANGE	BY	DATE
A	REDRAWN WITH CHANGE		

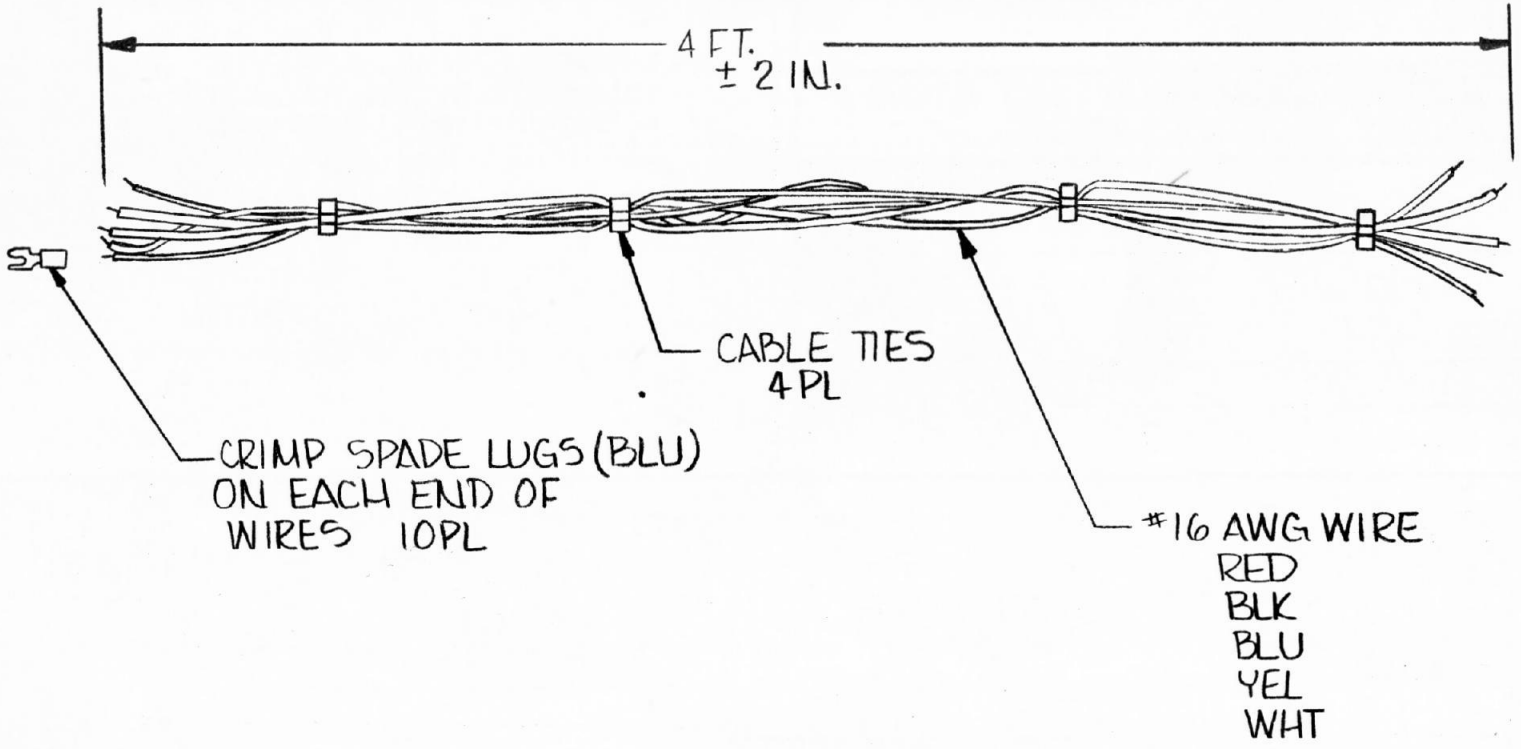
1 POT WITH RTV SILICONE RUBBER

WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY PET.
DATE: JUNE 18 '76		REVISED A

CABLE ASSEMBLY RUDDER POSITION TRANSDUCER

DRAWING NUMBER AP900-4422



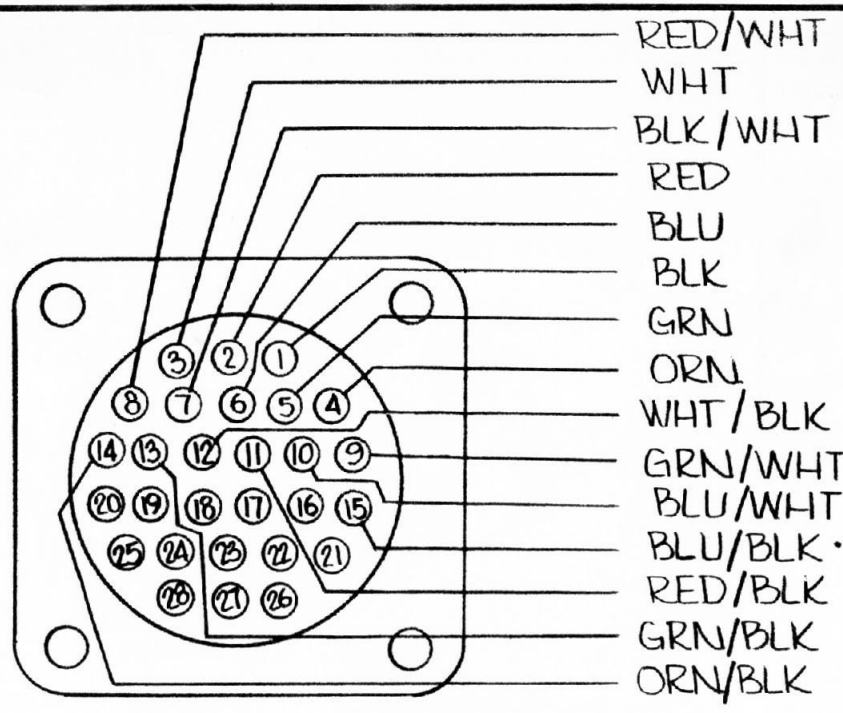
REV	DESCRIPTION OF CHANGE	BY	DATE
—	REDRAWN	P.T.	6-21-6

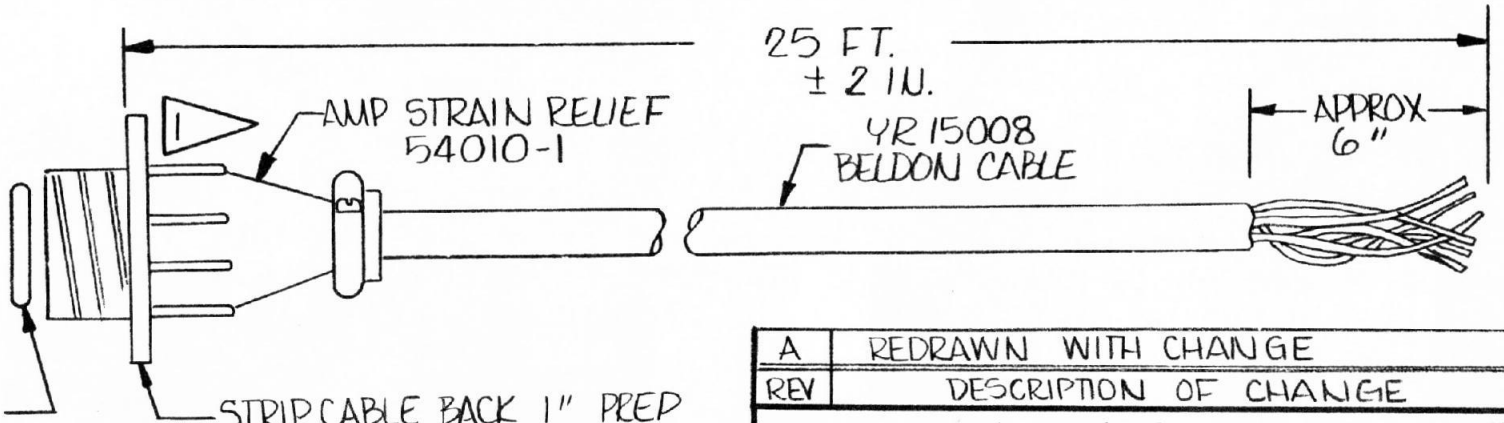
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: JUNE 21 '76		REVISED —

CABLE ASSEMBLY
SERVO DRIVER TO MOTOR

DRAWING NUMBER
AP900-4425





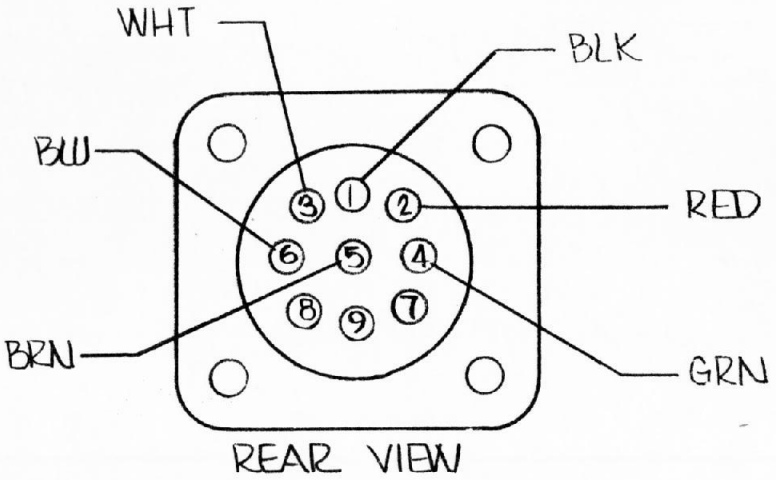
REV	DESCRIPTION OF CHANGE	BY	DATE
A	REDRAWN WITH CHANGE	P.T.	6-23-76

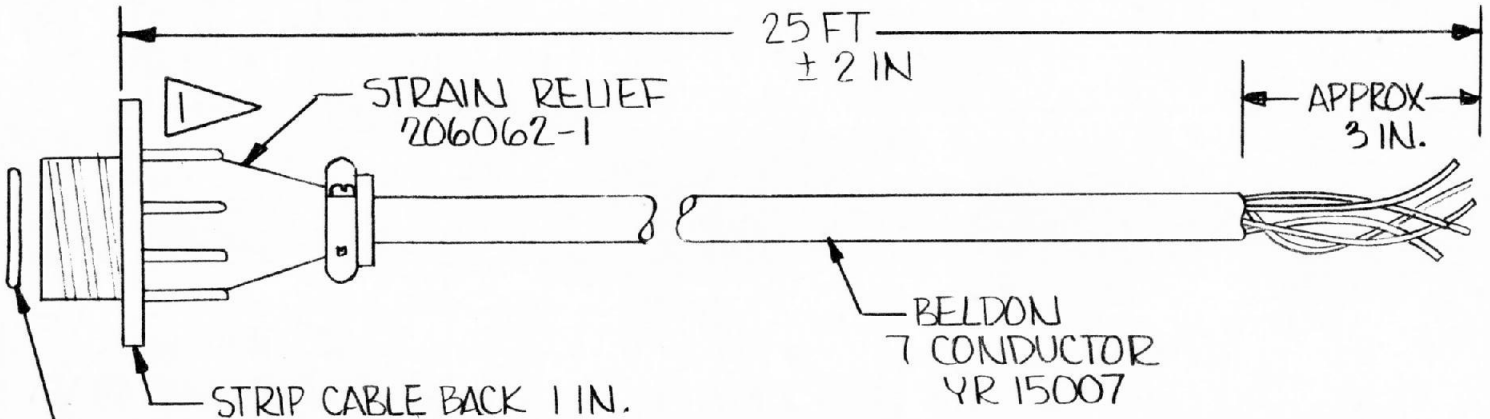
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.T.
DATE: JUNE 23 '76		REVISED

CABLE ASSEMBLY
HAND CONTROL BULKHEAD

DRAWING NUMBER
AP900-4426





1 POT WITH RTV SILICONE RUBBER

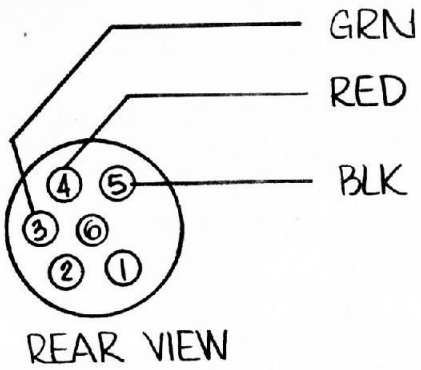
REV	DESCRIPTION OF CHANGE	BY	DATE
A	REDRAWN WITH CHANGE	P.T	6/21

WESMAR NAVIGATIONAL SYSTEMS DIVISION

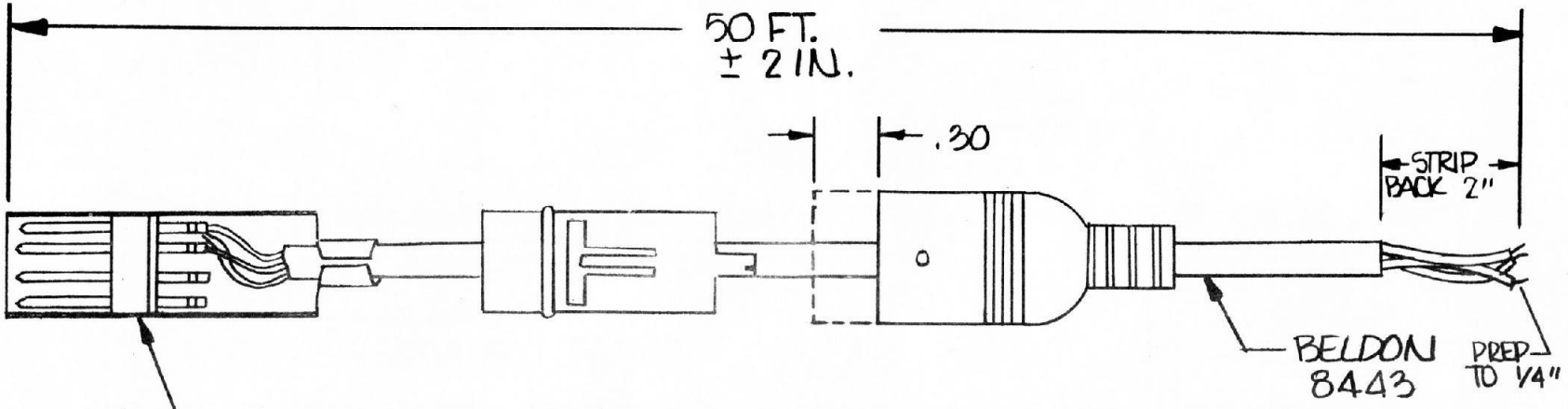
SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: JUNE 18 '76		REVISED A

CABLE ASSEMBLY
REMOTE PROP STEERING HAND CONTROL

DRAWING NUMBER
AP900-4427



PROPRIETARY



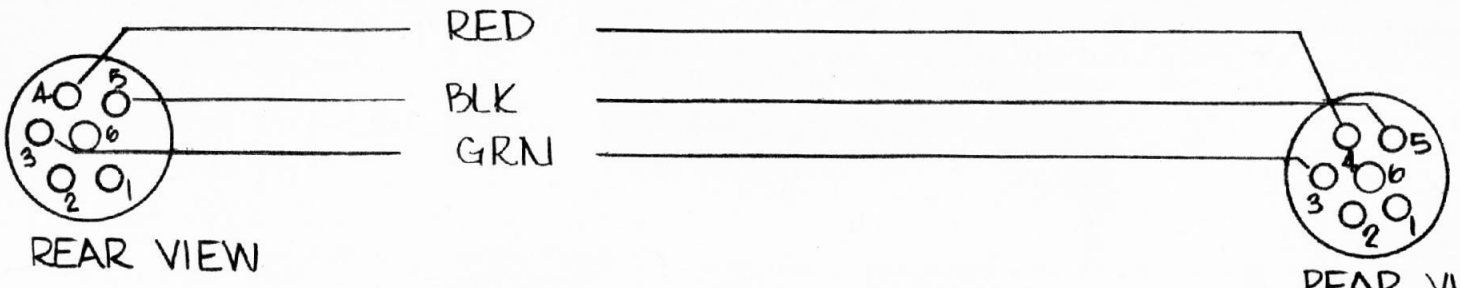
REV	DESCRIPTION OF CHANGE	BY	DATE
B	REV-GRN WAS WHT - CHG CON #	P.T.	9-13-6
A	REDRAWN WITH CHANGE	P.T.	6-21

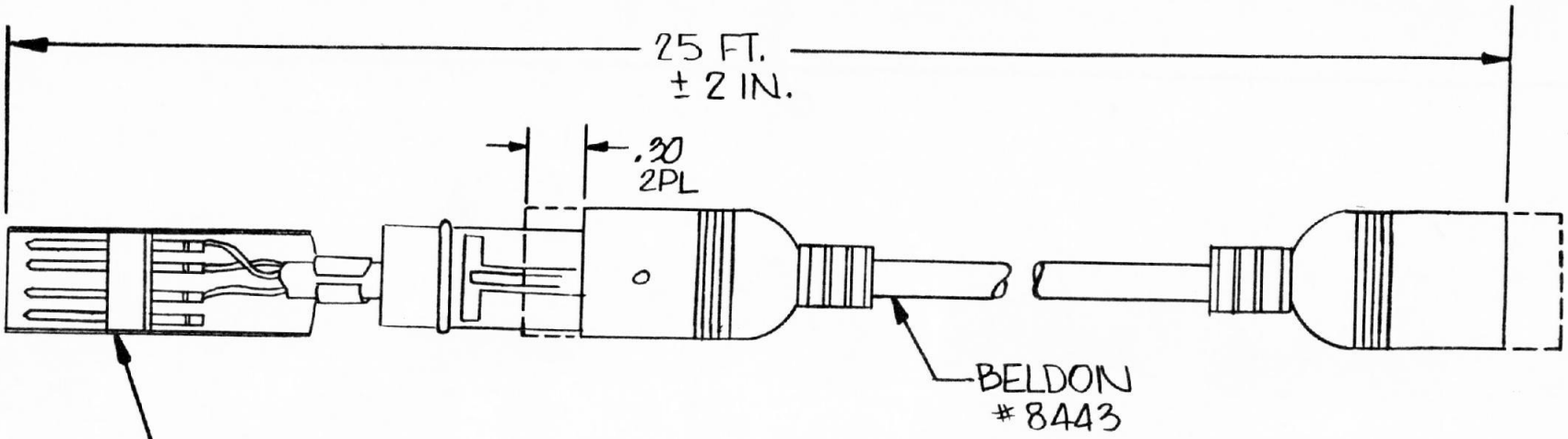
WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: JUNE 18 '76		REVISED B

CABLE ASSEMBLY
R.A.I. ACCESSORY - AP-0128

DRAWING NUMBER
AP900-4428





SMK CONN
S-13608-01 2PL
STRIP CABLE BACK
9/16" & PREP WIRES
TO 1/8" FOR
BOTH CONNECTORS

REV	DESCRIPTION OF CHANGE	BY	DATE
A	REV CON #	P.T	9-13-76

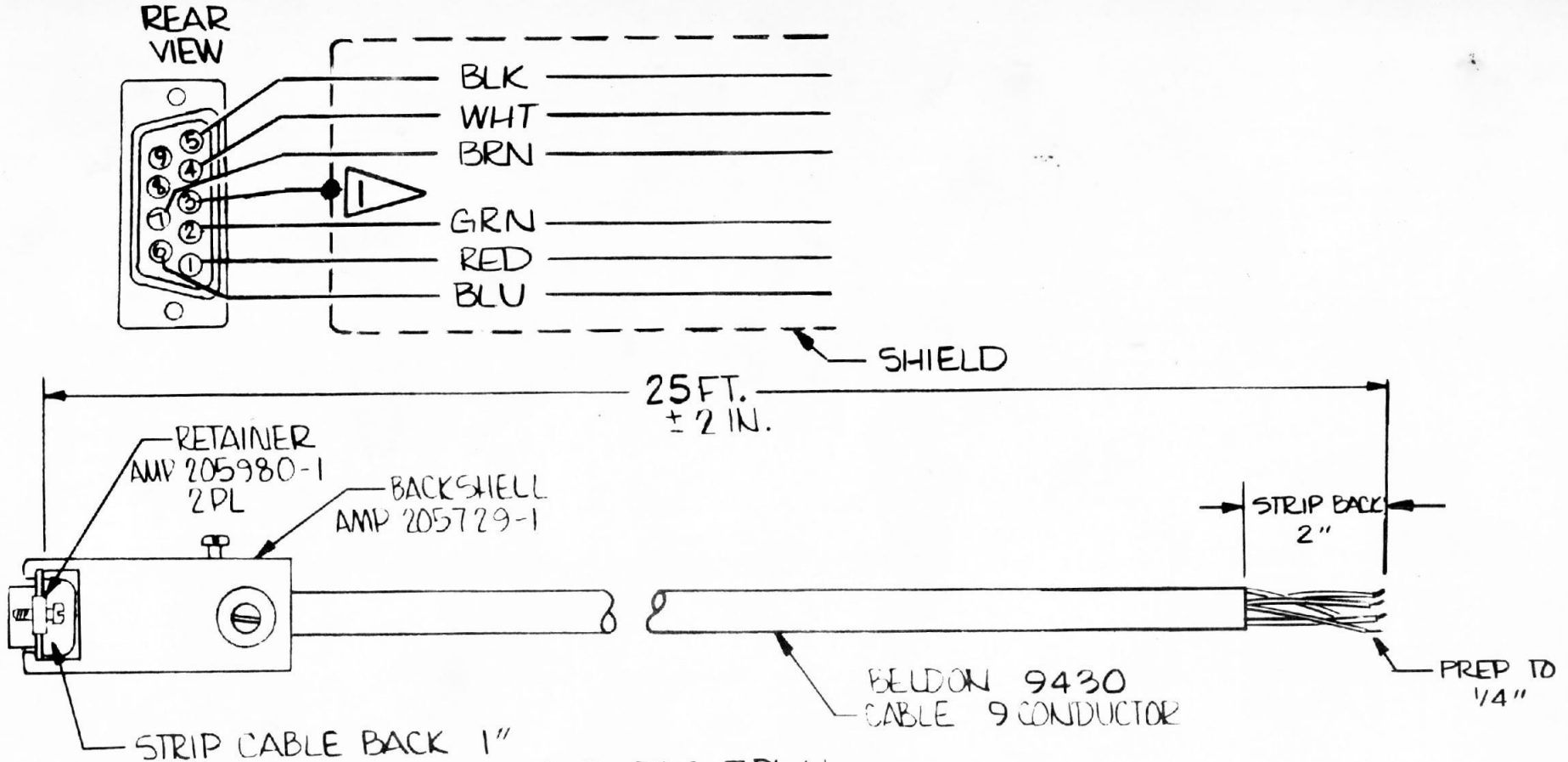
WESMAR NAVIGATIONAL SYSTEM DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: JULY 16 '76		REVISED A

CABLE ASSEMBLY
R.A.I. REMOTE INTERCONNECTING CABLE

DRAWING NUMBER
AP900-4429

PROPRIETARY



1 PIN 3 IS SOLDERED TO CABLE SHIELD, WIRE COLOR USED IS OPTIONAL.

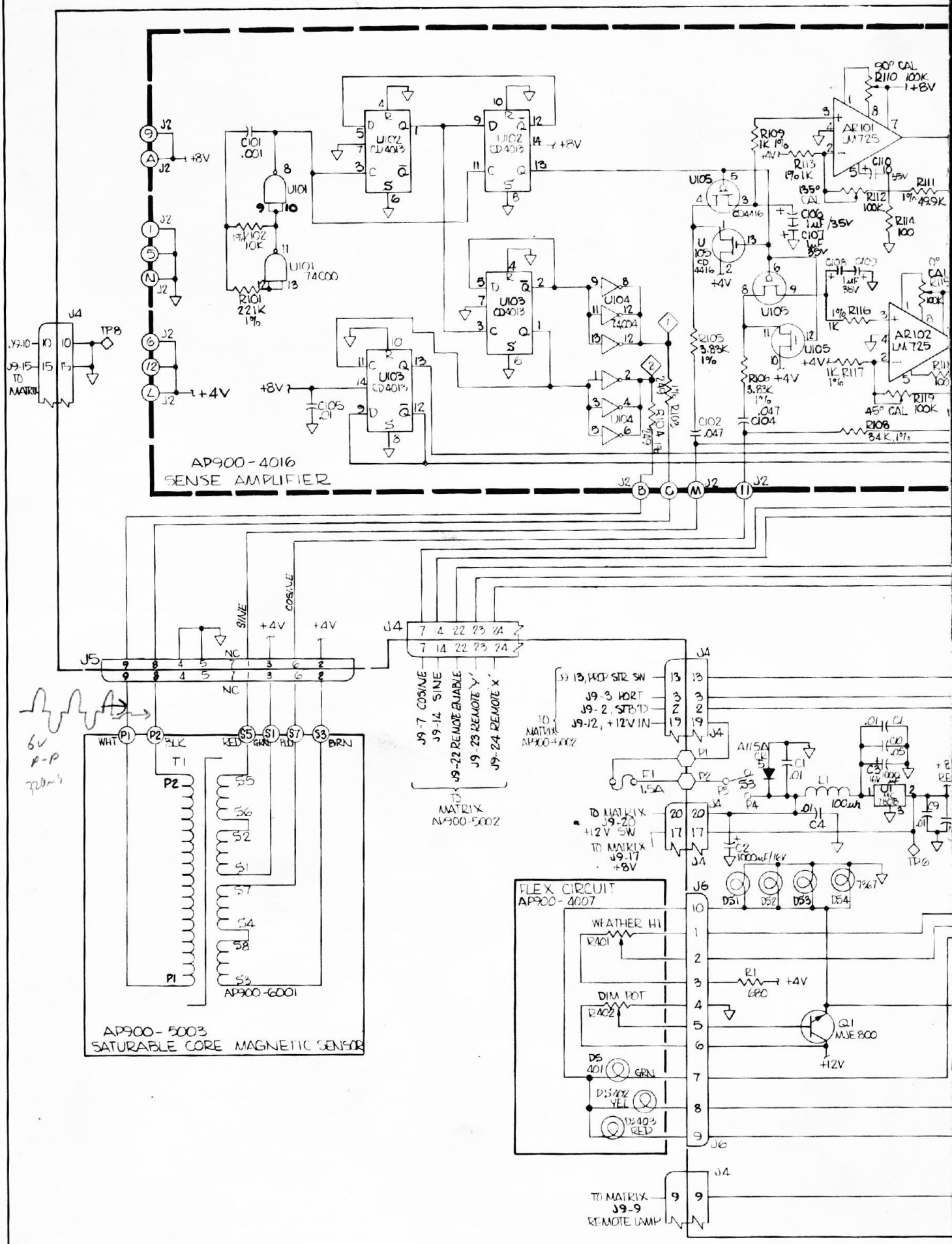
REV	DESCRIPTION OF CHANGE	BY	DATE
A	REDRAWN WITH CHANGE		

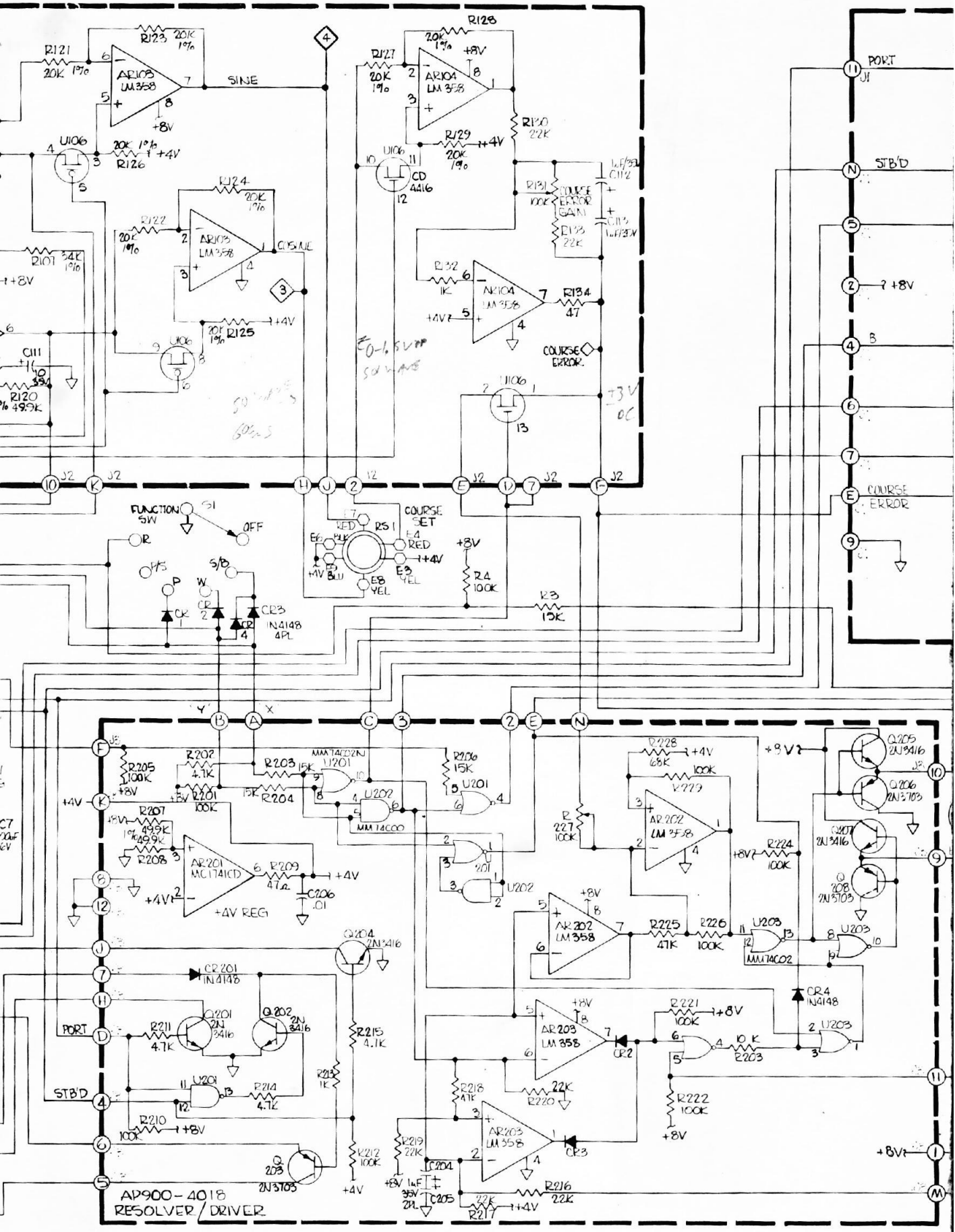
WESMAR NAVIGATIONAL SYSTEMS DIVISION

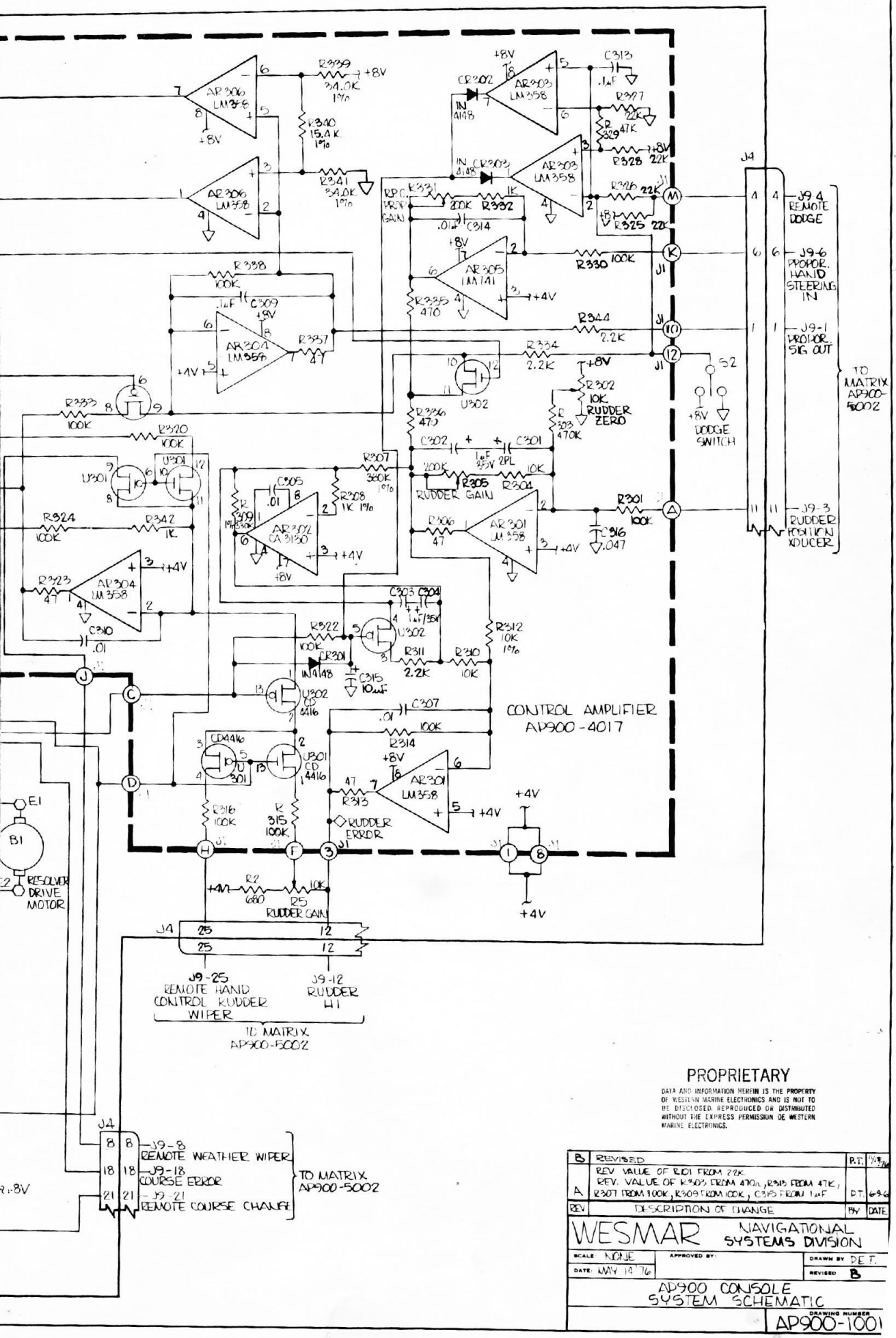
SCALE: NONE	APPROVED BY:	DRAWN BY PET.
DATE: JUNE 18 '76		REVISED A

CABLE ASSEMBLY
CONSOLE TO MATRIX AUTO PILOT MOD.

DRAWING NUMBER DC700/AP-4405


AP900-4016
SENSE AMPLIFIER
AP900-5003
SATURABLE CORE MAGNETIC SENSOR
AP900-6001
FLEX CIRCUIT
AP900-4007
SINE
COSINE
+4V
+8V
NC
TO MATRIX AP900-5002
J9-7 COSINE
J9-14 SINE
J9-22 REMOTE ENABLE
J9-23 REMOTE 'Y'
J9-24 REMOTE 'X'
J9-13, PROP STR SW
J9-3 PORT
J9-2, STBD
J9-12, +12V IN
TO MATRIX J9-20 +12V SW
TO MATRIX J9-17 +8V
TO MATRIX J9-9 REMOTE LAMP
WEATHER HI
DIM POT
6V P-P
90° CAL
45° CAL
135° CAL
0° CAL


AR103 LM358
SINE
COSINE
AR104 LM358
COURSE ERROR
COURSE ERROR GAIN
CD 4416
PORT
STB'D
FUNCTION SW
OFF
COURSE SET
CR1 CR2 CR3 IN4148 4PL
AR201 MC1741CD
+4V REG
MM74C00
MM74C02N
AR202 LM358
AR203 LM358
Q201 2N3416
Q202 2N3416
Q203 2N3703
Q204 2N3416
Q205 2N3416
Q206 2N3703
Q207 2N3416
Q208 2N3703
AP900-4018
RESOLVER/DRIVER



REV	DESCRIPTION OF CHANGE	BY	DATE
B	REVISED	P.T.	7/8/76
A	REV. VALUE OF R101 FROM 22K TO 47K, REV. VALUE OF R303 FROM 470Ω, R313 FROM 47K, R307 FROM 100K, R309 FROM 100K, C315 FROM 1μF	P.T.	6-9-6

WESMAR NAVIGATIONAL SYSTEMS DIVISION

SCALE: NONE	APPROVED BY:	DRAWN BY P.E.T.
DATE: MAY 14 '76		REVISED B

AP900 CONSOLE SYSTEM SCHEMATIC

DRAWING NUMBER AP900-1001

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Seller warrants title, materials, and workmanship on equipment, except components manufactured by others for which Seller assigns, as permitted, the original manufacturer's warranty. SELLER'S WARRANTY PERIOD SHALL BE SIX (6) MONTHS AFTER DATE OF SHIPMENT TO THE ORIGINAL PURCHASER, during which time nonconforming equipment returned to Seller at Buyer's expense and risk shall be repaired or replaced at Seller's option. THE DURATION OF ALL IMPLIED WARRANTIES SHALL BE SIX (6) MONTHS AFTER SHIPMENT TO ORIGINAL PURCHASER.

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