INSTRUCTION MANUAL

Robertson AP9 Mk3

Autopilot

20169223

SIMRAD
A KONGSBERG Company

NOTE!

Simrad Robertson AS makes every effort to ensure that the information contained within this document is correct. However, our equipment is continuously being improved and updated, so we cannot assume liability for any errors which may occur.

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment or injury to personnel. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.

Simrad Robertson AS disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

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Instruction Manual

The manual is intended as a reference guide for operating and correctly installing the AP9 Mk3 Autopilot.

Great care has been paid to simplify operation and set-up. However, an autopilot is a complex electronic system; it is affected by sea conditions, speed of the vessel, hull shape and size.

Please take time to read this manual to get a thorough understanding of the operation and system components and their relationship to a complete autopilot system.

Other documentation materials that is provided with your system include a warranty card. This must be filled in by the authorized dealer that performed the installation and mailed in to activate the warranty.

Document revisions

	Documentation department		Hardware / Software design		Project / Product Management	
Rev	Date	Sign	Date	Sign	Date	Sign
–	10.04.96	N.G.	10.04.96	G.K.	10.04.96	Th.H.
A	30.05.96	N.G.	30.05.96	G.K.	30.05.96	Th.H.
B	12.07.96	N.G.	12.07.96	T.J.	12.07.96	Th.H.
C	3.9.99	N.G.	3.9.99	T.J.	3.9.99	Th.H.
D	07.11.00	N.G.	07.11.00	T.J.	07.11.00	T.R.

Document history

Rev. – First edition

Rev. A Updated table of contents and references throughout the manual

Rev. B Minor corrections in table page 1-6 and fig. 1-5. New dimensional drawing of control unit, fig. 4.1. Section 5: Due to modified PCBs the instructions for ferrite core mounting are omitted. New component layout and set-up procedure for Dual Analogue Board included. Section 8: Updated circuit diagrams included. Section 9: Certificate of Type Approval included.

Rev. C New layout. Section 2 and 5 revised according to new software version V1R3. Diagrams updated. Dimensional drawing of RF Standard Transmission link included. D9X Bus cable connection included. Index and distributor list included.

Rev. C has not been released.

Rev. D Updated according to software version V1R4.

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1 INTRODUCTION

1.1 General

To day Simrad manufacture a complete range of autopilots for all types of vessels, from leisure boats up to advanced steering systems for merchant marine vessels. Our factory for these products – branded Robertson – is located in Egersund, on the south-west coast of Norway. The company's involvement in autopilots began in 1953 with equipment for the North Sea fishing fleet.

The AP9 MK3 autopilot described in this document is based on predecessor, the AP9 MkII. The major changes are on the hardware to comply with IMO resolution 694 (17) and the Marine Directive (Wheelmark). The hardware changes are compatible with the AP9 MkII.

1.2 MK3 System Layout

The complete AP9 MK3 system layout is shown in Fig. 1-1

A number of configurations can be made from the complete system layout, and certain standard systems are shown in separate figures.

The relationship between control signals, mode signals and the different versions of distribution unit are shown in the standard system drawings.

The combinations of heading sensors are shown in Fig. 1-5.

1.3 Options available with the standard system

The AP9 MK3 system has a series of options that can be specified, allowing the autopilot system to be configured to suit virtually any particular vessel.

Optional equipment:

- Dual station
  This is a second control unit for remote control of the main station functions
- Non Follow Up (NFU) steering lever with mode selector and lock mechanism
- Follow up (FU) steering lever with mode selection
- Rudder angle indicators
- Watch alarm
- Thruster control / second parameter set; i.e. the ability to control either a thruster or both the rudder and thruster simultaneously. This option requires a special interface board in the Distribution Unit.

For operation, technical specifications, installation and spare parts, see the respective sections of this manual.

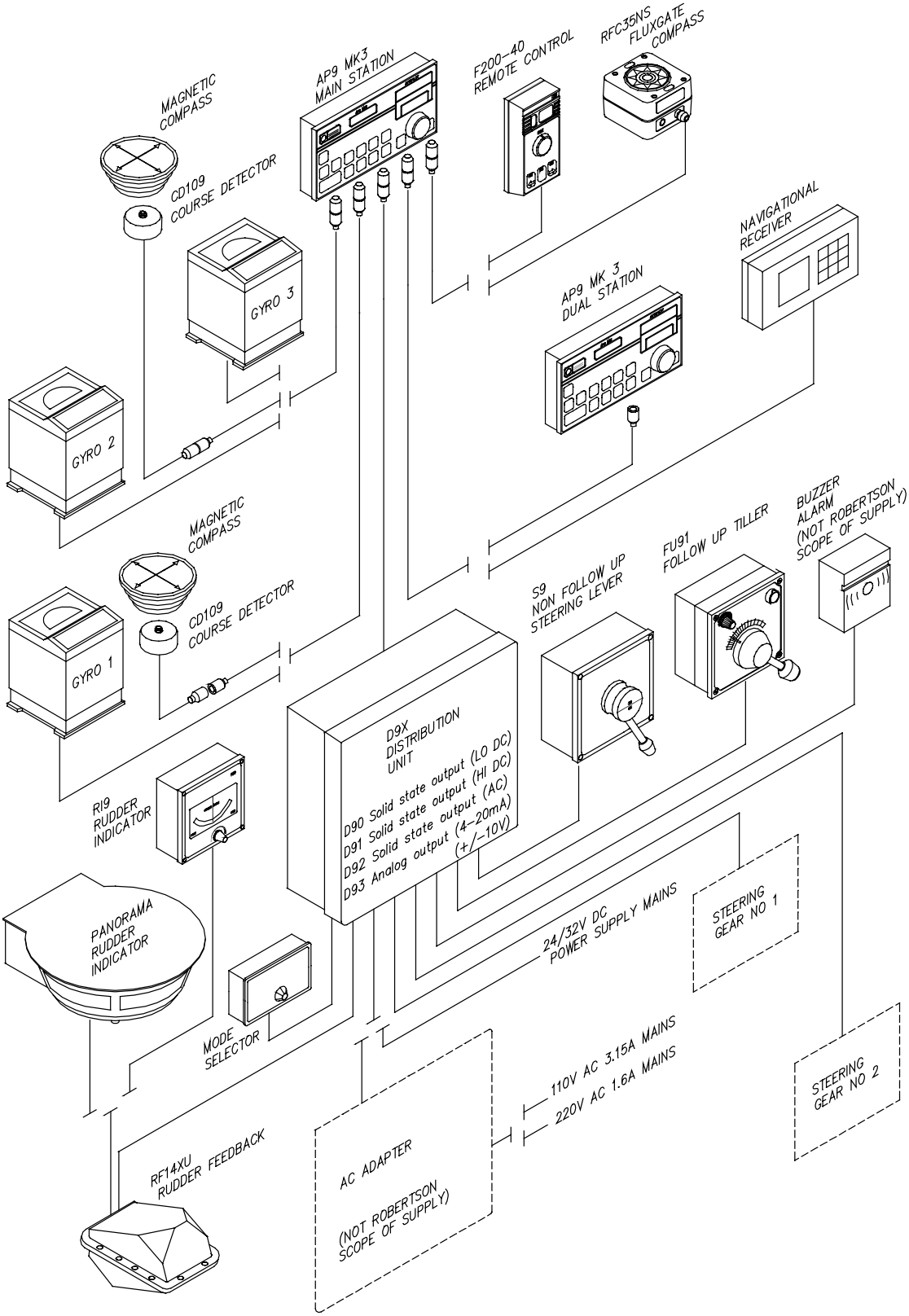


Fig. 1-1
AP9 MK3 System layout

1.4 AP9 MK3 Standard System, On-Off Valves

Ref. Fig. 1-2.

The standard AP9 MK3 system consist of the following units:

- AP9 MK3 Control Unit P / N 20169199
  Optional Gyro interface PCB P / N 20168316
- CD109 Magnetic Course Detector
  (with tripod holder) P / N 20120861
- RF14XU Feedback Unit (with transm. link) P / N 22501647
- D9X Distribution Units:
  Version D90 (19-40V DC, 3A solenoids) P / N 20125001
  (Extra S.S.B. P / N 20125043)
  Version D91 (110V DC, 1A solenoids) P / N 20125407
  (Extra S.S.B. P / N 20125423)
  Version D92 (110 / 220V AC, 1A solenoids) P / N 20125704
  (Extra S.S.B. P / N 20125720)

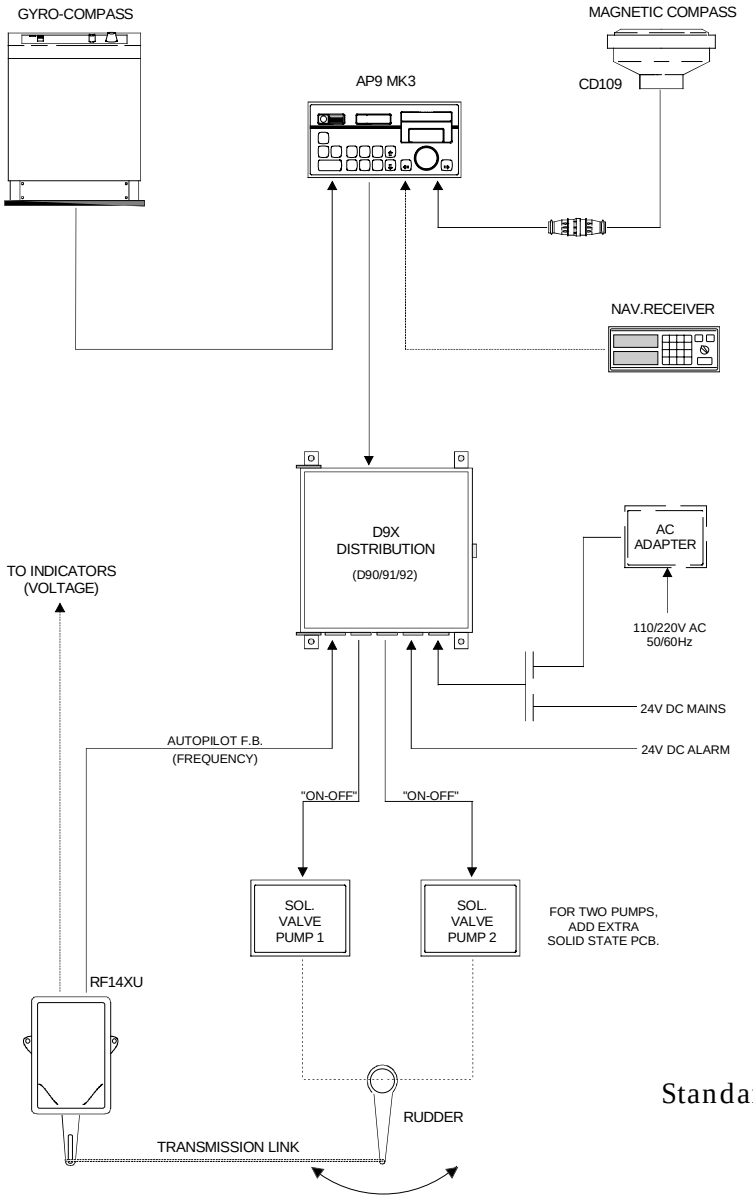


Fig. 1-2
Standard system with ON-OFF valves

Note that the standard mains supply is 24V DC.

If AC mains is used, the system must also include an AC Power Adapter (Not supplied by Simrad Robertson AS)

Where the system shall operate two sets of solenoid valves, one extra Solid State PCB (S.S.B.) must be mounted in the D9X Distribution Unit (see above).

Interface to navigational receiver is incorporated.

1.5 AP9 MK3 Standard System, Dual analogue output

The dual analogue system consist of the following units (Ref. Fig. 1-3.):

- AP9 MK3 Control Unit P / N 20169199
- Gyro Interface Board (Optional) P / N 20168316
- CD109 Magnetic Course Detector (with tripod holder) P / N 20120861
- D93 Distribution Unit: Provides two galvanic isolated ±10V (adjustable) or 4-20mA output signals P / N 20126009

Note ! *No autopilot feedback unit is required.*

It is recommended to use a separate mode selector to provide change-over (c / o) signals to the respective steering gear electronic units. The following functions can be included:

A: MANUAL - AUTO
B: MANUAL - PORT - STBD - BOTH

(Function to be specified when ordering)

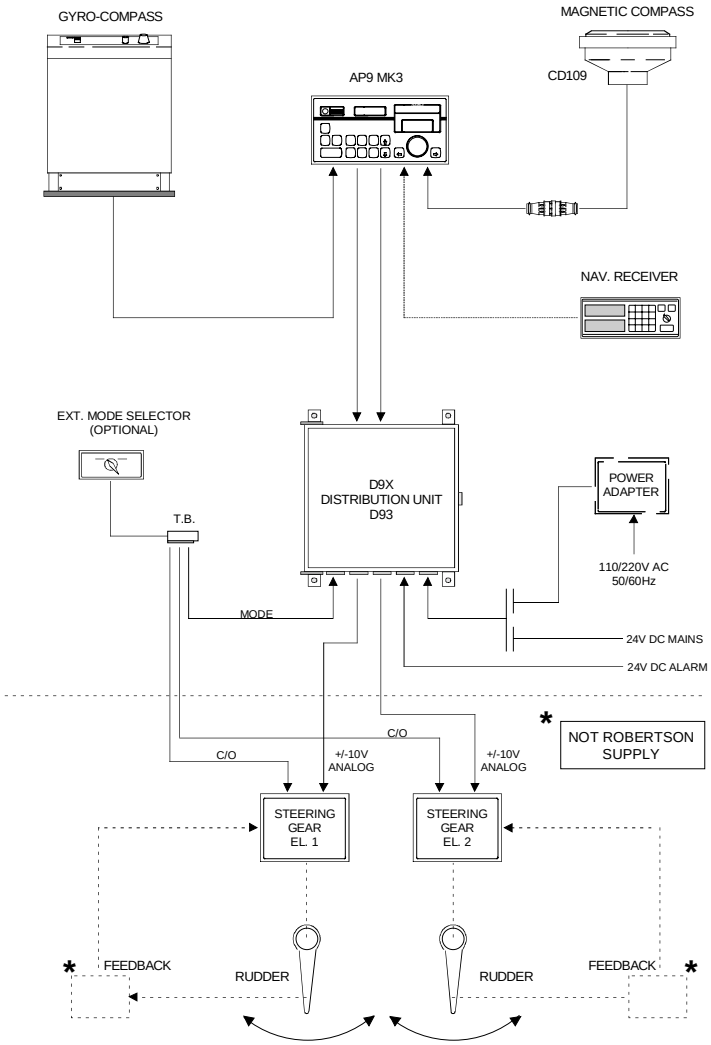


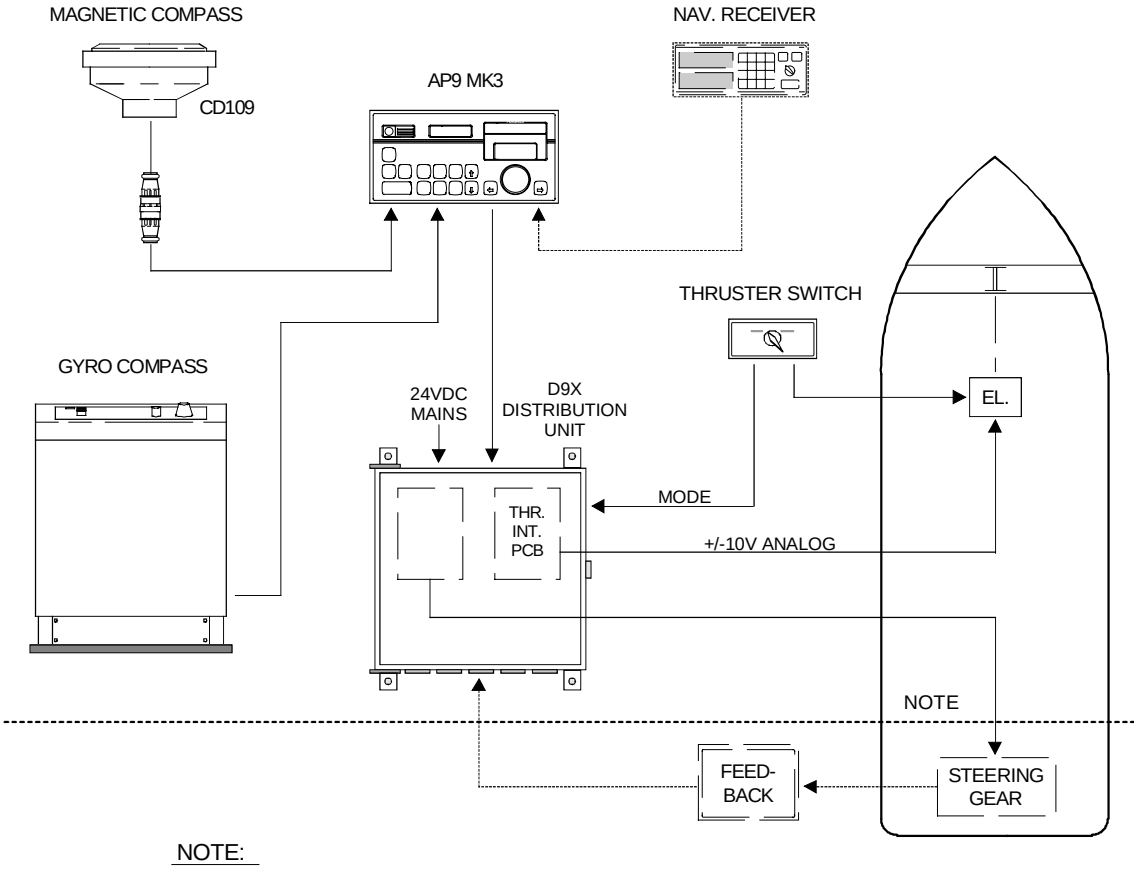
Fig. 1-3
Standard system, ±10V
Dual Analogue

1.6 AP9 MK3 with analogue thruster control

Ref. Fig. 1-4.

The system consists of the following units:

- AP9 MK3 Control Unit P / N 20169199
  Optional Gyro Interface Board P / N 20168316
- CD109 Magnetic Course Detector
  (with tripod holder) P / N 20120861
- D9X Distribution Unit P / N 20126306
  (Includes S.S.B.(s) or Dual Analogue PCB P / N as per D9X
  depending on steering gear interface)
- Thruster Interface PCB P / N 20126017
  (Replaces Interconnection PCB P / N 20125027
  in D9X Distribution Unit)
- Thruster switch (RUDDER - THRUSTER) P / N 20168605
- RF14XU Feedback Unit P / N 22501647
  (When connected to solenoid valves)



NOTE:

STEERING SYSTEM EITHER ON-OFF OR ANALOGUE.
FOR ANALOGUE, NO FEEDBACK IS REQUIRED FOR AUTOPILOT.

Fig. 1-4
Thruster control

1.7 Combinations of Heading Sensors

Ref. Fig. 1-5.

The AP9 MK3 Control Unit is designed to accept several types of heading sensors. The sensors can be divided in three groups:

1. Gyro Compass
2. Fluxgate Compass (Recommended as monitor compass only)
3. Magnetic Compass (Recommended as monitor compass only)

GYRO COMPASS

To interface to SYNCHRO, GYRO EXCITED, A / P EXCITED or STEP type gyro, the AP9 MK3 Control Unit must be equipped with the Gyro Interface Board P / N 20168316.

Signal type	**Optional hardware**
Synchro 11,8V l-l 400Hz	Gyro Interface PCB
Synchro 20-115V l-l 50-60Hz, 400Hz	Gyro Interface PCB
Step 6 step / degree	Gyro Interface PCB
Sin / cos	Not required
Serial	Not required

Note ! *Two SYNCHRO or two STEP signals can not be connected at the same time. When using two gyrocompasses, one gyro must provide SYNCHRO signal and the other gyro must provide STEP signal.*

When using gyro with serial signal, no Gyro Interface Board is required.

Notice that dual station system communication can not be made when UART or NMEA serial line is used.

The Robertson RGC gyros can be connected according to the following table:

	Direct connection	**RGC Interface connection**
RGC10	Synchro	Serial, sin / cos, 6 step / degree
RGC11	RS422 Tokimec spes.	Serial, sin / cos, 6 step / degree
RGC50	Synchro	Serial, sin / cos, 6 step / degree
RGC12	Serial	Serial, sin / cos, 6 step / degree

For details of gyro selection see page 5-58.

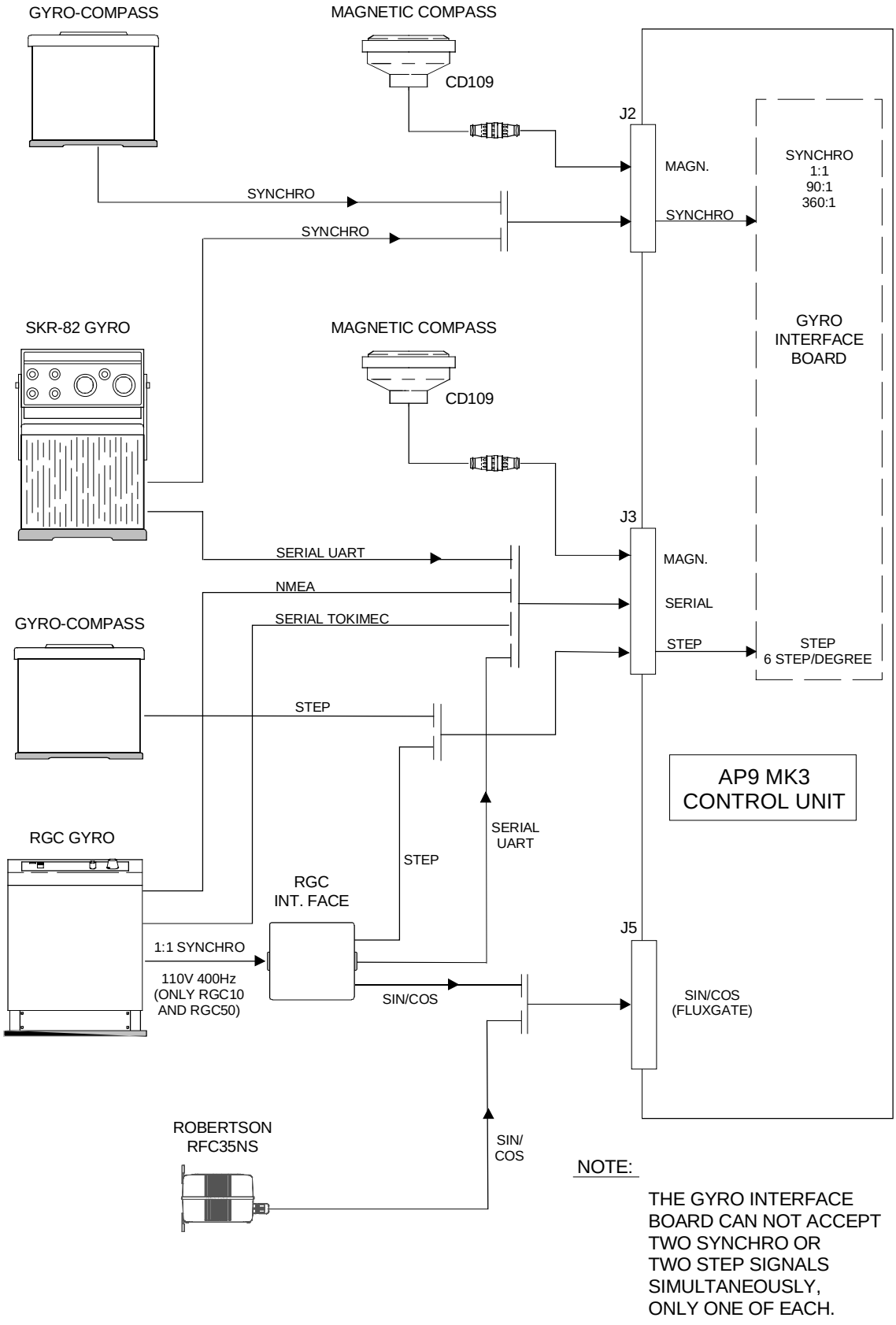


Fig. 1-5
Heading Sensors

RGC Gyro with RGC Signal Interface Unit

When using an RGC gyro together with the RGC Signal Interface, four options of connections are possible:

1. UART serial line, 20mA. (Identical to the SKR 82 serial line)
2. NMEA serial signal
3. Fluxgate sin / cos signal, identical to the Robertson fluxgate signal.
4. Step signal, 24V – 6 step / degree.

When using the fluxgate signal, select FLUXGATE compass.

When using step signal, select STEP SIGNAL.

See page 2-6 for compass selection.

RGC12 Gyrocompass

The RGC12 RS422 Tokimec special protocol or NMEA can be connected directly to the AP9 MK3 without any Gyro Interface PCB.

FLUXGATE COMPASS

The AP9 MK3 is designed to accept fluxgate compass sin / cos signals, using 2.5V DC as reference.

The Robertson type of Fluxgate Compasses, such as the RFC35NS therefore interfaces directly to the AP9 MK3.

Note ! *A fluxgate compass should only be used as a Monitor Compass. Gyrocompass is always recommended as Main Compass.*

For details, refer to page 5-10.

1.8 Dual Station

See Fig. 1-7

The AP9 MK3 Control Unit can also be used as a remote station, communicating with the main station by serial lines.

The dual station system is designed to enable individual connections of NFU levers, F200-40 remote controls and mode selectors. This makes it possible to select mode and change parameters from the two stations individually. FU levers can only be connected to the main Control Unit via D9X.

Note ! *Change of parameters except the selection of compass on one unit, will change the same parameters on the other unit.*

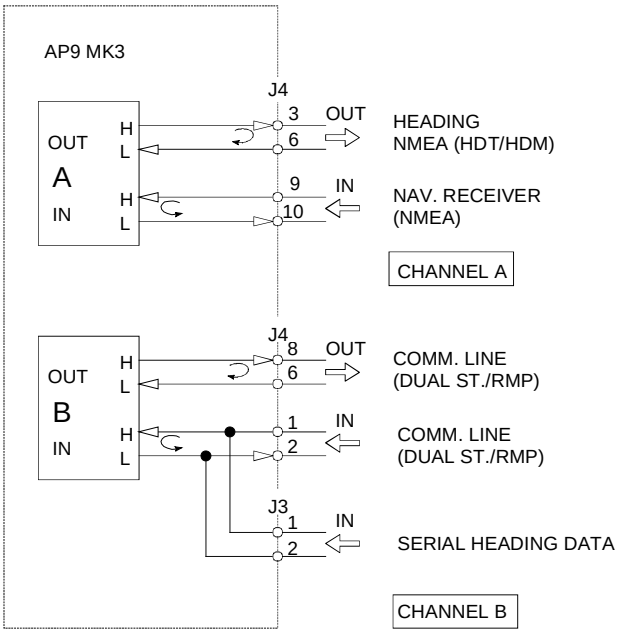
Parameter 2 option (Thruster function) can be selected individually on the two units, but adjustment of parameters on one unit will automatically change the same parameters on the other unit.

When a F200-40 Remote Control is connected, a mode selector must have an "OFF" position to allow proper function of the F200-40.

SERIAL LINES

The AP9 MK3 has several serial line connections.

As shown in Fig. 1-6, two input lines are in parallel, the "COMM. LINE" and the "SERIAL HDG. DATA". This excludes the interface to serial heading data when a dual station is used.



NOTE: In Dual Station configuration, serial heading data can not be connected to J3, 1-2.

Fig. 1-6
Serial line connections

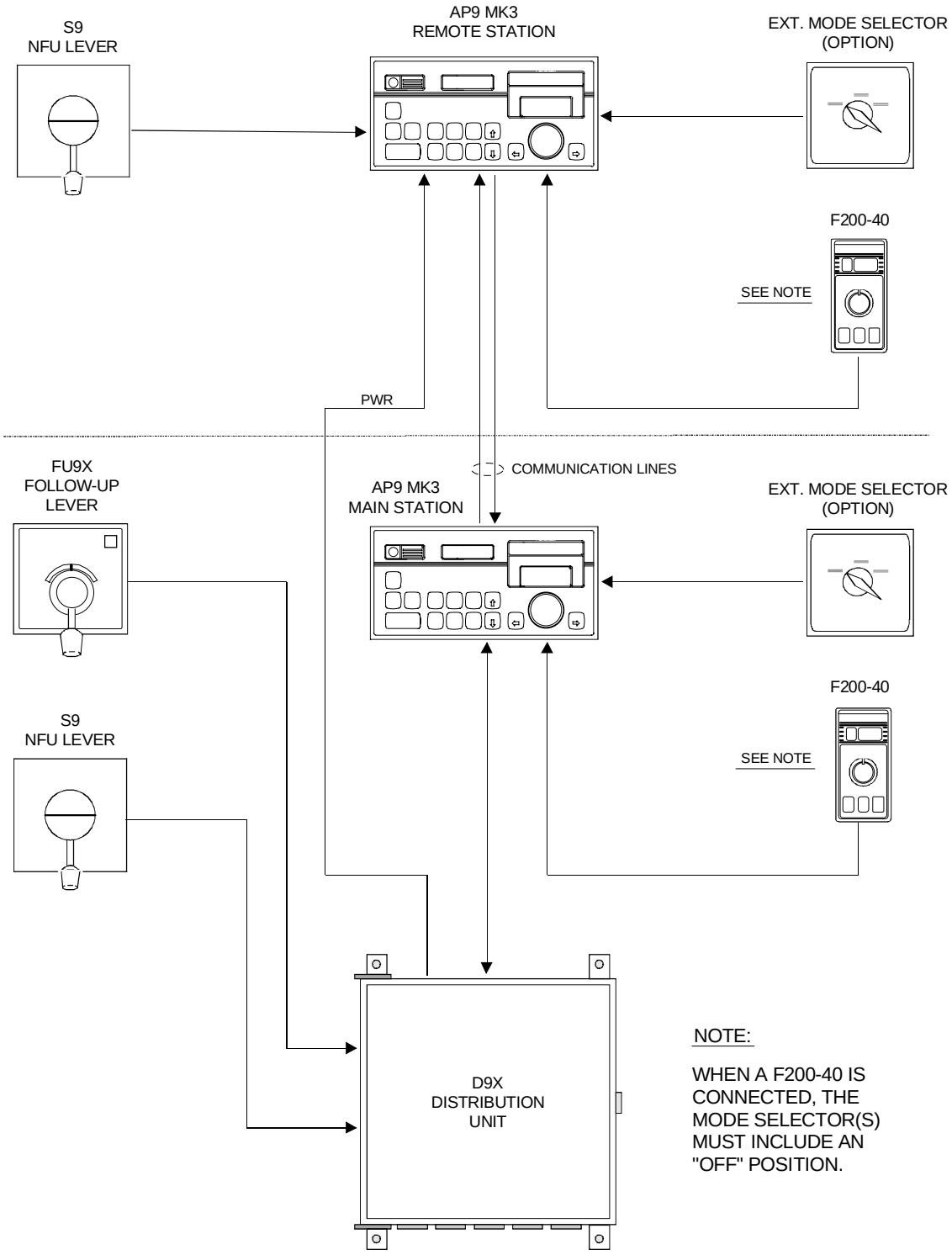


Fig. 1-7
Dual Station System

1.9 Connection of steering levers

As shown on Fig. 1-8., a number of NFU levers and a single FU lever can be connected to the AP9 MK3 autopilot system.

The S9 NFU lever combines an "IN - OUT" function with the normal PORT - STBD operation. The "IN - OUT" function can be combined with the external mode-selection of the autopilot and this automatically brings the autopilot to NFU mode when the S9 lever is pulled out. The mode change has two alternatives:

A. Sets the autopilot to NFU mode when the S9 is pulled out. NFU mode will remain when S9 is pushed in again. AUTOMATIC or NAV to be selected on the control unit. For this alternative refer to page 5-24.

B. Sets the autopilot to NFU-mode when the S9 is pulled out. Mode will change back to AUTOMATIC or NAV when the S9 lever is pushed in again. To obtain this function, the closing contacts if S9 no. A5-A6 is used to control the mode. Refer to page 5-21.

An unlimited number of S9's can be connected in parallel.

Note ! *It is also possible to add several FU-levers to an AP9 MK3 system by using the FUA9X Follow-Up Amplifier instead of the D9X Distribution Unit.*

Note ! *NFU levers should <u>not</u> be used for analogue steering(±10V output).*

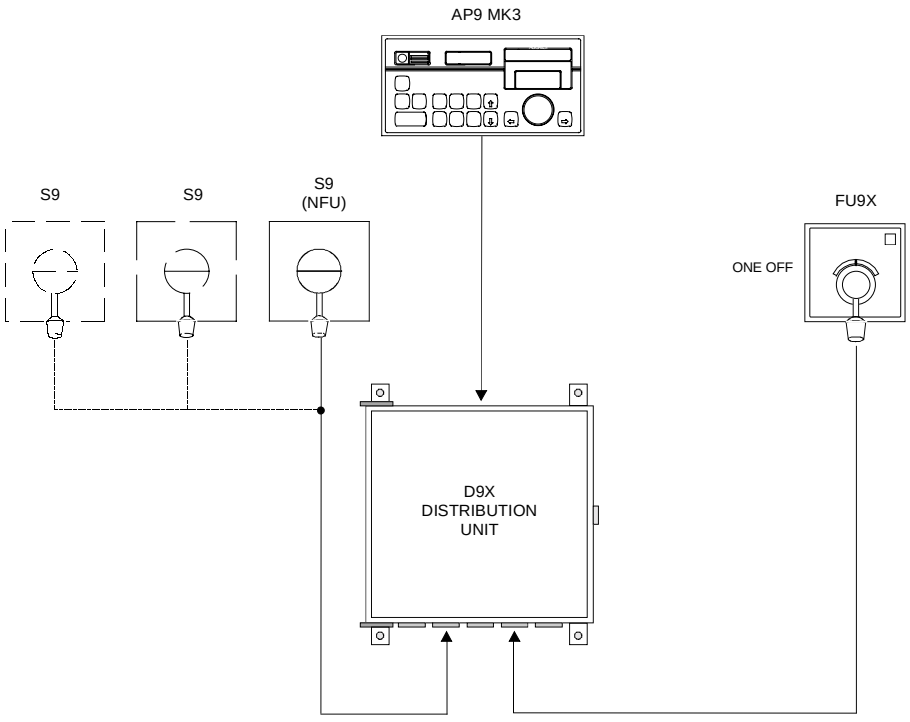


Fig. 1-8
NFU/FU Levers

1.10 Rudder Angle Indicators

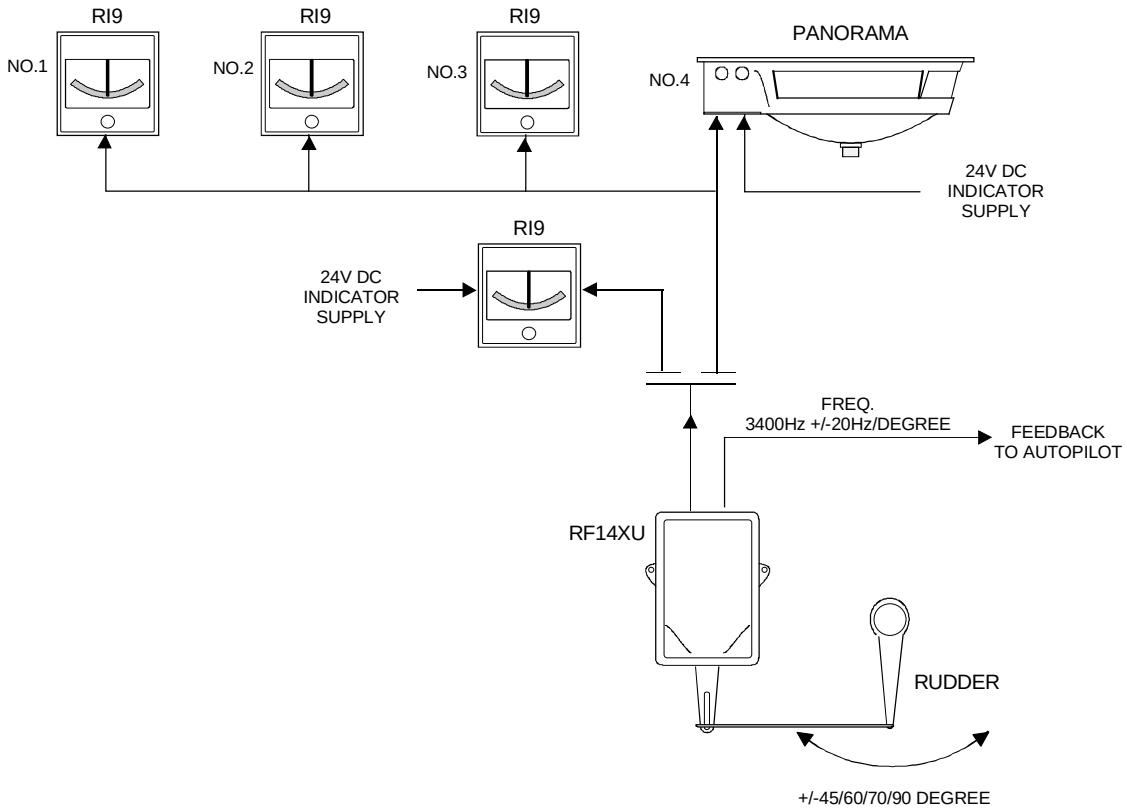


Fig. 1-9
Rudder Angle Indicators

Fig. 1-9 shows a typical Rudder Angle configuration. Number and type of indicators varies from ship to ship.

The indicators must be of the "voltage" type, such as Panorama, RI40 and RI9. Installation instructions are supplied with the indicators.

1.11 Special Applications

Example I:

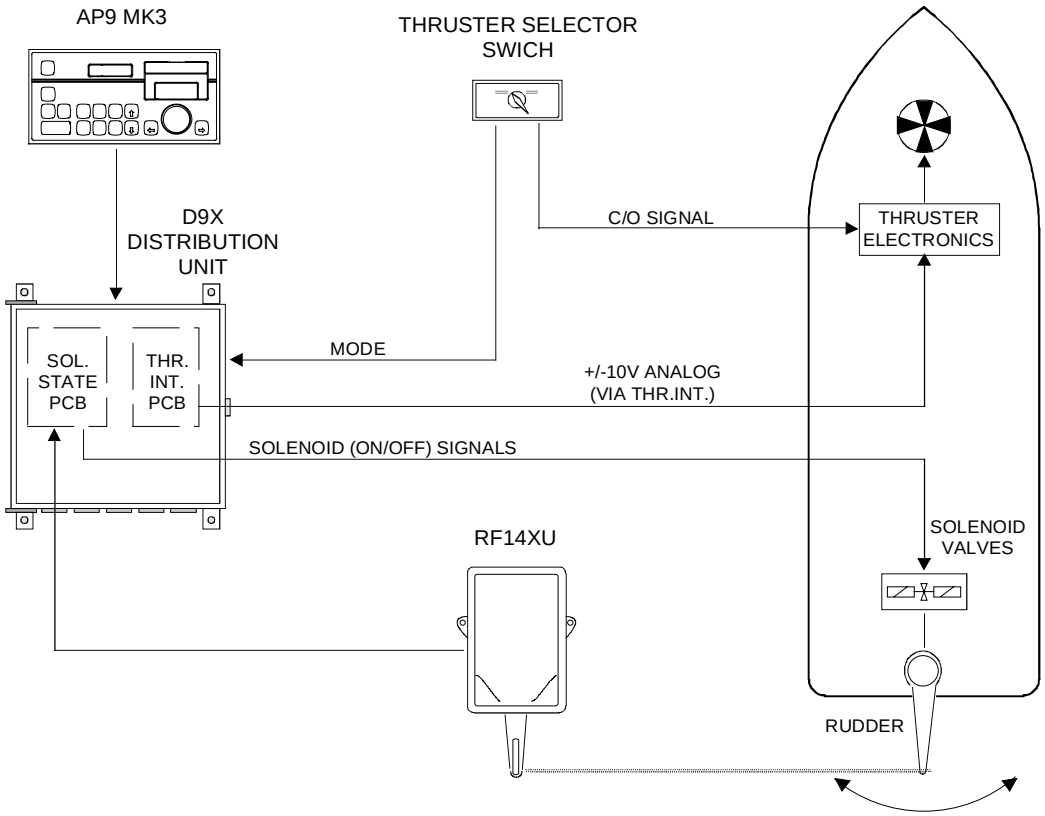


Fig. 1-10
Special applications, Example 1

In this example the autopilot is interfaced both to a conventional rudder system, using ON - OFF solenoid valves, and an azimuthing bow thruster with ±10V as control signal.

The AP9 MK3 can provide different parameters for the thruster and the rudder control respectively, and the combination is determined under the INFO loop 2 (Ref. page 2-9).

The combination shown above requires a Thruster Interface PCB to provide the single ±10V analogue output, and a Thruster Selector Switch to provide the change-over (C/O) signal to the thruster combined with the mode control to the autopilot. The Thruster Interface PCB, part no. 20126017 is mounted in the Distribution Unit, and the solid state PCB must be specified according to the switching voltage. (Ref. Standard System).

Example 2:

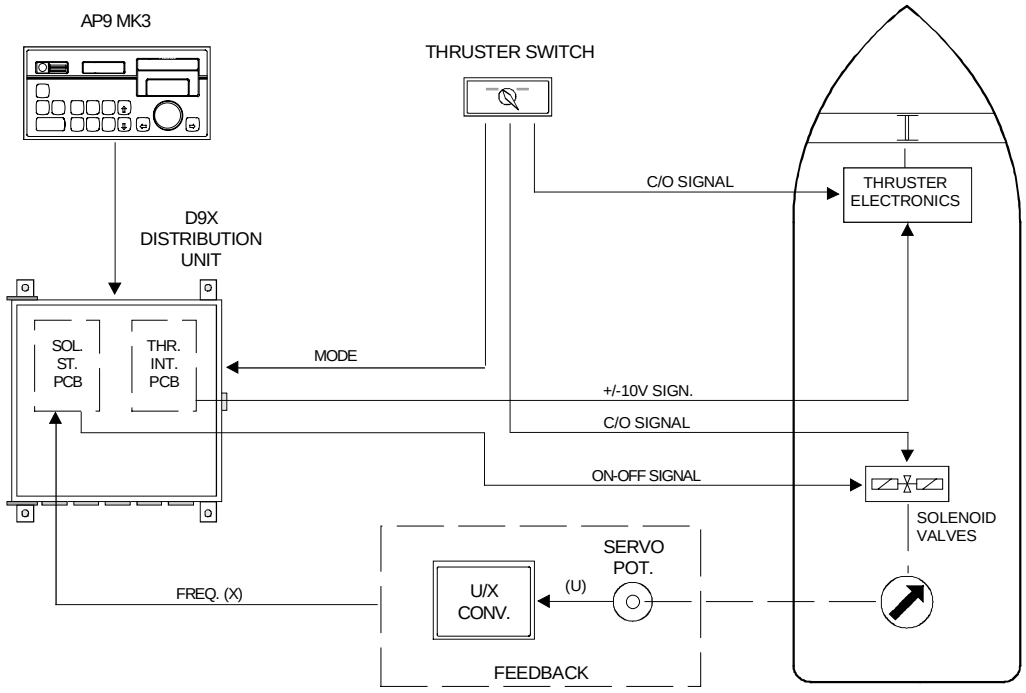


Fig. 1-11
Special applications, Example 2

The AP9 MK3 autopilot is also designed to operate a tunnel bow thruster, with possibility to set deadband and thruster power in the second parameter set.

The control signal is the ±10V analogue, generated via the Thruster Interface PCB.

The shown configuration also includes a main propulsion azimuth thruster, operated by ordinary ON-OFF solenoid valves.

A special feedback arrangement is required to replace the standard RF14XU. It consists of a servo potentiometer and a voltage-to-frequency converter, to facilitate the installation of the mechanical and electrical part of the feedback system. Contact Simrad for further information

Example 3:

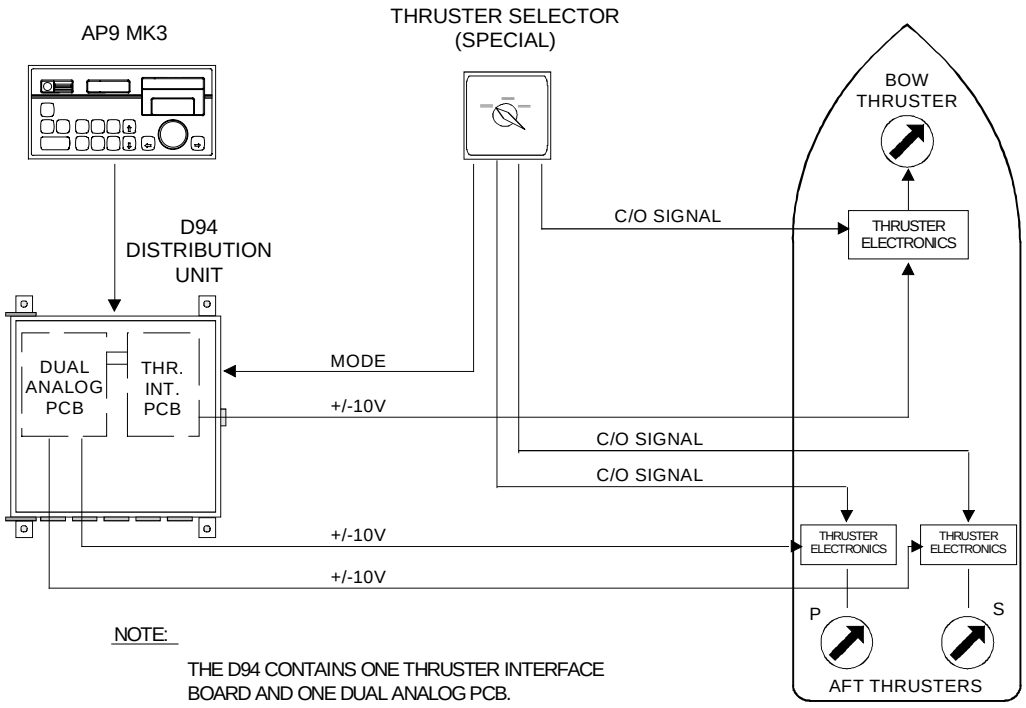


Fig. 1-12
Special application, Example 3

The AP9 MK3 autopilot system can provide three galvanic isolated ±10V outputs and be configured as shown in Fig. 1-12.

In this example the Distribution Unit is equipped with one Thruster Interface board to control the bow thruster, and one Dual Analogue PCB to control the two aft thrusters.

The Thruster Selector Switch is normally custom-made for each individual system, and provides the change-over signals for the thrusters, and the mode for the autopilot.

No Feedback Unit is required!

Thruster Selector Positions:

- MANUAL
- AUTO AFT (Aft Thruster)
- AUTO BOW (Bow Thruster)

FEATURES: First parameter set for synchronized operation of the aft thrusters.

Second parameter set for the operation of the bow thruster.

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2 OPERATION

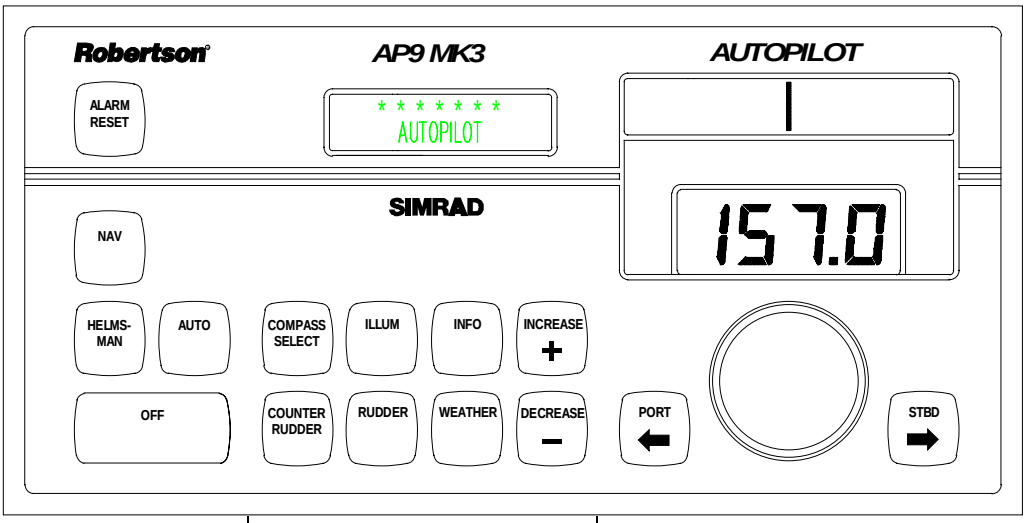


Fig. 2-1
AP9 MK3 Front panel

2.1 General

AP9 MK3 autopilot is operated by means of keypad push buttons on the front panel. The buttons are back lighted, activated buttons being brighter than the others.

Course selection is made by the rotary Course Selector Knob. Course adjustments in steps of one degree can be achieved by the port or starboard push buttons.

The front panel has three LCD displays, referred to as the information display (left side), bargraph display (upper right) and the course display. An alarm buzzer and an alarm reset button is also on the front panel.

A few simple operations like pressing a button and/or turning the Course Selector Knob is required in ordinary use of the autopilot. All other instructions and data required for the operation are stored in the autopilot upon delivery.

2.2 Front Panel

The front panel is divided into three sections: Mode selection, Parameter setting and Course selection (Fig. 2-1).

2.3 Mode selection

Together with the OFF-button and the 3 mode buttons, this section also contains an alarm buzzer and ALARM RESET-button.

HELMSMAN (Power ON)

The HELMSMAN button serves two purposes. It switches on the autopilot and selects manual steering mode. In this mode the course display gives a digital read-out of compass heading, while the vessel can be steered manually by helm or steering lever(s).

AUTOPILOT

The AUTOPILOT-mode is used under normal conditions when the boat is steered automatically on a pre-set course.

When the AUTOPILOT-button is pressed, the autopilot selects the current vessel heading as "course to steer".

Any difference between course to steer and the vessel's actual heading will then be shown as a bargraph in the bargraph display. One bar equals one degree.

The autopilot uses the activated heading sensor unit, selected from the COMPASS SELECT button to calculate the difference between course to steer and actual ships heading. Rudder command signals are then based on steering parameter settings.

Rudder commands are indicated by an arrow to left or right in the bargraph display depending upon which direction the autopilot commands the rudder to move. These arrows do not appear when the autopilot output signal is analogue voltage. The “Debug” rudder angle may show a random number as no rudder feedback is connected.

For the ±10V analogue control signal, a separate rudder control system moves the rudder to match the rudder angle command.

NAV. MODE

NAV.-mode is used when a navigation receiver is connected to the autopilot for automatic "waypoint" steering.

When the NAV-mode is selected, the AP9 MK3 automatically monitors the signals from the navigation system. If the signals are absent or in a wrong data format, an alarm will be given to alert the operator. See page 2-15: Navigational Steering.

OFF

The autopilot is switched off by pressing the OFF-button for 2 seconds, during which time the alarm will sound. The alarm ceases

when the AP9 MK3 is switched off. If the OFF-button is released before two seconds have elapsed, the autopilot will continue to operate as before and the alarm signal is automatically reset.

Rudder commands will stop as long as the OFF-button is pressed. All pre-set parameters in the autopilot are stored while the unit is switched off.

ALARM

The acoustic alarm is reset by pressing the alarm reset button.

Alarm messages shown on the information display are described on page 2-25. Fault Warnings.

Thruster/rudder parameters

When the autopilot is connected to a thruster in addition to the rudder, a separate Thruster Switch will enable a second set of parameters to control the thruster. Whenever the Thruster Mode is selected, all parameters can be individually set for optimal performance from the thruster, while the parameters used for Rudder-steering are saved and resumed when the Thruster Switch is set to "RUDDER".

2.4 Parameter setting

Note ! *When the "RUDDER" and "WEATHER" buttons are pressed simultaneously, IDEAL parameters are recalled, provided the parameters have been stored earlier (during sea-trial). See installation section, page 5-69.*

General

The middle section of the AP9 MK3 control unit contains 8 push buttons and an information display. The display shows selected mode, deviation from set course, parameter settings and other user information. The text in the information display can be shown in one of four selectable languages: English, French, Spanish or Norwegian (see page 5-40).

When RUDDER, COUNTER RUDDER, WEATHER or ILLUM buttons are pressed, the display shows which button has been activated and to what level the value has been set by the number of bars as well as in plain figures. The display returns to normal read-out, showing the selected mode one minute after the last press on one of the buttons.

The ability of the autopilot to steer a vessel is not only dependent upon the control logic used, but also the hull shape of the vessel, the steering gear and the weather conditions. The AP9 MK3 can be set up to steer almost any vessel. During normal day to day operation

RUDDER, COUNTER RUDDER and WEATHER can be easily adjusted from the front panel. In addition the autotrim can also be adjusted, but should be permanently set during initial sea trials. The autotrim parameter is accessed using the INFO button.

Switch ON

The autopilot is switched on by pushing the HELMSMAN button (The switch can be sensed by the finger!)

The autopilot will acknowledge with a short audible "blip" and confirms initialisation by showing:

SOFTWARE: mk3 V1R4
INITIATING

or

SOFTWARE: mk3 V1R4
CHECKING COMPASS

If the serial compass switch is ON the text ‘CHECKING COMPASS’ is displayed while type of serial compass is detected.

If serial compass data is not connected the alarm text ‘SERIAL COMP FAIL’ is displayed and serial compass is removed from sensor setup.

If serial data has wrong polarity or has UART format, then the text ‘Uart OK’ or ‘Chg HiLo’ (Change Hi-Lo) is displayed.

After a few seconds Helmsman will be shown in the information display:

*** * * * * * ***
HELMSMAN

If the autopilot is connected to a gyrocompass where the gyro heading needs to be set, the display will show at switch on:

GYROADJUST
PRESS INC / DEC

Press the INCREASE or DECREASE button until the autopilot display shows the same heading as the gyrocompass.

Then press the HELMSMAN button and the display will show:

*** * * * * * ***
HELMSMAN

Note ! *If another language is preselected, the display may show:*

TIMONEL (Spanish), MANUEL (French) or RORMANN (Norwegian)

To change the language, do the following:

- Press INFO and keep it pressed.
- Press WEATHER
- Release WEATHER
- Release INFO.

The INFO display will show one of the following:

ENGLISH, ESPANOL (Spanish), FRANCAIS (French) or NORSK (Norwegian)

The language can now be selected and stored by pressing either INCREASE or DECREASE. The INFO display will fall back to HELMSMAN approx. 1 minute after the last operation of INCREASE/ DECREASE, or immediately by pressing HELMSMAN.

HELMSMAN

This is the "stand-by" mode for the autopilot. When this mode is selected, the autopilot is passive and manual rudder operation, either by steering wheel or Non Follow Up (NFU) levers, is made.

The Heading Display will show the actual course with resolution of one tenth of a degree, operating as a heading repeater. The Bargraph Display will show one single vertical line, indicating zero heading error.

AUTOPILOT

When clear of obstacles and in open waters, steer the vessel on course and press the AUTOPILOT button.

The display will now show:

and the autopilot will automatically keep the vessel on course.

INCREASE- and DECREASE-buttons

These buttons are used to alter various settings. Each time one button is pressed, the value shown on the information display, will increase or decrease by one unit. The value is also shown as a graphical bar. If the button is kept pressed for more than two seconds, the value will automatically count up or down until the button is released.

ILLUM

The ILLUM button is used to adjust the illumination of buttons and displays. .

- To adjust the illumination, first press the DIMMER button, than the INCREASE or DECREASE button. In the information display a number and a bargraph represent the brightness level.

COMPASS SELECT

The autopilot is capable of reading two heading sensors simultaneously: Main (steering) compass and monitor (comp. difference) compass.

If only one compass is connected, this will always be the main compass. The autopilot shows the main compass heading in HELMSMAN-mode and selects this heading as set course in AUTOPILOT mode. The difference between the set course on the autopilot and the main compass heading is known as the *off course* deviation.

The autopilot monitors the off course deviation and if it exceeds the selected off course limit, an off course alarm will sound. (See page 5-36 for selection of off course limit).

If more than one compass is connected, one is selected as main compass and one as monitor compass. The autopilot now monitors the heading difference between the main compass and the monitor compass. The heading difference alarm is given when the difference exceeds the off course limit and thus the heading difference alarm also acts as an additional off-course alarm.

Press the COMPASS SELECT button once and the information display shows the selected main compass. By then pressing the INCREASE or DECREASE button another compass can be selected as main compass from one of the compasses connected to the autopilot.

Press the COMPASS SELECT button a second time and the information display shows the selected monitor compass. Another monitor compass can be selected (not the one selected as main compass) by using the INCREASE or DECREASE buttons. The monitor compass can also be switched off by the same buttons.

RUDDER

When the RUDDER button is pressed, the Information Display shows selected RUDDER value. The RUDDER value sets the ratio between rudder angle and heading error (p-factor).

Example: If RUDDER is set to 1.0 and there is a heading error of 2 degrees, the rudder angle will be 2 degrees. (Heading error x RUDDER value = rudder angle).

The correct RUDDER setting is dependent upon the size and speed of the vessel. The RUDDER value should increase with decreasing speed.

Examples of incorrect RUDDER settings:

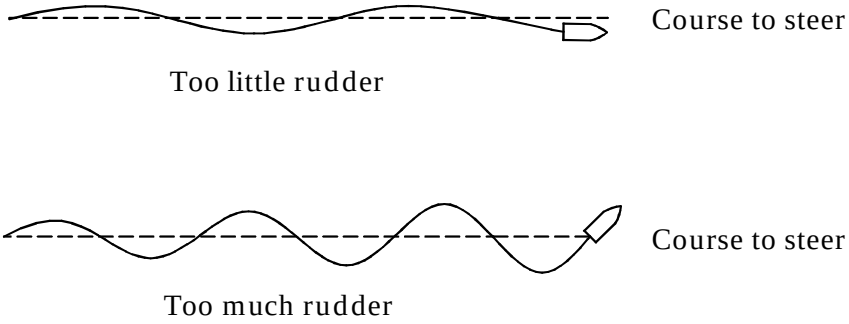


Fig. 2-2
Rudder settings

A value which is too low gives relatively large and slow oscillations (s-ing) around set course, and several rudder commands are given in the same direction before the vessel is back on course.

A value which is too high will give quick and increasing oscillations (s-ing) around set course.

The correct setting of RUDDER will be approximately in the middle of the settings described in Fig. 2-2

Press RUDDER, thereafter INCREASE or DECREASE for required amount of rudder.

Range: 0.1 - 3.3.

Recommended start value: 0.6 - 1.5.

WEATHER

The WEATHER setting determines the number of degrees the vessel may fall off the set course before any response is given to the rudder. In calm weather it should be set to OFF which means that theoretically the autopilot allows no deviation from set course. The WEATHER value should be increased with increasing sea state. This will cause the sensitivity to be decreased such that the vessel has to fall off course with the number of degrees selected by the Weather setting before a rudder command is given. The amount of rudder is calculated by the heading error exceeding the set limit, multiplied with the p-factor. This will prevent big rudder amounts and reduce rudder activity.

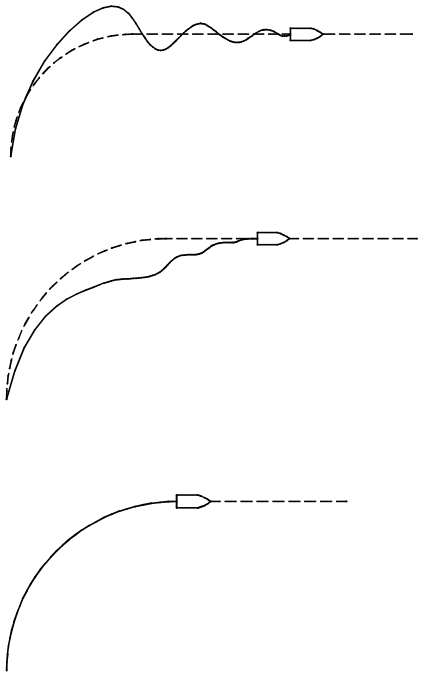
In conditions where active steering is required, (e.g. following sea condition), the value should be reduced.

Press WEATHER, thereafter INCREASE or DECREASE for required sensitivity.

Range: OFF - 8°. (OFF is max. sensitivity).

Recommended start value: OFF - 3°.

COUNTER RUDDER



The COUNTER RUDDER serves two purposes, firstly to give a smooth transition to a new heading after a major course change has been made, and secondly to enable the autopilot to stabilize the vessel on a straight course. The steering characteristic of the autopilot is determined by the RUDDER and the COUNTER RUDDER adjustment.

The effect of the Counter Rudder is partly determined by the selected Turn Rate, hence tuning the Counter Rudder effect also involves the Rudder Control.

A too low value results in an overshoot past the new heading and it takes a long time before the new heading is stabilized.

A value that is too high results in an over correction followed by a small overshoot past the new heading, and the vessel then tends to oscillate around the new heading. A typically symptom here is an over active-rudder.

Range: 0 – 8.0

Recommended start value: 0.6

INFO

The INFO button is used to call up a number of parameters and other information.

The INFO loops can be entered in any autopilot mode. No change will be made unless the INCREASE or DECREASE button is pressed.

The parameters are divided in two loops, one for the often used parameters and one for seldom used parameters. The two loops are entered differently and Loop 2 is mainly for installation set-up.

For detailed description of functions, see page 5-33. Information and Debug loops.

INFO loop 1:

- Rate of turn or Radius steering
- Turn Rate / Radius
- Rudder Limit
- Off course
- Autotrim
  - Nav. Filter *
  - Nav. Gain *
  - Nav. Trim *
- Gyro adjust **
- Comp. diff. ***

INFO loop 2:

- Language
- Deadband
- Minimum Rudder
- Serv. speed
- Speed sens.
- Minimum radius
- Thruster function
  - Only Thruster
  - Only Rudder
  - Rudder + Thruster
  - Thruster deadband
  - Minimum thrust
- FU / A Scale
- Maximum rudder limit
- Navigational Mode
  - Ecdis
  - Priority
  - XTE
  - CTS
- 1 / sec. out
  - 5 / sec out
- Software version / Runtime

* Only when Nav. Steering is selected.

** Only when step gyro or synchro is selected, not 1:1.

*** Only when two compasses are connected.

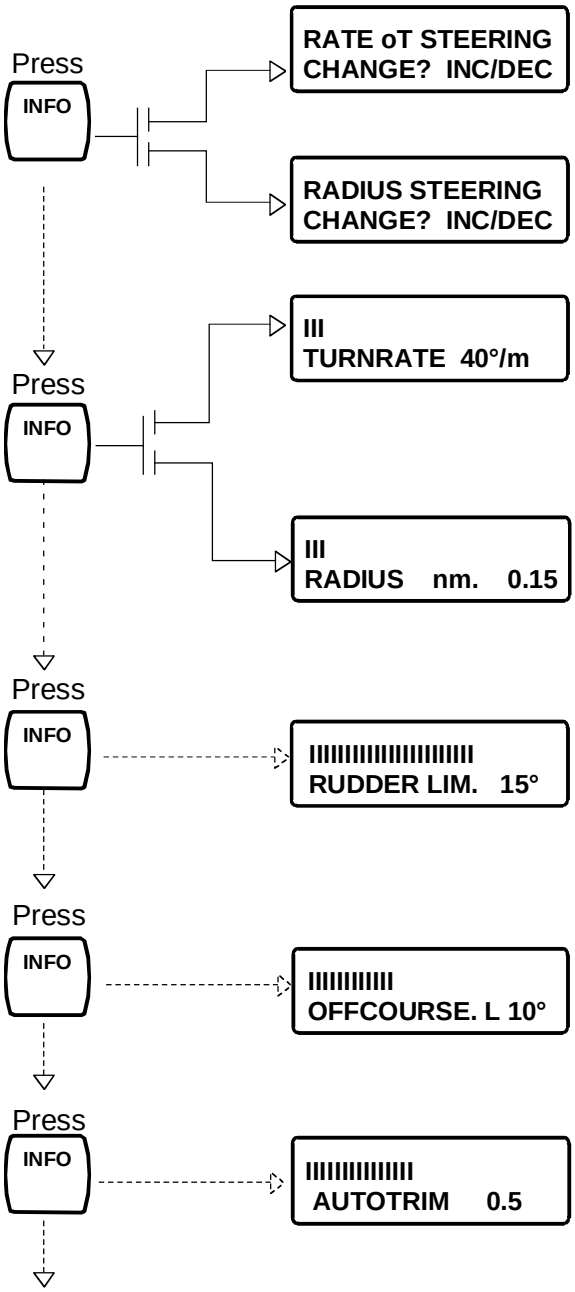
To escape from the INFO loops, press any mode or parameter button.

Note ! *The INFO display will fall back to show the autopilot mode approximately 1 minute after the last entry of any parameter.*

Operation, INFO loop 1

Press the INFO button. For adjustment of each parameter use INCREASE or DECREASE button.

(First display readout depends on what has been selected by "Rate of turn (RATEoT) steering /Radius steering", see next parameter.)



Press INC or DEC to alter between ROT and Radius steering.

Range: 1°/min - 360°/min.

Note: The range is limited by "min radius" value in INFO LOOP 2.

Recommended: 40°/min

Range: 0,01 nm - 10 nm

Note: The range is limited by "min radius" value in INFO LOOP 2.

Recommended: 0,1 nm

This rudder limitation setting is only active during autosteering on straight courses, NOT course changes.

Range: 1° - 85°

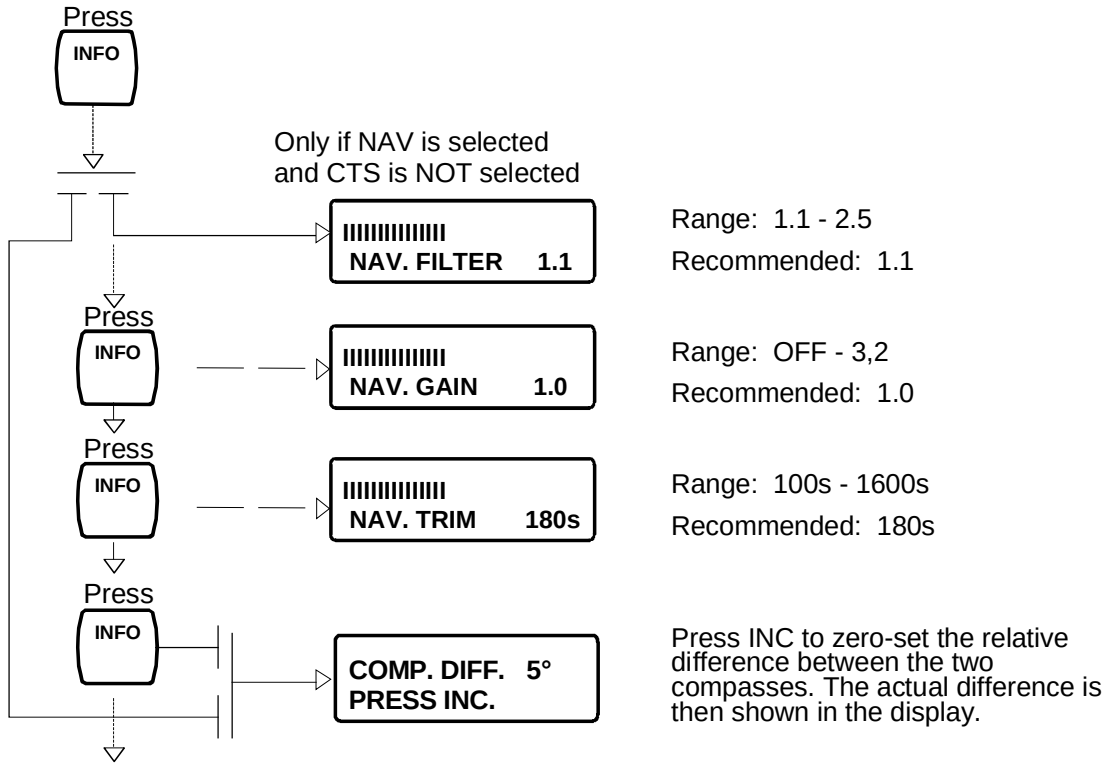
Recommended: 15°

Range: 3° - 35°

Recommended: 10°

Range: OFF - 3,2

Recommended: 0,5



INFO loop 2

(For detailed description, see Sea Trial, page 5-62)

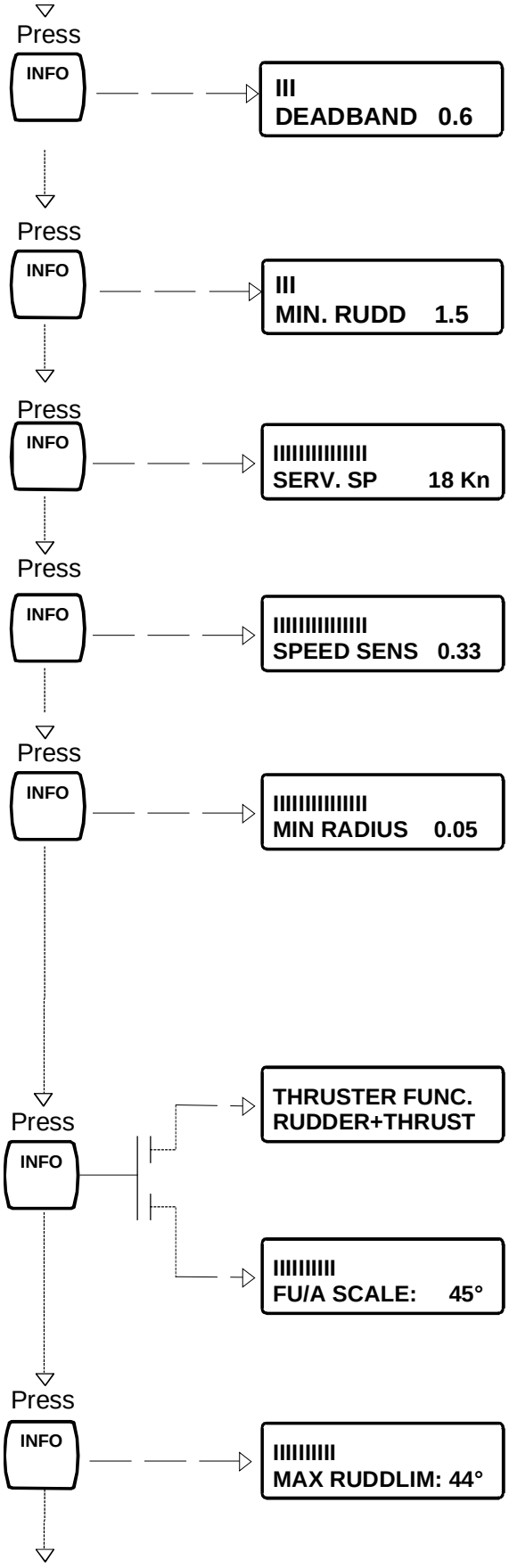
To enter this loop, do as follows:

- Press the INFO button and keep it pressed
- Press and release WEATHER button
- Release the INFO button

The display will now show:

This is the language parameter. Use INCREASE / DECREASE to select the required language. The different options are:

ENGLISH – FRANCAIS – ESPANOL – NORSK



Determines the deadband for the feedback loop (rudder hunting) and also the heading sensitivity of the autopilot.

Range: 0,2° - 3,4°

Recommended: 0,6°

Determines the minimum amount of rudder as first command.

Range: OFF - 10°

Recommended: OFF - 2°

Sets the autopilot speed reference to the ship's service speed.

Range: 3 kn - 70 kn

Recommended setting: Ship's cruising speed.

This setting scales the amount of rudder for speed change (lower speed, more rudder!)

Range: OFF - 1.92

Recommended: 0.36

This parameter limits the maximum allowed turnrate setting or the minimum allowed turn radius that can be set by the Rate of Turn or Radius steering, selected in *Info loop 1.* The setting also depends on the service speed of the vessel. The lower speed, the higher turn rate can be set.

Range: 0.01 - 1.10 nm.

Recommended: Ship dependent

The thruster parameters only appear if J4, 11-13 "Thruster Ident" on the control unit are connected (via a switch). See separate description.

Determines the scaling of the follow up function.

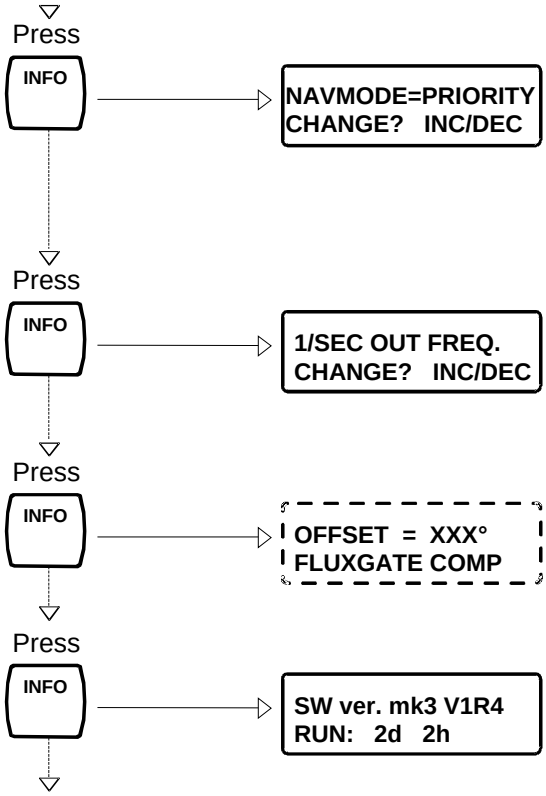
Range: 45° - 60° - 70° - 90°

Recommended: Set to relevant rudder scale.

Sets the absolute maximum rudder deflection.

Range: 26° - 90°

Recommended: Appr. 5° less than max rudder travel.



The next press repeates the loop, starting with language.

Selects the Nav. mode function

Range: Priority-XTE-CTS-ECDIS

Recommended: Priority (unless ECDIS is used)

Determines the NMEA output rate.

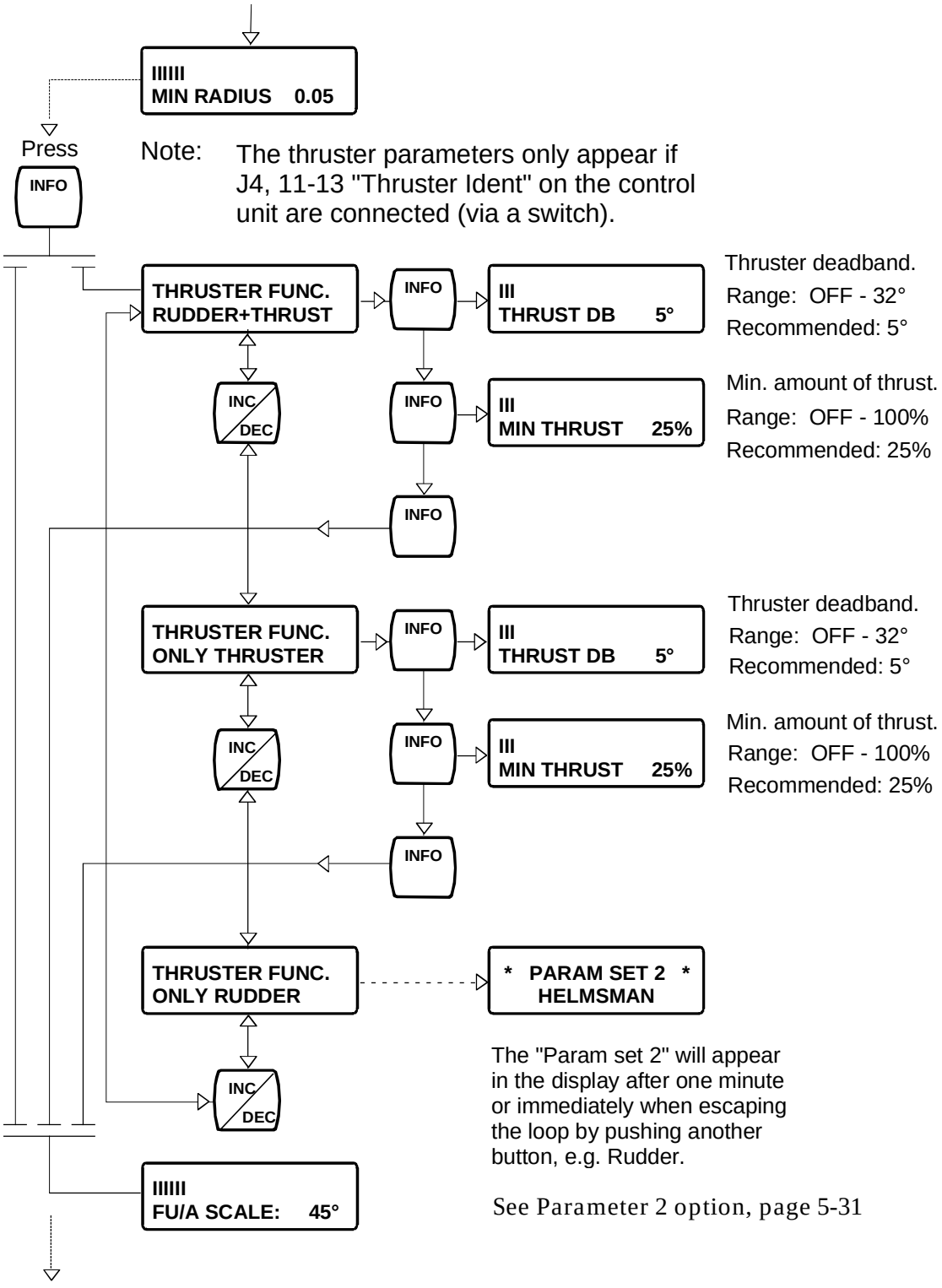
Range: 1/sec - 5/sec

Recommended: Refer to equipment to be interfaced.

Only shown if signal is present on sin/cos input or at serial HDM input.
Used when fluxgate compass is selected as steering compass.

Displays software version and runtime in days and hours when in automatic mode.

Thruster Function



See Parameter 2 option, page 5-31

2.5 Course selection

The course selector section on the autopilot consists of a bargraph display, a digital heading display, a course selector and two course adjustment buttons, PORT and STBD.

The bargraph display operates in two modes, AUTOPILOT and NAVIGATION-mode, displaying in degrees the difference between actual vessel heading and course to steer. On the display each "bar" is equal to one degree, and the range is 20 degrees to port and starboard. An arrow on each side indicates starboard and port rudder commands.

Note ! *No arrows for analogue signal output.*

In HELMSMAN mode the digital heading display gives a read-out of actual ships heading, while in AUTOPILOT and NAVIGATION modes the read-out is course to steer.

The Course Selector is used for major course changes in AUTOPILOT mode. To activate the knob it must be pressed down and released. If the knob is not turned within 10 seconds, it has to be pressed again. Clockwise turns gives a starboard course change and vice versa. One revolution on the course selector knob is equal to a 60 degree course change.

The PORT and STBD push buttons are for minor course adjustments, pressed once gives a one degree course change in the appropriate direction.

These two buttons and the course selector are only active in AUTOPILOT mode.

Note ! *When making course changes by the push buttons the TURNRATE function is not activated.*

2.6 Navigational steering

General

Navigational steering should be used in open waters only.

Navigational steering is based upon signals taken from Loran C and GPS Nav. receivers. The signals are called Cross Track Error (XTE) and Bearing waypoint-waypoint (BWW), termed course to steer (CTS).

When cross track steering is used, the information display gives a read-out of actual cross track error in thousandths of a nautical mile (.001). The XTE signal changes the set course to keep the vessel on track.

AP9 MK3 can operate in a (CTS) mode where the bearing to the waypoint is defined to be the course to steer by the autopilot. The information display gives bearing to waypoint, elapsed time since

last update and the amount of course change. If a change of more than 10 degrees is commanded, the alarm will sound and the ALARM RESET button has to be pressed to acknowledge the course change. The plain CTS mode is rarely used today after the GPS has replaced the Transit system.

For receivers with NMEA 0183 format that outputs both the cross track error (XTE) and bearing waypoint-waypoint (BWW), e.g. an APB sentence, the autopilot can operate in the priority mode (also called mixed mode) utilizing both signals.

Note ! *The Course Change knob and buttons are disabled when operating the autopilot in NAV. mode.*

Steering by XTE to waypoint

When the autopilot is using XTE, the set course is automatically adjusted in order to keep the vessel on a straight track between two waypoints. Satisfactory steering depends upon good reception conditions and correct adjustment of the autopilot.

During poor reception conditions, the receiver transmits an alarm warning which activates the alarm circuit in the autopilot. The set course reference is not updated until the reception conditions improve. See Fault Warnings on page 2-25.

Make the following check before using navigational steering:

1. Set the Nav. receiver to calculate the bearing from present position to a waypoint.
2. Steer the vessel by hand on the calculated bearing and select AUTOPILOT-mode.
3. Let the autopilot steer the vessel for a period of about 2 minutes to settle on the new course.
4. Make a starboard course change of 5°, by pushing 5 times on STBD button and check that a course track error is built up on the navigation receiver showing that the vessel is located to the right of the bearing line.
5. Repeat step 4 with a 10° course change to port and check that the vessel moves to the opposite side of the bearing line.

When the autopilot is performing satisfactorily in AUTO-mode, use the following procedure:

1. Enter the desired bearing line(s) to the Nav. receiver using the present position and the first waypoint or destination. Distance between waypoints should be of minimum 1 n.m. Otherwise there may not be sufficient time for the system to calculate the XTE, and for the autopilot to alter the course and bring the vessel onto the bearing line again.

2. Read the calculated bearing to waypoint from the Nav. receiver.
3. Set the course to the waypoint showed on the navigation receiver. Before going to step 4, ensure that the XTE is within 0.1 n.m. to avoid a hazardous course change when selecting NAV-mode.
4. Select NAV-mode on the AP9 MK3. The autopilot now automatically changes the set course to reduce the Cross Track Error (XTE) to zero. The information display shows the number of degrees the autopilot has changed the set course, and the XTE in 1/1000's of a nautical mile. Note that the display read-out will be delayed, depending upon the NAV. FILTER setting.

Note ! *The accuracy of the autopilot depends on the accuracy of the GPS and it's output.*

Example:

NAVIGATING
05°XTE = R0.021N

R indicates that the vessel is located to the right of the bearing line, and L indicates to the left of the bearing line. 05 is the number of degrees course change relative to initial set course. As the vessel approaches the bearing line, the correction value decreases and when the vessel is on track, the information display shows:

NAVIGATING
00° ON TRACK

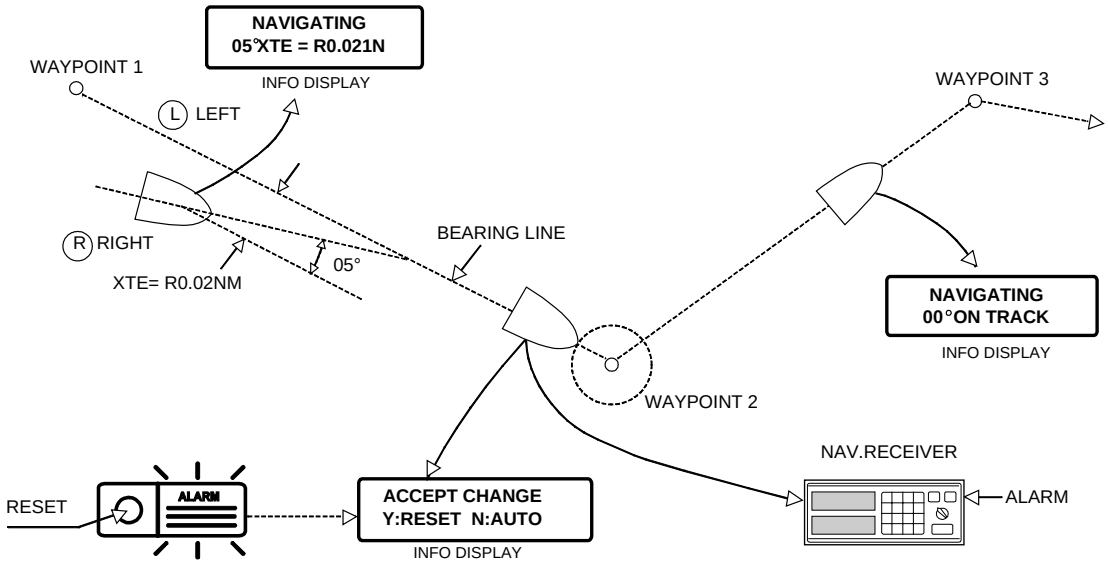
5. As the vessel gets within the arrival circle set on the navigational receiver, or as the vessel passes the perpendicular line to the waypoint, the receiver transmits a "data not valid" signal to the autopilot. An audible alarm will then activate and the course to steer will no longer be updated.

To proceed to the next waypoint, the procedure should be repeated from step 2 onwards.

Procedure:

- Reset the alarm on the autopilot and navigational receiver.
- Select "AUTOPILOT" mode on the autopilot.
- Use Course Change knob/buttons on the autopilot and to set the new course given by the Nav. receiver.
- Press "NAV"

Priority mode (APB sentence)



Note ! *The waypoint arrival warning will depend on the arrival zone setting on the navigational receiver.*

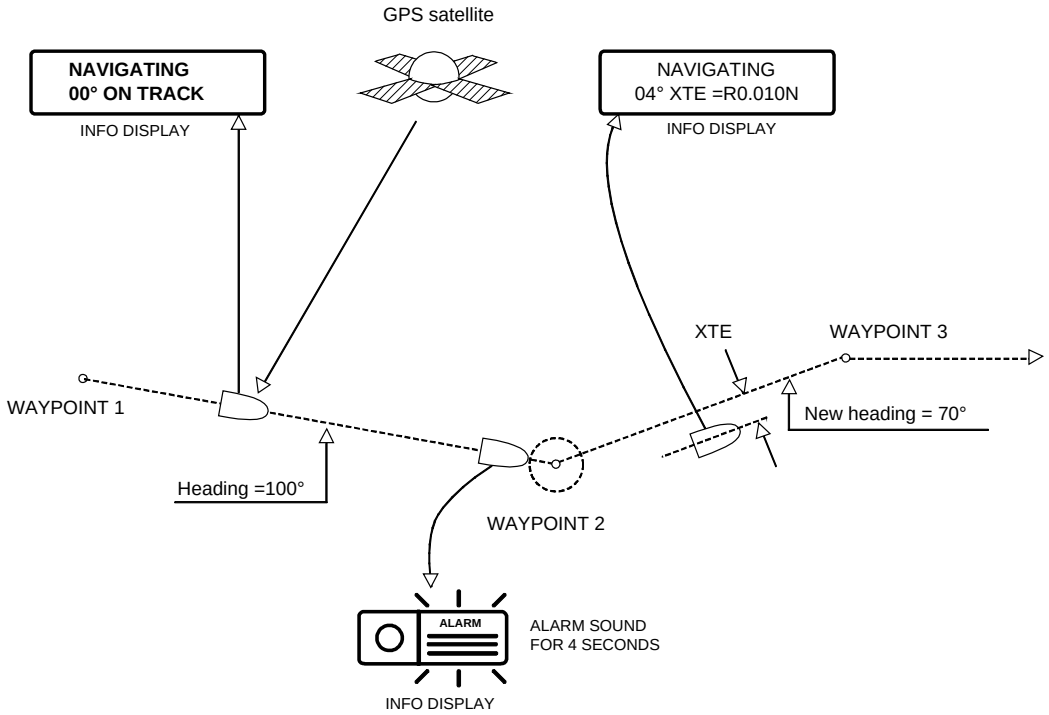
The AP9 MK3 uses bearing waypoint – waypoint as the initial heading reference. The XTE is used to update this heading reference in order to minimise the XTE.

When arrival circle for the next waypoint is reached, the ACCEPT CHANGE alarm will start.

If the turn is accepted by ALARM RESET, then the vessel is turned towards the bearing for the next waypoint. The internally values on RADIUS/RATE OF TURN is used for turning. When the vessel is within 35° of the bearing waypoint- waypoint, the internally nav. mode will change from CTS to XTE and the XTE is used to control the vessel along next leg.

If the turn is not accepted by ALARM RESET, the alarm is continuously on and the vessel proceeds on present course.

Ecdis mode (APB sentence)



The AP9 Mk3 uses the bearing waypoint – waypoint as the initial heading reference. The XTE is used to update this heading reference in order to minimise the XTE.

When arrival circle for the next waypoint is reached, the alarm (sound only) will go on for 4 seconds and the turn will start immediately. This mode is best to use if ECDIS/ECS/PLOTTER is connected between GPS and AP9 Mk3, where the APB sentence has bearing waypoint – waypoint and XTE calculated as tangents to radius arc. and distance to radius.

Note ! *When using GPS only, and ECDIS mode is selected, the autopilot will automatically turn to upcoming waypoints.*

Remote Control

The different types of Remote Controls that can be connected to AP9 MK3, have different ways of operation, depending on the system configuration. When operating a dual station system, there is a slight difference in the operation of the remote controls if the system includes an external mode selector.

AP9 MK3 Dual Station

Transfer of command from one unit to the other unit is made by pressing the HELMSMAN button on the respective control unit. Change of steering mode is made either on the control unit mode buttons or by a separate mode selector.

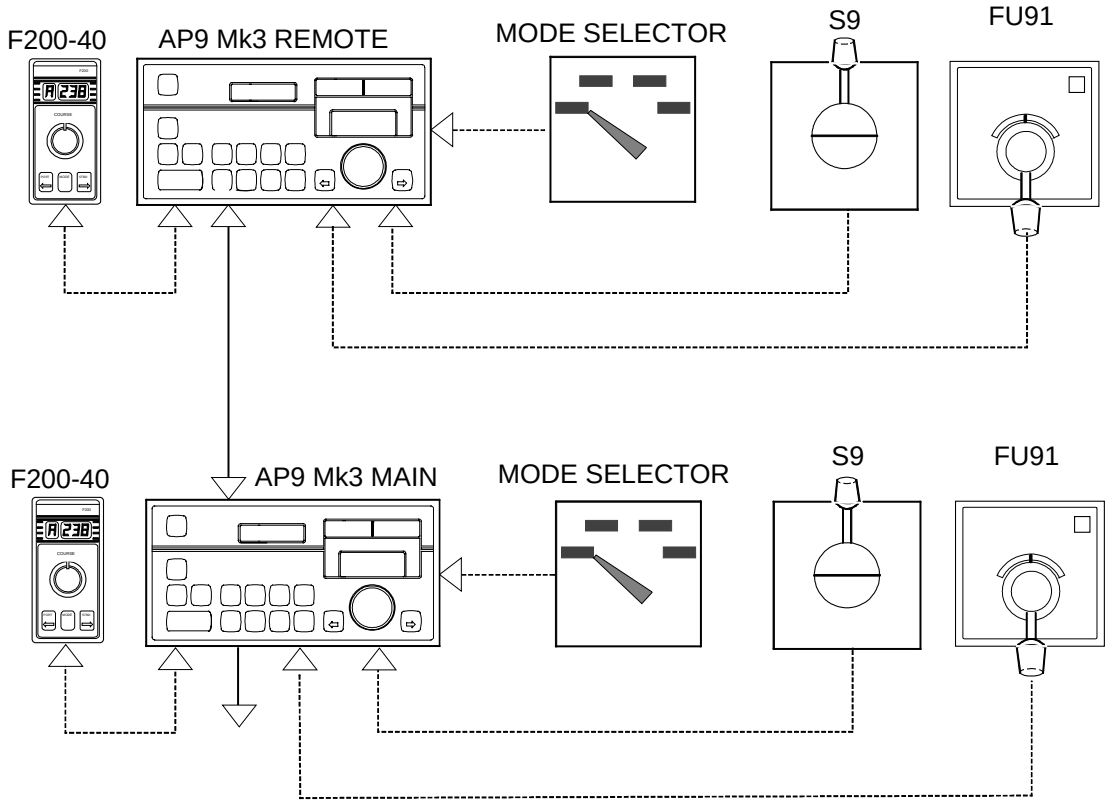
Mode control function may also be included in an NFU lever (S9 connected for mode control, see mode selection).

All parameters can be readjusted from both units.

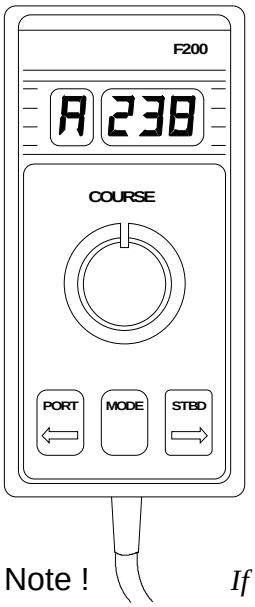
Note ! *Compass selection and selection of NAV-mode (XTE-CTS-PRIORITY-ECDIS) can only be made from the main station.*

Additional equipment can be connected as for the Main unit.

The following description of operation for the optional equipment also applies for the dual station configuration, when installed.



F200-40 Remote Control



The F200-40 hand held remote control makes it possible to remotely control the AP9 MK3 autopilot.

The following control functions are obtainable:

- Display that shows operational mode and vessel heading or set course like the course display on the control unit.
- Course selection by a rotary knob
- Course adjustments by push buttons
- Mode selection
- Manual steering by course selector knob (Follow-Up)
- Manual steering by push buttons (Non-Follow-Up)

In a dual station system, using one main and one remote control unit, it is possible to connect one F200-40 to each control unit and obtain individual control from each unit.

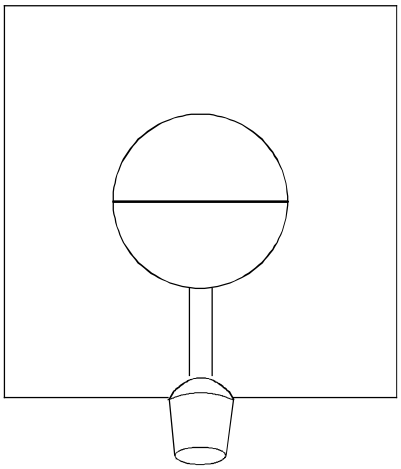
Note ! *If a separate external mode selector is used, this must include an off position to enable mode changes from the F200-40 Remote Control. Refer to page 5-23.*

F200-40 Functions

The table starts with the autopilot switched to HELMSMAN mode with 080° as heading.

F200-40 Mode button	AP9MKII Display	Function	F200-40 Display
	NON FOLLOW UP HELMSMAN	NFU steering by F200-40 PORT/ STBD push buttons.	H 080 Vessel heading
Press F200-40 Mode button one time		Follow-Up steering by F200-40 Course Selector button	F 100 Midship rudder
	F200 FOLLOW UP HELMSMAN		F 104 4°port rudder
			F 132 32° stbd rudder
Press F200-40 Mode button a second time		Autosteering. Course changes can be made either by the F200-40 Course Selector, PORT and STBD buttons or, by the autopilot Course Selector.	A 146 Automode 146° Course to steer
	* * * * * * * AUTOPILOT		
Press F200-40 Mode button a third time			

S9 Steering Lever (NFU)



NFU (Non Follow Up) steering means the rudder will move for as long as the lever (tiller) is activated out from its spring-loaded centre position.

In addition to the ordinary PORT and STARBOARD movement, the S9 also has an IN-OUT movement. When the S9 lever is pushed to the IN position, it is physically locked and can not be moved to PORT or STARBOARD.

Activation is achieved by pulling out the lever. The lever is spring-loaded to the mid-position, and rudder commands are made by moving the lever to PORT or STARBOARD. Rudder movement will stop when the lever is released and returns to the mid-position.

The S9 is disabled when pushed IN.

Several units may be connected in parallel.

Connecting details are shown on page 5-24.

ALTERNATIVE 1

AUTO / FU - NFU

When pulling out the lever, the autopilot mode will be set to NFU.

PORT and STARBOARD commands can be made, but when the S9 lever is pushed back to locked position, the NFU mode is maintained and you have to select AUTO on the control unit.

ALTERNATIVE 2

AUTO - NFU - AUTO

This alternative will change the mode from AUTO or NAV to NFU shown in the INFO display as:

NON FOLLOW UP
HELMSMAN

when S9 lever is pulled out. When the S9 is pushed in again, the mode will change to AUTO, shown in the INFO display as AUTOPILOT (NAV must be entered on the control unit).

* * * * * * *
AUTOPILOT

ALTERNATIVE 3

When autopilot is in AUTO, course change can be made by the S9 by repeated operations of the lever to one side or the other side. Every operation will provide one degree course change, to PORT or STARBOARD dependent of direction of operation.

When the autopilot mode is set to HELMSMAN, the NFU lever will provide ordinary NFU operation.

Note ! *All mode changes must be made on the control unit. As the S9 mode change function is not activated on this alternative, any NFU lever can be used to obtain this function.*

Special arrangements can be configured by using mode selector and change-over switch, see “mode selection”.

FOLLOW-UP Steering Levers

A follow-up lever features a dial (scale), graduated in degrees. This enables the operator to predetermine the required rudder movement simply by moving the follow-up lever to the required rudder angle. The rudder will move to and stop at the set angle.

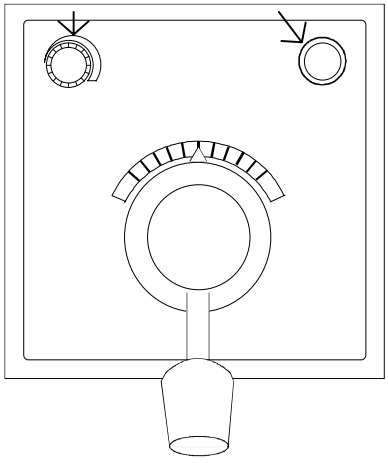
Auto mode is then selected at the AP9 MK3 Control Unit after switching off the FU switch.

OPERATION

The FU91 FU lever is activated by pressing the push to take command (PTTC) button. When in "COMMAND", the button is lit and the autopilot INFO display will show:

FOLLOW UP HELMSMAN

Rudder commands are made by setting the lever to the required rudder angle, whereafter the rudder will move to the commanded rudder angle and stop. The FU91 lever is turned off by pressing the PTTC button one more time. The light goes out and the autopilot mode is then selected at the control unit.

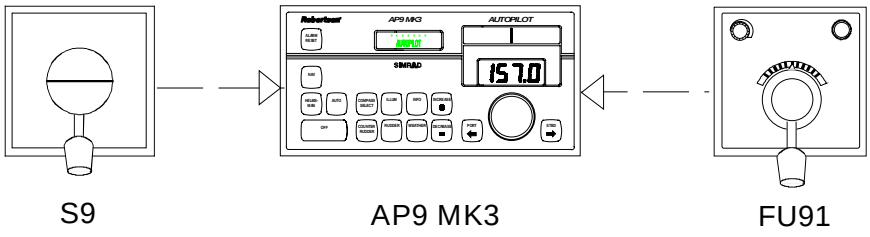


FU91 Lever

Note ! *To obtain the proper mode selection from the FU lever, AN EXTERNAL AUTOPILOT MODE SELECTOR MUST INCLUDE MODE “OFF” FUNCTION.*

COMBINATION OF S9/FU91 LEVERS

A combined system of S9 (NFU) and FU91 (FU) may be configured as illustrated (simplified):



OPERATION

The autopilot is used as previously described. Mode changes are made as normal. As an example the AP9 MK3 is in the AUTOPILOT mode.

TRANSFER TO NFU:

- Pull out the required S9 lever for activation and NFU commands can be made.

Note ! *When the manoeuvring is finished, push the S9 lever back to locked position (IN).*

TRANSFER TO FU:

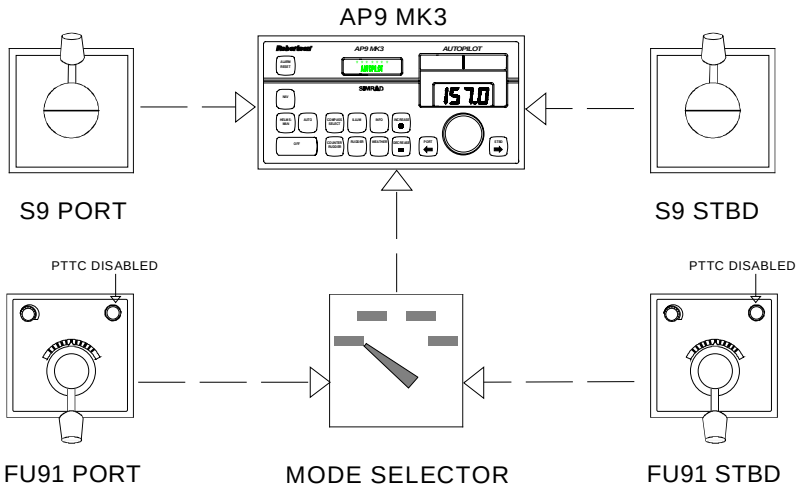
- Push the PTTC button on the required FU91 to activate the lever.

RESUME AUTOPILOT MODE

When finishing the operation by either the FU91 or the S9 (remember to push back to locked position), automatic steering is resumed by pushing "AUTOPILOT" on the control unit.

If external mode switch is used in combination with the selection of NFU and FU levers, simply select the function marked on the switch.

Example:



2.7 Fault Warnings

A fault warning is given by an interrupted sound from the alarm buzzer. The INFO DISPLAY will show what type of alarm is present.

The audible alarm is cancelled by pressing the Alarm Reset button.

HEADING SENSOR WARNINGS

The AP9 MK3 autopilot normally operates with two heading sensors connected.

One, normally a gyrocompass, is selected as the MAIN COMPASS, while a magnetic compass normally is selected as the MONITOR compass. It is possible to select individually what compass shall be the MAIN COMPASS and what compass shall be the MONITOR compass.

Note ! *Selection of compass can only be made in HELMSMAN Mode.*

The types of heading sensors may be separated in two groups:

Group 1 (Gyro Interface Board not required):

- Serial line signals (NMEA, UART, TOKIMEC)
- RGC Gyro (Fluxgate or serial line signal)
- Magnetic Compass (CD109 sensor)
- Fluxgate Compass (Sin / cos signal)

The AP9 MK3 will automatically detect if any of these types of sensors are connected and selected either as main compass or monitor compass. If only one compass is connected, it will automatically be selected as the main compass. Monitor compass selection is disabled.

A signal failure will cause a compass alarm.

Group 2 (Gyro Interface Board required):

- SYNCHRO Signals (1:1 , 360:1 , 90:1)
- STEP Signals (6 step / degree)

The AP9 MK3 will detect if synchro or step signals are connected. A signal failure will cause a compass alarm.

Note ! *No failure detect for synchro 90:1 or 360:1. A signal failure will, however, be detected as an off-course or compass difference alarm.*

The following alarms and fault codes may occur:

SERIAL COMP FAIL
CHECK COMPASS

An alarm condition is cancelled by pressing the ALARM RESET button. If the autopilot is in the AUTOMATIC mode, also press

HELMSMAN. This will automatically select the monitor compass as the MAIN compass.

MAGN. COMP 1 FAIL
PRESS ALARM

Cancel alarm / select compass as described above.

MAGN. COMP 2 FAIL
PRESS ALARM

Cancel alarm / select compass as described for MAGN. COMP 1 FAIL.

FLUXGATE FAIL
PRESS ALARM

Cancel alarm / select compass as described for MAGN. COMP 1 FAIL

SYNCHRO COMP FAIL
CHECK COMPASS

This alarm will only sound when the autopilot is in the Automatic mode and synchro 1:1 has been selected.

Cancel the alarm as described before.

STEP COMP FAIL
CHECK COMPASS

This failure occurs in Automatic mode if loss of any phase (S1, S2, S3) are detected. When a compass fail alarm is reset, the compass is removed from the internal sensor table. To get the compass into the sensor table it is necessary to switch AP9 Mk3 OFF and ON.

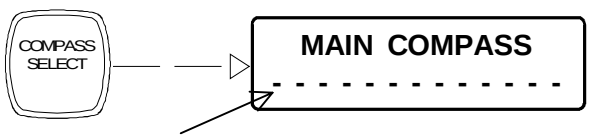
Cancel the alarm by pressing Alarm Reset button.

COMPASS SELECT
ONLY IN HELMSMAN

This warning will occur in the INFO display if COMPASS SELECT button is pressed when the pilot operates in the AUTOPILOT mode.

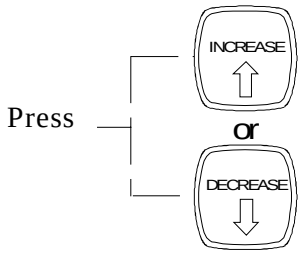
Select HELMSMAN mode and then press the COMPASS SELECT button

1st press



This line may show one of the following:

- SERIAL COMP.
- SYNCHRO 1:1 GYRO
- SYNC 90:1 GYRO
- SYNC 360:1 GYRO
- STEPPER GYRO
- MAGN COMP 1
- MAGN COMP 2
- FLUXG COMP



The type of compass that will appear in the INFO display depends on the internal dip switch settings in the Control Unit.

For details, refer to the Installation section, page 5-58.

To select another compass as MAIN Compass, press INCREASE or DECREASE.

2nd press

One of the same type of compasses listed as MAIN Compass may be displayed.

To select another MONITOR COMPASS, press INCREASE or DECREASE.

If a single compass is connected, no selection of compass can be made.

COMPASS SELECT FAIL

No heading sensors are functioning (or connected).

Press ALARM RESET to cancel the audible alarm. The INFO display will now show:

COMPASS FAIL
USE HELMSMAN/NFU

Only the NFU and FU steering levers can be used as Autopilot mode is disabled.

For remote station only:

COMPASS SELECT
ONLY ON MAIN CONT.

This warning applies only for the remote station in a DUAL STATION system.

Compass selection can ONLY be made at the Main control unit, when in HELMSMAN mode.

Note ! *After repair/reconnection of sensors, the autopilot must be switched OFF - ON for master reset.*

OTHER FAULT WARNINGS

The following warnings are given by the audible alarm, together with information in the INFO display:

OUT OF COURSE
RESET ALARM

This alarm will occur when course deviation is greater than the selected OFF COURSE LIMIT.

Cancel the alarm by pressing the ALARM RESET button.

If required, the OFF COURSE LIMIT can be readjusted.(Press INFO once, press INCREASE to adjust value).

COMP DIFF
RESET ALARM

Note ! *This alarm appears only if two compasses are connected.*

This alarm will appear if the difference between the MAIN compass and the MONITOR compass reading is more than the set value of the OFF COURSE LIMIT.

Normally the MAIN COMPASS is a gyro (True Heading) while the monitor compass is magnetic (Magnetic Heading). Deviation and Variation may cause the difference to exceed the pre-set OFF COURSE LIMIT.

Press the ALARM RESET to cancel the alarm. This will at the same time compensate for the present difference between the two compasses.

COMMUNICATION
FAILURE

Serial lines make all internal communication between the two stations in a DUAL STATION system. A failure in the communication is given by this warning.

RUDDER FEEDBACK
FAIL

This alarm shows that the autopilot does not read the Rudder Feedback Unit.

The AP9 MK3 has, however, a built-in simulated feedback signal that will substitute the feedback signal.

RUDD LIM STOP
AUTOPILOT

If the autopilot is restricted by a low rudder limit, this text will be displayed.

Press ALARM RESET

This will switch on the simulated feedback signal shown in the INFO display as a continuous flashing text:

*** * * SIM * * ***

SERVICE IS REQUIRED BY AN AUTHORIZED DEALER

Note ! *In case rudder angle indicators are connected to the rudder feedback unit, they may also be out of order.*

NO RUDDER
RESPONSE

This alarm will appear if the rudder does not respond to a given rudder command.

Check that the steering gear is switched on and that any system change-over switches are set for autopilot steering.

The reason may also be related to a failure in the steering gear system or the autopilot drive signal switches (solid state PCB in the D9X unit).

NAVDATA NOT REC
FAILURE

No Navigational Steering can be made if this fault warning should appear.

Check that the nav. receiver is switched on and properly set to provide the NMEA signals:

Cross Track Steering (XTE): APA, APB.

Course to Steer (CTS): BOD, BWC, BWW, BWR.

Also check the autopilot nav. settings in INFO-loop 2.

NAVDATA INVALID
FAILURE

This fault warning indicates that the reception conditions are poor.

Note ! *The same warning can also be given during Nav. mode operation of the autopilot when a waypoint is reached. The given heading from the nav. receiver is then to be set on the autopilot in AUTO mode before switching back to Nav. steering (XTE).*

WRONG DATAFORMAT
CHECK NAVSETTING

This fault alarm indicates wrong data format.

WATCH ALARM
PRESS RESET

This warning will occur every four minute when a Watch Alarm unit is connected (Not supplied by Simrad Robertson any longer).

If the watch alarm should occur when a Watch Alarm Unit is **not** connected, use the following procedure to cancel the alarm:

- Enter INFO loop 2 (Press INFO and keep pressed, press WEATHER, release WEATHER, release INFO)
- Step through the INFO loop 2 by pressing INFO until SOFTWARE / RUNTIME is reached.
- Press DECREASE appr. 15 times and verify that days / hours changes to 0 (zero).
- This will then have cancelled the Watch Alarm

For further information refer to paragraph 6.1 Fault warnings.

3 DESIGN AND THEORY OF OPERATION

3.1 General system description

An autopilot is an apparatus that controls the rudder of a vessel in order to maintain a selected heading. There are different design principles for such an apparatus, but they all basically operate as shown in Fig. 3-1. This diagram shows that the vessel's heading is supplied from the compass to a detector circuit. The detector will sense when the vessel is off course and to what side. The detected signal is amplified and directed to energize either the port or starboard solenoids, i.e. make the rudder move one way or the other.

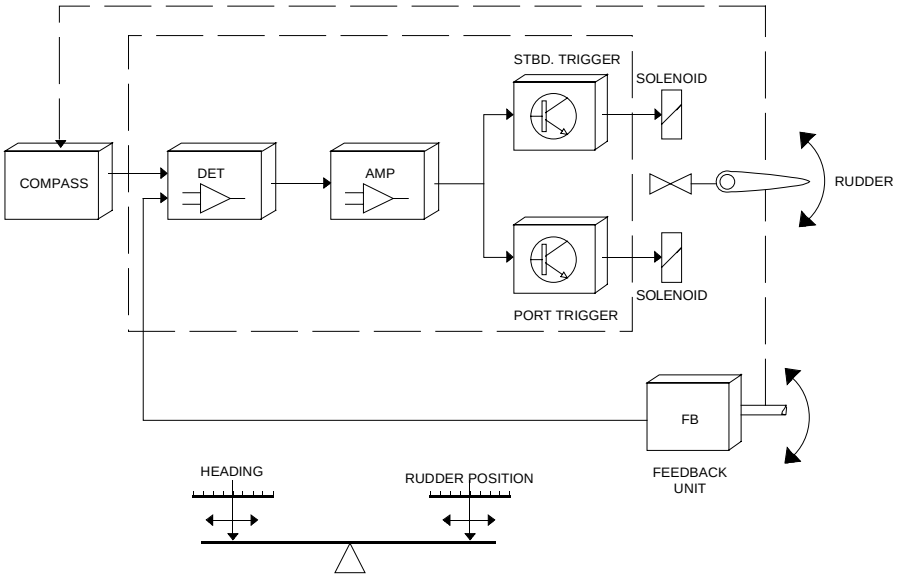


Fig. 3-1
Autopilot principle diagram

In order to stop the rudder movement, a feedback signal is produced by the feedback unit. The feedback signal will be compared with the compass signal and when there is a balance between the two, the solenoid will be de-energized. The rudder has now been moved to a position that makes the vessel turn. This turn is picked up by the compass and causes a new unbalance between the feedback signal and the error signal which energizes the opposite solenoid. Now the rudder will start to move back towards the previous position, and the feedback signal will again cancel out the unbalance and de-energize the solenoid to stop the rudder.

By utilizing digital technology to perform the function of an autopilot, the typical block diagram will be slightly changed. Even so, the basic operation should be recognized on Fig. 3-2.

As we know, a microprocessor can only do what it has been programmed to. This is called software. The program can be either fixed or partly adjustable to adapt the microprocessor to the individual type of vessels.

In Robertson terminology this is called "setting parameters", and it will determine the performance of the autopilot.

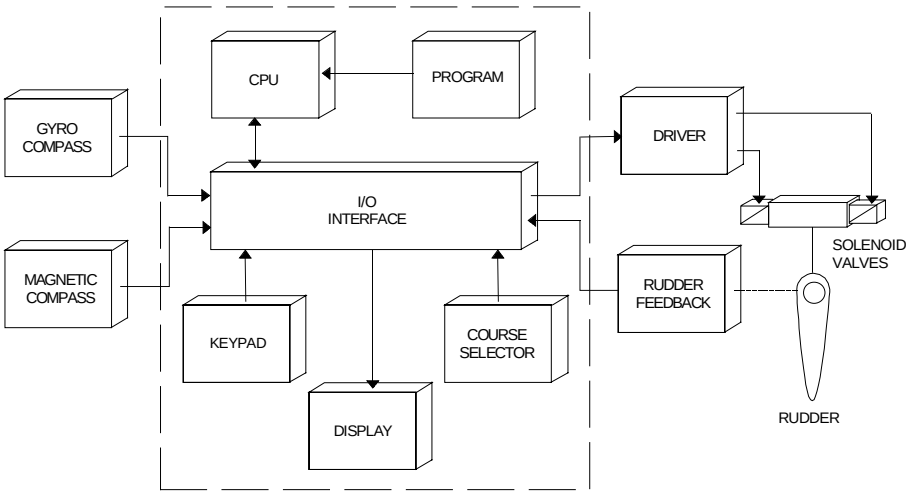


Fig. 3-2
Processor controlled autopilot

3.2 AP9 MK3 Control Unit

The AP9 MK3 Control Unit is made of sea water resistant aluminium and has a polyester coating which gives good protection against environmental exposure.

The unit contains three electronic boards (See Fig. 3-3), which are the Front Board, Display Board and the Interface Board.

The Front Board contains the micro computing circuitry, together with the electronics for the course selector. The alarm circuit is also included on this board.

The Display Board consists of the back lighting- and the display electronics.

All interface plugs for Heading Sensors, Distribution Unit, Navigational Receiver, Remote Controls etc. are mounted on the Interface Board.

The three boards are interconnected by plugs, and the interconnection is executed by mounting the boards into the control unit. (If the control unit is to be tested open with mains supplied, special cables are required).

If the control unit is to be connected to gyros other than the serial signal type, an optional AP9 MK3 Gyro Interface Board is required.

All connections to the autopilot are made through Amp CPC connectors to facilitate easy maintenance.

All parameter settings and operation of the autopilot are made using the push buttons on the AP9 MK3 Control Unit.

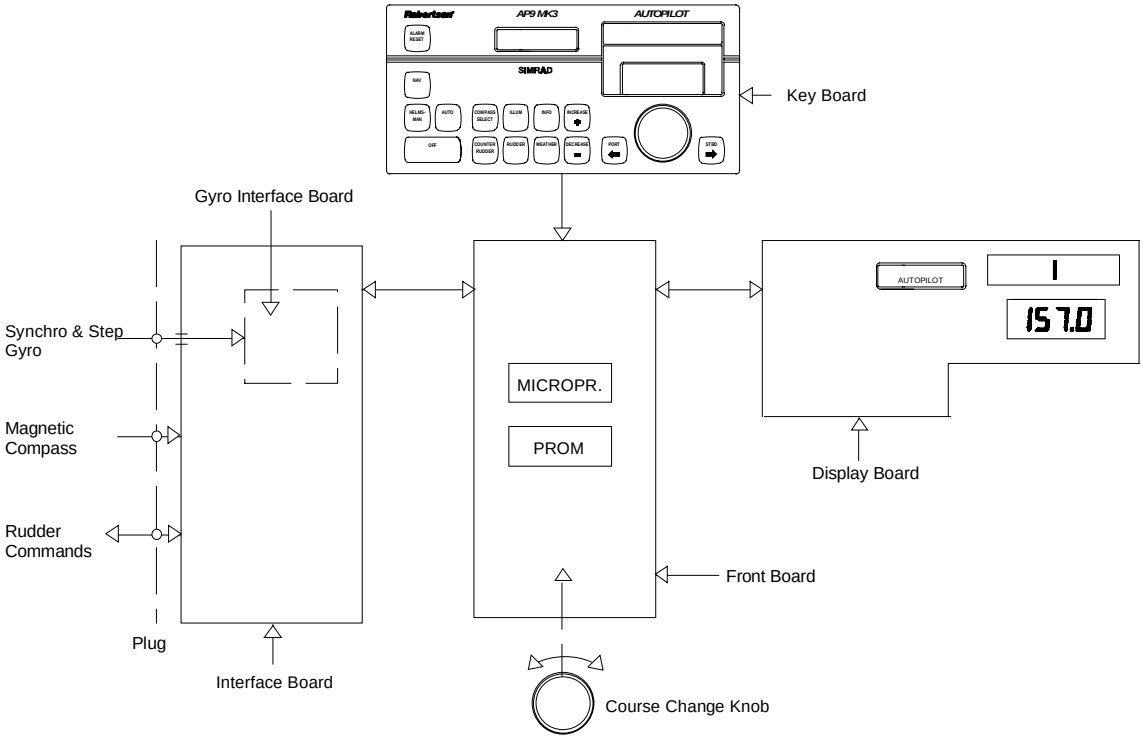


Fig. 3-3
AP9 MK3 Electronic boards

3.3 CD109 Course Detector

CD109 is the magnetic compass sensor in moulded plastic. It is mounted to a vessel's magnetic compass to transfer the heading information to the control unit. It operates on the fluxgate-principle where the resultant of the compass magnetism and the magnetism excited in the coil by the autopilot, makes it possible to register the compass heading.

CD109 Course Detector Principle

The primary windings are excited by a pulsating signal. Dependent of the magnetism induced by the position of the compass card magnets (Heading), pulses of variable amplitude will be generated in the secondary sine and cosine windings. These pulses are filtered through the R/C network and amplified before entering the A/D converter.

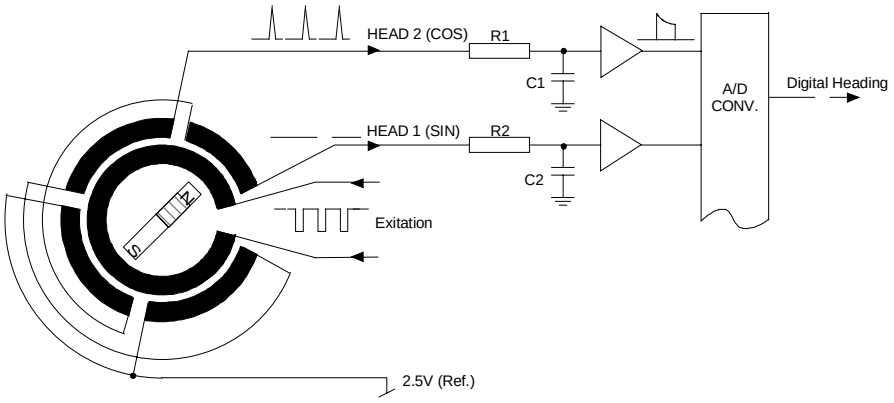


Fig. 3-4
Course Detector principle

3.4 Course Handling

(Ref. Fig. 3-5).

The AP9 MK3 may use different combinations of heading sensors such as magnetic compass (CD109), Gyrocompass (serial line, synchro 1:1 and geared, step signal and fluxgate). The options are selected by the compass select (COMP.SELECT) switch SW1 and SW2 on the interface board.

One compass will thus provide steering signal (steering compass) while the other will provide compass difference alarm (monitor compass).

Course changes are made in three different ways:

1. By the course change knob when operating in AUTOPILOT mode

2. By the PORT and STBD one-degree-course change-buttons, also when operating in the AUTOPILOT mode

3. By navigation receiver in CTS or Mixed Nav. steering modes.

During operation of the autopilot, only one compass (main compass or steering compass) will provide ship's heading reference for auto steering. The other compass (monitor compass) is only used to compare the main compass heading and eventually trigger a COMPASS DIFFERENCE alarm. The setting of the limit is made by altering the OFF-COURSE LIMIT value.

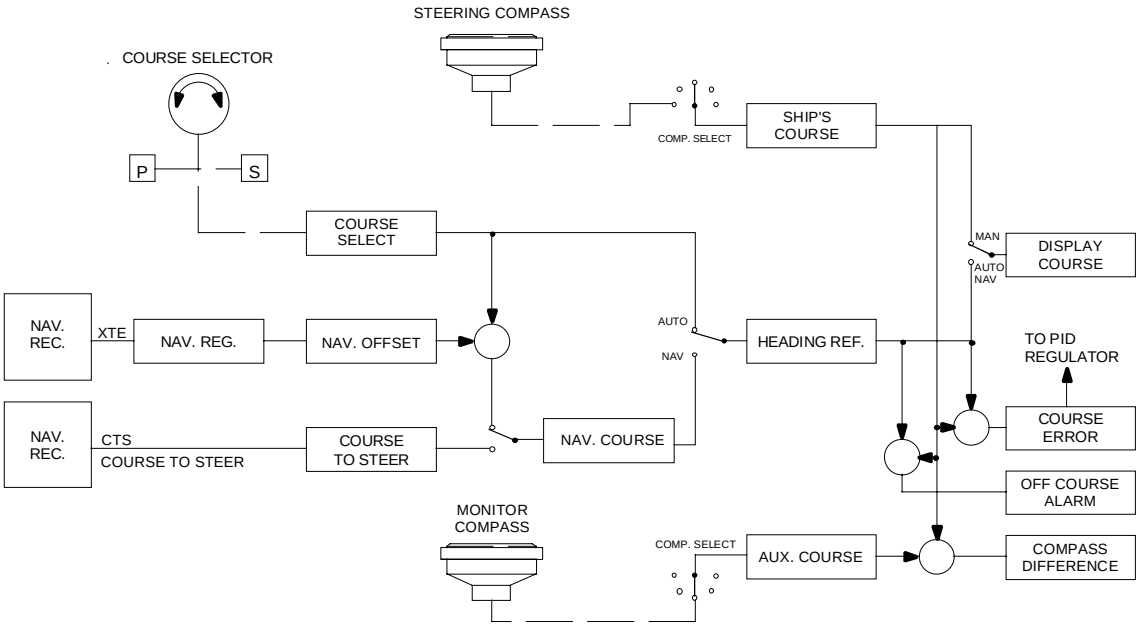


Fig. 3-5
AP9 MK3 Course Handling

This means that even with one compass connected, the OFF-COURSE warning will still be active, but NO COMPASS DIFFERENCE will occur.

The COURSE ERROR signal for the PID regulator is determined by the steering compass heading and the course selector / one-degree buttons.

When switching for NAV mode, the course selector and one-degree buttons are disconnected. The heading will then be determined by the NAV OFFSET signal from the XTE navigational receiver or from the CTS SAT.NAV receiver.

Selection is made by the INFO LOOP 2, Nav. Steering Type XTE / CTS / PRIORITY.

3.5 RF14XU Rudder Feedback Unit

(For details, ref. installation)

The RF14XU Rudder Feedback Unit consists of a glass-reinforced fire inhibiting polyester housing with a mounting plate of seawater resistant aluminium. Potentiometer, limit switches and an electronic drive module are also contained in the unit. The electronic drive module comprises a voltage section and a frequency section.

The voltage section outputs a voltage to the rudder angle indicator(s) which is proportional to the rudder angle. The voltage varies ±9V with half of the supply voltage as reference. The voltage shall therefore read "24VDC" supply/2 for midship position.

The frequency section outputs a signal to the control unit with 3400 Hz as midposition reference. It varies at a rate of 20 Hz/degree, increasing when the rudder moves to port and vice versa.

The shaft of the Feedback Unit is free to travel 360 degrees, but only ±90 degrees from midposition are used for signal control.

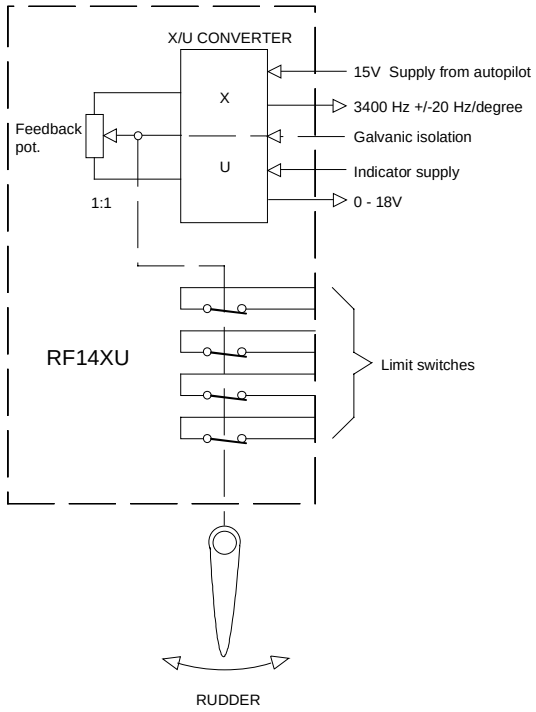


Fig. 3-6
RF14XU principle

RF14XU is equipped with two sets of limit switches. One set can be connected in series with the autopilot solid state switch, the other can be incorporated in an independent hand steering system, if required.

3.6 D90 Series Distribution Unit

This unit is the main interconnection unit. The 24V DC mains power, alarm power, solenoid drive, rudder feedback and external alarms are connected to this unit.

The Distribution Unit always contains at least one Power Supply Board. Depending on requirement, one additional Power Supply Board may be added.

In addition, the Distribution Unit can contain a combination of the following boards:

- Interconnection Board
- Thruster Interface Board
- Solid State Board
- Dual Analogue Board

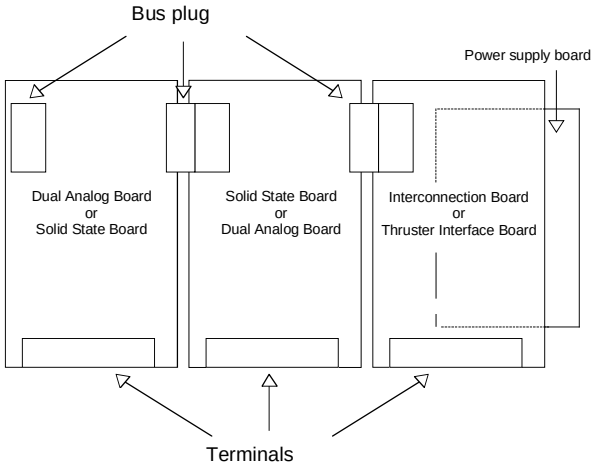


Fig. 3-7
D9X PCBs

The Solid State Board and Dual Analogue Board are identical in size and may be plugged together to the Interconnection Board or Thruster Interface Board in any combination.

The different versions of the D90 (also termed D9X) series are:

D90: Provides solid state switching of one directional valve solenoids, 19-40V DC 3A

D91: Provides solid state switching of one directional valve solenoids, 110V DC 1A

D92: Provides solid state switching of one directional valve solenoids, 110/220V AC 1A

D93: Provides two galvanic isolated ±10V or 4-20 mA signals

For double set of directional valves, one extra Solid State Board must be added.

POWER SUPPLY BOARD

(For detailed diagram refer to SCHEMATICS)

The 24V DC mains input voltage is connected to TB1 - 1/2.

The 24V DC is passing through a filter for protection of noise pulses that may have been induced in the 24V DC mains supply line. To obtain galvanic isolation from the 24V mains, for improved noise protection, the 24V DC is chopped up by the oscillator. The pulsating

DC voltage is coupled via the isolation transformer T1 to the rectifier diode D2. The filtered 15V DC voltage is regulated by the feedback line through the optocoupler to maintain isolation.

The green LD1 indicates presents of voltage.

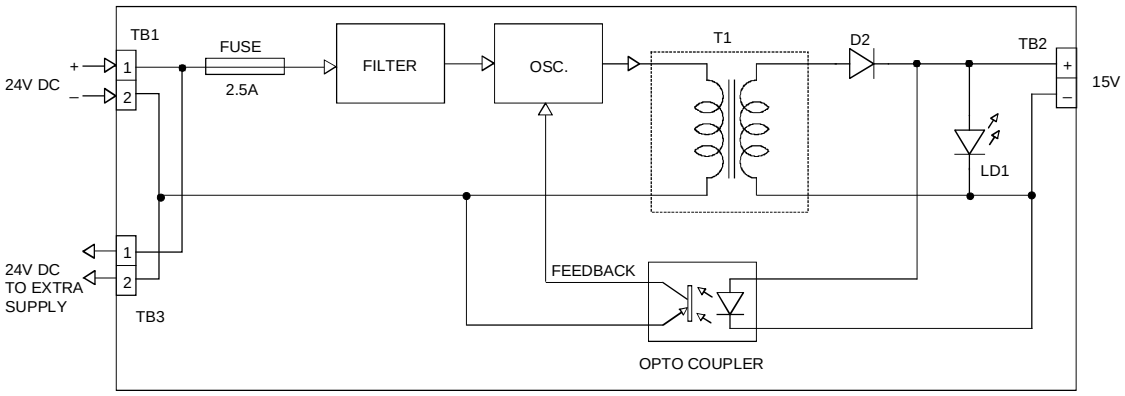


Fig. 3-8
Power supply PCB - Simplified diagram

INTERCONNECTION BOARD

(For detailed diagram, refer to SCHEMATICS)

The AP9 MK3 Control Unit is connected to the distribution unit via one cable from J1, terminated to TB1, TB2 and TB3.

The Interconnection Board provides distribution of the signals to the BUS plug.

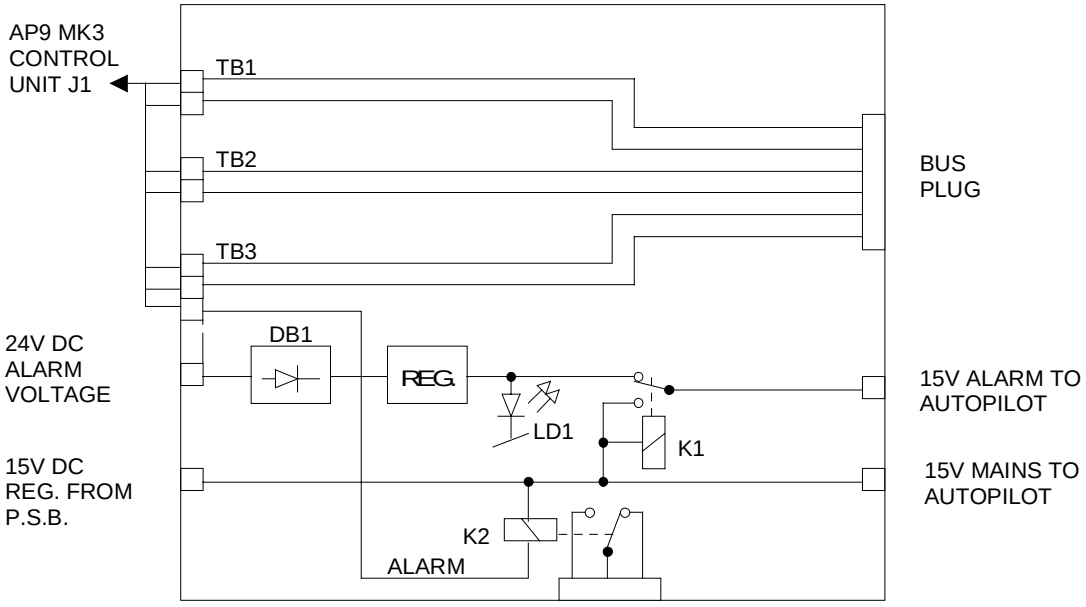


Fig. 3-9
Interconnection PCB - Simplified diagram

The 24V DC alarm voltage is connected to TB3. Polarity of voltage is not critical as the bridge rectifier DB1 rectifies the voltage. The 24V

alarm voltage is regulated to 15V DC by the regulator Q2, and the LED LD1 indicates presents of voltage.

During normal operation, the relay K1 will be energized, thus connecting the 15V regulated mains voltage as alarm supply. In the event of a mains power failure, the alarm voltage will be connected as supply via the deenergized K1 relay.

The alarm relay K2 is energized by an alarm signal from the control unit (alarm = GND)

THRUSTER INTERFACE BOARD

(For detailed diagram, refer to SCHEMATICS)

The Thruster Interface Board is identical in size with the Interconnection Board, but includes one ±10V analogue signal or one 4-20mA current signal output, both galvanic isolated.

There is also a 10 kHz generator to provide feedback signal to the Control Unit in order to enable the ±10V analogue signal from the control unit.

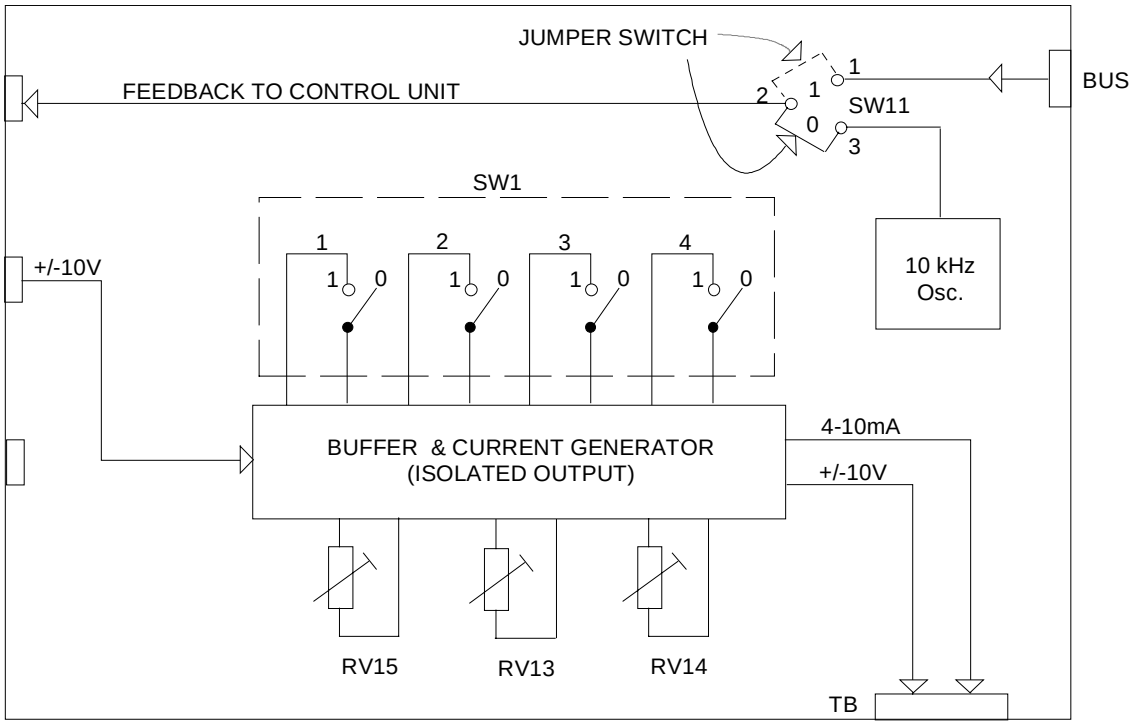


Fig. 3-10
Thruster Interface PCB - Simplified diagram

The jumper switch SW11 selects either a feedback signal via the bus connector or the 10 kHz signal to be applied to the control unit. For the 10 kHz signal, the jumper switch shall be set in position "0" (shorting pin 2 and 3).

The resulting ±10V signal from the control unit is then applied to the Buffer & Current generator.

Provisions have been made for offset and level adjustments of the output signals by the SW1, containing four switches, and trim potentiometers RV13-14 and 15. The adjustment procedure is described under section Installation: Analogue signal, Rudder & Thruster (page 5-50.).

SOLID STATE BOARD

This PCB performs the switching of the solenoids.

There are three versions:

- D90: switching 19-40V DC, 3A
- D91: switching 110V DC, 1A
- D92: switching 110/220V AC, 1A

All versions are made from the same PCB. Only the components related to the solid state switch-"relays" are different. The differences are listed on the detailed schematics. (Drw. N1-012815)

A simplified diagram is shown below.

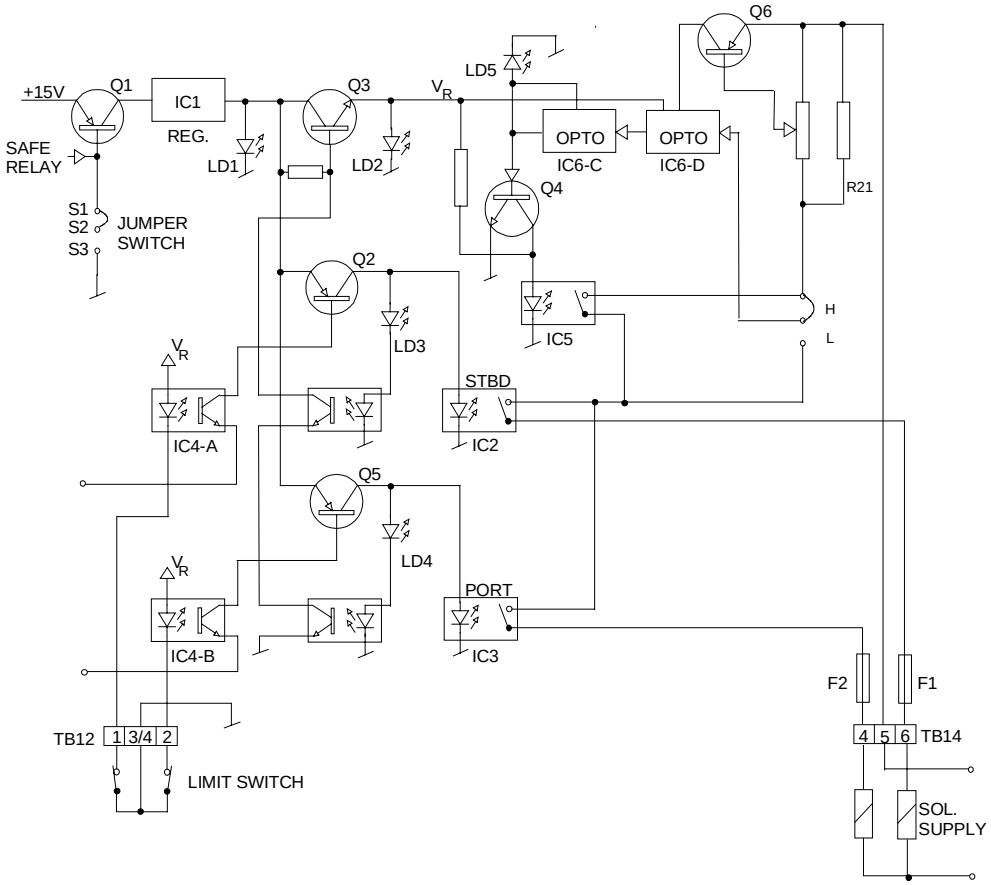


Fig. 3-11
Solid state PCB - Simplified diagram

FUNCTIONAL DESCRIPTION

The Q1 transistor functions as an ON-OFF switch, controlled by the "Safe Relay" signal from the control unit to the base.

Provisions for independent ON-OFF switching is also made for by the jumper switch S1-S2-S3. When placing the jumper switch in pos. 2-3, the Q1 transistor will be switched ON.

The IC1 voltage regulator output is monitored by LD1 (Green LED).

The starboard and port signals are connected to IC4 + A and B optocouplers and will switch on the transistor current when the rudder command signals switches low, also provided that the optocoupler diodes are on via limit switches.

The IC4-A and B transistor current will control Q2 and Q5 and thus switch on IC2 or IC3 solid state switch. The control signals are monitored by the red and green LED's (LD3 and LD4). The LD3 and LD4 are connected to the diodes of the optocouplers IC6-A and B, such that if both should conduct at the same time (PORT and STBD rudder commands both on), the switch transistor Q3 will be switched off.

This will result that the safety relay IC5 will deenergize, and no rudder commands to the solenoids will be made.

During normal operation, the transistor Q3 will be conducting, and status is monitored by the LD2 LED.

The safety relay IC5 is also controlled by a load protection circuit. The solenoid current is sensed by the resistor R21 and RV1, controlling transistor Q6. When Q6 is conducting, the optocoupler IC6-D will be switched ON, thus switching on the next optocoupler, IC6-C, that will start to conduct, switching on the Fault indicator LD5, and make the transistor Q4 start to conduct. The Q4 will start the diode in IC5 and thus deenergize the safety relay IC5. At the same time, the IC6-C will be latched to conduct. To reset, the system must be switched OFF and ON.

The jumper switch marked H/L determines the current through R21 for low (19-40V) or high voltage (110-220V). If the jumper switch is pulled out, the safety device is disabled. The fuses F1 and F2 are connected in series with each solenoid.

CONNECTION OF LIMIT SWITCHES AND SOLENOIDS

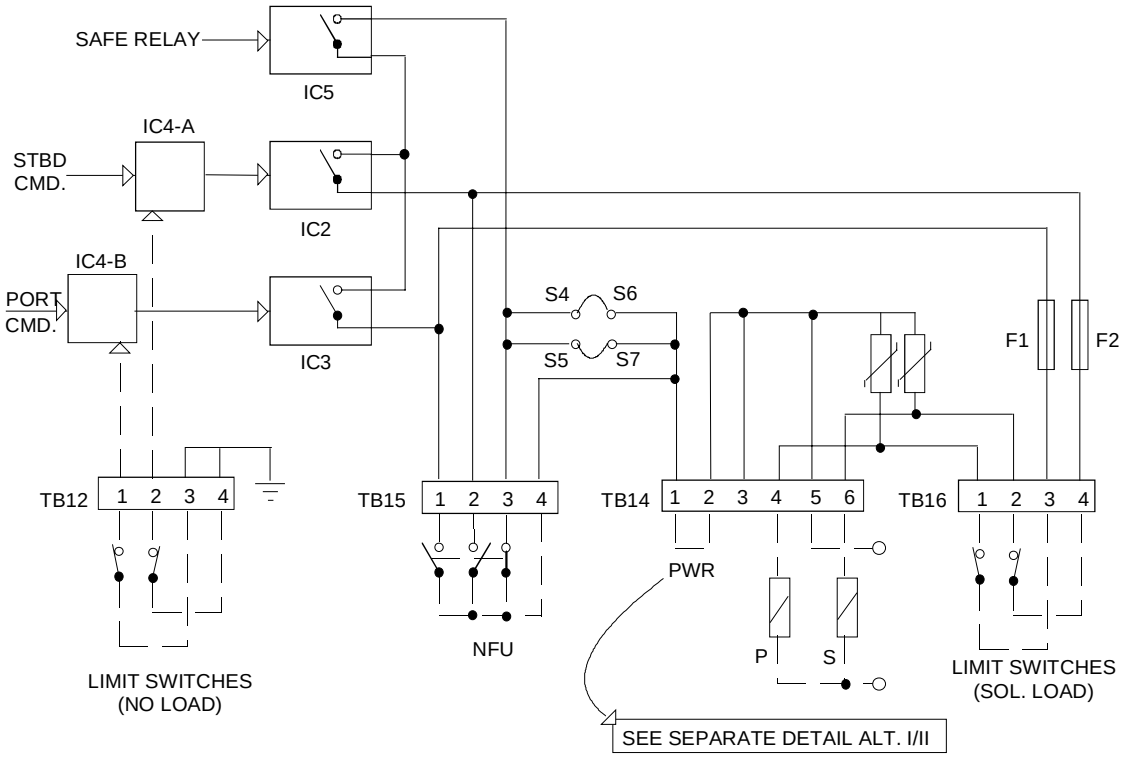


Fig. 3-12
Solid state PCB - connection of limit switches

When the RF14XU limit switches are connected to the TB12, only control signals are switched. When the limit switches are connected to TB16, the solenoid load (current) is switched. It is recommended not to use the TB16 connections if the load exceeds appr. 30W. If so, TB16 no. 1-3 and 2-4 are jumpered and the limit switches connected to TB12. If TB16 is used for limit switches, TB12 no. 1-3 and 2-4 must be jumpered.

Note ! *Limit switch connections not used must be jumpered*

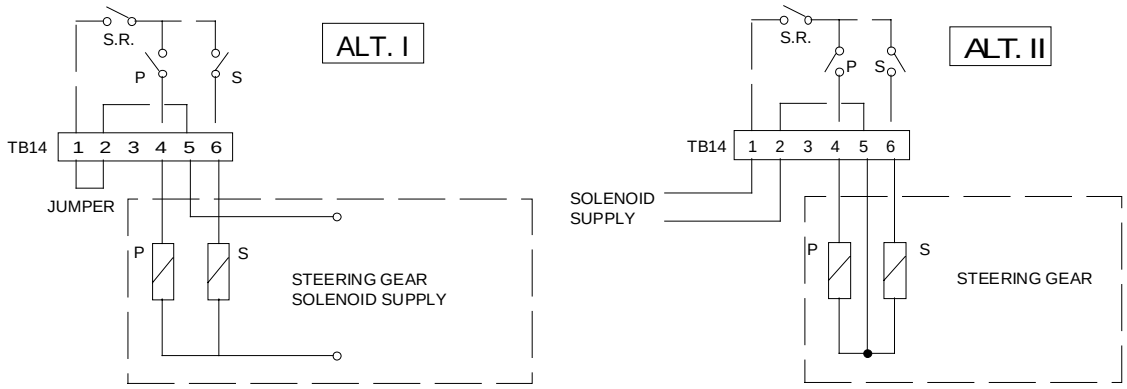


Fig. 3-13
Solid state PCB - connection of solenoids

DUAL ANALOGUE PCB

The Dual Analogue PCB contains two identical circuits, each providing a galvanic isolated analogue voltage, ±10V, 0-30V or 4-20mA current. There is also a 10 kHz oscillator for feedback signal to enable the ±10V signal from the control unit, jumpered in by S21 and S22 in pos. 1.

The simplified diagram shows only one of the two circuits, and the component numbers differs by 10.

The input signal is normally the ±10V from the control unit, selected by S1 and S2 in pos. 1.

By setting S1 and S2 in pos. 2, an external signal connected to TB21 5 - 6 is selected as input signal.

The signal is then connected to IC2, the AD converter where the output signal is galvanic isolated from the input signal.

When the 4-20 mA signal is used, the input signal to IC3 must be 0-10V for ±10V input signal to the AD converter. This is obtained by setting the SW 1-1 switch in pos. 1, thus connecting the voltage divider R1/R2. SW1-2 must be placed in pos. 1 (ON) to connect the DC/DC converter. RV4 is used to adjust the 0V output for -10V input of IC2.

The DC/DC (IC4) converter, providing ±15V, is used for supply voltage to the 4-20 mA current generator consisting of IC3, Q1 - Q2 and Q3. The 4-20 mA current is adjusted by RV1 (4mA) and RV2 (20mA). The current return line is connected to the DC/DC converter neg. output (-15V).

The maximum load resistance for the current output is limited to 500 ohm.

The voltage output may be selected to operate as 0±10V or less, adjusted by the attenuator RV5. For this output, switches SW1-1 shall be set to 0 (open) and SW1-3 shall be in pos. 1 (closed). An offset of ±3V may be adjusted by RV3.

The voltage output may also be selected to work from +12 ±6V or similar when using the DC/DC converter. The switches SW1-3 and 4 shall be in pos. 1 (ON). The output voltage can be adjusted by RV4, RV3 and RV1 for proper midpoint and max/min voltages.

Minimum load resistance for ±10V signal is 2K, and for 6-12-18 signals (with DC/DC converter) the load is 36K.

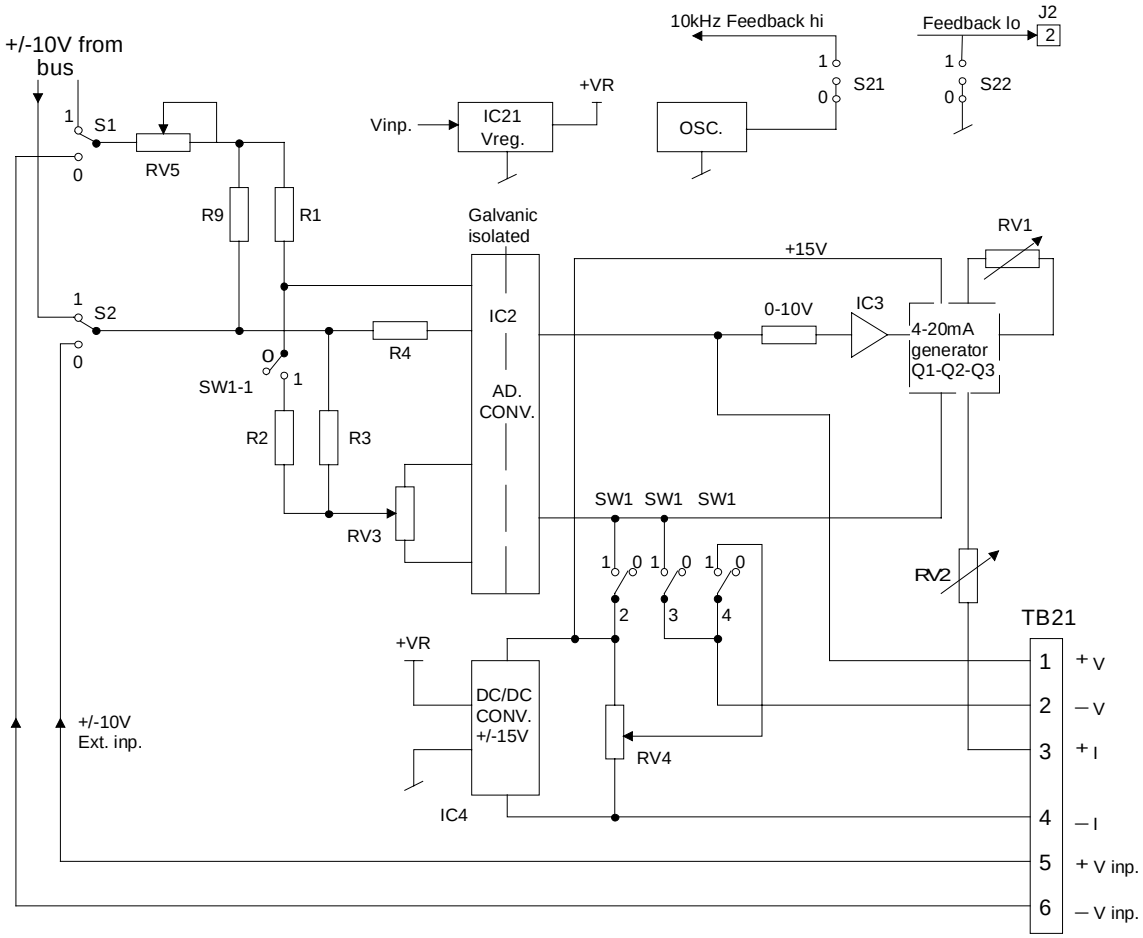


Fig. 3-14
Dual Analogue PCB - Simplified diagram

3.7 F200-40 Remote Control

This unit enable remote control of the AP9 MK3 Control unit.

A simplified diagram is shown below:

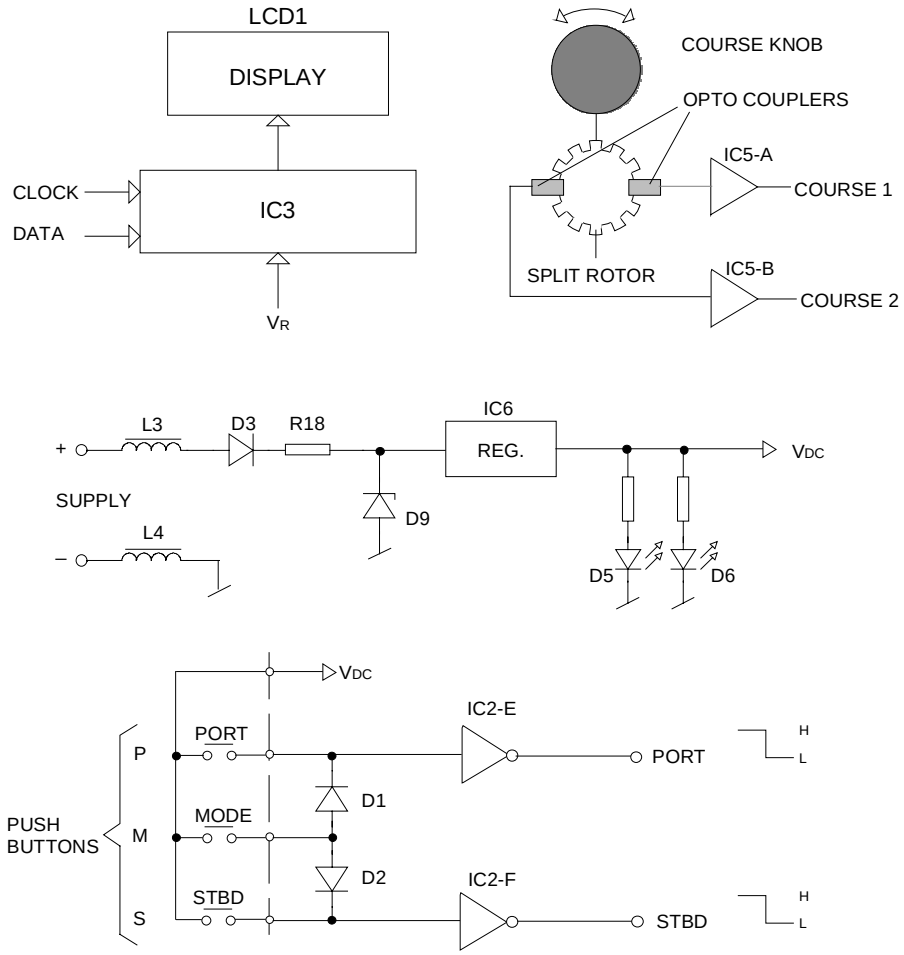


Fig. 3-15
F200-40 Simplified diagram

The F200-40 display is operated via clock and data signals from the control unit and will display actual course or set course, dependent of operational mode.

When turning the course knob, IC5-A and B will shape the pulses generated by the two opto-couplers that are switched ON / OFF via the split-rotor, and thus provide pulses as course 1 and course 2.

The operational mode of the control unit can be selected by the push button M (Mode). This button provides both PORT and STBD signals simultaneously by the two diodes D1 and D2. The sequence of mode change is described under the OPERATION section.

When pushing the P and S buttons, the PORT and STBD signals will switch to low (GND) and provide course change or NFU-steering depending on the operational mode.

3.8 FU91/92 Follow-Up Lever

The FU91/92 FU lever has been designed for use primarily together with the FU9X follow-up amplifier. The construction is made such that either one single PCB, containing all the electronics, including the follow up potentiometer or two identical PCB's can be mounted and operated from one common FU-shaft.

The single version is the FU91, and the double version is the FU92.

The designed is based on "TAKE COMMAND" pulses and "IN COMMAND" signals that makes it possible to use several units connected to the FUA9X.

There are four jumper switches for selection of functions, and for use together with the AP9 MK3 autopilot, the settings are as shown:

S1: Selects direction of signal versus direction of lever movement. Pos 1-4 and 2-3
S2: Pos 1
S3: Pos 2
S4: Pos 1

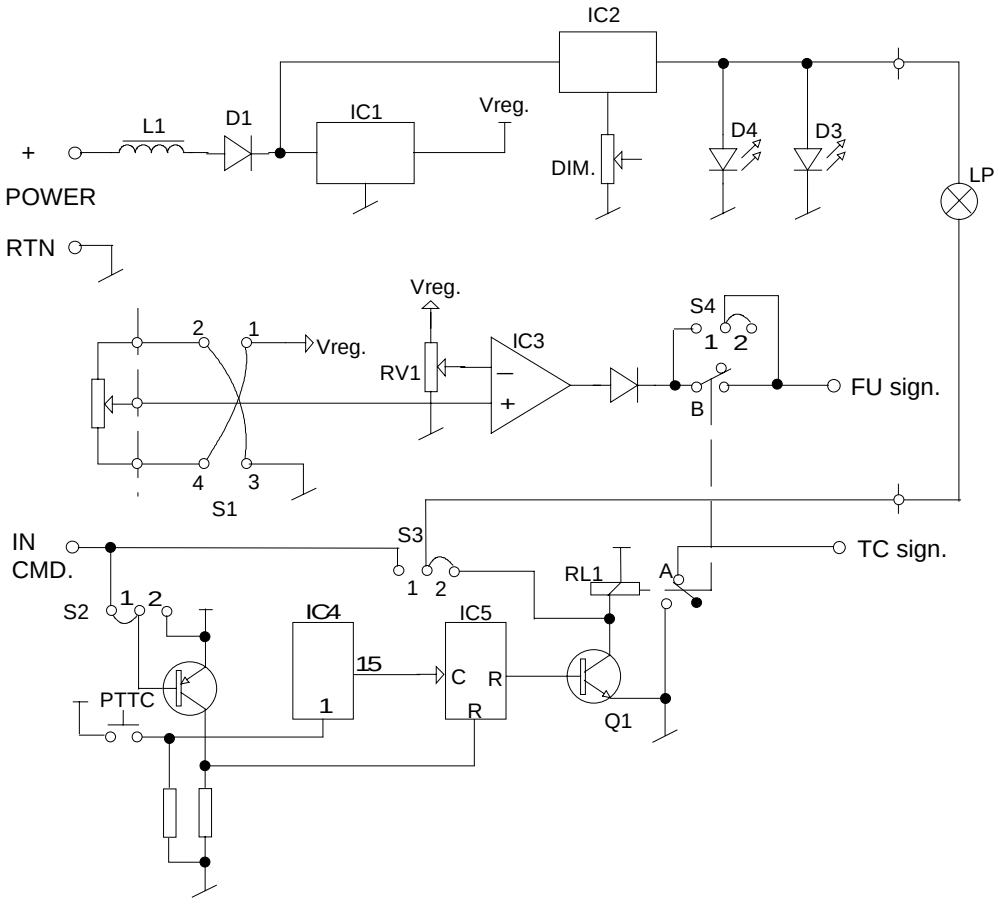


Fig. 3-16
FU91/92 Simplified diagram

The signal/wire terminations are listed as follows:

TB1-1: Power pos (10-15VDC)

TB1-2: Power RTN

TB1-3: TC (Take Command) signal

TB1-4: IC (In Command) signal (Enable)

TB1-5: FU (Follow-up) signal 0-1mA

When pushing the PTTC button, the flip-flop circuit IC5 is switched via the IC4, thus switching on transistor Q1 to energize the relay RL-1. The relay contact A switches TC to LO (GND) at the same time, the "IN CMD" lamp LP will be switched on via the jumper switch S3 in pos. 2. The dimmer control varies the voltage output of the regulator. IC2 and LED's D3 and D4 are for scale illumination.

The relay RL1 will be deenergized by another push on the TC button, as this will make the flip-flop change one more time.

The trim potentiometer RV1 provides offset adjustment.

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4 TECHNICAL SPECIFICATIONS

4.1 AP9 MK3 Control Unit

Dimensions ..... See Fig. 4-1.
Weight ..... 3.0 kg
Protection ..... IP43 (Refer to page 4-13.)
Ambient temperature, ... storage: –25 - +70°C
operation: 0 - +55°C
Safe distance to compass: 0.3m
Max. current consumption: .. 0.6A

Input signals:

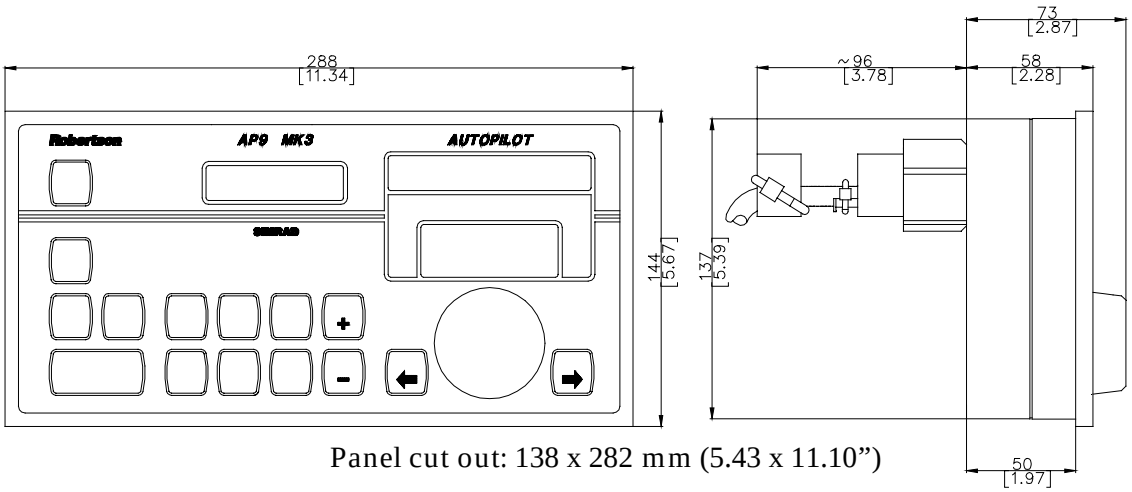
Magnetic compass: ..... sin / cos 2V, 2.5V ref.
Fluxgate compass: ..... sin / cos 2V, 2.5V ref.
Gyro compass serial signal:
- RGC11 and RGC12 proprietary sentences, NMEA, UART (SKR80 / 82)
- Other formats require optional Gyro Interface Board.

Nav.signal: Format: NMEA 0183
XTE: APA, APB, XTE,
CTS: APA, APB, BOD, BWC, BWR, BWW, HSC
Baudrate: 4800

Speed signal: ..... VTG
Also see page 4-14.

Output signals:

"ON / OFF" steering signals (12V)
±10V analogue signal
NMEA, HDM / HDT with 0.1 degree resolution
Repetition rate: Selectable between 5 / sec. and 1 / sec.
Ref. page 5-43.



Panel cut out: 138 x 282 mm (5.43 x 11.10”)

Fig. 4-1 AP9 MK3 Control Unit, dimensions

4.2 AP9 MK3 Gyro Interface Board

Input signals: Synchro 1:1
Synchro 90:1
Synchro 360:1
Autopilot excited synchro
Stepper 6 step / deg, 24-70V

4.3 CD109 Course Detector

Dimensions : ..... See Fig. 4-2.
Protection : IP56
Ambient temperature,
storage:..... –40 - +85°C
operation: –30 - +60°C
Cable length: ..... 1 m

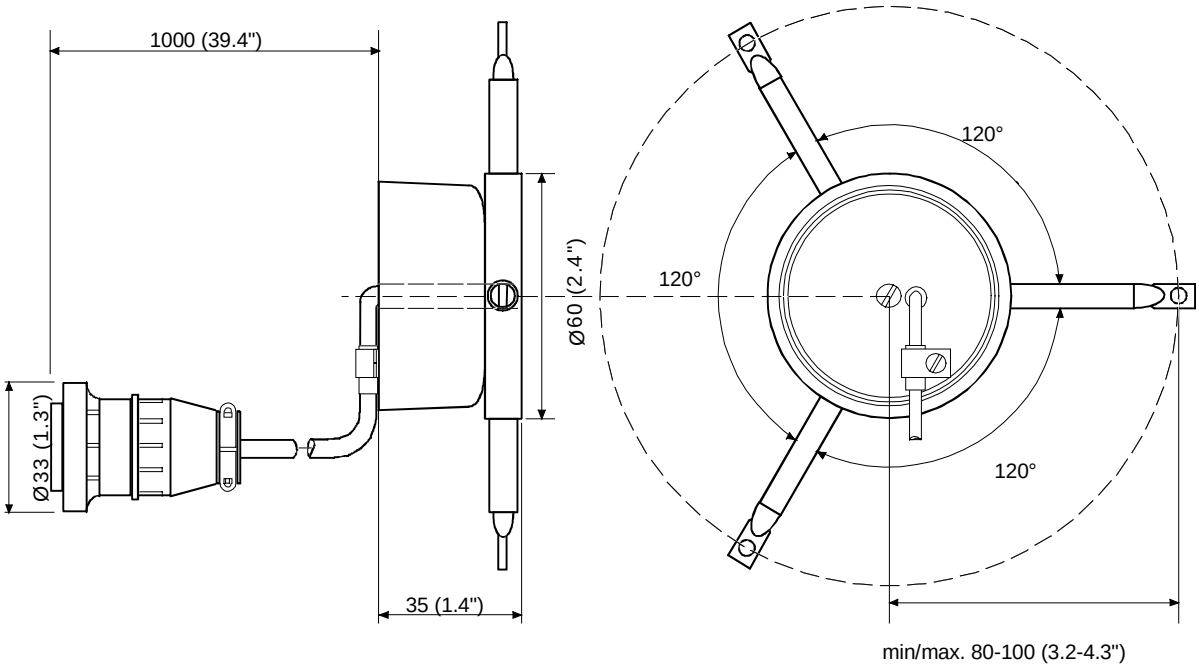


Fig. 4-2
CD109 Course Detector, dimensions

4.4 RFC35R Rate Compass

Dimensions: ..... See Fig. 4-3
Weight: ..... 0,9 kg (2,0 lbs)
Supply: ..... 10-29VDC, 1 watt
Heading output: ..... Serial, rate sensor stabilized
Output format: ..... Serial, Robnet™ bus for Robertson autopilots or NMEA 0183 10x / sec.
NMEA heading: ..... $IIHDM,x.x,M*hh<cr><lf>
x.x=heading, hh=checksum
Standard configuration: ..... Robnet output
Optional analogue output: ... Sine / cosine by plug-in PCB
Accuracy: ..... <1.25 degrees rms (after calibration)
Repeatability: ..... <0.2 degrees rms
Calibration: ..... Automatic
Roll / Pitch: ..... ± 35 degrees
Cable supplied: ..... 15 m (49 ft) TP shielded with Robnet plug
Temperature range:
Operation: ..... 0 to +55 °C (+32 to + 130 °F)
Storage: ..... –30 to +80 °C (–22 to +176 °F)
Environmental Protection: ... IP56
Mounting: ..... Deck or bulkhead
Material: ..... Black ABS

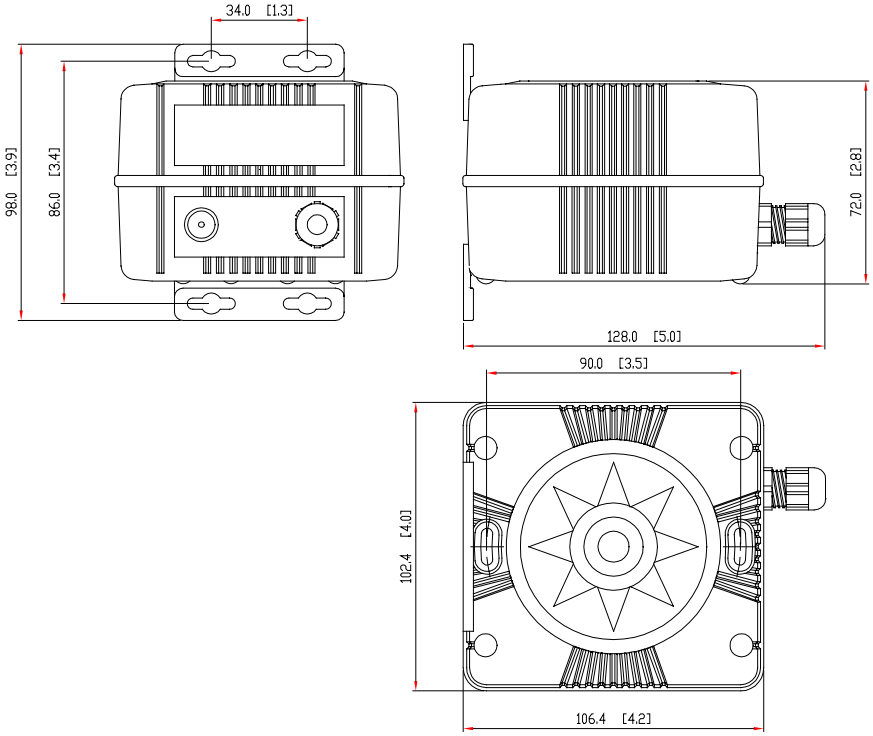


Fig. 4-3 RFC35R Rate Compass, Dimensions

4.5 RFC35NS Fluxgate Compass

Dimensions: ..... See Fig. 4-3
Heading output: ..... Serial and analogue
Output format: ..... NMEA183 10x / sec. and sine / cosine.
NMEA data: ..... $IIHDM,x.x,m*hh<cr><If>x.x=heading, hh = checksum
Analogue data: ..... Sine / Cosine ±2V, 2.5VDC reference.
Accuracy: ..... <1.25° rms
Repeatability: ..... <0.2° rms
Calibration: ..... Automatic
Roll & Pitch: ..... ±35°
Supply: ..... 10-29 VDC, 1 W
Temperature:
- Operation: ..... 0 to +55°C (+32 to + 130°F)
- Storage: ..... –30 to +80°C (–22 to +176°F)

Protection: IP56
Mounting: ..... Deck or bulkhead
Cable supplied: ..... 0.3 m (1 ft.) with Viking connector for Robertson autopilots (Sine / Cosine data) and N2500 NMEA Interface.

4.6 RFC35N NMEA Compass

Dimensions: ..... See Fig. 4-3
Supply: 12, 24VDC
Output: ..... NMEA0183, HDM (10x / second)
Calibration: ..... Automatic
Repeatability: ..... ± 0.5 degrees
Roll / Pitch: ..... ± 35 degrees
Accuracy: ..... ± 3 degrees after calibration
Protection: IP56
Temperature range:
- Operation: ..... 0 to +55°C (+32 to + 130°F)
- Storage: ..... –30 to +80°C (–22 to +176°F)

NMEA0183 output data:
Heading: ..... $IIHDM,x.x,M*hh<cr><lf>
x.x=heading, hh= checksum
Status: ..... $PSTOK,R<cr><lf>Calibration running
$PSTOK,C<cr><lf>Calibration terminated, or not running (Also presented before calibration is done).

NMEA0183 input data:

Calibration start command:.....$PSTOC<cr><lf>

Heading offset adjust: .....$PSTOK,,,nnn,<cr><lf>

nnn = offset adjust angle 0 – 360 degree.

PSTOK and PSTOC are Stowe Dataline proprietary sentences

4.7 Distribution Unit

Dimensions: ..... See Fig. 4-4.

Protection: IP22

Weight: ..... 3,5 kg

Ambient temperature,

storage: ..... –25 - +70°C

operation: ..... 0 - +55°C

Safe distance to magnetic compass: 1.5 m (5')

Mains voltage: ..... 24V DC +30 / –25%

Alarm voltage : ..... 24V DC ±20 %

Input signals:

Rudder Feedback Unit: ..... 3400 Hz + / -20Hz / degree

Steering Lever

FU :..... Current signal: 0-1mA (±45°)

NFU : ..... Switch contacts

D90 Distribution Unit:

Solid state output: ..... Switching low DC (19-40V) single channel. 3A.

D91 Distribution Unit:

Solid state output: ..... Switching high DC (110V) single channel. 1A.

D92 Distribution Unit:

Solid state output: ..... Switching high / low AC (110-220V) single channel. 1A.

D93 Distribution Unit:

Analogue output: ..... Two independent channels with + / -10V or 4-20mA output

D99 Distribution Unit:

Output: ..... Switching reversible motor, max. 10A, 24VDC.

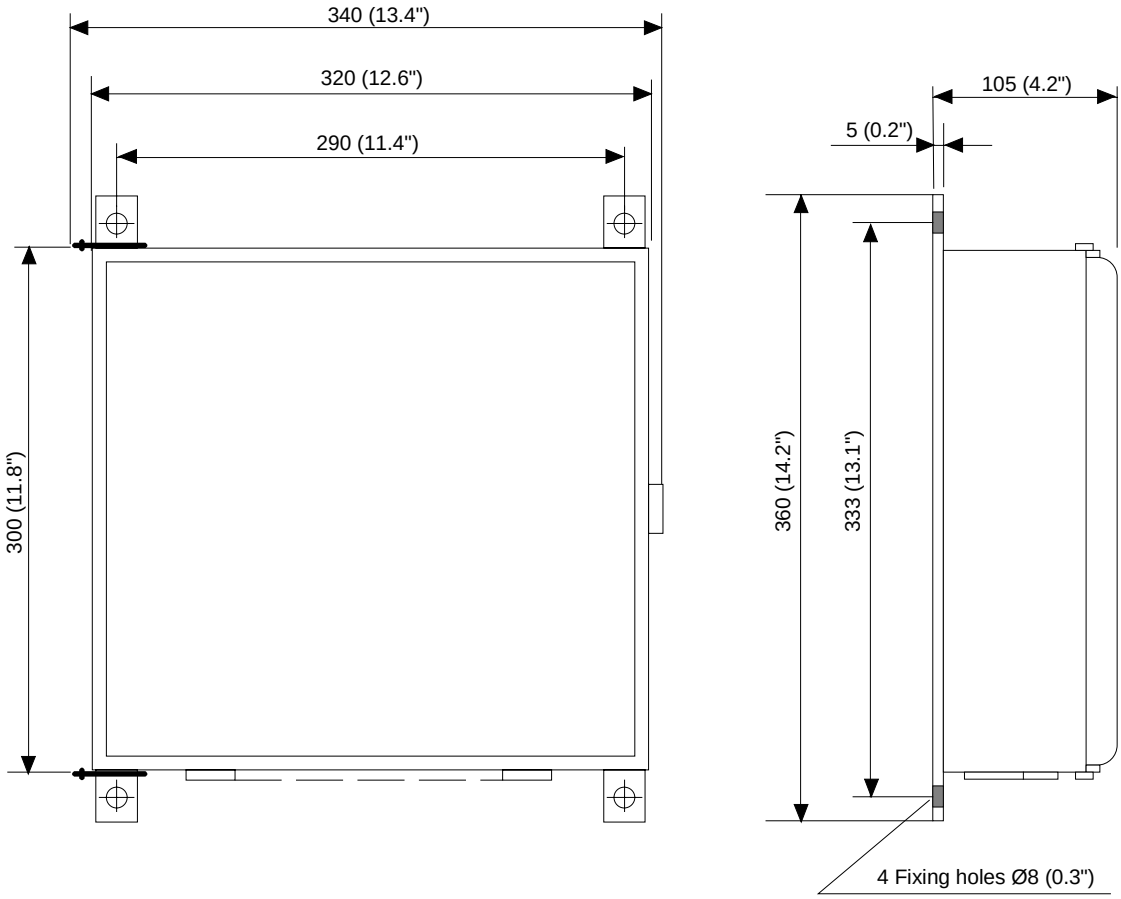


Fig. 4-4
D9X Distribution Unit, Dimensions

4.8 RF14XU Rudder Feedback Unit

Dimensions:	See Fig. 4-5.
Protection:	IP56
Ambient temperature:	–10 - +55°C
Operating voltage:	24VDC +30 / –20%
Voltage output:	0-18V DC (9V as midships reference)
Frequency output:	3400Hz (midships reference) Port: +20Hz / degree, Stbd: –20Hz / degree
Capacity:	5 indicators in parallel
Rudder angle:	±45 ° (Changeable to 60, 70 or 90°)
Limit switches:	Adjustable from ±5 to ±160°

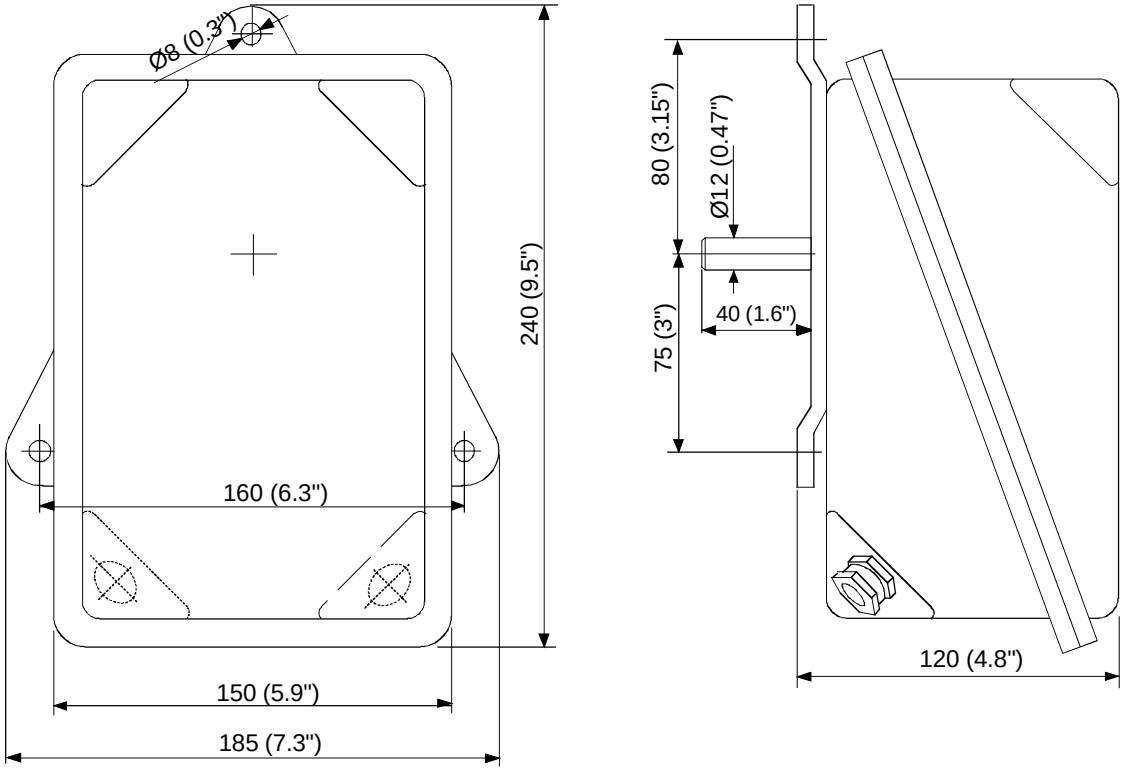


Fig. 4-5
RF14XU Rudder Feedback Unit
Dimensions

4.9 RF Standard Transmission Link

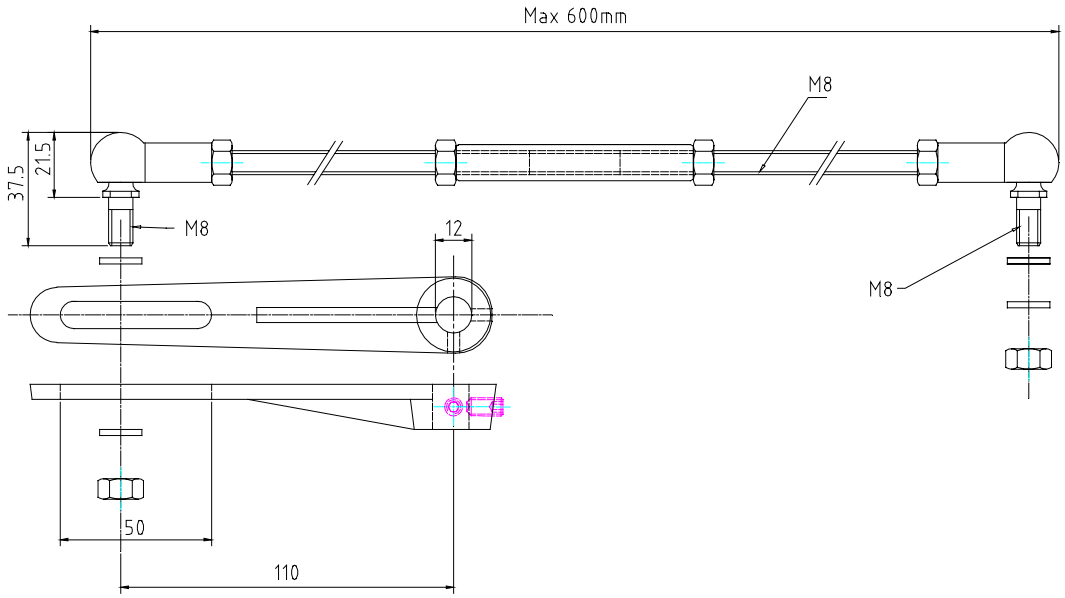


Fig. 4-6
RF Standard Transmission Link - dimensions

4.10 S9 Steering Lever

Dimensions: ..... See Fig. 4-7.
Protection: IP56
Ambient temperature: ..... –25 - +70°C
Safe distance to compass: ..... 0.3 m
Max. inductive load: ..... 4A / 24V DC, 0.6A / 110V DC,
0.3A / 220V DC, 10A / AC

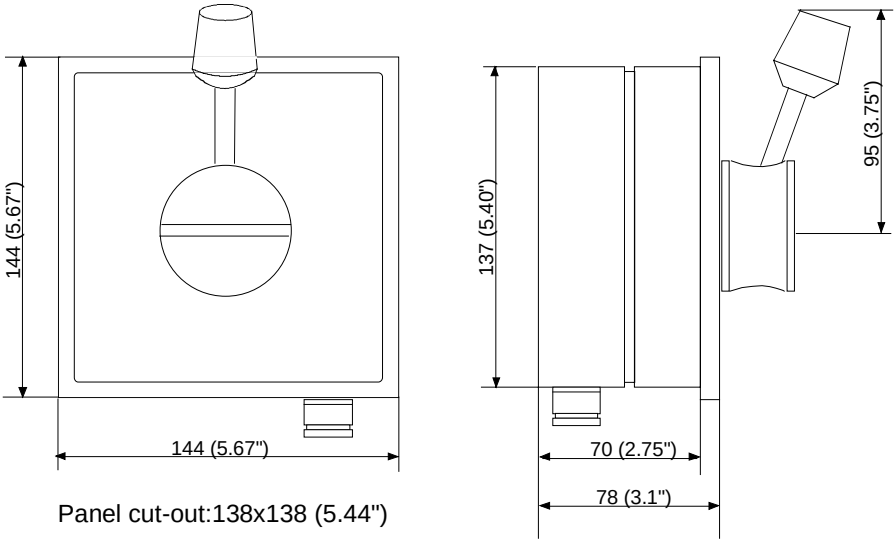


Fig. 4-7
S9 Steering Lever - Dimensions

4.11 FU91 Steering Lever

Dimensions: ..... See Fig. 4-8.
Protection: IP56
Ambient temperature, ... storage: –25 - +70°C
operation: –10 - +55°C
Safe distance to compass: ..... 0.3 m

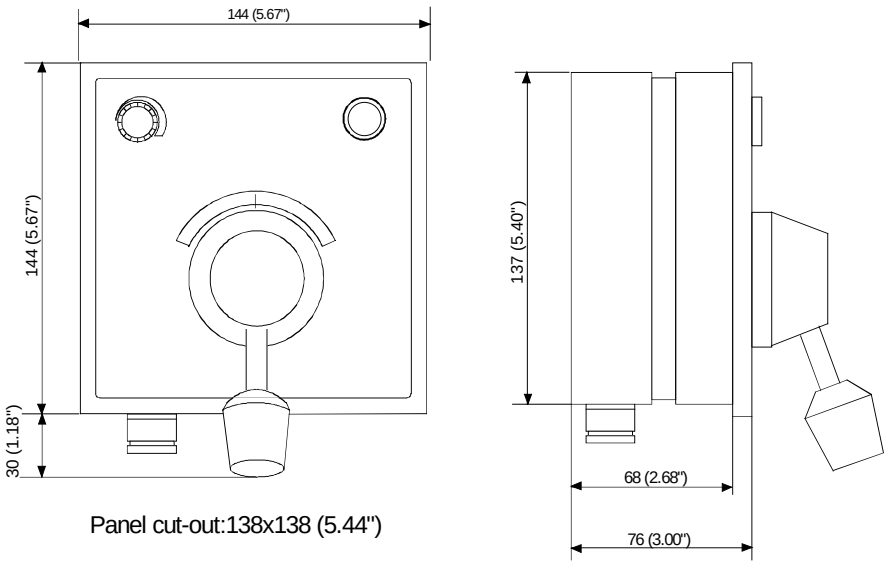


Fig. 4-8
FU91 Steering Lever - Dimensions

4.12 S35 Steering Lever

Dimensions: ..... See Fig. 4-9.

Weight: ..... 1.4 kg (inclusive cable)

Max. inductive load: ..... 4A / 24V DC, 60mA / 110V AC, 25mA / 220V AC

Temperature range: ..... Storage: –30 to 80° C
Operation: –10 to 55° C.

Environmental protection: IP56

Safe distance to compass: ..... 0.5 m (1,6 ft.)

Power consumption (light): .. 6 mA

Cable: ..... 10 m cable with six wires connected through bottom gland

Note! Cable gland can be moved to the back side.

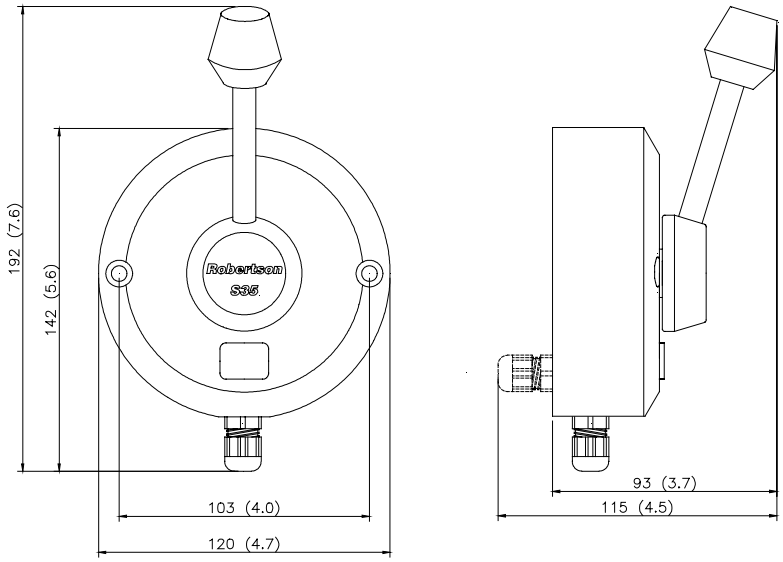


Fig. 4-9
S35 Steering Lever - Dimensions

4.13 F1/2 Remote Control

Dimensions: ..... See Fig. 4-10
Protection: IP56
Cable length: ..... 10 meters (30 ft.)
Max. inductive load: ..... 4A / 24V DC, 60mA / 110W AC, 25mA / 220V AC

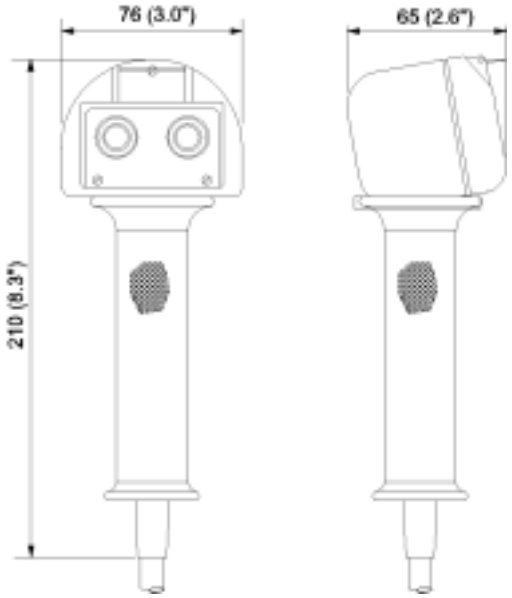


Fig. 4-10
F1/2 Remote Control - Dimensions

4.14 F200-40 Remote Control

Dimensions: See *Fig. 4-11*
Protection: IP56
Ambient temperature,
storage: –25 - +70°C
operation: 0 - +55° C
Safe distance
to compass: 0.3 m
Cable length: 7 m (21ft.)

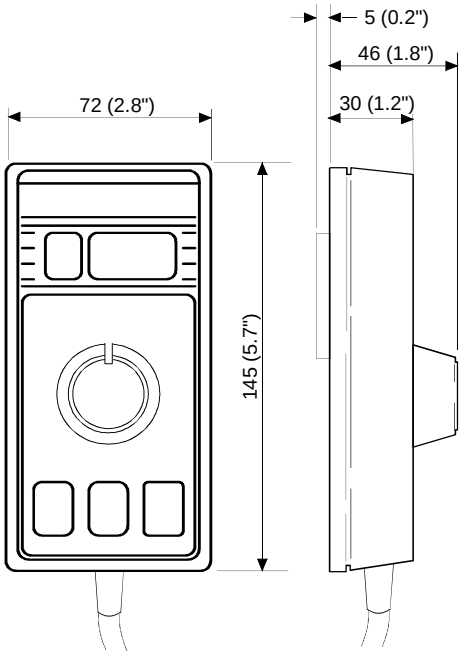


Fig. 4-11
F200-40 Remote Control Dimensions

4.15 RI9 Rudder Angle Indicator

Dimensions: ..... See Fig. 4-12.
Supply voltage: ..... 24 / 32V DC ±20%
Illumination: ..... Maximum 80 mA
Input signal: ..... 0.1 -1.1 mA or ±10V
Rudder angle: ..... 45°-0-45° (other angles as option)
Ambient temperature,
storage: ..... –25 - +70°C
operation: ..... –10 - +55°C
Protection: IP56
Safe distance to magnetic compass: 2.6 m (9ft.)
Rudder Feedback Units: ..... RF45, RF45X, RF14XU (RF100, RF140).

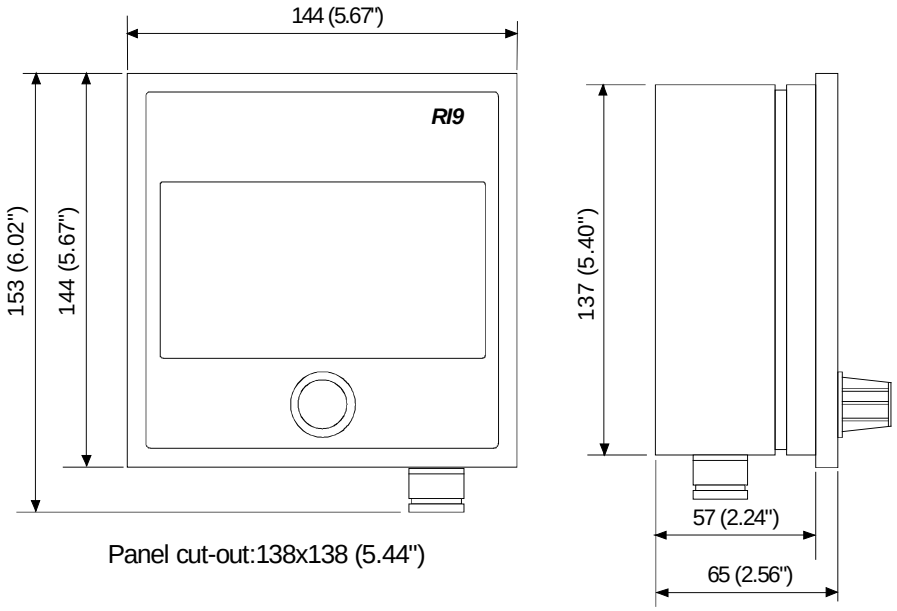


Fig. 4-12
RI9 Rudder Angle Indicator - Dimensions

4.16 IP protection

Each part of a Robertson autopilot system has got a two digits IP protection code.

The IP rating system provides a means of classifying the degrees of protection from dust, water and impact afforded by electrical equipment and enclosures. The system is recognised in most European countries and is set out in a number of British and European standards.

The first code number describes the protection against solid objects, and the second number describes the protection against liquids.

FIRST NUMBER Protection against solid objects		**SECOND NUMBER** Protection against liquids	
IP	**TESTS**	**IP**	**TESTS**
0	No protection	0	No protection
1	Protection against solid objects up to 50 mm, eg. accidental touch by hands.	1	Protected against vertically falling drops of water (eg. condensation).
2	Protection against solid objects up to 12 mm, eg. fingers.	2	Protected against direct sprays of water up to 15° from the vertical.
3	Protection against solid objects over 2.5 mm (tools + wires)	3	Protected against sprays to 60° from the vertical.
4	Protection against solid objects over 1 mm (tools + wires + small wires)	4	Protected against water sprayed from all directions - limited ingress permitted.
5	Protection against dust - limited ingress (no harmful deposit)	5	Protected against low pressure jets of water from all directions - limited ingress permitted.
6	Totally protected against dust	6	Protected against strong jets of water, eg. for use on shipdecks - limited ingress permitted.
		7	Protected against the effects of immersion between 15 cm and 1 m.
		8	Protected against long periods of immersion under pressure.

4.17 Specification of messages

Data that are used are underlined. Which steering mode to be used depends on the received messages as follows.

CTS steering

$--XTE,A/V,A/V,X.XX,L/R,N[CR][LF]

Bearing steering

$--BWR,XXXXXX,XXXX.XX,N,XXXXX.XX,W,XXX,T,XXX,M,XXX.X,N,XXX[CR][LF]
$--BWC,XXXXXX,XXXX.XX,N,XXXXX.XX,W,XXX,T,XXX,M,XXX.X,N,XXX[CR][LF]
$--BWW,XXX,T,XXX,M,XXX,XXX[CR][LF]$--BOD,XXX,T,XXX,M,XXX,XXX[CR][LF]
$--HSC,XXX,T,XXX,M[CR][LF]

Priority (mixed) steering

(cross-track with automatic new bearing at waypoints)

$--APA,A/V,A/V,X.XX,L/R,N,A,A,XXX,M/T,XXX[CR][LF]
$--APB,A/V,A/V,X.XX,L/R,N,A,A,XXX,M/T,XXX,XXX,M/T,XXX,M/T[CR][LF]

Speed correction signal (VTG)

$--VTG,X.X,T,X.X,M,X.X,N,X.X,K<CR><LF>

5 INSTALLATION

5.1 Unpacking and handling

Care should be taken when unpacking and handling the equipment. A visual inspection should be made to check that the equipment has not been damaged during shipment and that all components and parts are present according to the packing list.

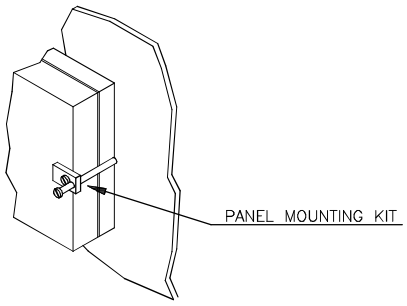
5.2 General

When installing the units, particular attention being given to the operator's need for ease of access.

For cable layout refer to the External Cabling Diagram.

5.3 Control Unit

The unit is built to standard DIN dimensions for console mounting. Dimensions for the panel cut out are shown on Fig. 4-1. A fastening device for console mounting and a bracket for panel mounting are supplied with the equipment. The mounting bracket has four screw holes for bulkhead mounting, and the Control Unit is fitted to the bracket by two Allan screws (Fig. 5-2). A matching Allan wrench is supplied.



It is important to locate the Control Unit so that the viewing angle to the displays is between 45 and 90 degrees in both planes. When console mounting, locate the control unit as near the front edge as possible. This makes the reading of the displays easier. Avoid direct sunlight on the display.

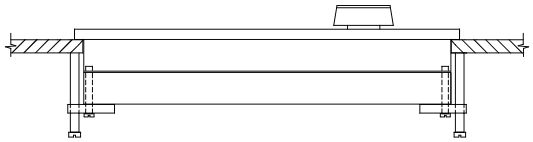


Fig. 5-1
Control unit - panel mount

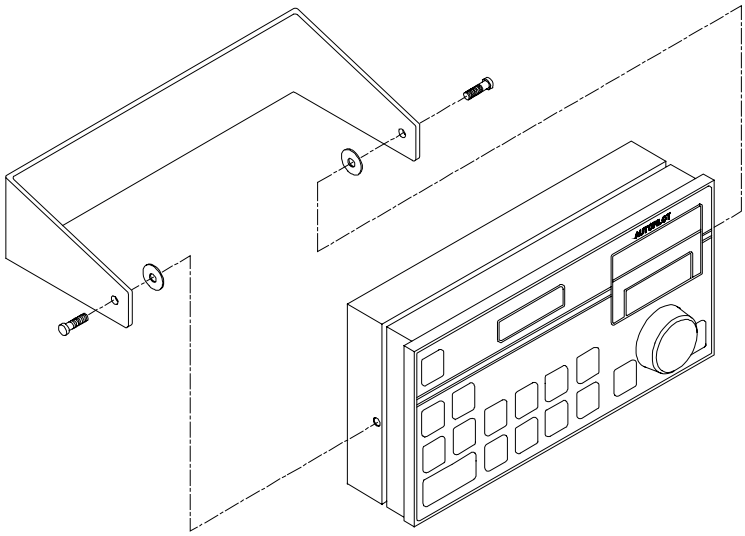


Fig. 5-2
Control unit - bracket mounting

Connector assembly

The cable conductors are connected to the connector block according to the connection lists drw. no. N4-016896. The following tools are required to crimp the connector pins and sockets to the individual cable conductors:

Crimping tool : Amp 58495-1
Extraction tool: Amp 725840

Note ! *Do not use other tools than those specified!*

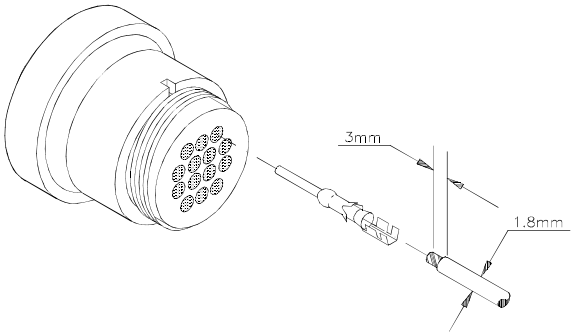


Fig. 5-3
Connector assemble

For protection against electro magnetic interference, all control unit connectors must be fitted with the supplied metal shell and cover. In addition, the cable for J1, J2 and J3 must be fitted with the supplied ferrite cores.

Screen termination

Strip about 1 cm (0.4") of the cable's insulation and pull the screen backwards to cover the insulation. Screw the connector block onto the actual control unit socket. Screw the connector shell onto the connector block. Fix the cable screen to the shell by a wire strap and tighten well to make sure the screen has good contact. Apply a thin layer of pure Vaseline on the shell threads. Screw the cover onto the shell until it makes good connection with the control unit cabinet. Fasten the ferrite core as close to the connector cover as possible by a wire strip (Only for J1, J2 and J3 cables).

The control unit has a ground terminal and must have a proper ground connection to the hull. The grounding wire should be as short as possible and at least 10 mm wide.

For grounding of the screws, also refer to Fig. 8-6 screen termination.

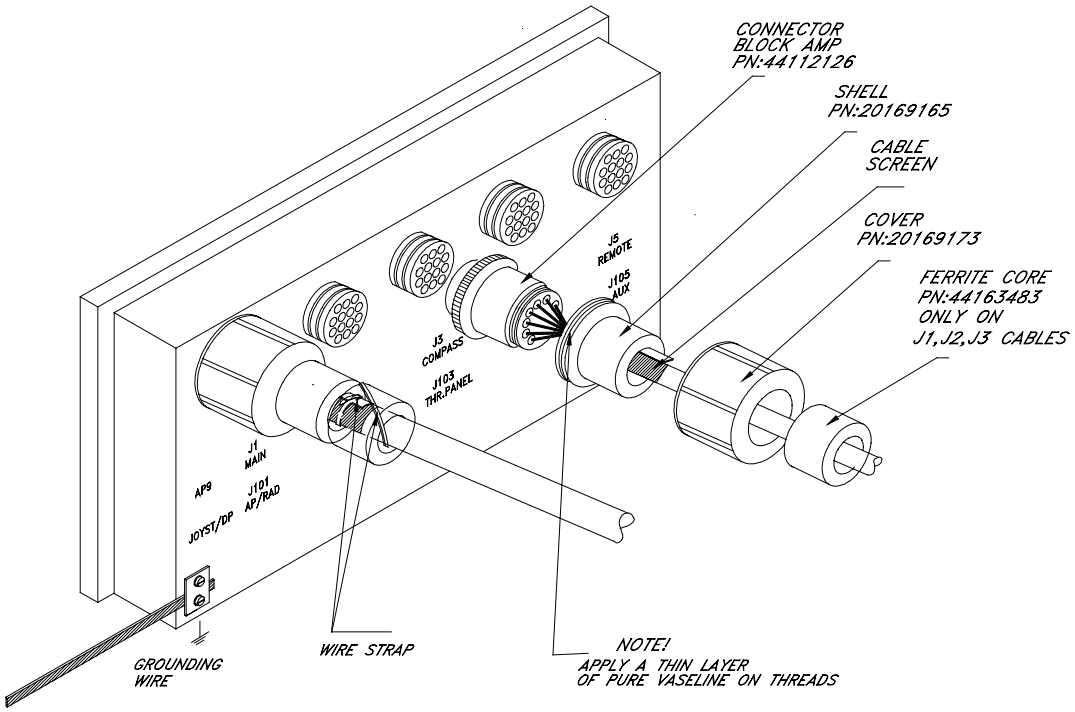


Fig. 5-4
Control unit - connector mounting

5.4 Heading sensors

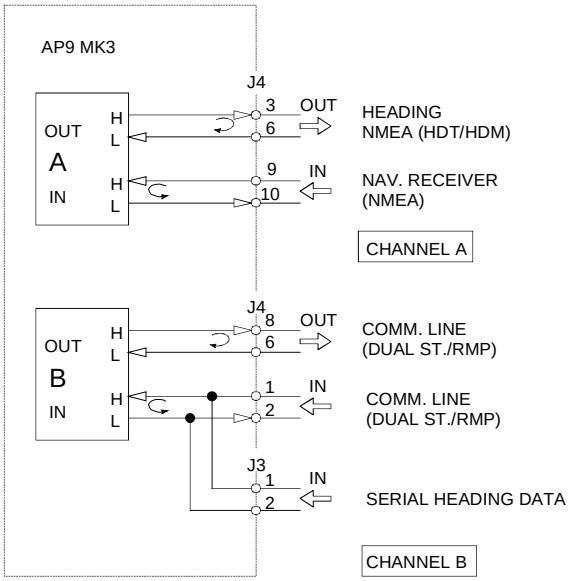
Note ! *In the case of dual station system, the heading sensor shall be connected only to the main control unit.*

General

The AP9 MK3 is capable of reading most types of heading reference sensors. These can be magnetic compasses, fluxgate sensors or gyrocompasses.

Combination of different sensors can be made, the maximum configuration is: 2 magnetic compasses, 1 gyro compass (synchro), 1 gyro compass (stepper), 1 gyro compass (current loop) and 1 fluxgate compass.

Two gyros of same type cannot be used simultaneously, e.g. 2 synchros or 2 steppers or 2 fluxgates.



NOTE: In Dual Station configuration, serial heading data can not be connected to J3, 1-2.

Fig. 5-5
Serial line connections

Note ! *A gyro compass with only serial data output, can not be used in a dual station configuration.*

When delivered from the factory, the AP9 MK3 is prepared for magnetic compasses and fluxgate compass. Gyro compass with serial / current loop output may also be directly connected, but SW1-6 on the Interface Board must be set to ON position. For connection to other types of gyros, the AP9 MK3 Gyro Interface Board is required, and switches on the Interface Board must be set to correct position. See page 5-58.

Desired steering compass and Monitor compass are selected by means of the COMPASS SELECT button and the INCREASE / DECREASE button on the front panel. See page 2-6.

Magnetic compass

To obtain an accurate heading from the magnetic compass, great care should be taken when determining the location of the compass. If possible, select a location that provides a solid horizontal mounting base, free from vibration and as close to the vessel's centre of roll and pitch as possible. It should be as far as possible from disturbing

magnetic influences such as the engines, cables, transmitter antennas or other electromagnetic objects.

Note ! *The compass must be adjusted.*

Heeling error

Heeling error may be observed when the boat is rolling and pitching, causing an unstable compass card. This can be adjusted for by using a "heeling magnet", placed vertically below or above the exact centre of the compass. The magnet is normally placed with the red end up in the Northern Hemisphere and the blue end up in the Southern Hemisphere. The correct distance between magnet and compass can best be found during sea trials. Mounting the compass close to the vessel’s centre of roll can also reduce the heeling error.

Northerly/southerly turning error

Symptoms of northerly turning error are that a vessel is "S-ing" on northerly headings when at high latitudes. The reason for this phenomena is that the earth's magnetic lines of flux are parallel to the earth's surface only at the equator, and thus no vertical magnetic component exists. When moving further north from the equator, the vertical component of the earth's magnetic field increases.

The directional reading from a magnetic compass is based upon the horizontal component of the earth's magnetic field. This component becomes smaller and smaller with increasing latitude, while the vertical magnetic component increases. The resulting effect at high latitudes magnetic compasses become sluggish and appear to be unstable. These symptoms become more apparent as speed increases.

The same phenomena is experienced in the southern hemisphere, but on southerly courses and is referred to as southerly turning error.

There is no patent cure for this problem, besides making a proper installation and adjustment of the compass.

CD109 Course Detector mounting

The course detector is mounted on the ship's magnetic compass to transmit the compass signal to the control unit. The mounting method will depend upon the compass design. The distance between the course detector and the compass card depends upon the magnetic momentum of the compass card magnets. A distance of 70-90 mm for a magnetic momentum of 1500-2000 cgs is therefore recommended. For adjustment of signal level, see below.

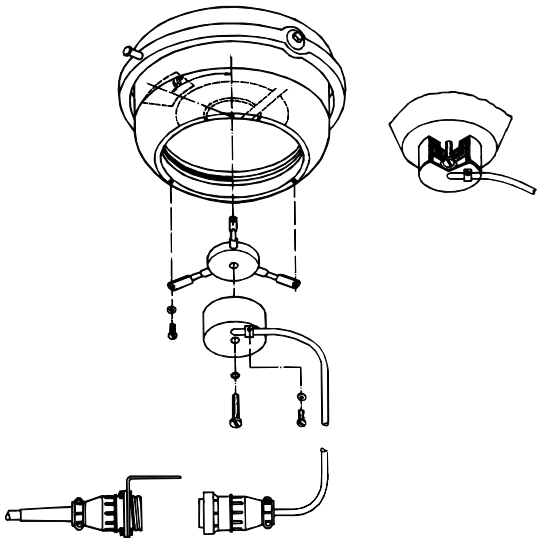


Fig. 5-6
CD109 Course Detector mounting

For mounting instructions refer to Fig. 5-6. The course detector can be attached to the compass either by a 6 mm screw to the bottom of the compass bowl or by use of the tri-pod holder supplied with the course detector.

The course detector is also supplied with cable (1m) and plug. Socket and connector with bracket for extension cable are in the standard scope of supply. The extension cable is optional equipment.

The compass should be checked for free movement in the gimbals without stressing the detector cable.

The CD109 Course Detector is connected to J2 or J3 of the control unit, and the connection is shown on the External Wiring Diagram. When connecting two magnetic compasses, one must be connected to J2 and the other to J3.

If the Course Detector is mounted on the top of the compass, the sine / cosine signal on J2 / J3 pin 10 and 11 must be interchanged.

Adjustment of signal level

The control unit supplies a 2.5V reference voltage (V / 2) to the Course Detector secondary windings, together with exciter pulses of fixed frequency to the primary winding.

The resultant voltage on the secondary windings follows the sine and cosine of the compass heading. The peak values of the sine and cosine signals are dependent on the distance between the course detector and the compass magnets. Both the reference voltage (V / 2) called CENT.SIN1 and CENT.COS1 and the sine and cosine voltages called COMP1 SIN and COMP1 COS (0-5V approximately) are

monitored by the electronics and shown in plane text on the display. Refer to the Detailed Debug list, page 5-45

The routine will monitor the signals on both course detectors if two magnetic compasses are connected.

Gyro Compass

The AP9 MK3 will normally interface to the repeater signals of a gyrocompass.

Upon delivery the Control Unit is prepared only for connection to magnetic and fluxgate compass and gyro compass with serial interface.

When connecting to other types of gyrocompasses, an extra circuit board (AP9 MK3 Gyro Interface Board) must be mounted in the Control Unit. This board is mounted to the Interface Board by means of a 40 pins plug and 4 spacers. The spacers are already mounted on the Gyro Interface Board which is plugged into the Interface Board without screw connections. If the Autopilot is ordered for gyro compass interface the Gyro Interface Board will be factory mounted.

Further more, the Control Unit must be set up for the correct type of gyro, correct phase- and reference voltage and whether gyro signal is autopilot excited or not. This is done by means of DIP switches (two packages with 8 switches in each), mounted on the solder side of the Interface Board.

Note ! *All switches are factory set to OFF position.*

Initially check the position of SW1-7 and 8 (excitation) carefully. These switches must be in OFF position prior to setting up the interface and connecting the gyrocompass.

The set-up is done in accordance to Dockside Alignment / test; page 5-49.

Electrical connections

Connection of the different types of gyro compasses are shown in the External Wiring Diagram or the diagrams on the next pages.

Gyro compass with synchro output is connected to J2 of the Control Unit.

Gyrocompass with stepper output (24-70V DC) is connected to J3 and the connection is polarity independent.

Gyrocompass with current loop (serial data) output is connected to J3 of the Control Unit.

Gyro compass synchro signal connections:

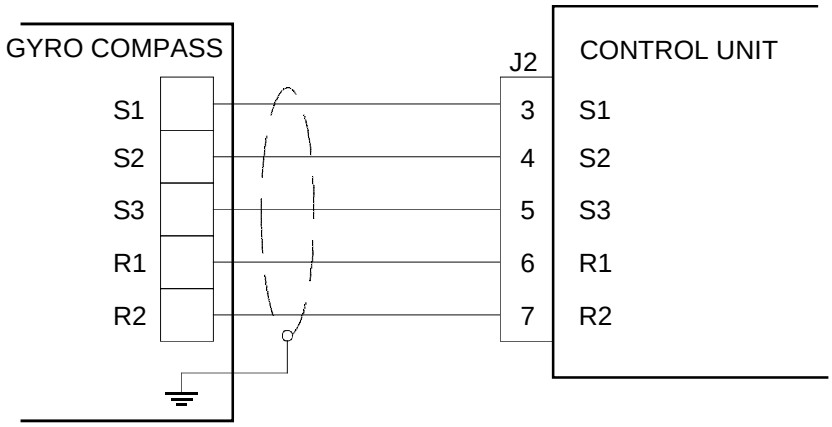


Fig. 5-7
Synchro signal connection

Caution ! ***Make sure that the SW1/2 are correctly set before connecting the plug. Ref. page 5-58.***

Gyro compass step signal connections:

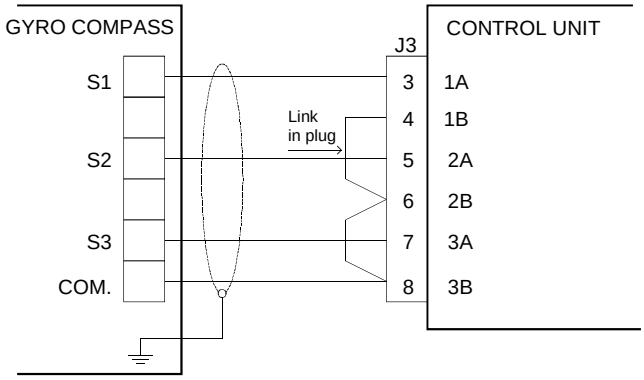


Fig. 5-8
Step signal connection

24-70V step signal, positive or negative.

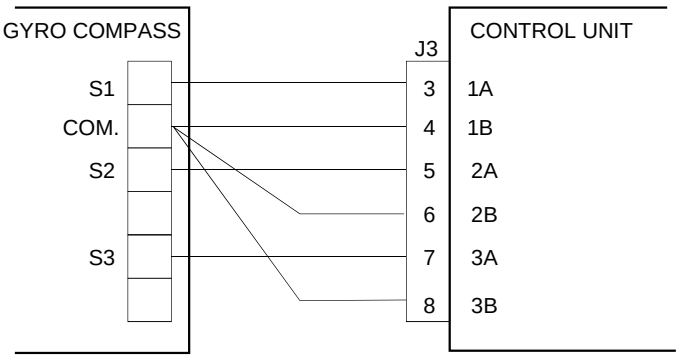


Fig. 5-9
Step signal, alternative connection

RGC50/10/11 Gyro compass connection to AP9 MK3

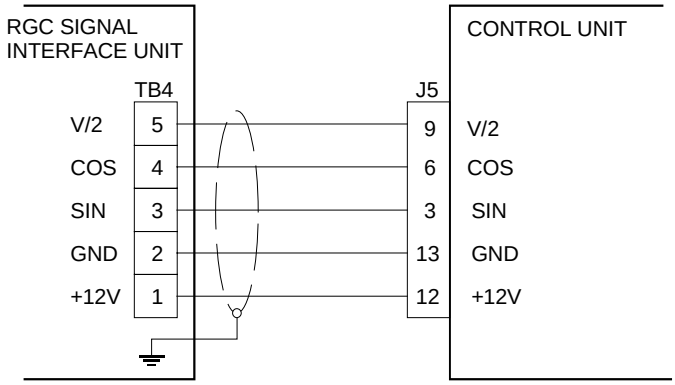


Fig. 5-10
Sine/cosine connection

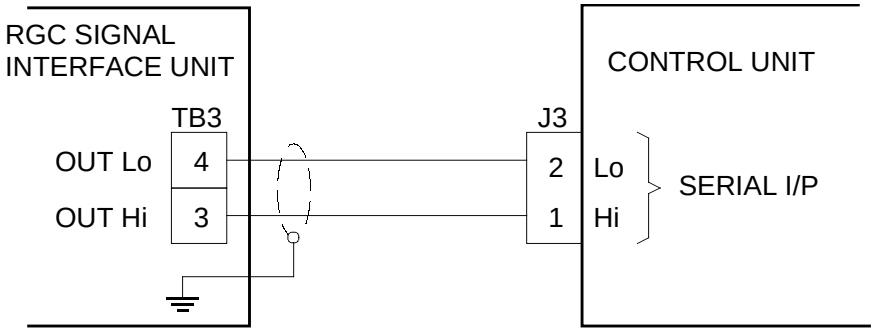


Fig. 5-11
Serial line connection

RGC12 Gyro compass connection to AP9 MK3

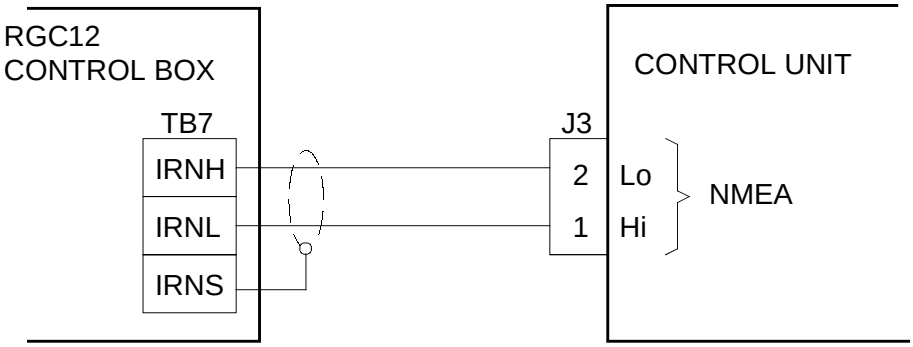


Fig. 5-12
RGC12 Serial line connection

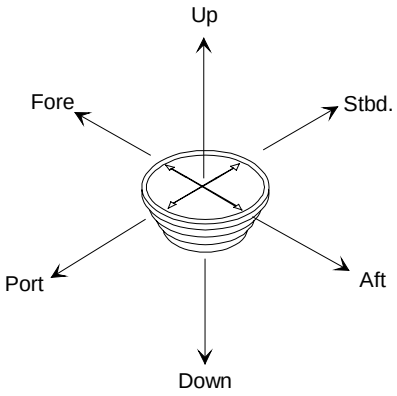
Note ! *If Dual Station is used, serial heading data can not be connected to J3, 1-2.*

RFC35NS Fluxgate Compass

For initial installation of the compass, the desired mounting location should be checked for unseen items which may cause compass error.

This is done easily by a (small) hand held magnetic compass, provided it has a visible card with markings, to detect magnetic interference.

Place the compass in the desired mounting location. Allow the compass card to come to rest and note what heading it is reading (refer to lubber line or other mark on the compass bowl).



Then slowly proceed to move the compass in a straight line fore and aft (without turning it!) approximately 30 cm out of the mounting location. Repeat the movement, but this time athwart ship.

If at all possible, also move the compass in the vertical plane (up and down).

As a thumb rule, the compass reading should not vary more than 5 degrees from the initial reading during this test. You can then be reasonably sure that the compass location is OK.

If more than 5 degrees deflection is observed, it might still be OK, but if exceeding 10 degrees, chances are that the calibration / compensation will not be optimal.

If a large deflection is observed, try to find what is causing it or find a new compass location.

Even though the RFC35 Fluxgate compasses can compensate for up to 30 degrees of deviation, these general rules should be followed to ensure the best performance from the compass.

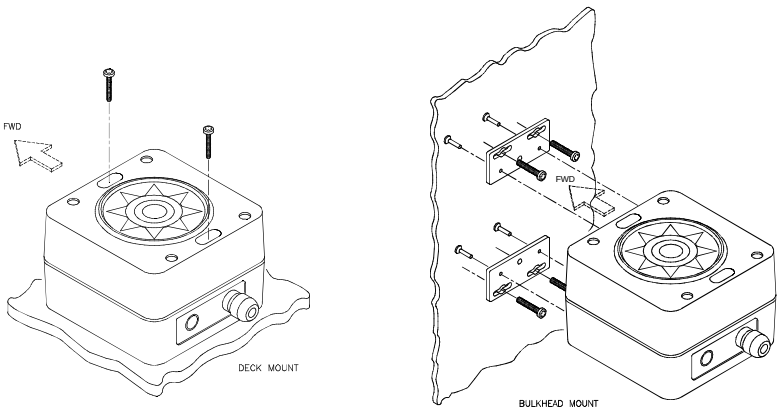


Fig. 5-13 RFC35 mounting

Electrical connection

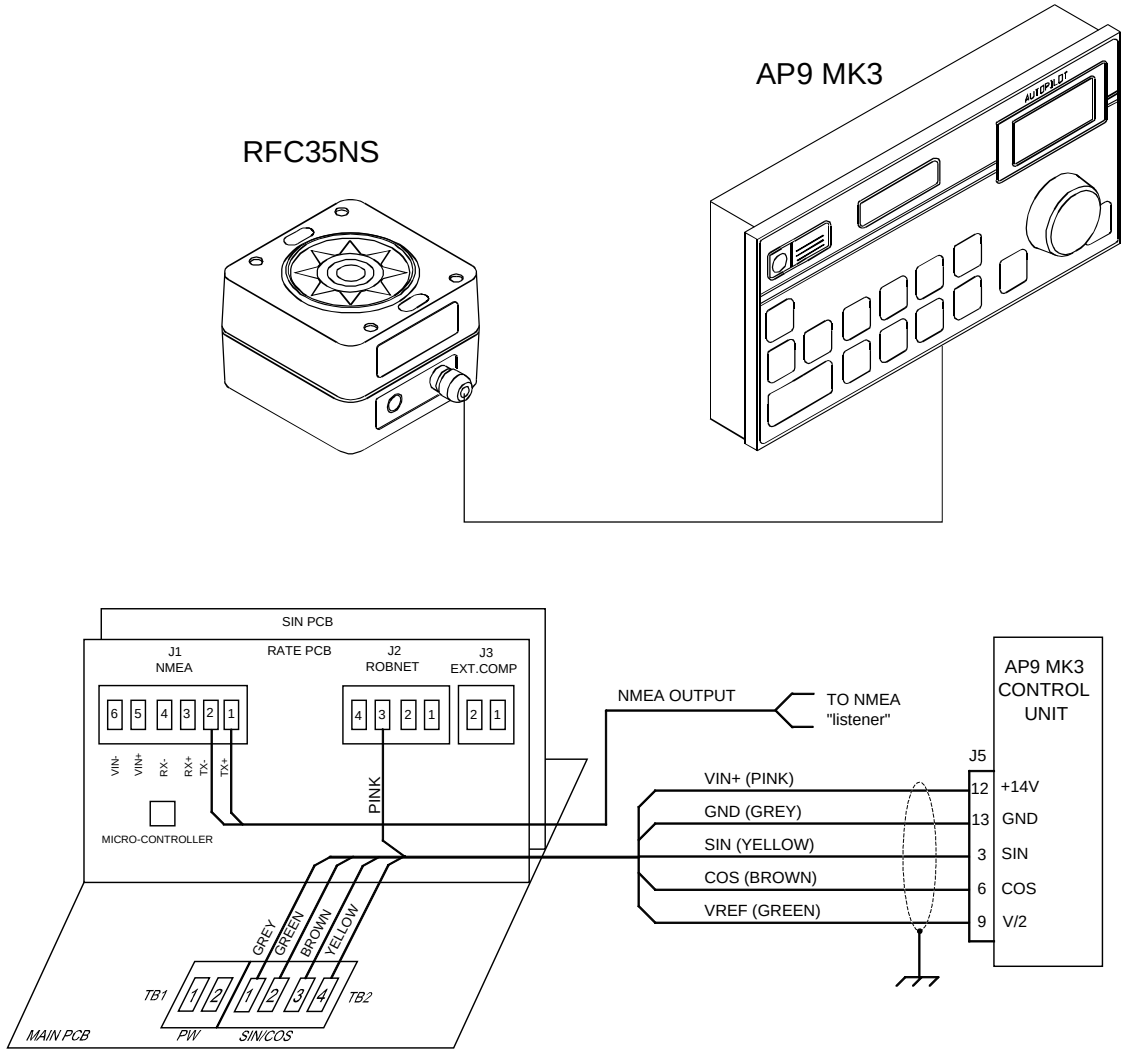


Fig. 5-14 RFC35NS wiring to AP9 MK3

RFC35N NMEA Compass

Mounting

See RFC35NS

Electrical connection

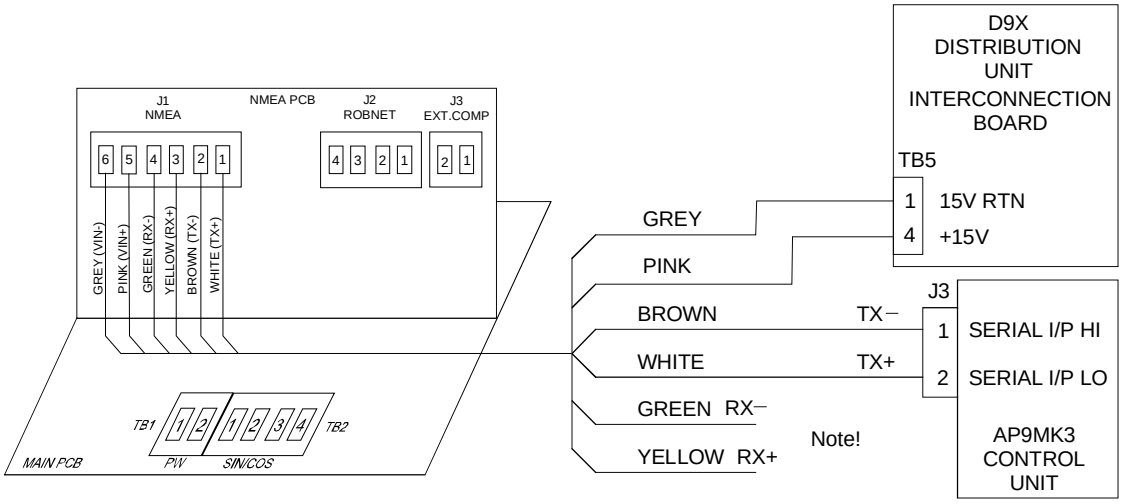


Fig. 5-15 RFC35N NMEA compass wiring to AP9 MK3

Note ! *RX+ (Yellow) and RX- (Green) are only used if the NMEA equipment can send the proprietary sentences for calibration and offset. See page 5-65.*

5.5 D90/D91/D92/D93/D99 Distribution Unit

The unit has 4 screw holes for mounting, and should be placed as near the Control Unit as practicable. It can also be mounted inside the console.

For AC mains connection an AC adapter rated at 24VDC 1,5A must be connected between the mains source and the Distribution Unit (not standard scope of supply).

For electrical connections see Wiring Diagrams.

Depending on type of Distribution Unit, the solid state relays are capable of operating solenoids for high and low DC or AC. Analogue voltage or current signal is also available for steering gears that requires analogue input signals and for reversible motors.

The relation between type of Distribution Unit and control voltage is as follows:

D90: Single relay output for low DC (19-40V), 3A

D91: Single relay output for high DC (110V), 1A

D92: Single relay output for AC (110-220V / 50-60Hz), 1A

D93: Dual analogue voltage / current output (±10V and 4-20mA)

D99: Output to control reversing motor (20A max.)

When the Distribution Unit is supplied with additional outputs or additional functions, this is indicated on the identification label on the front.

Note ! *In systems where analogue output is required, the Rudder Feedback Unit is omitted.*

Mounting

The unit has 4 screw holes for mounting, and should be placed as near the Control Unit as practicable. It can also be mounted inside the console.

Electrical connections

The DC unit has power input for 24V DC.

For AC mains connection an AC Adapter (not Simrad Robertson supply) must be connected between the mains source and the Distribution Unit.

For electrical connections refer to External Cabling Diagram and External Wiring Diagram, section 8.

Screen termination

Terminate the feedback cable screen to ST6 on the Screen termination board. Cable screen of cable from the control unit J1 should be connected to the ST7 and the cable screen of cable from the control unit J2 should be connected to ST8.

Other cable screens are connected to ST1-ST5.

The distribution unit has an external ground terminal an must have a proper ground connection to the hull. The grounding wire should be as short as possible and at least 10 mm wide.

Bus cable connection

When an extra PCB (SSB or Dual Analogue) has to be fitted inside the D9X box in the “bottom row”, a bus extension cable (FUA9X Bus Cable P/N 23602857) must be used. The bus cable is made to interconnect the “output” (left bus-plug) of the “upper row” to the “output” (left bus-plug) of the “lower” row as shown below.

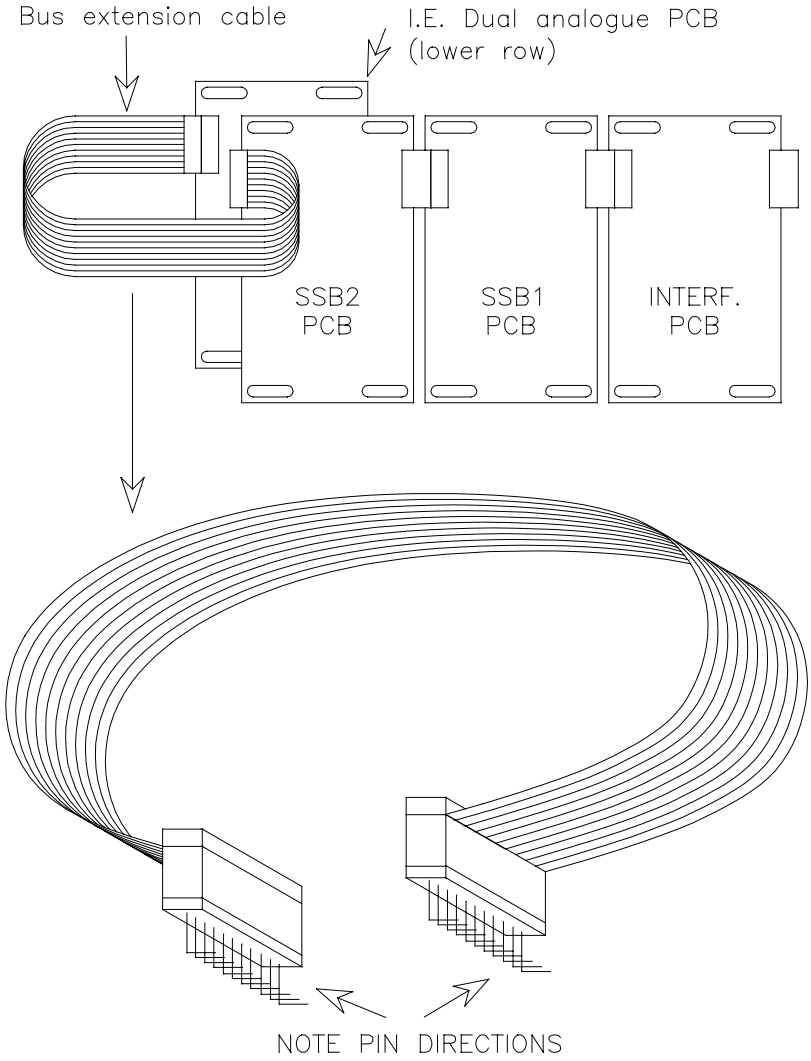


Fig. 5-16
Bus cable (P/N 23602857) connection

Adjustments

Normally no adjustment is necessary in the Distribution Unit. However, if the unit includes the Dual Analogue Board or the Thruster Interface Board, these boards must be set up during installation in accordance with the set up procedure on page 5-50.

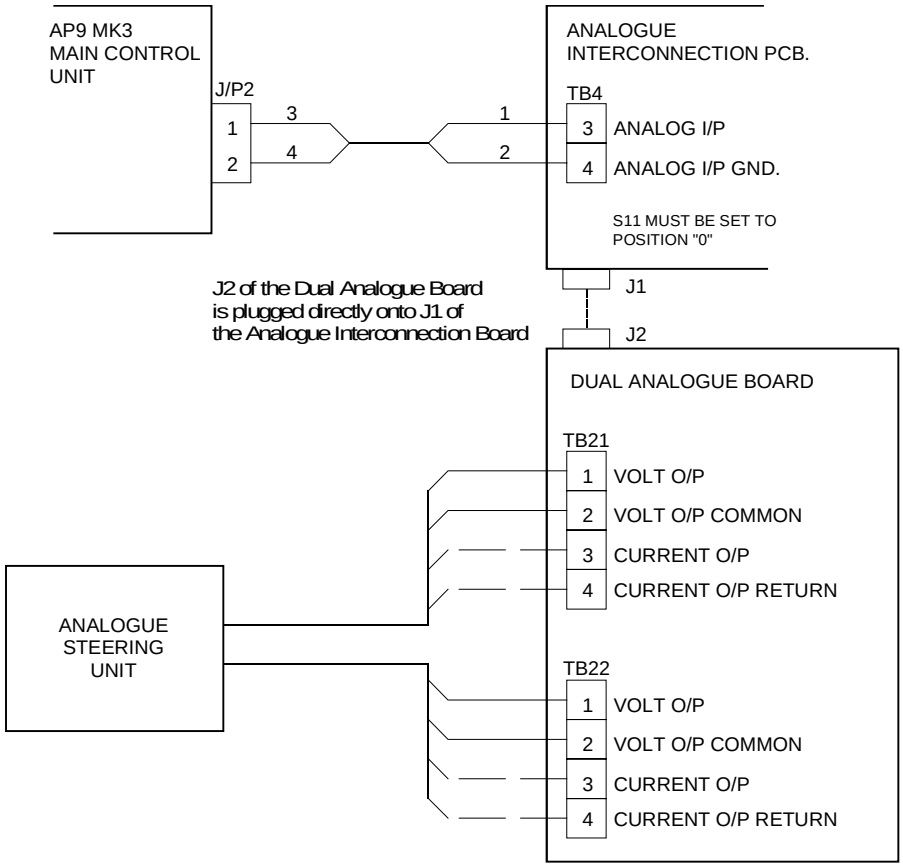


Fig. 5-17
AP9 MK3 / D93 (Dual Analogue PCB) Interconnection

5.6 RF14XU Rudder Feedback Unit

Mechanical mounting

Before installation check that the alignment mark on the mounting plate agrees with the mark on the shaft. Bring the rudder to Midships position. The feedback unit should be mounted on a plane surface and secured by bolts through the three holes in the mounting plate. It should be linked to the rudder in accordance with Fig. 5-18. It is important that the linkage is linear, i.e. the A-a and D-d are pairs of equal length. This will give a ratio 1:1 between the rudder angle and that of the feedback unit shaft. Final adjustment is made by loosen the fixing screws for the potentiometer, and carefully turn the potentiometer for correct positioning.

Note ! *If the RF14XU is mounted with the shaft pointing upwards, the yellow and the blue lead to the potentiometer inside must be interchanged (See Fig. 5-20).*

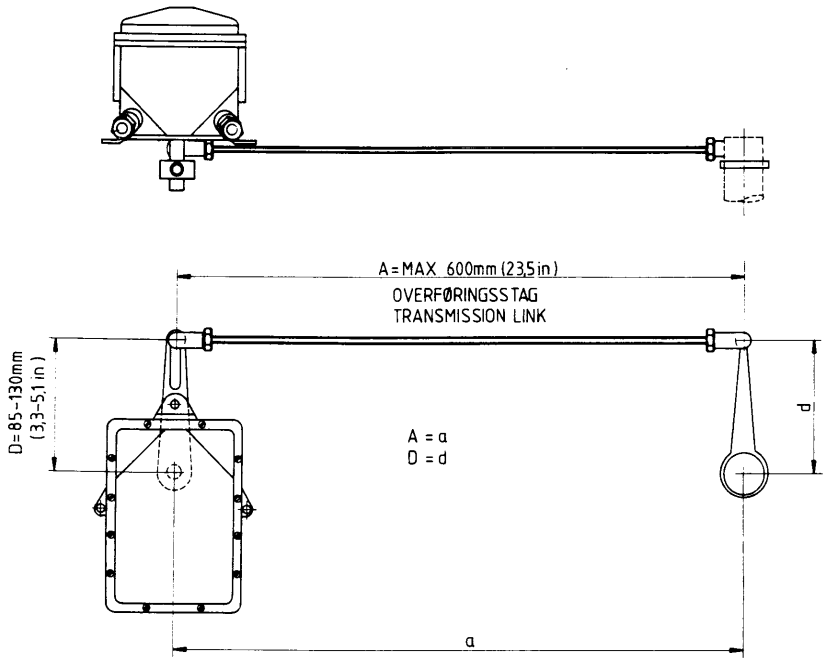


Fig. 5-18
RF14XU - Mounting

Electrical installation

The cables are carried through cable glands. If required, to avoid any mechanical damage, the cables should be run in a conduit between the rudder feedback unit and the Distribution unit or rudder angle indicator. Electrical connection is shown in the cabling diagram and the Connection list. The cable screen must be connected to the internal ground terminal. Ref. Fig. 5-19.

The feedback unit has an external ground terminal an must have a proper ground connection to the hull. The grounding wire should be as short as possible and at least 10 mm wide.

The RF14XU can be powered either from the rudder angle indicator supply (19-40V DC) or directly from the autopilot Distribution unit. If a rudder angle indicator is connected, the RF14XU is powered from the rudder angle indicator supply. If the rudder angle indicator voltage disappears, or rudder angle indicator is not connected to the RF14XU, the feedback unit is powered directly from the autopilot. The change over is done automatically.

Note ! *If RF14XU is connected to rudder angle indicators, and the indicators are powered from an unfiltered 24V supply, the enclosed 470uF capacitor should be connected across the supply. Without the capacitor, a deviation*

may occur between the autopilot feedback midposition reference and that of the rudder angle indicator(s).

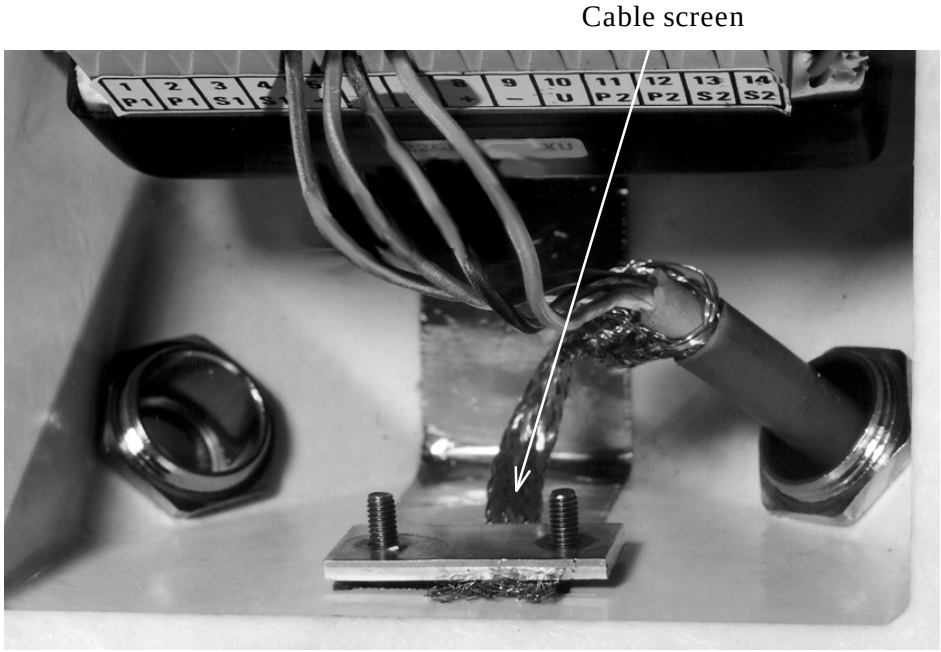
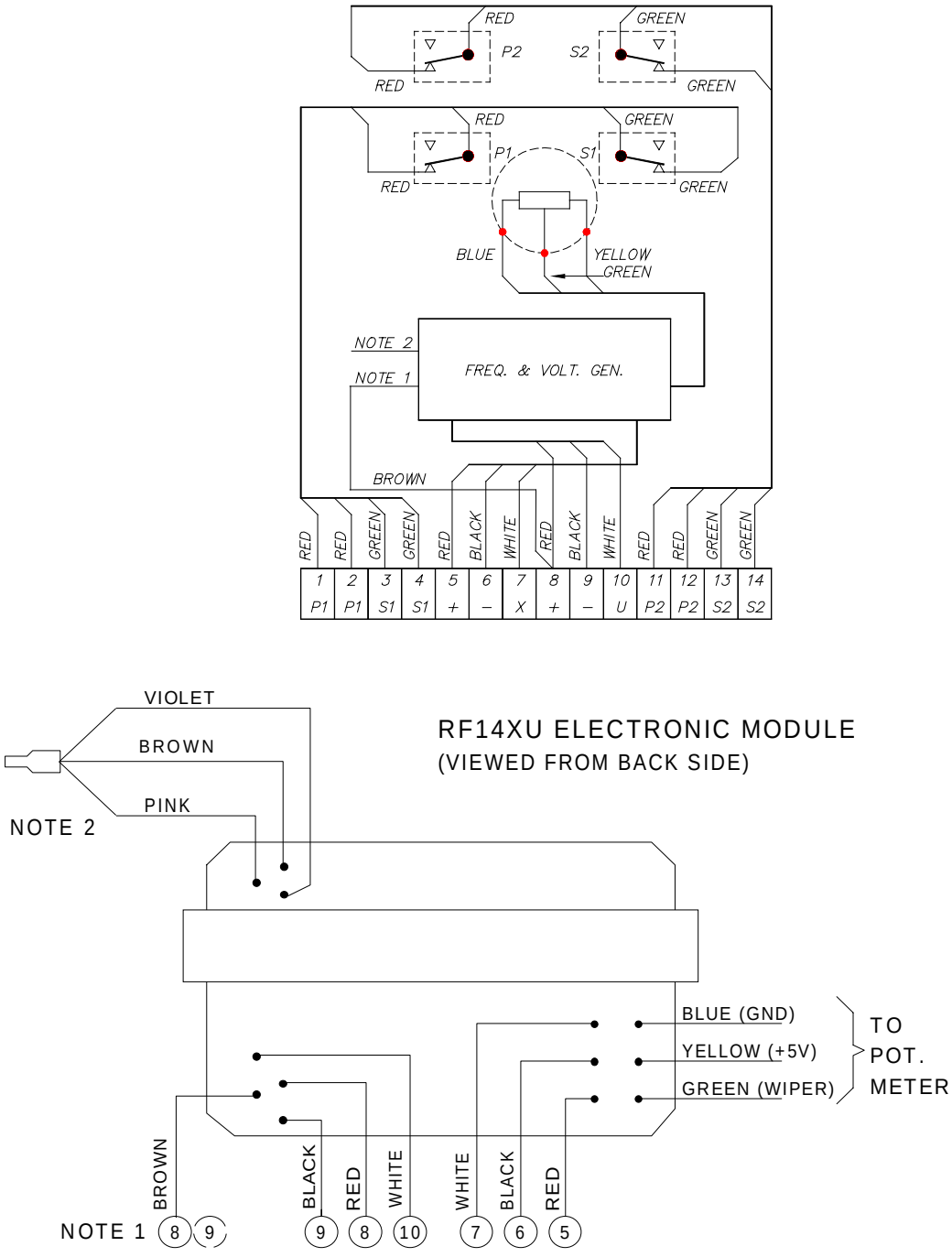


Fig. 5-19
Screen termination

Scaling of rudder angle

The RF14XU is normally delivered for ±45 degrees rudder angle (violet, brown and pink leads are not connected). For ±60 degrees, connect brown lead to terminal 10, for ±70 degrees, connect pink to terminal 10 and for ±90 degrees, connect the violet lead to terminal 10. White lead must remain connected. To invert the indicator deflection, the brown lead to terminal 8 of the RF14XU terminal board must be connected to terminal 9. See Fig. 5-20.



NOTE 1: Brown lead normally connected to (8). Move to (9) to invert the rudder indicator deflection.

NOTE 2: Normally connected for +/-45˚ rudder angle (violet, brown and pink leads are not connected). For +/-60˚ connect brown lead to terminal 10, for +/-70˚ connect pink lead to terminal 10, for +/-90˚ connect violet lead to terminal 10. White lead must remain connected.

Fig. 5-20
RF14XU Internal wiring

Final check

After installation, the cable glands must be sealed with silicon to prevent water from seeping in. Also apply silicon grease to the gasket between the bottom and top cover.

On the inside of the feedback unit cover, a piece of moisture protecting sponge is attached. The sponge produces a corrosion preventive gas, and to increase the efficiency of the gas the cover must be kept tight.

5.7 Optional equipment

AP9 MK3 Dual Station

The extra AP9 MK3 Control Unit is connected to the main control unit according to the Dual Station Wiring Diagram. Operating voltage and alarm voltage are supplied from the distribution unit. The remote unit communicates through the main control unit, and requires the main control unit switched on before use. The main control unit and remote control unit can change places in the system.

External mode selector and NFU Lever can also be connected to the remote unit.

Note ! *FU function is not possible from Remote unit*

Gyro compass with serial gyro information output (current loop and NMEA) can not be connected to the Control Unit when a Dual Station is connected.

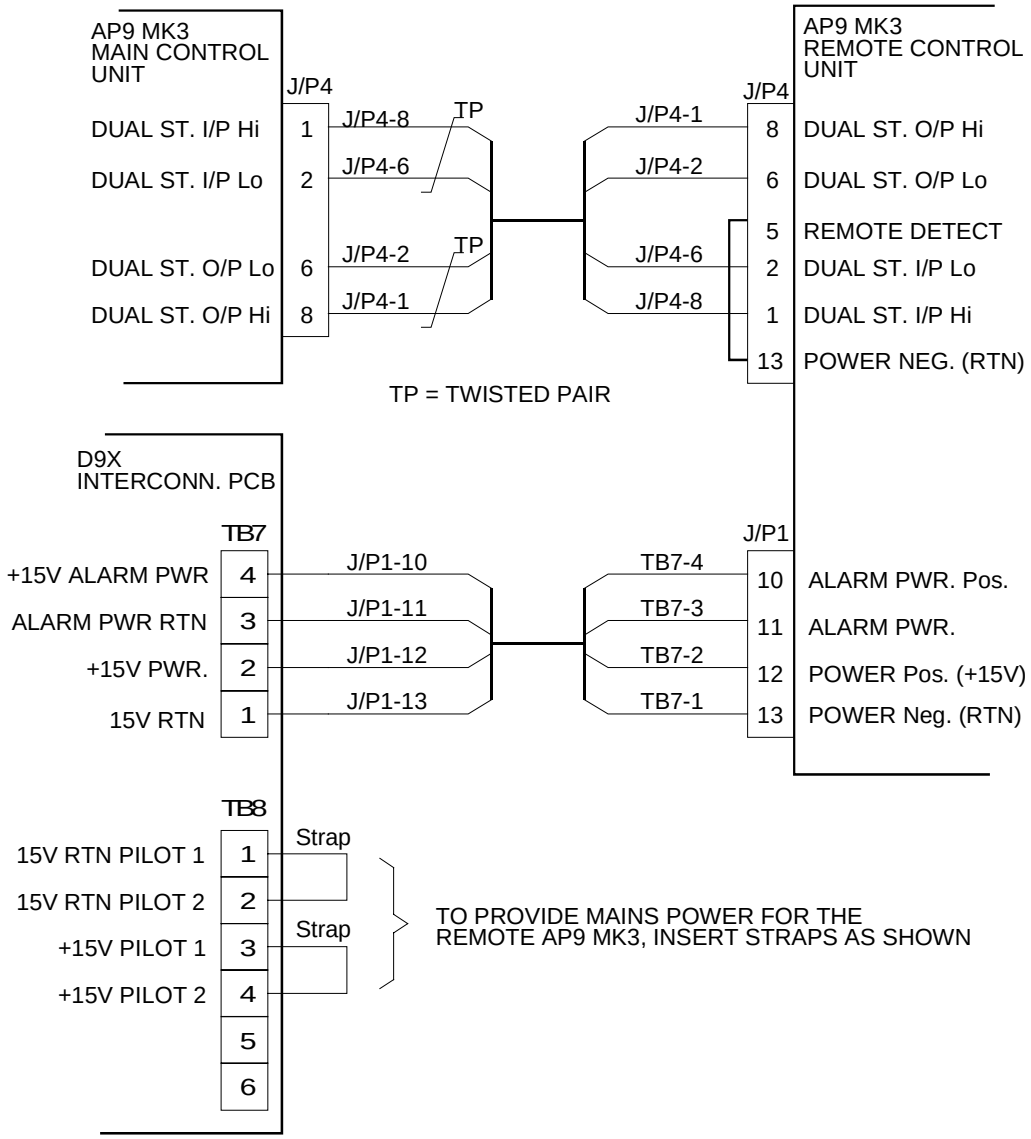


Fig. 5-21
Dual station wiring diagram

5.8 Mode selection (External mode selector)

(For connection diagram of optional equipment, refer to section 8.)

The mode selector lines from the AP9 MK3 Control Unit J1 are marked as:

A: Modus 1 NFU (J1-1)

B: Modus 2 FU (J1-2)

Whenever one of the mode lines is connected to common (J1-13), the selected mode will be entered. The mode will however change to NFU when the mode line is disconnected from common.

It is also possible to arrange the mode lines for absolute control of the modes.

By one single ON-OFF switch, the autopilot can be connected to alter between NFU-AUTO or FU-AUTO as follows:

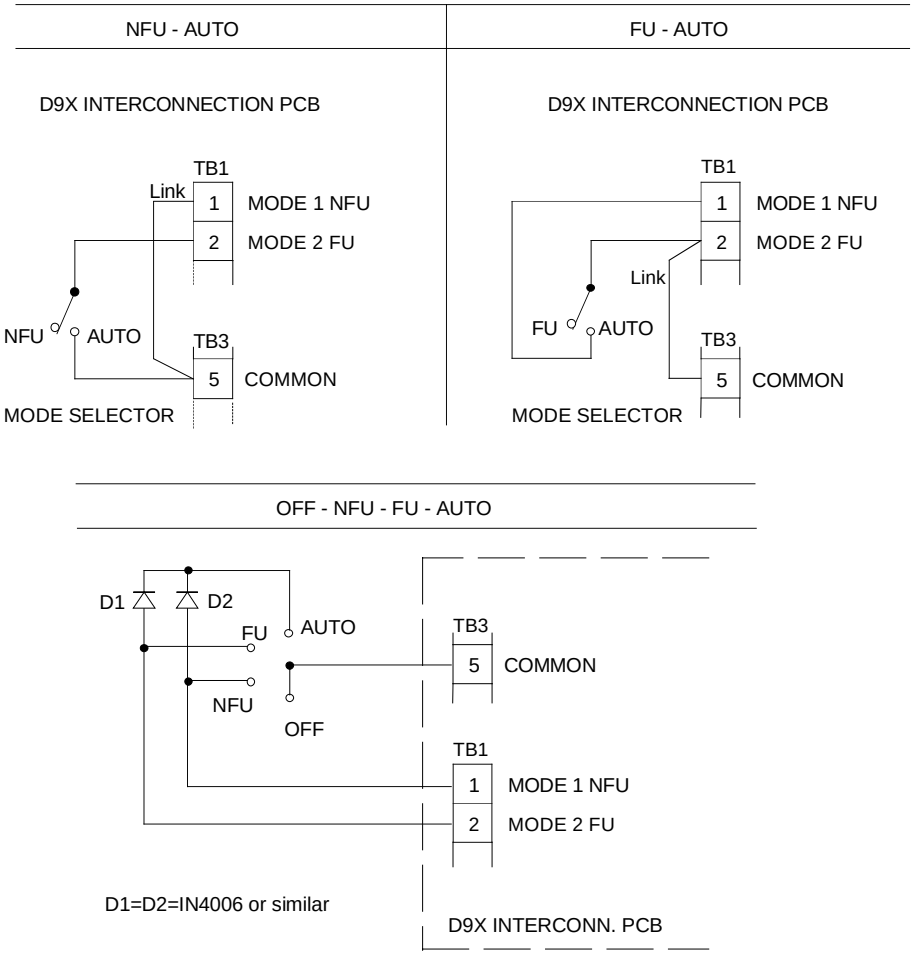


Fig. 5-22
Mode Selector connection

Caution ! ***F200-40 can be used only when the mode selector includes an OFF position to disable external mode selection.***

F200-40 and Mode Selection

To allow the F200-40 to control the modes of the AP9 MK3, no links in connection with NFU-AUTO or FU-AUTO must be present. It is therefore required to disconnect the links by adding an extra function to the Mode Selector Switch.

Example:

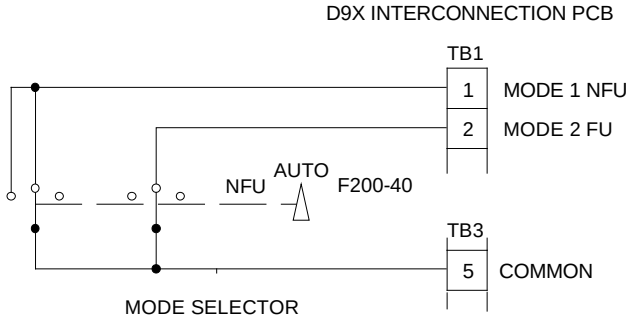


Fig. 5-23
F200-40 as Mode Selector

Complete Mode Selections

By using the following connection, mode selection between F200-40 / NFU / FU / AUTO can be made:

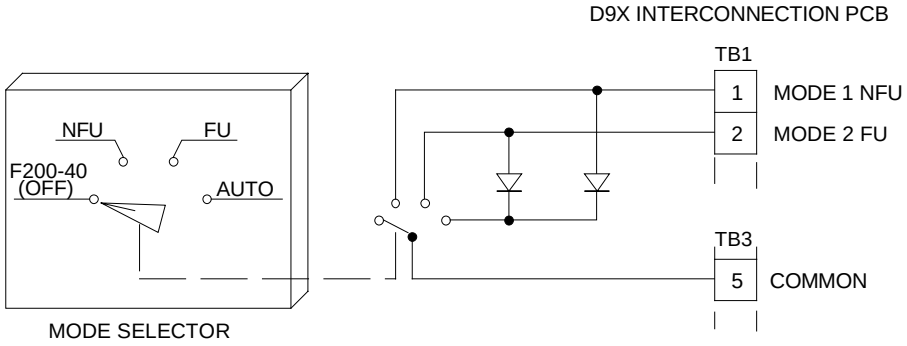


Fig. 5-24
Complete mode selection

Note ! *If F200-40 is not used, this position can be omitted.*

5.9 F200-40 Remote Control

This unit is fixed to a mounting bracket, which is secured by four screws. F200-40 is connected to J5 on the control unit according to Fig. 5-25

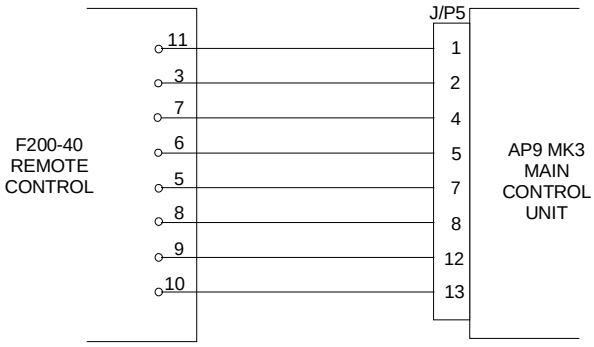


Fig. 5-25
F200 Remote Control, connection

5.10 S9 Steering Lever

Mounting

Refer to Fig. 5-26. For bulkhead mounting, use the 8 bushings enclosed with the unit. These are placed two and two against each other and the screws are put through them. Direct contact between S9 and a steel bulkhead is then avoided and corrosion is prevented. The cover plate can be turned 360 degrees for the most convenient position of cable outlet. For panel mounting use the two mounting brackets enclosed with the unit (Fig. 5-27.).

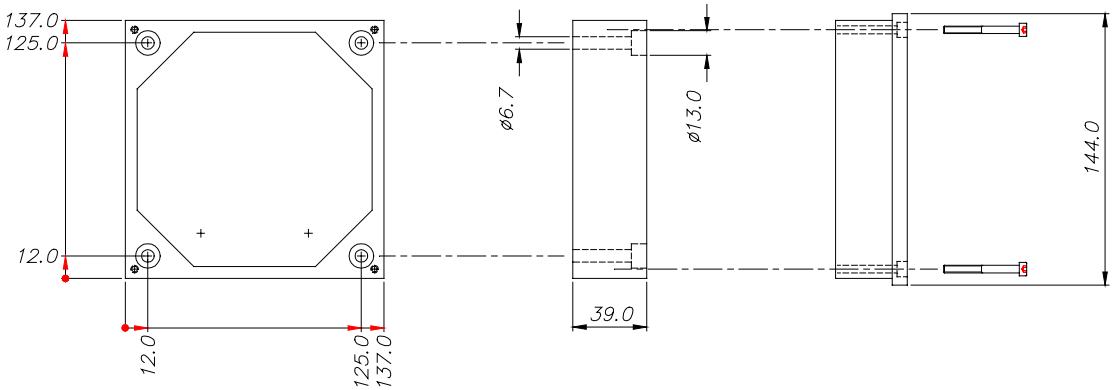


Fig. 5-26
S9 Steering Lever, bulkhead mounting

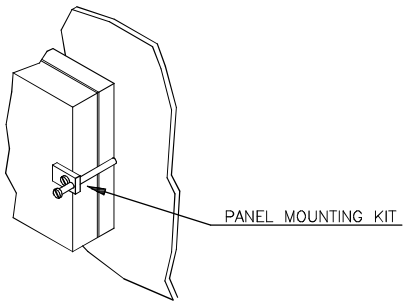


Fig. 5-27
S9 Steering Lever, panel mounting

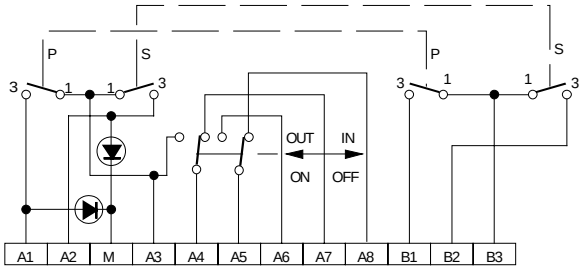


Fig. 5-28
S9 Steering Lever, Internal wiring

Electrical connection

(Refer to page 1-11 for options).

Connection to the D9X Distribution Unit is in accordance with Fig. 5-29 and Fig. 5-30 for priority and non-priority connection respectively.

AUTO / FU - NFU by S9

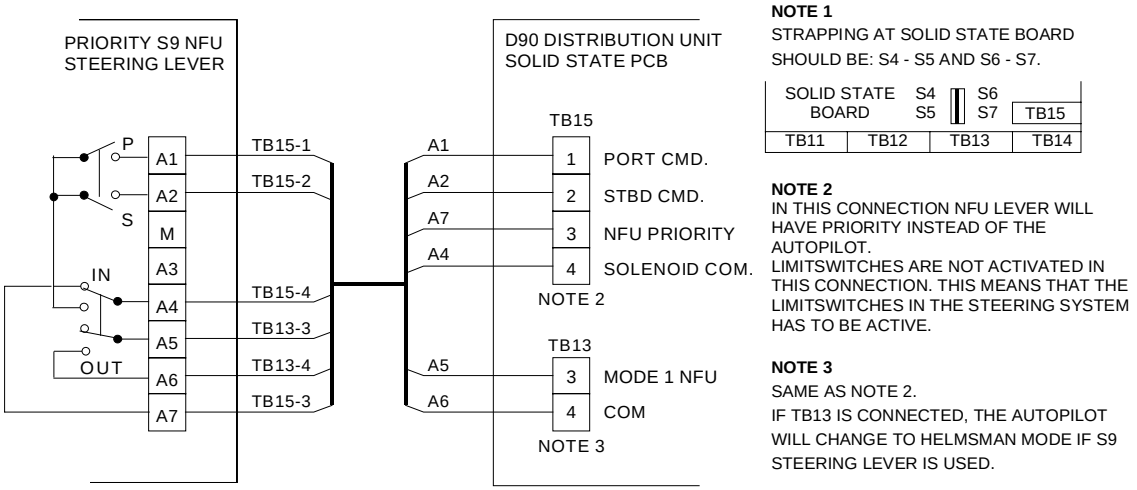


Fig. 5-29
Priority NFU control by S9 directly to valves

Note ! *Make sure the valves are within the rated specifications for the S9.*

Function

The mode will change to NFU when the S9 is pulled out. The Solid State PCB is disconnected and the valves are operated only from the S9. To resume AUTO function, the S9 must be pushed in and AUTO-button pressed.

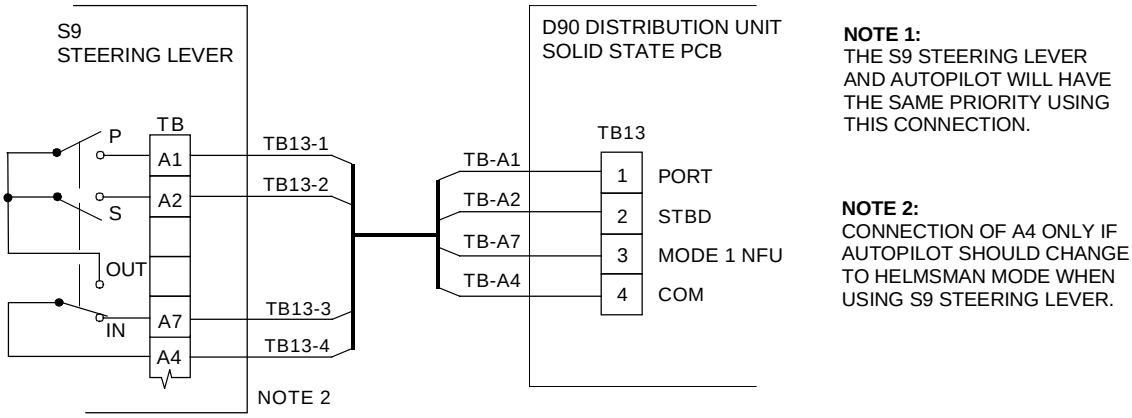


Fig. 5-30
Non-priority NFU control by S9, no valve load to S9

5.11 FU9X Follow up Steering Lever

Mounting

Refer to Fig. 5-31. For bulkhead mounting, use the 8 bushings enclosed with the unit. These are placed two and two against each other and the screws are put through them. Direct contact between FU9X and a steel bulkhead is then avoided and corrosion is prevented. The cover plate can be turned 360 degrees for the most convenient position of cable outlet. For panel mounting use the two mounting brackets enclosed with the unit (Fig. 5-27).

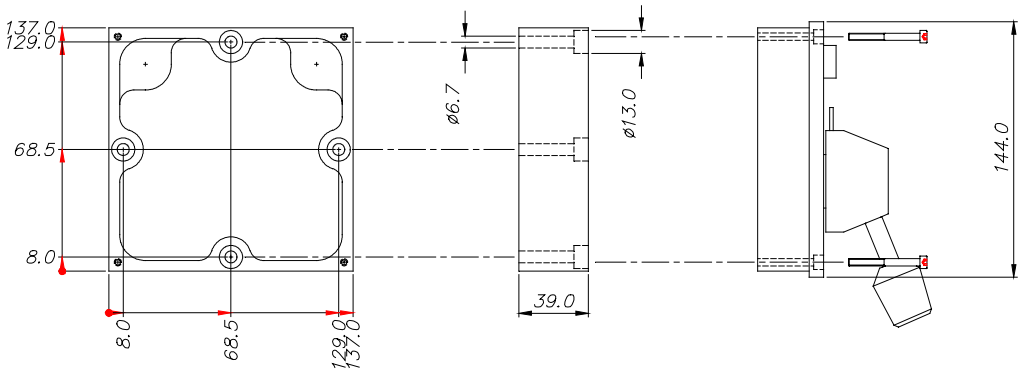


Fig. 5-31
FU9X Steering Lever, bulkhead mounting

Electrical connection

The FU lever is connected to the D9X Distribution unit according to Fig. 5-32.

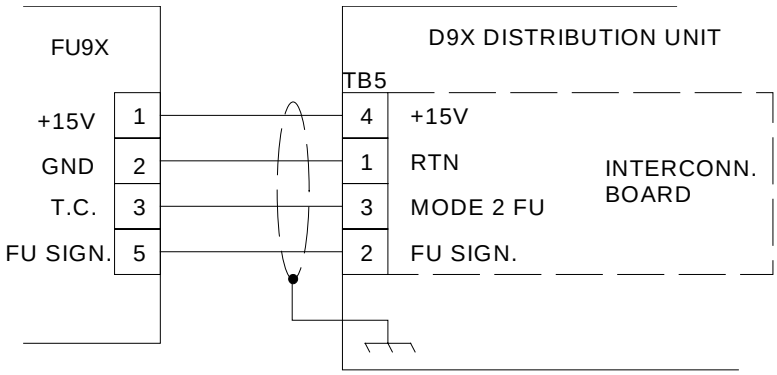


Fig. 5-32
FU9X connection to D9X

5.12 S35 connection to D9X

The unit is bulkhead mounted by two screws. For cable connection see Fig. 5-33 and Fig. 5-34. Note that the port and stbd. switches are determined by the position of the lever, i.e. whether it is pointing up or down.

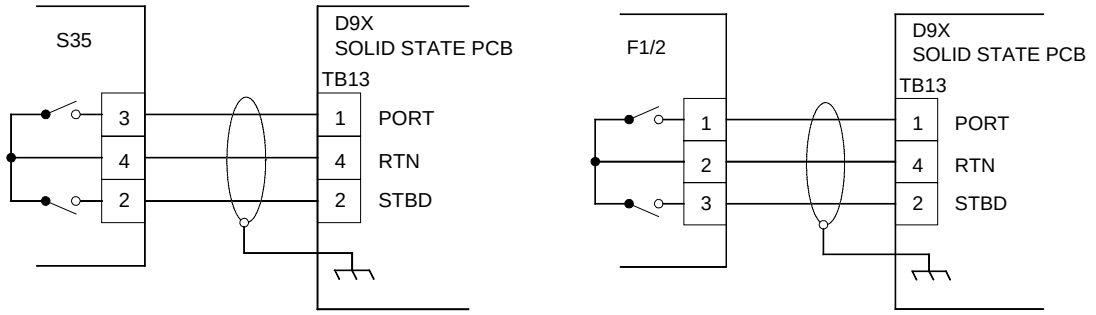


Fig. 5-33
S35 and F1/2 connection to D9X

Note ! *Remove jumper J1 in S35 when used with AP9 Mk3.*

S35 alternative connection

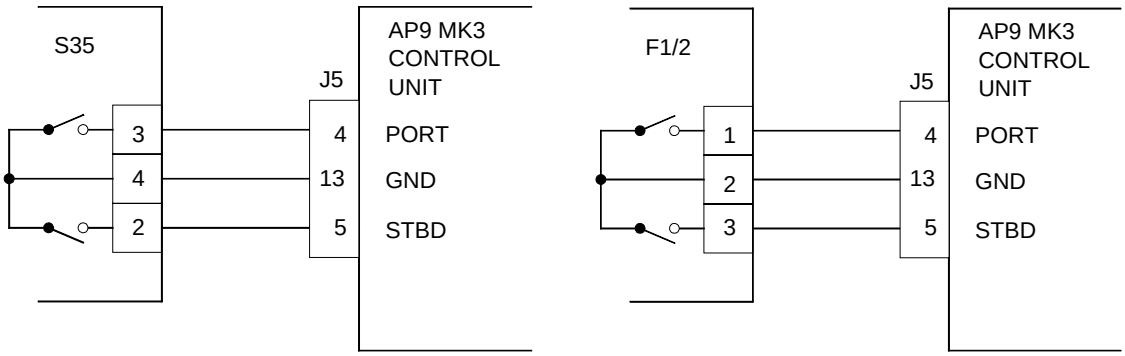


Fig. 5-34
S35 and F1/2 alternative connection to AP9 MK3

This connection allows the S35 to perform course change when the autopilot is set for Auto function. The course will be 1° for every operation of the lever. To make a 3 degree Port command activate the lever three times to port. Else normal NFU steering can be made when operating in the Helmsman mode.

Note ! *Remove jumper J1 in S35 when used with AP9 Mk3.*

5.13 RI9 Rudder Angle Indicator

The RI9 can be bulkhead or panel mounted in accordance with Fig. 5-26 or Fig. 5-27. It should be located in clear view of the helmsman. Two or more indicators may be connected in parallel to the rudder feedback unit. It is then recommended to use the R.A.I. Junction unit. Refer to the R.A.I. system manual.

Electrical connection for a single indicator is shown on Fig. 5-35.

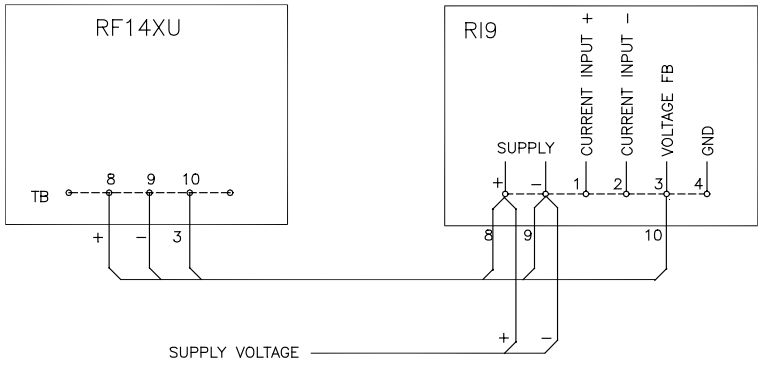


Fig. 5-35
RI9 connection

5.14 PANORAMA Mk2 Rudder Angle Indicator

The PANORAMA Rudder Angle Indicator is designed for overhead mounting. The splash proof plastic cabinet contains 3 identical scales to obtain accurate reading of rudder angle from any position in the wheel-house. The Indicator is designed for rudder angles up to 45 degrees on either side of midship position. Scales for 60, 70 and 90 degrees are available as optional extras. The Indicator has internal scale illumination, adjustable by an external dimmer.

Installation

Mount the unit at a place where the best possible viewing angle(s) is obtained and make sure there is room for the cables(s) to enter the unit.

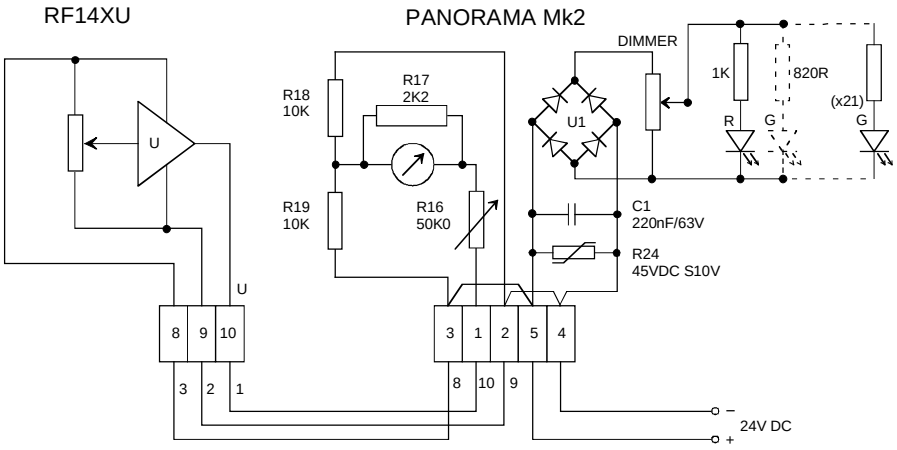


Fig. 5-36
Panorama connection

The electrical wiring between the PANORAMA Rudder Angle Indicator and the RF14XU Rudder Feedback Unit is shown in Fig. 5-36. The wiring should be a 4-core cable, preferably an armoured cable of approved type, and minimum 4x0,75 sq.mm.(AWG18).

Calibration procedure

1. The indicator has been calibrated from factory and should need no readjustment.
2. Check that the RF14XU Rudder Feedback Unit is installed in accordance with the instructions given on page 5-15.
3. Verify that the indicator shows zero degrees with the rudder amidships.
4. Take the rudder from starboard hard-over position to port hard-over position and verify that the reading is correct, eventually adjust the deflection potentiometer inside the connection housing.

5.15 Analogue ±10V or 4-20mA control signals

In case of ±10V analogue signal or 4-20mA current signal for steering or operation of thruster, two possibilities are available:

- Dual Analogue ±10V signals via the Dual Analogue Board. The signal is intended to control rudders with separate Follow-up amplifier. Refer to drw. N3-017115).
- One ±10V analogue signal can be obtained by using the Thruster Interface PCB. This system is described as the Thruster Control system. This optional feature enables the AP9 MK3 Autopilot to control one thruster in three different ways:
  - – Only rudder control (no thruster). PARAMETER 2 is shown.
  - – Only thruster control
  - – Combined rudder and thruster control

To enable the thruster interface, the standard Interconnection Board (part no. 20125027) is replaced by the Thruster Interface Board (part no. 20125017). This board will provide either one ±10V analogue signal or one 4-20 mA current signal, generated from the control unit via the Thruster Interface Board.

Note ! *There are two versions of the Thruster Interface Board. The latest includes a trim potentiometer (RV15) for adjustment of the output voltage level and is marked with revision "A".*

To enable the analogue signal from the control unit, a separate switch must be used to ground the "thruster ON / OFF line" (J / P4). Refer to Fig. 5-37.

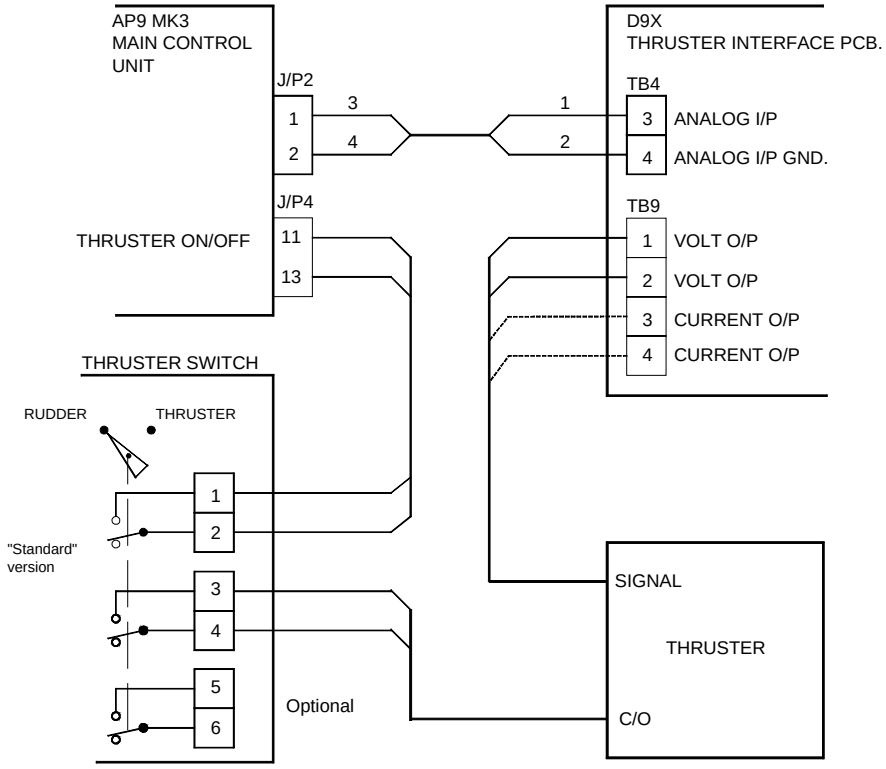


Fig. 5-37
AP9MK3 /Thruster Interconnection

Whenever entering the "Thruster" function, separate settings of the following parameters can be set:

- OFF COURSE LIMIT
- COUNTER RUDDER
- RUDDER
- WEATHER

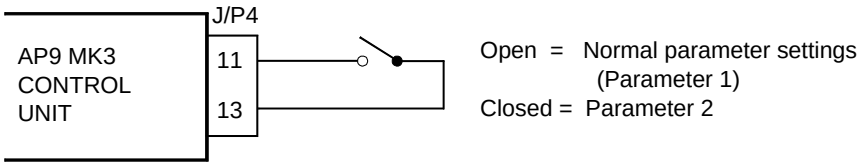
When “Thruster function” is selected separate settings of THRUSTER DEADBAND and MIN. THRUST are enabled. This means that deadband for the analogue thruster signal can be set independent from the ordinary Rudder Deadband. Also the gain (MIN. THRUST) of the analogue signal can be set independent from the RUDDER

gain. With MIN. THRUST, the gain of the analogue signal equals the RUDDER setting. By this combination it is possible to operate the rudder with one set of parameters and at the same time have different settings of the above mentioned parameters. Whenever the parameters are set or changed, they are stored.

Parameter 2 option

This parameter is entered by selection “Only Rudder” when the options “Only Thruster”, “Rudder+Thruster”, “Only Rudder”, is shown in the Thruster Function selection. Ref. page 2-14.

The parameter allows for a second set of parameters to be stored and recalled whenever this mode is entered, hence the parameters for i.e. high speed or low speed or i.e. loaded-unloaded may be selected by flipping a switch. The connection is shown below.



5.16 Connection to Navigational Receiver

The output from the navigational receiver is connected to AP9 MK3 J4 pin 9/10 (see Fig. 5-38.). The AP9 MK3 accepts signals of NMEA 0180/0183 format, with Baud rate of 4800 baud and standard polarity (Standard polarity: Logic "0"= 5V (20mA)). Correct NMEA format, baud rate and current loop polarity are found in the navigational receiver manual.

The NMEA 0183 format accepts different sentences. See Technical specifications, page 4-1.

For receivers with NMEA 0183 format that outputs both the cross track error and the course to steer type of nav. information, the autopilot displays the type of information selected from the INFO-function (NAV. TYPE). When radius steering is selected, the VTG sentence must be included.

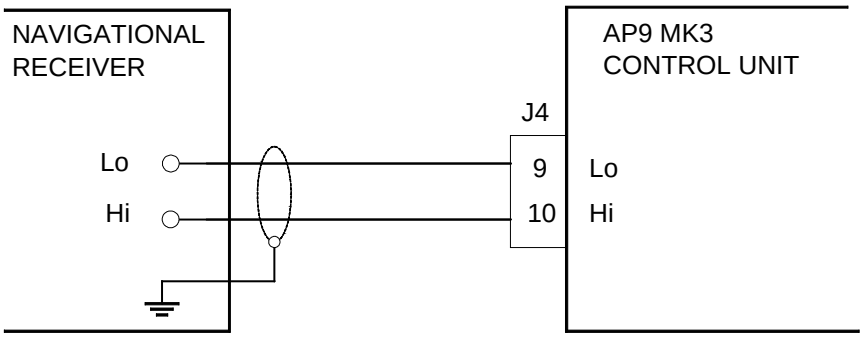


Fig. 5-38
Navigational receiver connection

5.17 Start-Up and commissioning

After finishing the installation and interconnection of all units, check that correct power and polarity is supplied to the distribution unit. A green light emitting diode on the Power Supply Board indicates that power is supplied to the control unit.

Alignments, selection of course sensor and adaption of the autopilot parameters to the vessel's characteristics must be carried out according to the following procedure.

Power ON

Turn on the control unit by pressing the HELMSMAN button. The Information Display shows INITIATION together with the software version for two-three seconds after switch on.

INITIATIONPROGRAM V1R4

If synchro-/stepper gyro already has been selected as steering compass by using the COMPASS SELECT button, GYROADJUST will appear in the information display and the heading readout in the course display has to be matched to the gyro heading by means of the INCREASE/DECREASE button before the autopilot can be brought into service.

For alarm messages, see Fault warnings; page 6-1.

Rudder Feedback Unit Adjustments

The Rudder Feedback Unit must be adjusted to centre position when the rudder is at mid-position. This is done by using the DEBUG mode, which enables the rudder angle to be shown digitally on the Information Display. Use the following procedure:

a. Move the rudder to mid position.

b. Select HELMSMAN mode on the control unit.

c. Select DEBUG-mode by pressing the hidden DEBUG button (just to the right of the NAV. SYSTEM button) and then the INFO button.
   The Information Display now shows:

   DEBUG MODE
   RUDDER S0.0

   S = starboard, P = port

   If DEBUG AD is shown on the information display press the hidden DEBUG-button one more time.

d. Adjust for approx. zero rudder angle (less than 0.6 degrees) by turning the shaft of the feedback unit after it has been loosened from the lever. Secure the lever after completion of adjustment.

e. Turn the rudder to 5° starboard and check that the information display reads S05. Then turn the rudder to 5° port and check that the display reads P05.

Pressing either the HELMSMAN or AUTOPILOT button restores normal operation of AP9 MK3.

5.18 Selection of parameter settings

After finishing the mechanical adjustments, the control unit itself must be "programmed" for adaption to the vessel's characteristics.

With the INFO button it is possible to call up a number of functions and adjust parameters. Some of which are used under normal operation, the others are set during installations and sea-trials.

The INFO function is divided into two levels. The first level is accessed simply by pressing the INFO button, and contains functions and settings used during normal operation.

The second level is accessed by keeping the INFO button pressed while pressing and releasing the WEATHER button. This INFO level contains functions and settings set during installation and sea trials.

Both levels are a closed loop and rotates one at a time each time the INFO button is pressed. The parameter that is called up is shown in the information display. The value of each parameter can be changed by pressing the INCREASE or DECREASE button.

Note that some changes will occur when "THRUSTER" function is selected (connecting J4-11 to J4-13).

In the table on page 5-48 the range of each function is listed, together with a recommended value for setting before sea trial. Note the final value selected under the sea trial, and also note any changes of values.

Note ! *Also use “SAVE PARAMETER” function to store all parameters after sea trial. Refer to Debug loops page 5-44.*

Information and Debug Loops

General

A number of information and signal status are available via the information display. The information are divided in two "loops", INFO loop 1 and INFO loop 2. The first loop contains settings of parameters not used daily, but regards as often used and therefore easy available.

The second loop contains parameter setting, entered during initialization. It also includes software version and runtime in AUTO / NAV mode.

The Debug loops are also divided in two loops and are intended for service purpose.

The first loop contains information of signal status while the second loop, the Service loop, contains different selections for test purpose and operating condition.

The service loop also contains a Save Ideal function. **Always store the parameters when change of tuning is made.**

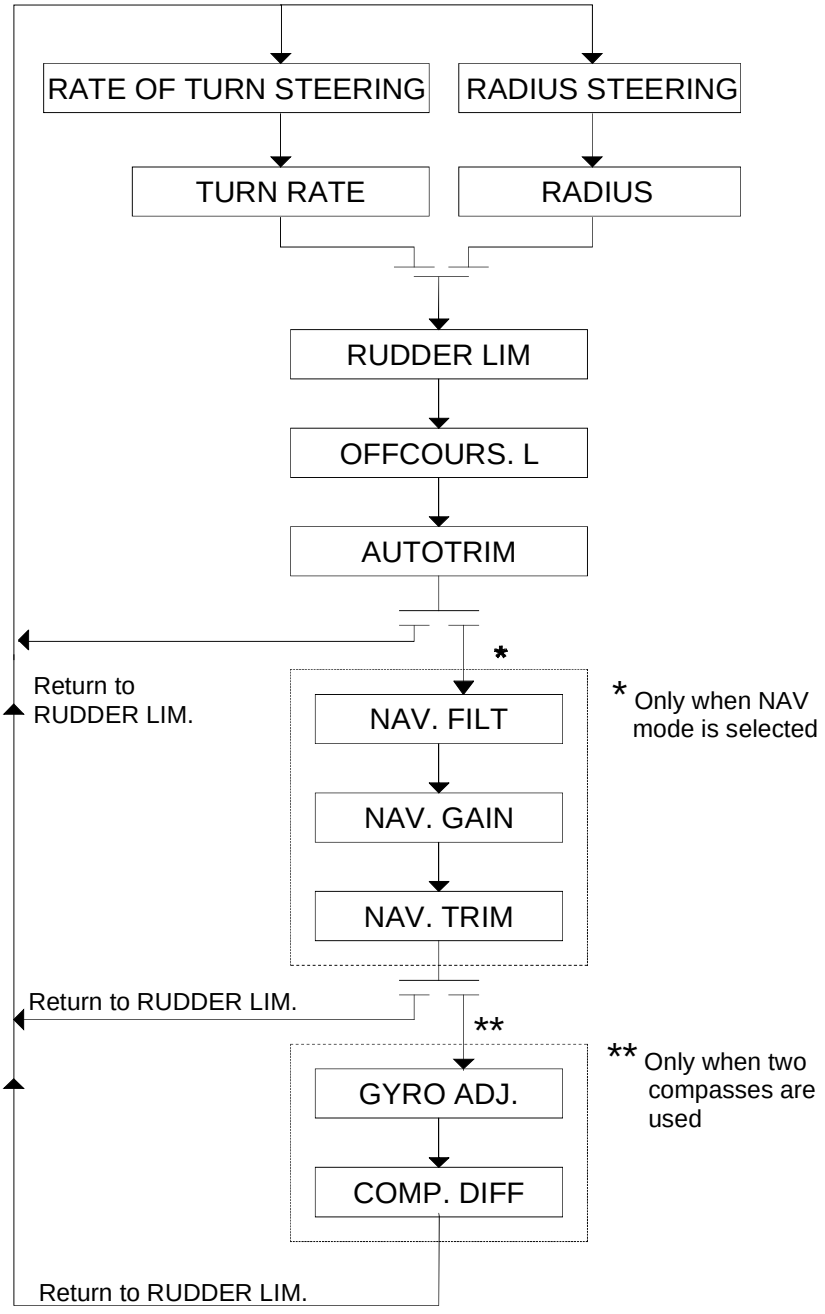


Fig. 5-39
Info loop 1

Detailed description

Information loop 1 (INFO I)

This loop is entered by pressing the INFO button. The parameter are as follows (First display readout depends on what has been selected by “Rate of turn (RATEoT) steering / Radius steering”, see page 2-10):

Turnrate

```
I I I I I I I I
TURNRATE
```

The autopilot has a selectable automatic **“Rate Of Turn”** or **“Radius Turn”** function. The Rate Of Turn function is used to maintain a predetermined turn rate (in degrees per minute). The activation of the turn rate function is determined by the following condition:

Turn rate (in deg. / min.) / 4,9 = Turn limit

The turn limit value is limited to maximum 20 degrees and minimum 3 degrees.

Example 1:

A turn rate of 50° / min. has been set. A 90° turn is made. According to the turn rate formula above, the turn rate control is activated when the course has changed by 50° / min. / 4,9 = 10,2 degrees.

Example 2:

Turnrate of 120° / min. has been set and a 90° course change is made. According to the formula, the turn rate control should start at 120 / 4,9 = 24,5°, but this is limited to 20°.

Range: 1° - 360° / min.

Note ! *The TURNRATE function is only activated when using the course change knob. NOT the Port and STBD buttons.*

Radius

```
I I I I I I
RADIUS
```

The turn control function may also be selected for Radius Turn. For this function speed information is required from GPS via the serial Nav input. The autopilot will sense the speed regardless of NAV mode steering or normal AUTO steering is selected.

The relationship between set turn radius and corresponding turn rate and vice versa is calculated internally. Hence the same limitations of maximum and minimum radius steering applies.

Range: 0.01 – 10,0 nm

Rudder limit

There are two settings of the Rudder Limit.

1. Rudder Limit in INFO LOOP 1
2. Max. Rudder Limit in INFO LOOP 2

The value of rudder limit in Info Loop 1 determines the maximum amount of rudder that can be ordered from the autopilot during ON-Course steering and can therefore be set to a small level (5-10°). This limitation will be disregarded when a course change is made. The rudder may instead travel to a maximum limit, set by the Rudder Limit function in INFO Loop 2.

Range: 1 – 85°

Off Course limit

The range for the Off Course limit is 3 to 35 degrees from set course. From 3-10 degrees the adjustments are in steps of one degree, and from 10-35 degrees in steps of 5. Adjust for appropriate limit by means of the INCREASE or DECREASE button. Alarm is given if the difference between set course and main compass heading exceeds the limit. See page 6-1.

When the acoustic alarm sounds, an alarm message readout is given in the information display. (OUT OF COURSE,). The acoustic alarm is cancelled by pressing the ALARM RESET button.

Note ! *The off course alarm will not be reactivated until the vessel's heading has re-entered the range set for the OFFCOURSE LIMIT. If the acoustic alarm is not cancelled, it will stop sounding when the vessel's heading returns to a point within the set range of the OFFCOURSE LIMIT.*

Range: 3°-10° in 1° increments

10° - 35° in 5° increments

Autotrim

When the vessel has a constant heading error, due to external forces such as wind and current, the AUTOTRIM function takes account for this by building up a constant rudder offset.

The time factor when the AUTOTRIM parameter is adjusted, is the time it takes to build up the rudder offset.

The effect is selectable in steps by the Increase / Decrease buttons. OFF indicates that there is no trim effect. The effect increases gradually when higher number is selected.

The AUTOTRIM parameter is reset every time the AUTOPILOT button is pressed and when a course change greater than 10° is made by the course selector.

The AUTOTRIM is automatically enabled when the vessel comes within 10° of the new course to steer.

Range: OFF – 3,2.

The following parameter settings (NAV. FILTER, NAV GAIN and NAV. TRIM), only appears when NAV function is selected.

Nav. filter (Only in NAV. mode)

This adjustment is for XTE navigation only, and not used in CTS mode (e.g. satellite receivers).

In areas with poor reception and where the Cross Track Error (XTE) from the navigational receiver is unstable, this filter averages out the values.

With a high setting on NAV. FILTER, it will take the autopilot longer to bring the vessel back on track.

Range: 1.1 - 2.5 in 0.1 increments

Nav. gain (Only in NAV. mode)

This adjustment is for XTE navigation only, and not used in CTS mode (e.g. satellite receivers).

The gain is a proportional value that is dependant upon the Cross Track Error and determines how many degrees the autopilot has to change the vessel's heading in order to bring the vessel back on track.

The higher value of the NAV. GAIN the greater correcting. Slow speed vessels should use a high value and fast vessels a low value.

Range: OFF – 6.4 in 0.2 increments

Nav. trim (Only in NAV. mode)

This adjustment is for XTE navigation only, and not used in CTS mode (e.g. satellite receivers).

The NAV. TRIM parameter compensates for a constant offset from the track line, caused by wind and current conditions.

This function gives a course to steer offset based upon the average track offset.

A low NAV. TRIM value will result in a quick build-up of the offset, and a high value will result in a slow build-up of the offset.

The NAV. TRIM is reset every time the NAV. SYSTEM button is pressed.

Range: 50s - 1550s in 50s increments

Gyro adjust

Note ! *This parameter will only appear in the display in HELMSMAN mode if the selected steering compass is of a geared synchro or stepper output type.*

Align the autopilot read-out to correspond with the gyro heading. Check the alignment every time the autopilot/gyro is switched on. The autopilot reading is aligned by using the INCREASE or DECREASE buttons.

On the same condition the autopilot will, at switch on, show GYRO ADJUST, and the same procedure will apply before the autopilot can be brought into service.

Compass difference

Note ! *This parameter only appears when two compasses are used.*

When two compasses are used (main compass and monitor compass), there is virtually always a difference between the readings of the two. The difference is displayed under the COMP. DIFF. in the information display. To ensure that the limits of the off-course alarm are symmetrical about the course to steer (set course), press the INCREASE button to cancel any difference between the two compass readings.

Note ! *The difference between the two compass readings may vary with the vessels heading and from one area to another where a vessel is in transit. The difference between the two compass readings is automatically reset when the COMP DIFF. alarm is given and the ALARM RESET button is pressed.*

INFO loop II

To access this level, keep the INFO button pressed while pressing and releasing the WEATHER button and thereafter the INFO button.

Note !

The settings in INFO-loop II are intended to be used to adapt the control logic of AP9 MK3 to the characteristics of the particular vessel on which it is installed. After satisfactory steering performance is reached during sea trials, these settings should not be altered. Remember to store according to SAVE IDEAL on page 5-46.

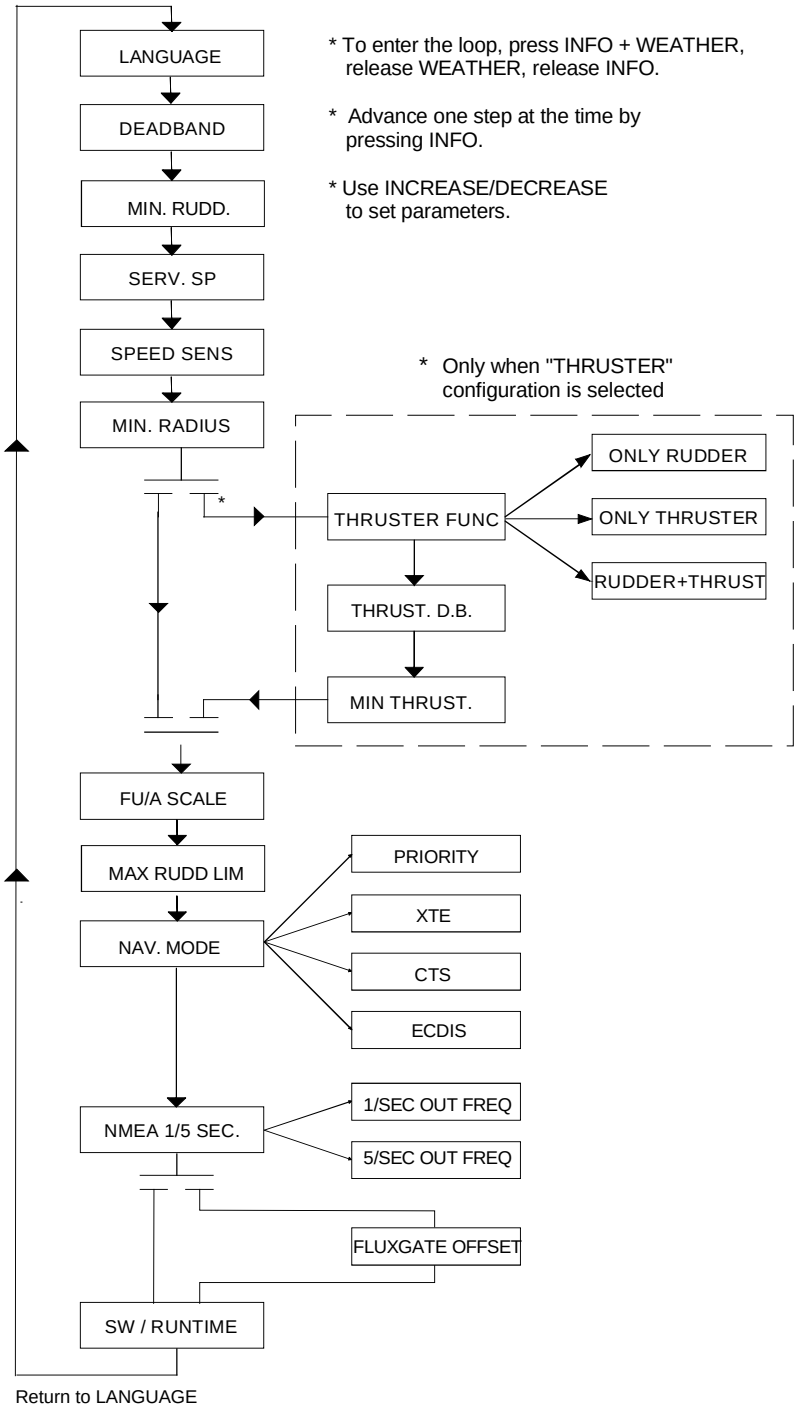


Fig. 5-40 Info loop 2

Language

The readout on the Information Display is available in four languages: English, French, Spanish and Norwegian. To select desired language press the INCREASE button.

Rudder deadband

A deadband in the rudder control loop is necessary to stabilize the rudder and prevent it being over-active. It also will optimize the adaptive rudder-loop function. The with of the DEADBAND can be adjusted by using the INCREASE or DECREASE button. A narrow deadband may cause the rudder to hunt, a broad deadband will cause the pilot to steer poorly and "essing".

Range: 0.2° - 3.4° in 0.1 increments

Minimum Rudder

Some vessels may have a tendency of not responding to a small rudder deflection around midship position, due to whirls / disturbance of the water-stream passing the rudder. This function is particularly useful on water jet boats.

By setting the Min. Rudder to a certain value, the rudder will move to the set rudder amount by one rudder command.

The amount of rudder decided by the p-factor (weather) and counter rudder is added to the Min. Rudder, i.e.:

Min. Rudder	4°
P-fact. / Counter Rudder	1°
Total rudder amount	5°

Additional rudder commands to the same side will not activate the Min. Rudder. When the rudder is returning towards midship, it will move in one step from the Min. Rudder value to the midship position.

Maximum amount is ±10°

Range:: OFF - 10° in 0.5° steps

Service Speed

The software includes a variable rudder gain, controlled by the VTG input signal from the GPS. The service speed is used to reference the scaling of the rudder gain set by the SPEED SENS. Note that the software will read the VTG speed sentence from the GPS in all modes, (not only NAV). The speed signal is also used to control RADIUS turns.

Range: 3-70 knots

Speed Sens

This feature allows for an adjustable relation between selected speed (service speed) rudder gain and low speed rudder gain. When the VTG sentence from the GPS is received, the amount of rudder (gain) when running with low speed is adjusted by the speed sens (Increase / Decrease) until best steering is obtained. The amount of rudder will hence be determined by the actual vessel speed within the low speed and full speed range.

Change of speed will now automatically adjust the rudder gain in a linear matter between “low speed gain” and “high speed gain”.

Range: OFF – 1.92

Minimum Radius

This parameter determines the minimum turning circle (or maximum turn rate). The maximum turn rate or minimum radius is automatically calculated by entering the minimum radius value in nautical mile. Once set it is not possible to exceed those limits in the 1st Info-loop (TURN RATE or RADIUS).

Range: 0,01 – 1,1 nautical mile.

Note ! *When "THRUSTER" is selected, the following applies. If "THRUSTER" is not selected, continue to "FU/A SCALE".*

THRUSTER FUNCT. ONLY THRUSTER	or	THRUSTER FUNCT. RUDDER & THRUSTER

These parameters determines how the combination of rudder and thruster is selected. When ONLY THRUSTER or RUDDER & THRUSTER is selected, two additional parameters are added as follows (when pressing INFO):

Thruster Deadband

I I I I I I THRUST. DB

The Thruster Deadband determines how many degrees the vessel must deviate from set course before a thruster command is given.

Range: OFF – 32°

Minimum Thrust

I I I I I I MIN. THRUST.

This parameter determines the amount of thrust to be provided when a thruster command is given. Also refer to page 5-57 for details.

Note ! *When ONLY RUDDER is selected "PARAM. SET 2" will appear in the display. In this way the autopilot can be configured for two sets of parameters, i.e. Hi speed and Lo speed.*

Follow-up scale

I I I I I I FU/A SCALE

As the maximum input current for the follow-up signal (handle hard-over) is the same, regardless of the follow-up scale, this parameter must be set in accordance to the rudder deflection in order to match the corresponding feedback signal from the RF14XU unit.

Range: 45°- 60°- 70°- 90°

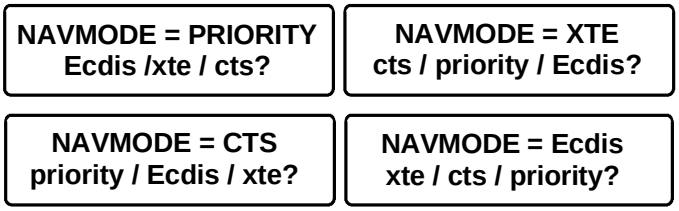
Maximum Rudder Limitation

This rudder limit is absolute and will limit the rudder deflection to the set value for all rudder commands including FU-steering.

Navigational steering

(Applies both for "Standard" and "Thruster" mode).

The Navigation Steering Mode can be selected between the following possibilities by the INCREASE / DECREASE button.



For details concerning the Nav. Steering, refer to page 2-15.

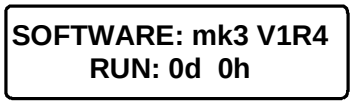
NMEA output

(Applies both for "Standard" and "Thruster" mode)

Selection of rate on the output signal is made by pressing the DECREASE or INCREASE button.

HDT or HDM selection is made by the selection of Main steering compass (HDT = gyro, HDM = magnetic compass).

Software version & Runtime



The display shows the software version (here V1R4) mounted.

The RUN (Runtime) is shown in days (d) and hours (h).

Runtime counting is only activated in AUTO or NAV mode.

Debug Loops

To aid service and operation, a number of information are available under the DEBUG loop.

The DEBUG is divided in three loops:

1. DEBUG AD (F800 [001])
   This loop is for factory service purpose only. It contains addresses and values in hexadecimal figures.
2. DEBUG MODE
   This loop contains measurements and information.
3. SERVICE MODE

   This loop is intended for test purpose and storing of parameters.

Note ! *Feedback Off-set is possible in this mode (see details)*

The DEBUG loops are entered by pushing the "hidden" button and INFO.

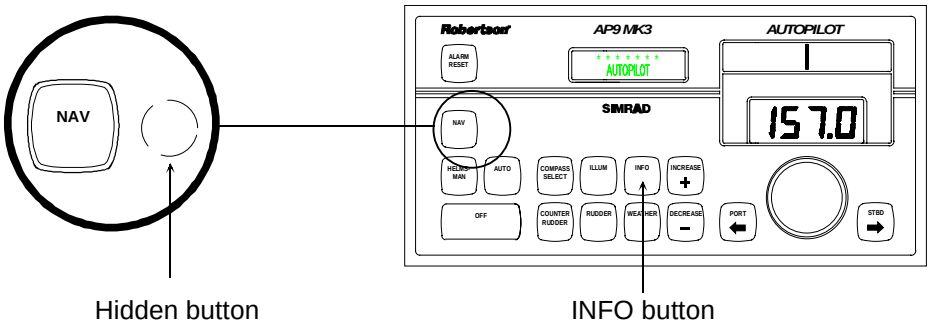


Fig. 5-41
"Hidden" button location

When entering the DEBUG loop, the display will show:

DEBUG MODE RUDDER XXX.X°

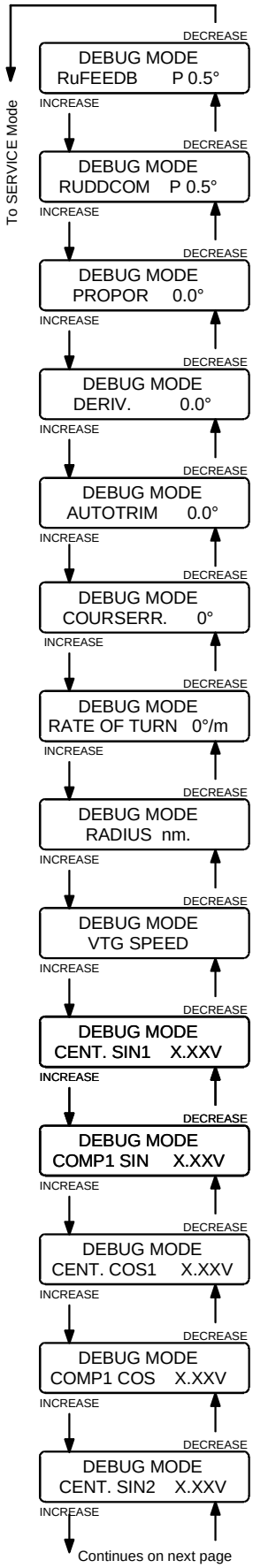
or

DEBUG MODE 7 DEBUGAD = F800[001]

If DEBUGAD is shown, press the hidden button one more time.

It is possible to search the loop both forwards and backwards, by pushing INCREASE or DECREASE.

Detailed debug list



RUDDER FEEDBACK
Shows the rudder angle with P (Port) or S (Stbd), degrees and tenth's.

RUDDCOM
Shows the commanded rudder with P or S and degrees/tenth's.

PROPOR
Shows the proportional part of the commanded rudder angle. (Rudder, P-part of the P.I.D. regulator).

DERIVAT
Shows the derivate part of the commanded rudder angle (Counter Rudder, D-part of P.I.D. regulator).

AUTOTRIM
Shows the integration part of the commanded rudder angle (I-part of the P.I.D. regulator).
* For reading in NAV mode, see Note after this table.

COURSERR
Shows the deviation from set course reference in degrees.

RATE OF TURN
Shows the turnrate of the vessel in degrees/minute.

RADIUS
Shows the turn radius in nautical miles.

VTG SPEED
Shows the ship speed in knots. If 0.0 it shows OFF.

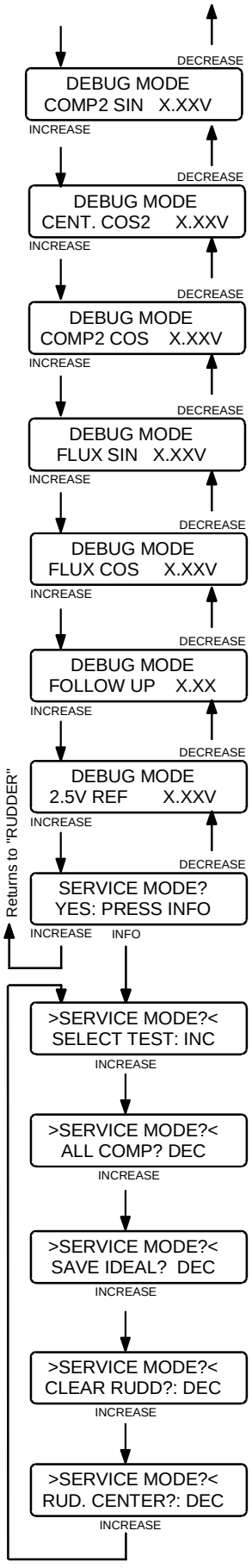
CENT. SIN1 (V)
Shows the reference voltage from compass 1 before exitation pulse is applied.

COMP1 SIN (V)
Shows the sine voltage from compass 1 with exitation pulse applied.

CENT. COS1 (V)
Shows the reference voltage from compass 1 before exitation pulse is applied.

COMP1 COS (V)
Shows the cosine voltage from compass 1 with exitation pulse applied.

CENT. SIN2 (V)
Shows the reference voltage from compass 2 before exitation pulse is applied.



COMP2 SIN (V)
Shows the sine voltage from compass 2 with exitation pulse applied.

CENT. COS2 (V)
Shows the reference voltage from compass 2 before exitation pulse is applied.

COMP2 COS (V)
Shows the cosine voltage from compass 2 with exitation pulse applied.

FLUX SIN (V)
Shows the sine voltage from fluxgate compass. Varies between 0 and 5V.

FLUX COS (V)
Shows the cosine signal from fluxgate compass. Varies between 0 and 5V.

FOLLOW UP (V)
Shows the input voltage from Follow Up Tiller. Varies between 0 and 5V.
2.5V is equel to zero degrees rudder command. A voltage level below 2.5V means port rudder command and above 2.5V means starboard rudder command.

2.5V REF (V)
Shows the 2.5V internal reference voltage (V/2)

NOTE:
This mode is intended for service purpose and is entered by pressing the INFO button.

The INCREASE button is used to step through the different alternatives under the SERVICE MODE. The DECREASE button is used to confirm a selection.

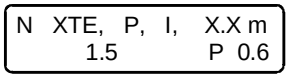
ALL COMP?: DEC
Possibility of making all connected heading sensors accessible from the COMPASS SELECT button. (Press DECREASE).

IMPORTANT:
Use this function to store all parameters (after sea trial) by pressing DECREASE. The display will confirm that the parameters are stored and saved by one short flash showing IDEAL SAVED To recall, press WEATHER and RUDDER simultaneously.

CLEAR RUDD?: DEC
Used to clear adapted rudder characteristics.

RUDDER CENTER
This parameter is used to offset the feedback. Maximum offset is +/-5°. Keep the vessel steady by hand and press DECREASE to store the zero-point.
NOTE: NO OFFSET FOR THE RUDDER ANGLE INDICATORS!

Note ! *When NAV mode has been selected, the following display picture will be shown instead of AUTOTRIM.*



*** NAV MODE ONLY**
This display picture is for checking the Nav. performance.

N = Autopilot in NAV mode.
XTE = ID for first figure; XTE in meters.
(If vessel is alongside and this value has big variations, check GPS and DGPS.)
P = ID for second figure; the effect from NAV GAIN to bring the vessel back on track.
I = ID for third figure; the effect of NAV TRIM to bring the vessel back on track.

Parameter settings

Push buttons	Range	Recommended setting	Seatrial	Final setting
RUDDER	OFF - 3.3	0.7		
WEATHER	OFF - 8°	OFF		
COUNTER RUDDER	OFF - 8	0.6		
COMPASS SELECT				

INFO loop no. 1: Press the INFO button

TURNRATE / RADIUS	1-360 / 0,1-10 nm.	40 / 0,18 nm		
RUDDERLIM	1 - 85°	15		
OFFCOURSE L.	3 - 35	15		
AUTOTRIM	OFF - 3.2	0.5		
NAV. FILTER (Only NAV-mode)	1.1 - 2.5			
NAV. GAIN (Only NAV-mode)	0.0 – 6.4	1.5		
NAV. TRIM (Only NAV-mode)	50-1550	250		
GYRO ADJUST (Only Helmsman mode with gyro connected)				

INFO loop no. 2: Keep the INFO button pressed while pressing the WEATHER button.

LANGUAGE	N, E			
DEADBAND	0,2 – 3,4	0,6		
MIN. RUDD.	OFF - 10			
SERV. SP.	3 – 70 kts			
SPEED SENS	OFF – 1.92	0,30		
MIN. RADIUS	0,01 – 1,1 nm	0,05 nm		
THRUSTER FUNC.				
THRUSTER DEADBAND (Thruster mode)				
MIN. THRUST				
FU / A SCALE	45-60-70-90			
MAX. RUDD. LIM.	26 – 90°	43°		
NAV. MODE	XTE-CTS-PRIORITY-ECDIS	PRIORITY		
NMEA	1 / sec. – 5 / sec.			
SOFTWARE / RUNTIME				

5.19 Dockside Alignment/test

General

Prior to sea-trial, the system shall be "Dock-tested" for alignment and pre-setting of parameters.
It is recommended that the following general procedure be followed.

RF14XU Feedback unit (ON-OFF valves)

Make sure that the RF14XU Feedback unit is configured for the correct rudder deflection direction and ratio (±45° - 60° - 70°- 90°). The RF14XU is normally delivered for ±45° rudder angle (the yellow and the green leads are soldered together). Violet, brown and pink leads are not connected. For ±60° rudder angle, connect yellow and brown leads. For ±70°, connect yellow and violet leads, and for ±90°, connect yellow and pink leads. Also ref. to the fig. below.

For change of deflection, make the connections in accordance to the following list.

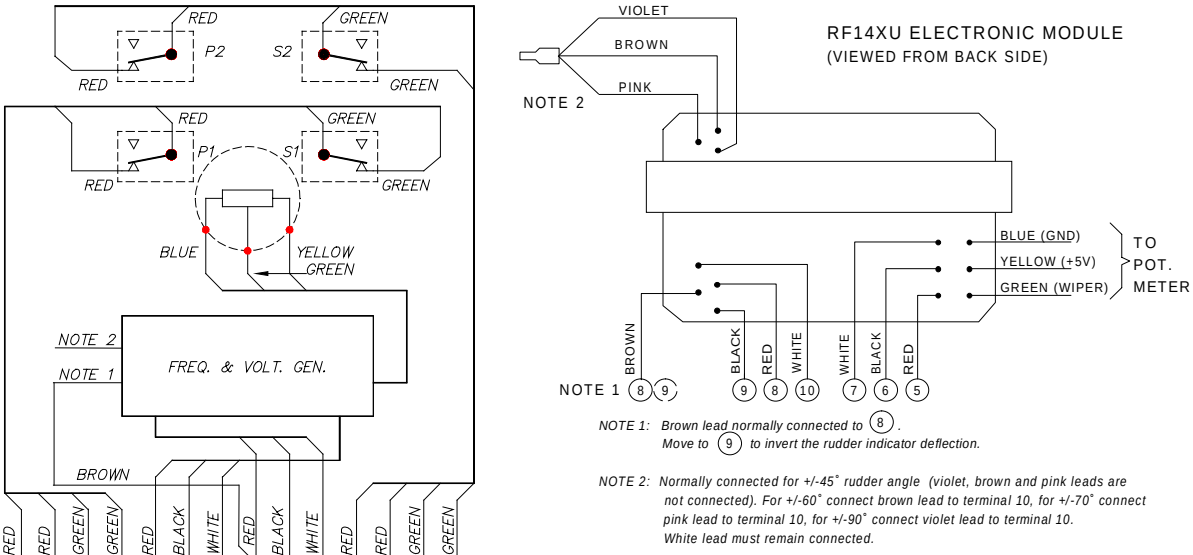


Fig. 5-42
RF14XU Internal Wiring

Note ! *Make sure that J1-5 (FB LO) is terminated at a GND point such as TB3-5.*

To check the autopilot for connected rudder response, make the following test:

- Set Counter Rudder to OFF
- Set Rudder to 1
- Set Weather to OFF

- Set Autotrim to OFF
- Set Rudder Limit to 30°
- Select AUTOPILOT mode and make a 10 degree Port (Stbd) course change. Verify (by reading the rudder stock scale) that the rudder moves to 10 degrees Port (Stbd). Reset the rudder limit to 25° and verify that the rudder responds correctly.

This ensures that the rudder response ratio is 1:1.

Rudder Angle Indicators

Verify that rudder angle indicators connected to the RF14XU Rudder Feedback unit respond with correct movement and deflection (refer to Fig. 5-43 or Fig. 5-44 and Fig. 5-46 for location of components).

If required, the rudder feedback signal may be inverted by interchanging the wires to the potentiometer (blue & yellow).

Note ! *Be aware of that a fine adjustment (offset) of the frequency via the DEBUG Service Mode WILL NOT influence the rudder angle indicator signal.*

Analogue signal, Rudder & Thruster

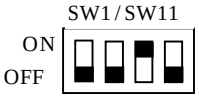
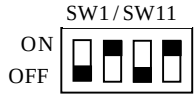
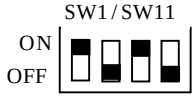
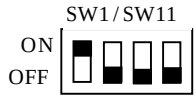
When using the analogue signal, normally 0±10V, the rudder response is checked both for correct direction and deflection.

Note ! *Verify that the 10kHz Feedback from the Dual Analogue PCB is connected to the control unit via jumper switches S21 and S22 (pos. 1). Also verify that switches S1, S2, S11, S12 are positioned for autopilot input (pos. 1). See Fig. 5-43 or Fig. 5-44. (Fb lo connected to Return/GND).*

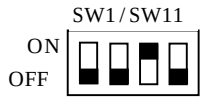
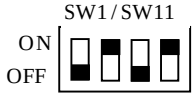
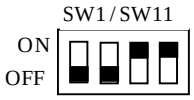
First make sure that the output from the Dual Analogue PCB (eventually the Thruster Interface PCB) matches the required input signal for the rudder amplifier. To select and adjust the output signal, refer to the following tables. The first table refers to Dual Analogue PCB with revision up to Rev. C. and to the Thruster Interface PCB. The second table is for Dual Analogue PCB with revision D and higher. The Dual Analogue PCB has two identical channels. The components in one channel are marked with numbers that differ by ten compared the corresponding component in the other channel. E.g. SW1 and SW11. (On the Thruster Interface PCB the corresponding component numbers are identical to the Dual Analogue channel with the highest number.)

Note ! *The voltage span and 4-20mA are adjusted with ±10V output from the AP9 MK3 Control Unit. The centre point (= midship rudder) is adjusted with 0V output from control unit.*

Dual Analogue PCB up to Rev. C and Thruster Interface PCB

	Signal	SW1/SW11 1	2	3	4	GAIN	OFFSET	Remarks
	0±10V	0	0	1	0	RV5/RV15 Span adj.	RV3/RV13 (±3V)	Required span set by RV5/RV15 (4-10V). Offset set by RV3/RV13.
	X ±Y (volt) i.e.: 12 ±6V	0	1	0	1	RV5/RV15 "Y" adj.	RV4/RV14 “X” adj.	Adjust "X" (i.e. +12V) by RV4/RV14 and the voltage span (i.e. ±6V) by RV5/RV15
	A) 4-(12)-20mA	1	0	1	0	RV5/RV15 Fully CCW	5V	A) Measure voltage on TB21 no. 1-2 and set RV3/RV13 for 5V. Continue with adjustment B
	B) 4-(12)-20mA	1	0	0	0	RV5/RV15 Fully CCW	RV1/RV11 RV2-RV12	Adjust 4 mA by RV1/RV11 and 20 mA by RV2/RV12. Repeat of adjustments may be necessary

Dual Analogue PCB Rev. D

	Signal	SW1/SW11 1	2	3	4	GAIN	OFFSET (centre point)	Remarks
	0±10V	0	0	1	0	RV5/RV15 Span adj.	RV3/RV13 (±3V)	Required span set by RV5/RV15 (4-10V). Offset set by RV3/RV13.
	X ±Y (volt) i.e.: 12 ±6V	0	1	0	1	RV5/RV15 "Y" adj.	RV4/RV14 “X” adj.	Adjust "X" (i.e. +12V) by RV4/RV14 and the voltage span (i.e. ±6V) by RV5/RV15
	A) 4-(12)-20mA	0	0	1	1	RV5/RV15 Fully CCW	RV3/RV13	A) Measure voltage on TB21 no. 1-2 and set RV3/RV13 for 0.0V. Continue with adjustment B
	B) 4-(12)-20mA	0	0	1	1	RV5/RV15 Fully CCW	RV4-RV14 RV1/RV11	Adjust centre point to 12 mA by RV4/RV14 and 4-20 mA span by RV1/RV11. Repeat of adjustment may be necessary

Deflection test (Rudder or azimuth thruster propulsion)

To check the deflection of the rudder / thruster, set the main controls as follows:

- Counter Rudder OFF
- Rudder Maximum (3,2)
- Weather OFF

Parameter via INFO I:

- Autotrim OFF
- Rudder Limit 20°

Select AUTOPILOT and make a 90° course change. Verify that the rudder / thruster stops at 20°, eventually adjust RV5 / 15 (Gain) for proper rudder / thruster deflection.

Note ! *If the Rudder/thruster response is of opposite direction, interchange the HI/LO analogue signals to the Rudder /Thruster system.*

Rudder Thruster combination

Normally a combination of rudder and thruster operation will consist of an ON / OFF signal for the rudder, and an analogue ±10V signal for the thruster. This may, however, vary from installation to installation and the check-out of signal / performance is made according to signal type (ON / OFF ±10 analogue) used.

As the parameters when using thruster is different from the parameters used for rudder, a second set of parameters will be enabled when switching the "TRUSTER SWITCH" to position "THRUSTER". This position closes the connection between J4, 11-13 (Thruster Ident - GND). At the same time the ±10V analogue signal from the control unit is enabled, and signal output is selected by the INFO II loop "Thruster selection".

Note ! *The analogue output will only appear when either THRUSTER or THRUSTER & RUDDER is selected. Also note that an ON-OFF signal may include the 2nd parameter set when Thruster Switch is activated. This means that if the thruster interface signal is the ON-OFF type, "RUDDER ONLY" function must be selected in the INFO II loop. Feedback is also required.*

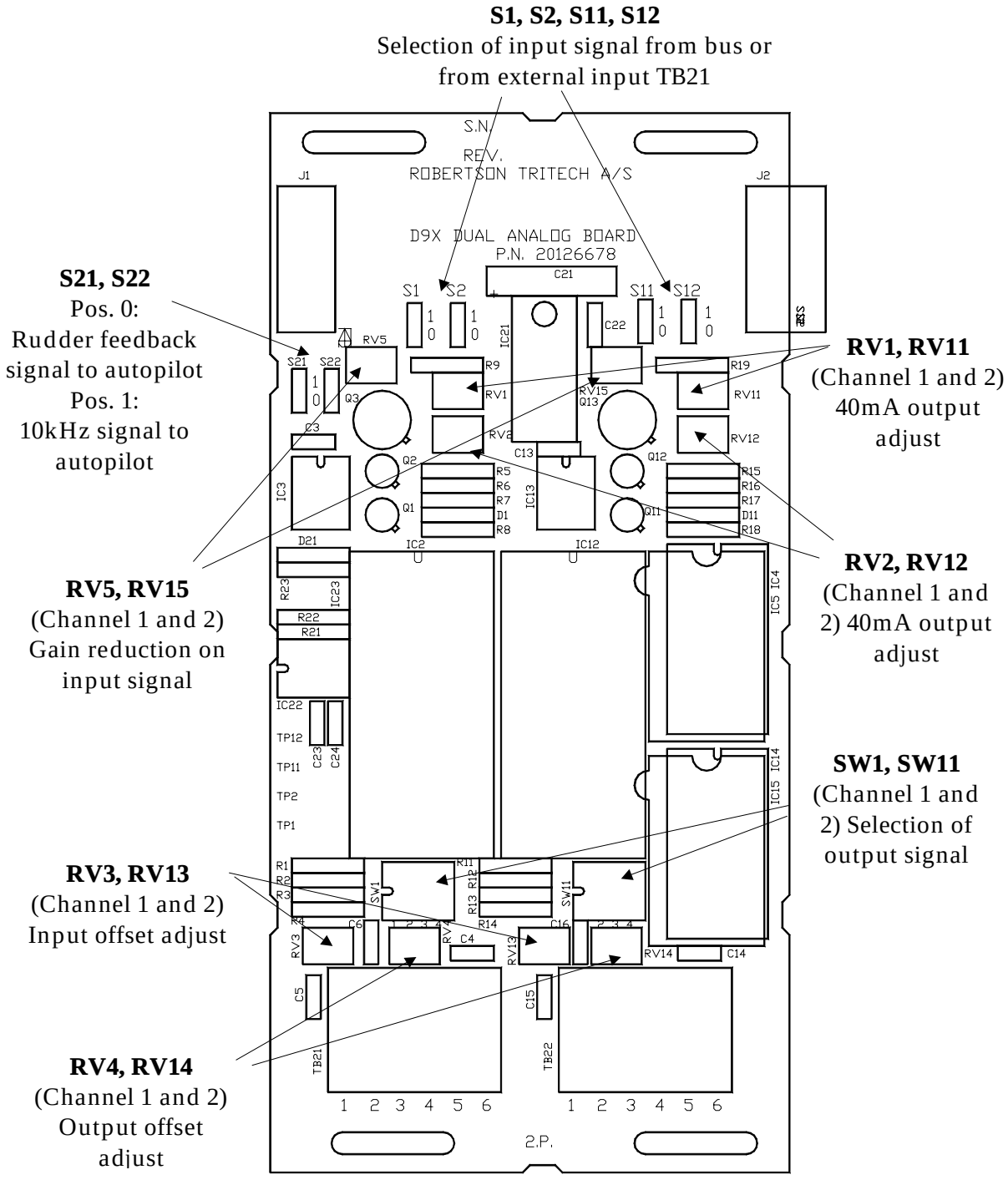
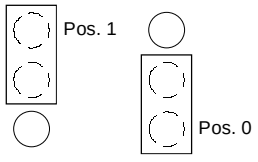
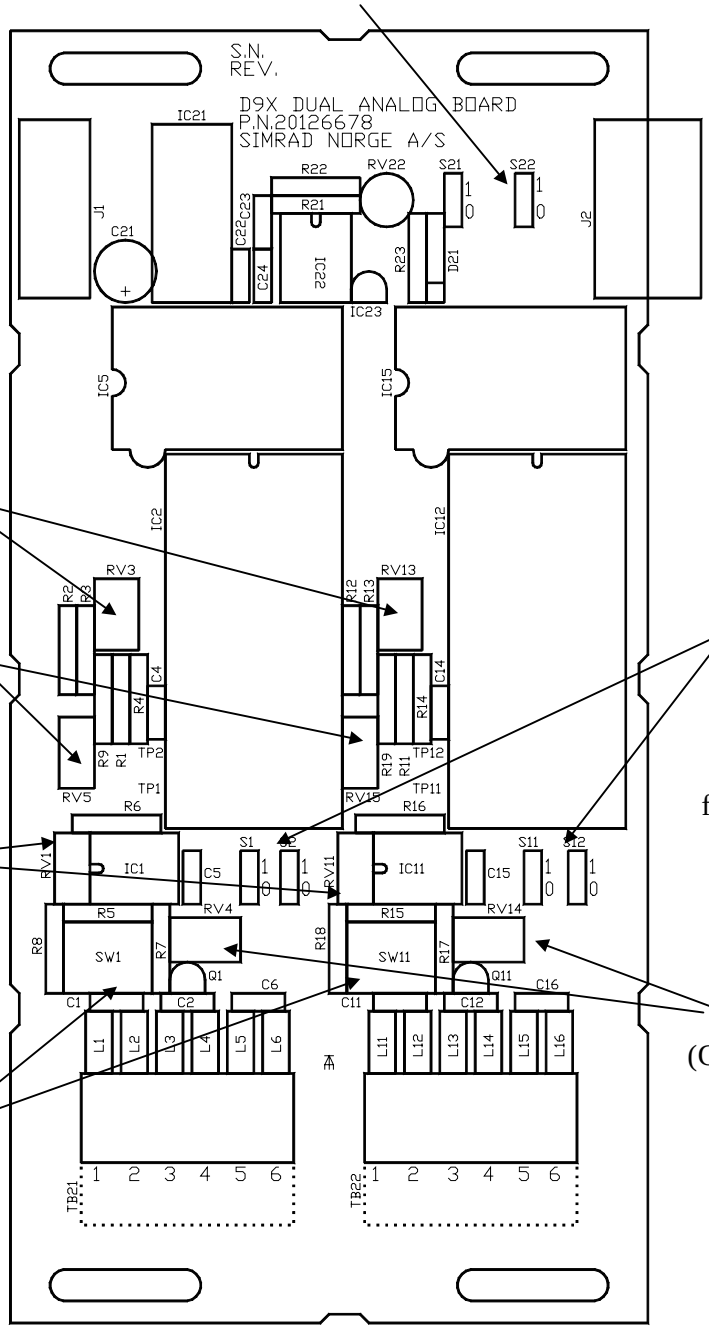


Fig. 5-43
D9X Dual Analogue Board, component layout (Rev. - C)

Legend: S1, S2,
S11, S12
S21, S22



S21, S22
Pos. 0: Rudder feedback signal to autopilot
Pos. 1: 10kHz signal to autopilot



RV3, RV13
(Channel 1 and 2)
Input offset adjust

RV5, RV15
(Channel 1 and 2)
Gain reduction on input signal

RV1, RV11
(Channel 1 and 2)
40mA output adjust

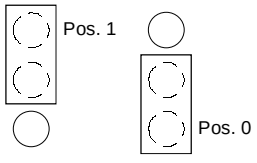
SW1, SW11
(Channel 1 and 2) Selection of output signal

S1, S2, S11, S12
Selection of input signal from bus or from external input TB21

RV4, RV14
(Channel 1 and 2)
Output offset adjust

Fig. 5-44
D9X Dual Analogue Board, component layout (Rev. D -)

Legend: S1, S2, S11, S12 S21, S22



S1-S3

No strap connections:	Safe relay controlled by autopilot
Connection between S1 and S2:	Safe relay controlled by NFU-handle and autopilot
Connection between S2 and S3:	Safe relay ON

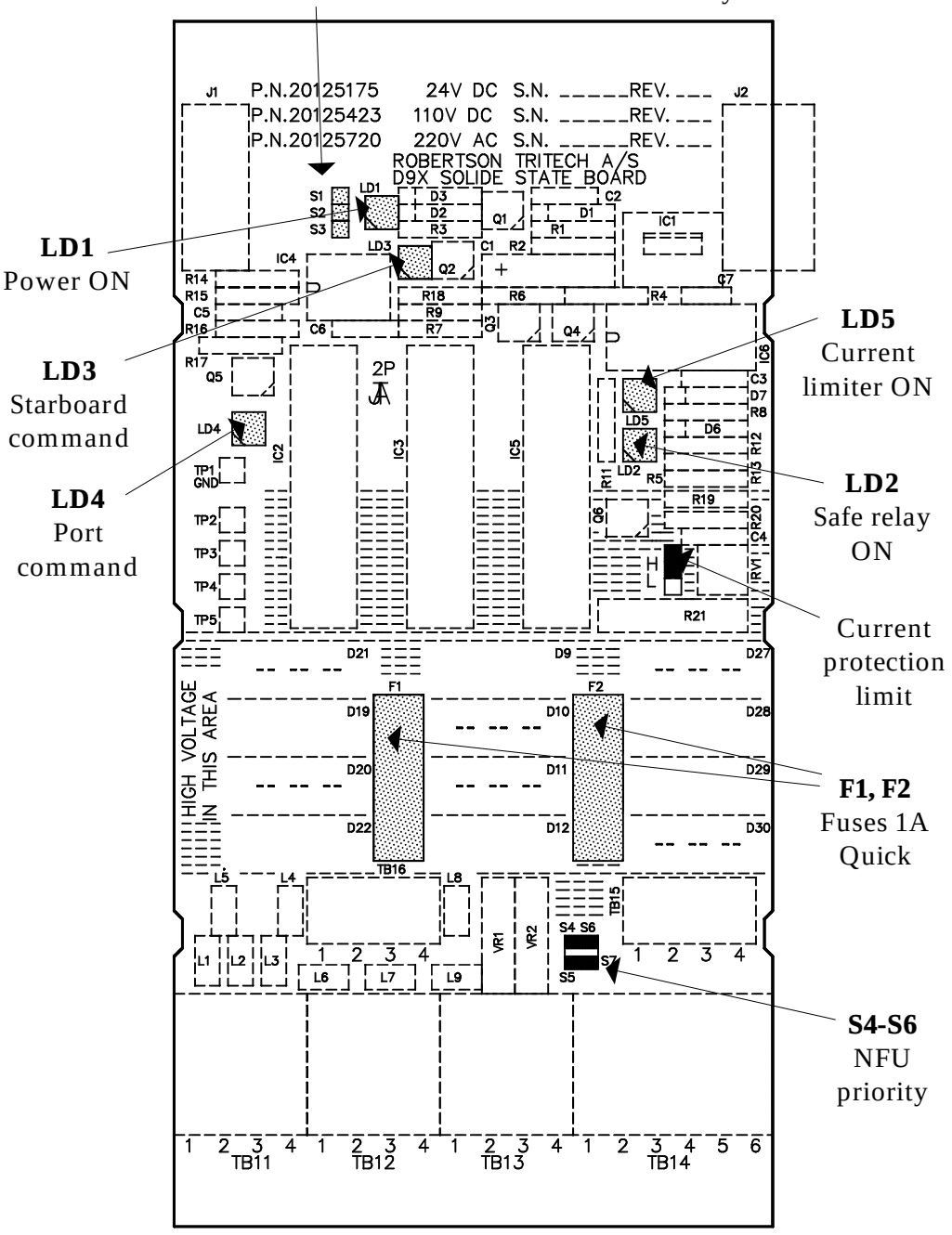


Fig. 5-45
D9X Solid State Board, component layout

S11
Pos. 0: 10kHz signal to AP9 MK3 (analogue rudder)
Pos. 1: Rudder Feedback to AP9 MK3

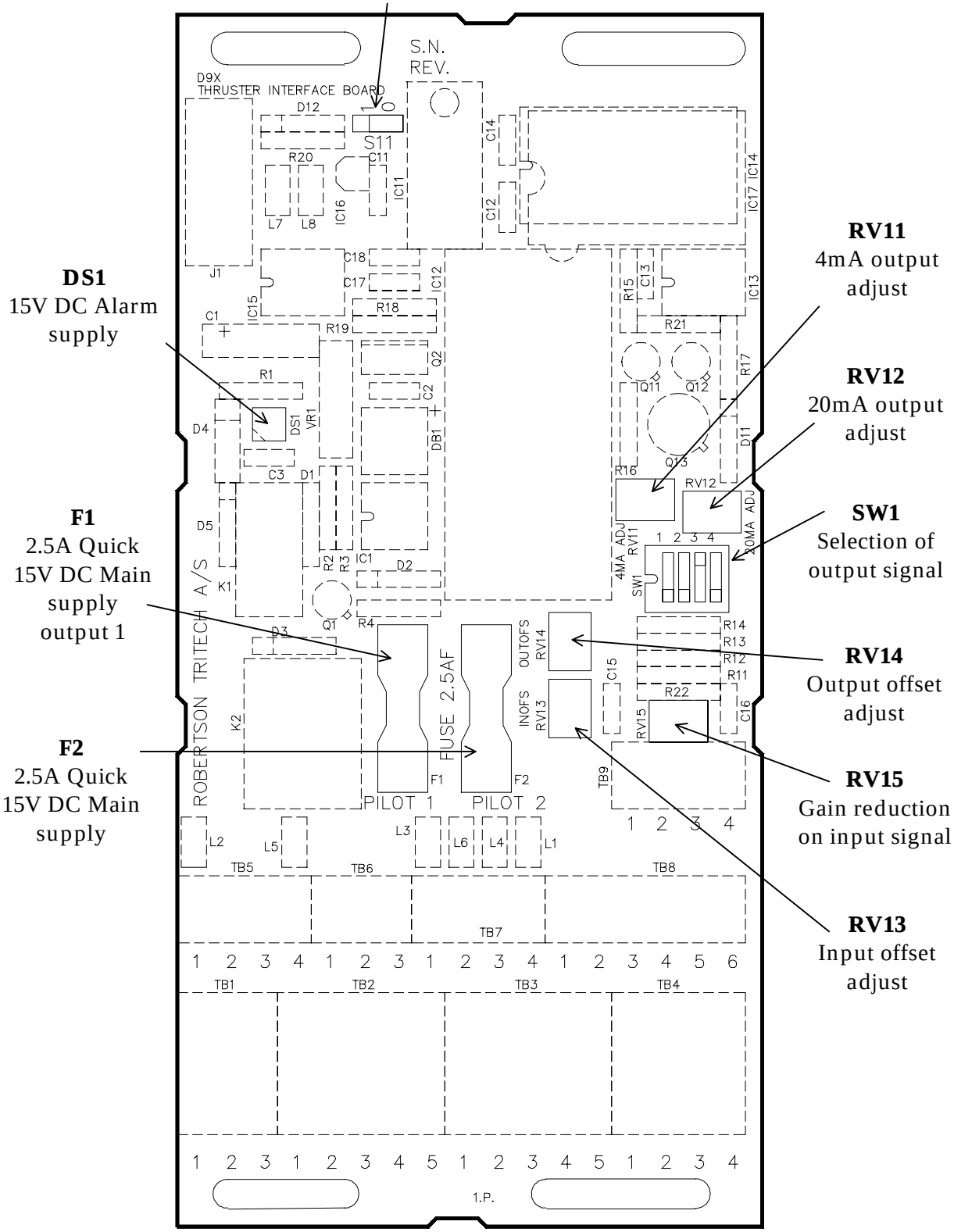
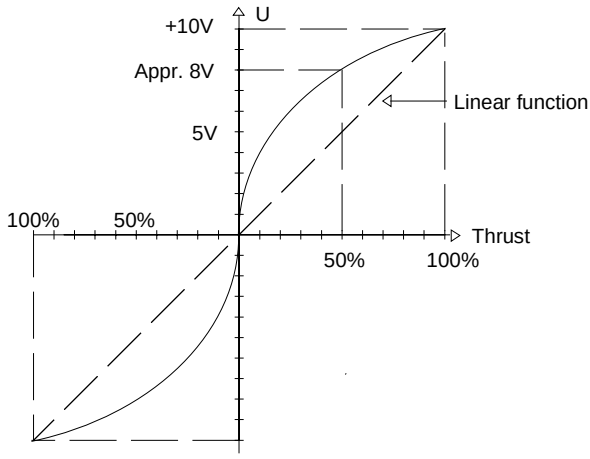


Fig. 5-46
D9X Thruster Interface board, component layout

Tunnel Thruster function

The operation of tunnel thruster is used for maintaining the heading with nearly no speed.



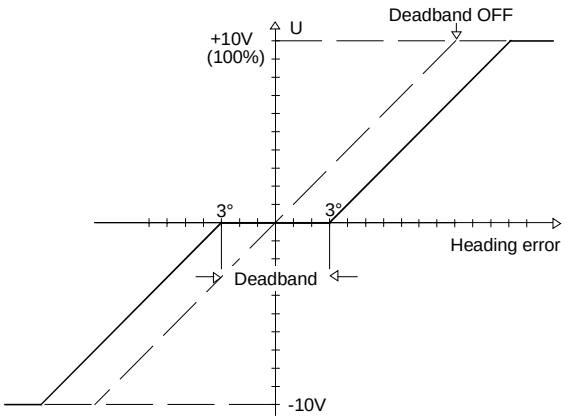
The typical tunnel thruster characteristic can be illustrated by the following graph:

The illustration shows that in order to obtain 50% thrust, the control signal must be nearly 8V (appr. 75% of the 10V). To obtain a thrust amount, capable of controlling the vessel, a certain minimum level of thruster control signal should be applied to the thruster for a minor heading error.

Special parameters for Thruster Function appears in INFO LOOP II when Thruster Function switch is set to THRUSTER.

Thruster Deadband

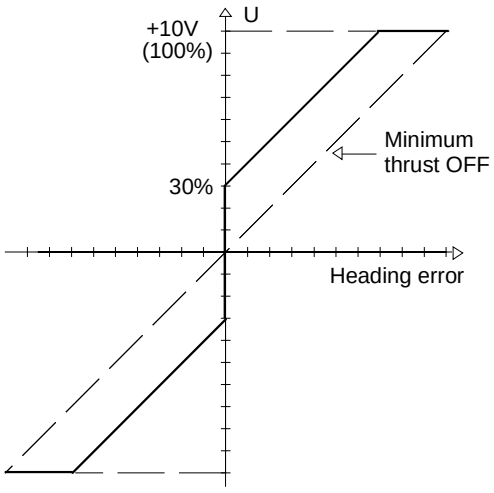
The Deadband determines the amount of error signal (in degrees) before command is applied to the thruster. The example shows ±5 degree deadband. No deadband is shown by the dotted line.



Minimum Thrust

The Minimum Thrust determines the amount of power (in % of maximum control signal) that is applied as "first command signal". The example shows 30% of the control signal applied as minimum thrust.

The dotted line shows the output signal for Minimum Thrust "OFF".

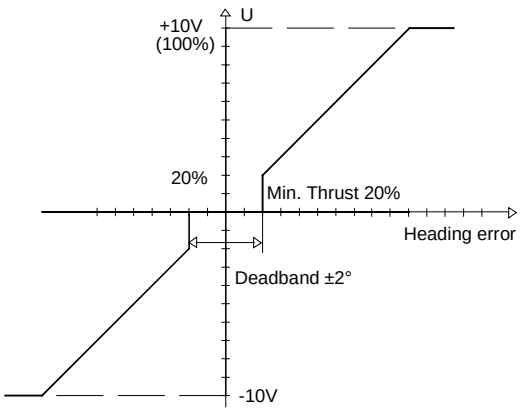


Minimum Thrust & Thruster deadband

This example shows how the control signal will appear for a combination of deadband and minimum thrust.

The control signal will stay at zero until the heading error exceeds 2 degrees. Than a 25% power signal will be applied.

The final values of the different parameters are selected during sea trial.



Gyro Compass selection

The AP9 MK3 Control Unit must be set up for the correct type of gyro. This means that selection of 1:1 synchro either from the gyro or the autopilot and current phase and reference voltage.

This is done by means of two packages of DIP switches, 8 switches each, located on the back of the Interface board (See Fig. 5-47.)

Note ! *All switches are factory set to OFF-position. Carefully check whether an eventual 1:1 synchro is excited from the gyro or not. SW1-7/8 must NOT be ON if the gyro provides excitation, or damage of the gyro interface module will occur.*

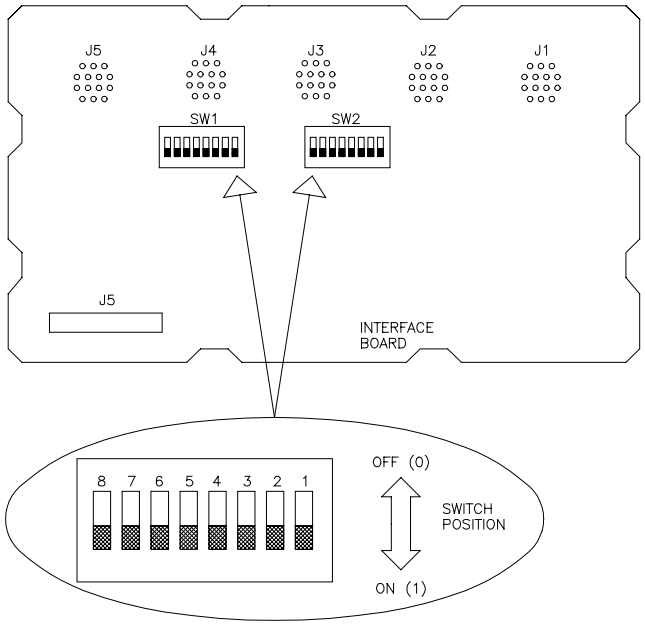


Fig. 5-47
Gyro Interface board, switches

If the synchro is "DEAD", switch on SW1-7/8. Appr. 15V, 400Hz signal square wave signal will excite R1-R2 of the synchro.

To open the Control unit, remove the four flat-head screws on the backside, and gently pull the two halves apart. Be aware that the internal PCB's are interconnected by plugs, thus care must be shown when putting the two halves together again.

Make sure that the internal dip switches, SW1-2 are correctly set according to the list below. The settings of SW2 only applies for synchro input.

Gyro type selection	**SW1**							
	8	7	6	5	4	3	2	1
Serial gyro	0	0	1	0	0	0	0	1
Stepper (6 steps / degree) 24, 35, 70V	0	0	0	0	0	0	1	1
Synchro 1:1, gyro ref. voltage	0	0	0	1	0	0	0	1
Synchro 90:1, ------- „ -------	0	0	0	0	1	0	0	1
Synchro 360:1 ------- „ -------	0	0	0	0	0	1	0	1

Ref. voltage selection	**SW2**							
	8				4			
150V ref. from gyrocompass	0				0			
100V ------- „ -------	0				1			
50 - 60V ------- „ -------	1				0			
26V ------- „ -------	1				1			
Phase voltage selection		7	6	5		3	2	1
110 - 115V		0	0	0		0	0	0
50 - 90V		0	0	0		1	1	1
20 - 24V		1	1	1		0	0	0
11.8V		1	1	1		1	1	1

Caution ! ***The switches SW1-7/8 must under no circumstance be set to ON (1) when Reference Voltage is taken from the gyro compass.***

AUTOPILOT EXCITATION OF 1:1 SYNCHRO

SW1								**SW2**							
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
1	1	0	1	0	0	0	1	1	1	1	1	1	1	1	1

Magnetic Compass (CD109) adjustments

The CD109 Course Detector is normally mounted underneath the magnetic compass.

To check and calibrate the course detector, do as follows:

- Make sure that the CD109 is connected.
- Select HELMSMAN mode
- Press "COMPASS SELECT"

The display will now show what type of compass is selected as Main Compass.

- Press one more time on the COMPASS SELECT. The display will now show the magnetic course from the CD109.

Loosen the fixing screw and turn the CD109 until the correct heading appear in the Heading Display. Use a screw driver or similar to deflect the compass to different headings and verify that the CD109 will read the correct heading. Some minor deviation may occur. Turn the Course Detector slightly to divide the error.

Note ! *If the readout of the heading is erratic or does not show the correct heading, enter the Debug Mode and check if the sine/cosine voltage are normal, eventually increase or decrease the distance between the compass card and the Course Detector.*

The sine / cosine voltage swing should be appr. 2.5±2V.

Inverted compass readout (CD109 top mounting)

On some installations it may be necessary to mount the CD109 Compass Detector on top of the magnetic compass. To obtain correct readout, the SINE and COSINE signals must be interchanged. This is normally done in the connector.

Fluxgate compass / RGC gyrocompass sine/cosine

The RFC35NS Fluxgate Compass provides sine / cosine (2.5±2V) signal to the autopilot. Also the RGC Interface Unit provides sin / cosine signal and must then be connected as "fluxgate input" to J5.

A. Fluxgate alignment (RFC35NS)

Note ! *Calibrate the compass prior to final alignment, ref. page 5-64*

Select Fluxgate as Main Compass by "COMPASS SELECT". Turn the Fluxgate compass for correct heading.

Note ! *Make sure that the "FLUXGATE OFFSET" parameter is set to 0 (zero). Ref Fig. 5-40, page 5-39. This offset is only present when Fluxgate compass is selected.*

B. Other Fluxgate manufacturer, alignment.

When an interface unit is used to connect a Non Robertson fluxgate to the AP9 MK3, the autopilot heading is adjusted by the "FLUXGATE OFFSET" parameter.

C. RGC Interface Unit

When interfacing the RGC sine / cosine signals, make sure that the Fluxgate parameter is set to 0 (zero) offset.

FOLLOW-UP Levers

Check that the FU / A scale parameter (Info loop II) is set for the proper rudder deflection.

FU91/92

Check that the rudder response is correct both with regard to direction of movement and deflection. Eventually reset the jumper switches for autopilot configuration as shown on Fig. 3-16. Zero setting may be adjusted by RV1.

Note that for the FU92, two identical boards are mounted side by side.

Dual Station Configuration

Verify that the remote unit is working properly by observing that the course display will show "STANDBY".

Push the helmsman button on the remote unit to take control. Observe that the information display changes status and reads HELMSMAN (or the mode selected by an external mode selector). The main unit will now show STANDBY.

Verify that rudder commands are given and that the rudder moves when making course change from the remote unit.

Mode selectors

When using external mode selector, either by a separate mode selector or in combination with rudder / thruster change-over switch. Verify that the proper autopilot mode is shown in the INFO display. Check details as described in the Installation section. See Fig. 5-22.

5.20 Sea Trial

The purpose of the sea-trial is to test the steering characteristics of the vessel during manoeuvring and cruising and adjust the autopilot parameters for optimum steering performance.

The steering characteristic varies from vessel to vessel, due to hull construction, speed, rudder type / size etc. It is therefore important to observe the behaviour of the vessel for rudder commands (amount and duration) when steering the vessel by hand (HELMSMAN) on a fixed heading and when making course changes and turns. The autopilot parameters should be adjusted to perform the steering with as few rudder commands as possible, and with as little rudder deflection as possible.

The following guide lines may be of use to adjust the parameters:

Steering on a fixed heading

Before switching the autopilot to AUTO function, set the parameters as follows:

- Control Unit parameters:

Counter Rudder	1
Rudder	1
Weather	OFF (See note)

Note ! *The Weather parameter will set the sensitivity deadband for minimum when OFF (sensitivity deadband controlled by the rudder deadband). By increasing the WEATHER from OFF to a value, the displayed value is the maximum sensitivity in degrees.*

- INFO loop I parameters:

Turn Rate	appr. 50° / minute
Radius / Rot	Set to Turn Rate
Rudder lim	appr. 15°
Off Course	15°
Autotrim	Initial OFF. When steering parameters has been adjusted, set the Autotrim to 1

- INFO loop II

Deadband	0,6 – 0,8°
Min. Rudder	OFF
Serv. speed	Set to ship's relevant speed
Speed sens.	0,3
Min. Radius	0,05 nm (≈140° / m)

Thruster function (Only when Thruster is selected)

Only thruster Only rudder Thruster and rudder	Selected according to the relevant combination
FU / A scale	45° (or appropriate)
Max. Rudder Lim.	Full rudder deflection – 2 or 3 degrees.
Nav. mode	XTE (or relevant mode)
NMEA output	Select appropriate output.

Helpful hints during sea trial of the AP9 MK3

Rate of Turn (ROT)

If in doubt of optimal vessel ROT, and before setting the ROT parameter, it may be helpful to enter the debug loop, and scroll through the menu until the vessel current ROT is displayed.

At service speed, make a manual, at least 90° constant turn at the desired rate, then read the calculated ROT from the display. This value will be a good starting point for wanted operation and may be tried as the ROT parameter setting.

Service speed and speed sensitivity

The service speed should be set to the vessel highest speed of normal operation. If the vessel is used at all speeds, the service speed parameter should be set to full speed, but if the vessel typically do not exceed it’s cruising speed, the parameter should be set to this speed.

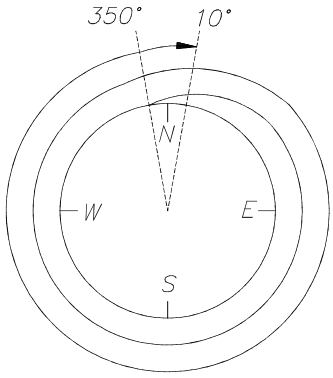
The speed sensitivity should be adjusted after the vessel is steering satisfactory. E.g. when the rudder setting (P-factor) is adjusted to desired value at service speed, reduce speed to a lower working speed (for instance half the service speed), now set the speed sensitivity parameter to a level where the vessel steers satisfactory at the lower speed.

RFC35NS Fluxgate Compass calibration and alignment

Calibration

The calibration of the heading sensor must be carried out during sea trials at very low speed. The sea state must be calm.

1. Switch on the autopilot by selecting HELMSMAN to provide mains to the heading sensor.
2. Make two 360 degrees turns to starboard within 5 minutes. Make sure the boat passes 3 times through the North (see figure). Ensure smooth and slow movements. A minimum of roll and acceleration will give the best result. When passing through north for the 3rd time, the course display shows 045 for a short moment (less than a second.)



3. The heading sensor is now calibrated. You may now perform the autopilot sea trial.

If you move your boat more than 15-20° north or south from the latitude where the compass has been calibrated, the calibration procedure should be repeated. Calibration data is stored in the compass and will not be deleted until a new calibration is performed.

Alignment

The calibration procedure must have been carried out.

Autopilot to HELMSMAN-mode.

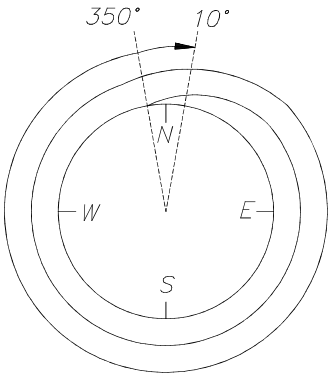
Steer the boat on a known heading. Slightly turn the heading sensor until the correct heading readout is obtained on the autopilot display. Fasten the tightening screws.

RFC35N NMEA and RFC35R Compass calibration and alignment

Calibration:

As AP9 Mk3 only can 'listen' not 'talk' to the compass on NMEA data (calibration start and confirmation) the RFC35N and RFC35R have to be calibrated the following way:

- Switch the compass off/on using the circuit breaker or the separate switch.
- Make two 360 degrees turns to starboard within 5 minutes from turn on. Make sure the boat passes 3 times through North (see figure) in smooth and slow turns. A minimum of roll and acceleration will give the best result.
- The heading sensor is now calibrated. As there is no confirmation of the completed calibration, you will have to verify the compass reading against one or more known headings.



Alignment (Offset)

The calibration procedure must have been carried out. Steer the boat on a known heading. Slightly turn the heading sensor until the correct heading readout is displayed. Tighten the screws.

General

If you take the boat more than 15-20° north or south from the latitude where the compass was calibrated, the calibration procedure should be repeated. Calibration data is stored in the compass and will not be deleted until a new calibration is performed.

On course steering

When in open water, switch the autopilot for AUTO function. Observe the rudder commands and rudder amount required to maintain the selected heading. Minimize the Weather and Counter Rudder as much as possible for optimum steering performance with minimum rudder commands and rudder amount.

The counter rudder may eventually be set to OFF to observe the effect of this parameter. The following figures show typical relationship between Rudder - Counter Rudder / Course.

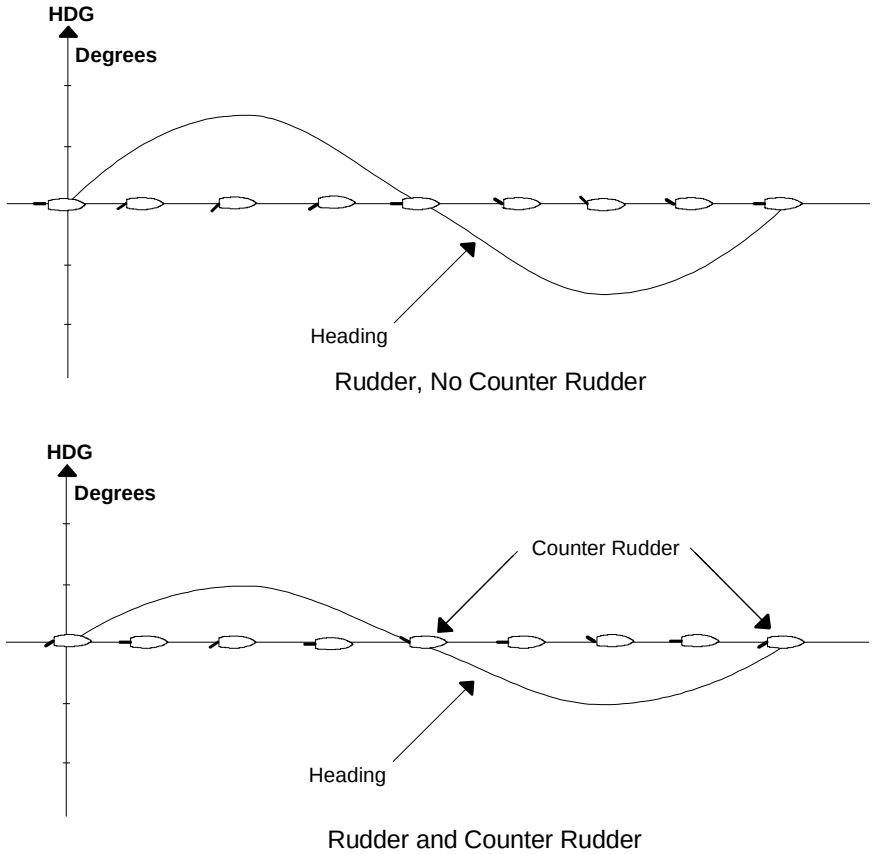


Fig. 5-48
Rudder/Counter rudder - Course relationship

Minimum rudder function

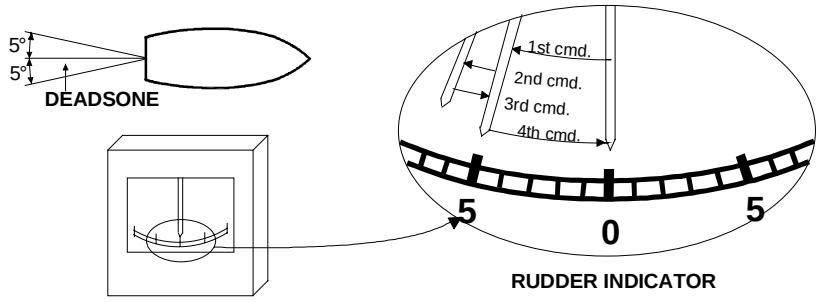
Some vessels have a tendency of creating an "inactive" rudder, due to hull construction, propeller whirls, loading and similar. The effect is that the rudder must be deflected to a certain amount before the vessel responds.

For rudder commands out of the "dead- zone", the response is "normal".

To counteract for this effect, the "Minimum rudder" parameter is set to the observed "dead-zone". The result is that the rudder will move from midship position to set minimum by one rudder command, but

additional rudder commands to the same side will cause "normal" rudder response.

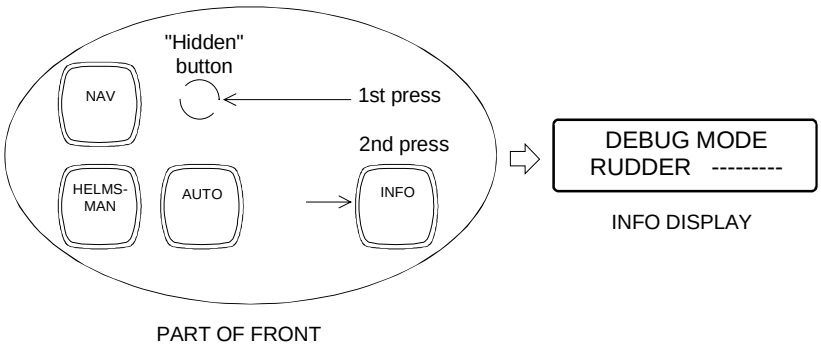
Example for 5° min. rudder.



Course Changes

When making course changes, the Rate of Turn parameter is enabled and will control the turn. In order to select the proper Rate of Turn parameter value, the following procedure can be used.

- Select HELMSMAN
- Enter DEBUG mode by pressing the "hidden" button and thereafter INFO:



Note ! *If "DEBUG MODE 7 (DEBUGAD = F80[00]" should occur, press the hidden button one more time.*

- Press INCREASE (6 times) until Rate of Turn appears, shown as:

DEBUG MODE
RATE OF TURN - - - - -

Have the captain (skipper) make a course change (more than 10° by hand, at the required turn rate (how fast the vessel turns) and note the rate of turn value in the INFO display. To escape from the DEBUG mode, press another button (i.e. Weather).
Press INFO and select Rate of Turn and adjust the parameter to the value found during the manually made course change.

- Engage the automatic function (either by pressing the Autopilot button or setting the Mode Selector to AUTO).

Note ! *The Minimum Radius in INFO Loop 2 shall be set to prevent the vessel from turning too fast.*

- Adjust the Rudder for best ON-Course steering.
- Make a small course change and observe how the Counter rudder function behaves. Adjust the amount for best performance.
- Make course changes of 20° or more. Fine adjust the performance by the Rudder and Counter Rudder for best possible result. Pay attention to how the rudder will counter up by moving to the opposite direction before the vessel is on course. This amount and time is tuned by the combination of Rudder and Counter Rudder.
- To adjust the Autotrim function, start with a value of 0,5 and monitor the Autotrim in the Debug Mode. If the Autotrim error seems to increase, increase the effect of the Autotrim until the error becomes stable. This indicates that compensation for wind / current has been made for.

  If an Autotrim error is present without influence of wind or current, it indicates that the rudder feedback zero setting is offset and therefore needs to be corrected, either by mechanically moving the centre point or electrically, in the Debug Service Mode, compensate the error.
- If speed signal (VTG sentence) is applied via the Nav. Input port, the adjustment of Speed Sense can be made. After adjusting the rudder during cruising speed, reduce the speed by 50% or less. Adjust the Speed Sense for best performance during turns and On-Course steering.

Save Parameters

Note ! *Store the parameter using the Debug Service Mode "SAVE IDEAL". To do this, proceed as follows:*

Enter DEBUG (Hidden button - INFO)	DEBUG MODE RUDDER --------
Press DECREASE	> SERVICE MODE < YES: PRESS INFO
Press INFO	> SERVICE MODE < SELECT TEST: INC
Press INCREASE	> SERVICE MODE < ALL COMP?: DEC
Press INCREASE	> SERVICE MODE < SAVE IDEAL?: DEC
Press DECREASE and observe that the display will show in one flash:	> SERVICE MODE < IDEAL SAVED

All settings are now saved.

To recall the parameters, simply push RUDDER and WEATHER simultaneously. The INFO display will show for approx. 3 seconds:

****
IDEAL RECALLED

The recall can be made in any operational mode!

Thruster Steering (Azimuth Thruster with ON-OFF valves)

When using an azimuth thruster for main propulsion, use the same procedure as described for PROPELLER & RUDDER.

Normally the RUDDER (P-factor) and Counter Rudder parameters have to be increased, but else the procedure is the same.

Combinations of RUDDER and THRUSTER propulsion

The sea-trial procedure is carried out as for normal RUDDER. Than switch to THRUSTER and observe that the 2nd paramset appears in the INFO display. Repeat the trial procedure to set parameters, and store the parameters as described for SAVE IDEAL.

Note ! *All parameters both for "normal" and "Thruster function" are stored in one operation and recalled when pressing RUDDER and WEATHER simultaneously.*

Tunnel Thruster (±10V analogue signal)

The tunnel thruster is primarily used to maintain a set heading at zero or very low speed.

Operate the thruster by hand to get a "feeling" of how much power is required to maintain the heading and make small corrections.

As explained under Dockside test, the autopilot thruster signal can be adjusted for different MINIMUM POWER under DEADBAND.

- Enter the MIN. THRUST value experienced from the manual operation of the thruster (appr. 30%).
- Make a course change of appr. 15° and observe how the applied control signal operates the thruster as the vessel approach the new heading.
- Apply Counter Rudder and eventually adjust the RUDDER and DEADBAND (Thruster) parameter to stabilize the heading on the new course. Repeat this test into different course changes to find the optimum settings of the parameters (Also refer Dock side test).

Note ! *Store the final values as "IDEAL SAVED".*

Navigational Steering test

Note ! *Navigational steering must only be used in open waters.*

Do the following check out before using navigational steering:

- The autosteering must be tested and found satisfactory.
- Any difference between the autopilot's magnetic compass course (course sensor) and the course displayed on the Nav. receiver should not exceed 5°. This is checked by steering on a straight course for 5-10 min. with the autopilot in AUTO mode and Nav. receiver in operation.

Note ! *During poor reception conditions, the receiver transmits an alarm warning which activates the alarm circuit in the autopilot. The set course reference is not updated until the reception conditions improve. See Fault Warnings on page 6-1.*

Now use the following procedure:

1. Set the Nav. receiver to calculate the distance and heading to a destination waypoint by following the manufacturers instruction manual. Make sure you have set up the receiver to calculate from your present position to the waypoint or to the first waypoint in a route.
2. Read calculated course heading (CTS) to the destination or first waypoint from the receiver.
3. Select AUTO-steering and set the course selector to this course (CTS).
4. Let the autopilot steer the boat for a period of from 30 second to one minute to allow the receiver to settle on the new course that you are heading.
5. Reset the receiver to calculate from your new present position to the destination waypoint. This step is required to set the cross track error to zero before you change to NAV mode on the AP9 MK3. Failure to reset the receiver will cause the autopilot to pull radically off course when you first switch to NAV. mode.
6. Set the AP9 MK3 to in NAV. SYSTEM mode. The autopilot will now automatically change the selected course to reduce any cross track error that the receiver senses, thereby steering the boat directly to the destination waypoint. This communication between the receiver and the autopilot is a slow acting process that takes time to respond. Distance between waypoints should therefore be of minimum 5 n.m. Otherwise there may not be sufficient time for the system to detect any XTE, and for the autopilot to alter the course to bring the boat onto the track line again.
7. If a number of track lines are entered in advance and these are continuously selected, then the AP9 MK3 must be returned to AUTO position between each course change and the procedure followed from step 2 and onwards.

On arrival at a waypoint, the autopilot course is locked to its last value.

The alarm is then activated and the AP9 MK3 shows WAYPOINT ARRIVAL or NAVDATA INVALID. (This assumes that the receiver either gives an alarm signal or ceases data transmission near destinations. See instruction manual for the receiver).

The boat normally follows the track line with a deviation of ±0.02 - 0.03 n.m., higher deviations can temporarily occur due to change of current, wind and speed or at start up from a position out of the track line.

When in NAV mode, the autopilot can correct the course selected in AUTO mode by up to ±32 degrees.

Special feedback arrangement

In some cases the standard RF14XU Rudder Feedback Unit does not fit into the rudder or thruster system. Instead, a separate 2k linear potentiometer, preferably a servo type, can be used together with a separate voltage to frequency converter. As converter the standard Freq. & Voltage Gen. in the RF14XU can be used, connected as shown below.

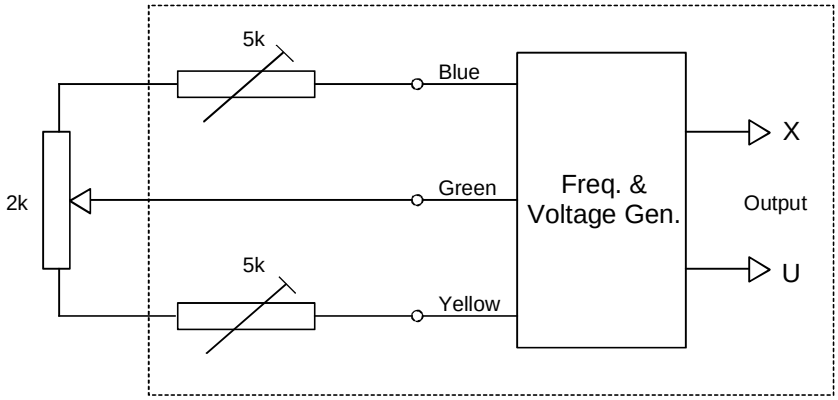


Fig. 5-49
Special feedback arrangement

The two 5k trim-potentiometers must be adjusted to provide correct feedback angle. (Compare true angle and autopilot display using "Debug Rudder".)

6 TROUBLE SHOOTING

6.1 Fault warnings

The following fault warnings may be shown on the information display:

OUT OF COURSE
RESET ALARM

Course deviation greater than selected off course alarm limit. The alarm is automatically reset when the vessel is back within the limit or cancelled by pressing Alarm reset button.

The following conditions may cause the alarm:

a. Low speed on vessel (slow acting response).

b. Extreme sea conditions (following sea).

c. Improper compass adjustment of magnetic compass when selected as Main Compass.

Readjustment of the autopilot (Weather, Rudder, Counter Rudder) to improve steering performance may cure the problem. Otherwise the off course limit should be adjusted.

This fault warning may also appear due to intermittent fault on the compass signal (open connection).

RUDDER FEEDBACK
FAIL!

Indicates that the autopilot is not reading any rudder feedback signal. By pressing the alarm reset button, the audible alarm will be disabled and the autopilot will switch to a simulated signal, instead of the real. This is indicated by a flashing *** * SIM * *** on the information display.

The autopilot will continue to steer the set course, but the steering performance is normally somewhat reduced.

The alarm is probably caused by one of the following reasons and should be checked in the following sequence:

a. Open wire in feedback cable.

b. Defective feedback unit.

c. Defective input circuit in control unit.

When the fault is rectified, the autopilot will automatically disable the simulated rudder angle signal.

NO RUDDER
RESPONSE

(May be disabled in Thruster steering)

If a rudder command is not executed, or the rudder moves in wrong direction, this message will be shown on the display. The reason can be a malfunction of the steering gear, or simply that the steering gear is not switched on.

Other reasons may be:

a. Wrong connection of feedback unit.

b. Broken feedback unit transmission link.

c. Opposite Port / Stbd output connection to solenoids or motor.

d. Sticking solenoid valve.

SIMULATION
DATA-ERROR

Rudder movement simulation failure

NAVDATA NOT REC.
FAILURE

Check that the nav. receiver is turned on and set up properly (see manual).

NAVDATA INVALID
FAILURE

Poor reception conditions or improper set-up of nav. receiver.

WRONG DATAFORMAT
CHECK NAVSETTING

Wrong NMEA-format selected on autopilot or transmitted by nav. receiver.

The last three messages indicate problems with reading the signals from the navigation receiver. If you are unable to cure the problem, after having checked all connections and the nav. receiver and autopilot set-up, consult the factory or main distributor.

SERIAL COMPASS FAIL
SELECT COMPASS

STEP SIGNAL FAIL
SELECT COMPASS

SYNCHRO SIGNAL FAIL (only 1:1)
SELECT COMPASS

MAGN. COMP. 1 FAIL
SELECT COMPASS

MAGN. COMP. 2 FAIL
SELECT COMPASS

FLUXCOMP. FAIL
SELECT COMPASS

One of these alarms will be given when the autopilot is unable to detect a proper signal from the selected heading sensor. The reason can be a faulty sensor or wrong selection of sensor.

COMPASS SELECT
FAIL

No heading sensor connected

COMPASS SELECT
ONLY ON MAINCONT

At sensor selection on remote AP9 MK3. The sensor selection should always be made from the main control unit.

COMPASS SELECT
ONLY IN HELMSMAN

At sensor selection in a mode different from HELMSMAN. The sensor selection should always be made in HELMSMAN mode.

COMP. DIFF.
RESET ALARM

Difference between Steering Compass and Off Course Compass greater than Off Course Limit

COMMUNICATION
FAILURE Control

Communication failure between Main and Remote Unit in dual station system.

WATCH ALARM
PRESS RESET

If a WA9 Watch Alarm (not in production any longer) is connected to the Control Unit J4, an internal watch alarm timer is enabled.

The watch alarm warning signal is repeated every four minutes and must be reset within one minute to avoid energizing the externally connected main alarm (if any).

Note ! *If a watch alarm is sounded when there is no watch alarm unit connected, use the following procedure to permanently cancel the alarm:*

Press the INFO and WEATHER buttons simultaneously, and step through the INFO loop until SOFTWARE/RUNTIME is reached. Press the DECREASE button 15 times to cancel the alarm (Ref. INFO program-loop).

6.2 CD109 COURSE DETECTOR

a) Enter the DEBUG-mode and verify that the compass sine, cosine (voltage swing of appr. 1,5-2,0V) and reference signals are correct. If not, proceed to "b".

b) Check the cable and connector for open or intermittent connection. If found OK, proceed to "c".

c) Try a new CD109.

6.3 FLUXGATE COMPASS

a) Enter the DEBUG-mode and verify that the sine and cosine signals varies with the heading between approx. 0.5 and 4.5 volts. If not, proceed to "b".

b) Check all connections between the compass and the control unit. Check the cable for a possible brake in one of the wires. If found OK, proceed to "c".

c) Try another fluxgate compass.

6.4 MALFUNCTION OF THE D90-91-92

No rudder movement

- Verify that the command arrows on the AP9 MK3 control display appears when a rudder command is given (Not for ±10V).
- If rudder commands are given, check that the LED's LD1 and LD2 are ON and that LD3 or LD4 lights up for PORT and STBD rudder commands. If OK, check that LD5 is off. When ON, an overload is present and the switching of the solenoids will be disabled.
- Check limit switches connections on TB12 (1-3/2-4) and eventually on TB16 (1-3/2-4)

- Check fuses F1 / F2
- Change PCB

6.5 MALFUNCTION OF THE D93/D94

- Check that the ±10V is present at the input terminals TB4-3 / 4 (Interconnection PCB)
- If not, check that the 10kHz feedback signal is present by measuring the frequency at TB2-1 / 2 (Interconnection PCB). Eventually check that the Thruster switch closes J4-11 to 13.
- Disconnect the analogue signal from dual analogue PCB (TB20, 1-2 and TB21, 1-2. If ±10V is normal, the analogue amplifier(s) must be checked.
- If no output, change PCB.

6.6 THRUSTER INTERFACE PCB

Check as for D93. Output signal is checked on TB9, 1-2.

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7 SPARE PARTS

7.1 AP9 MK3 Control Unit

Part no.	Pos.	Description
20169199		AP9 MK3 Control Unit (Complete without Gyro Interface Board)
20169207		AP9 MK3 Control Unit (without mounting accessories)
20120994		Mounting kit
20169330		EMC kit Type 9
20169256		AP9 MK3 Front housing ass'y (without Display Board)
20168332		Front panel (keypad)
20120622		Gasket for AMP connector block (J1-5)
20120630		Gasket for cabinet
20120580		Course selector knob (assembled)
20120556		Course selector tooth wheel
20120564		Return spring
44149508		C-ring A6x0.7 A2
20168357		Glass, Course display
20120549		Glass, Info-display
20168258	1	Display PC-board
20168274	2	Front PC-board
20168290	3	Interface PC-board
20168316	4	AP9 MK2 Gyro Interface board
20169264	5	EPROM (IC2) programmed

7.2 Distribution Unit

20125001	D90 Distribution Unit
20125407	D91 Distribution Unit
20125704	D92 Distribution Unit
20126009	D93 Distribution Unit
20126306	D94 Distribution Unit
20127817	D99 Distribution Unit
20126611	D9X Power Supply Board
20125027	D9X Interconnection Board
20125175	D9X Solid State Board 24V DC
20125423	D9X Solid State Board 110V DC / 1Amp.
20125720	D9X Solid State Board 220V AC
20126678	D9X Dual Analogue Board
20126017	D9X Thruster Interface Board
20127833	D9X Opto Board
21099908	J101A-40 Board
44115954	Servopotmeter SFERNICE 2K
44154417	Fuse 2.5A 5x20mm quick
44103679	Fuse 5A 5x20mm quick

44155232	Solid state relay 24V DC (D90)
44155265	Solid state relay 110V DC (D91)
44155240	Solid state relay 220V AC (D92)

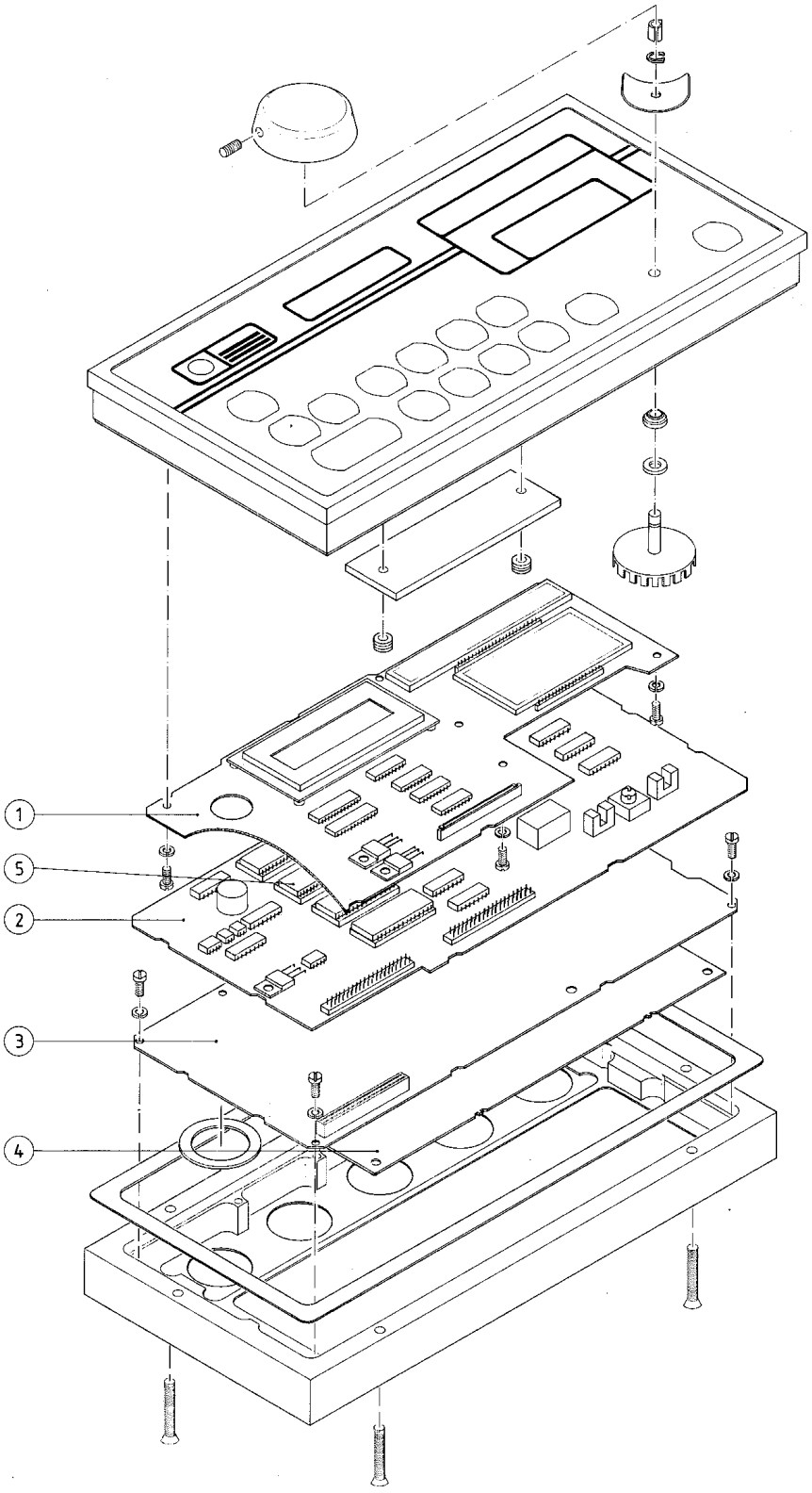

Fig. 7-1 AP9 Mk3 Control Unit, Spare Parts

7.3 CD109 Course Detector

20120861		CD109 Course Detector with holder
20120721	1	CD109 Course Detector
20331997	2	Holder for Course Detector
44112126	3	Connector block AMP NO 206044-1
44107217	4	Cable clamp AMP NO 206070-1
20120739	5	Cable with plug
44112134		Pin contact AMP NO 163090-0
20120853	6	Plug with bracket for extension cable
44106862		Socket contact AMP NO 163088-2
44150647	7	Washer
44151066	8	Screw M6x30
44149011	9	Washer M3
44149102	10	Screw M3x8
44108199	11	Cable clamp

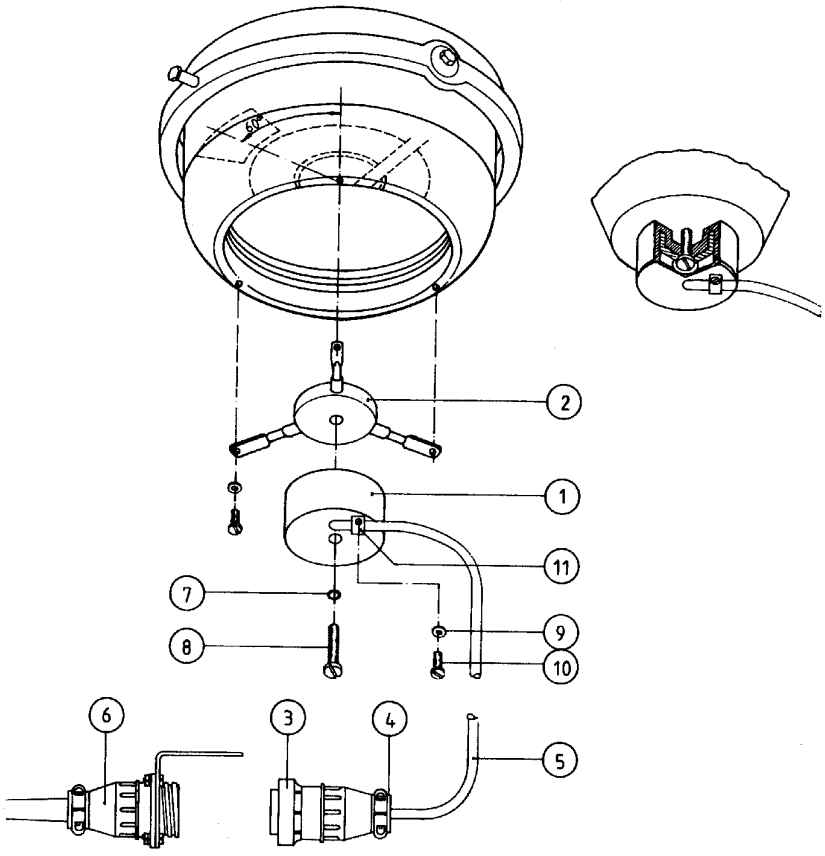

Fig. 7-2
CD109 - Spare parts

7.4 RF14XU Rudder Feedback Unit

22501647		RF14XU Rudder Feedback. Unit w / RF standard transmission link
22501654		RF14XU Rudder Feedback Unit
22500300		Shaft coupling
22500458	1	Gasket
22501605	2	Electronic XU drive module
44105120	3	Actuator
44105146	4	Limit switch
44118388	5	Potentiometer 5 Kohm
44132033	6	Corrosion inhibitor sponge
22500284	7	Activator block
22500276	8	Activator disc

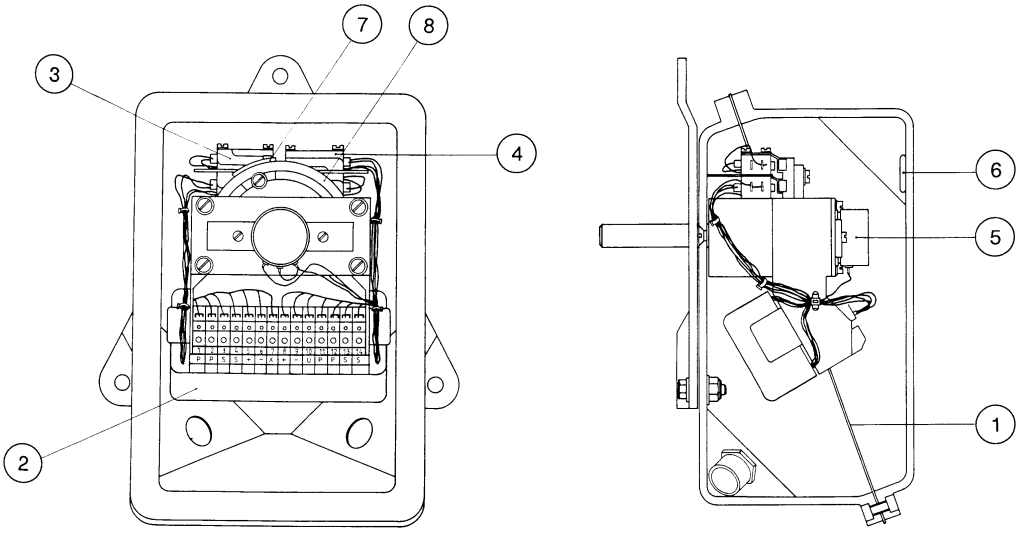

Fig. 7-3
RF14XU - Spare parts

7.5 RF Standard Transmission link

22504005		Transmission link complete
44132306	1	Ball joint, 8 mm stainless
44132322	2	Transmission rod M8x300 mm
44150225	3	Lock nut M8 (Hex)
22504021	4	Transmission lever Ø12 mm
44152676	5	Socket set screw M6x10
44151967	6	Washer M8
22504054	7	Joint nut M8 (Hex)

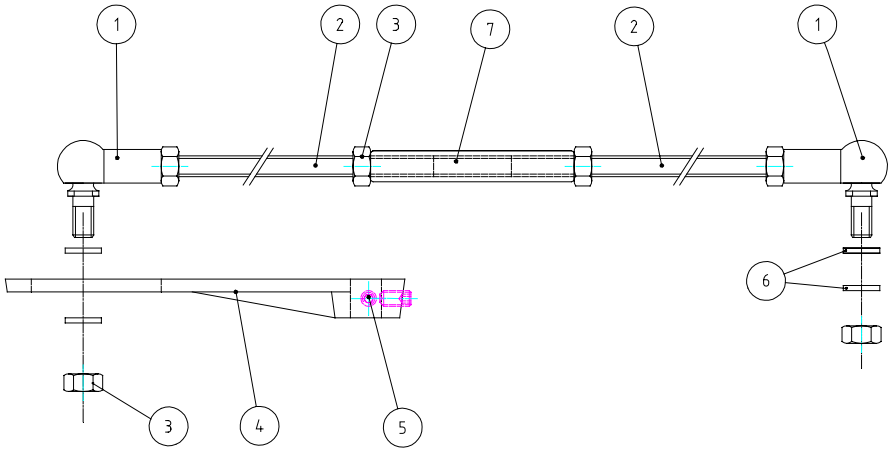

Fig. 7-4
RF Standard Transmission link

7.6 F200-40 Remote Control

20171377	F200-40 Remote Control w / mounting accessories
20171385	F200-40 Remote Control
20156410	Cable (7m) with AMP-plug
20103859	Mounting accessories
20171286	PC-board ass'y
44116754	LCD displays 4 digits
44115160	Light emitting diode SPR5531 D2, D3
20104220	Control knob assembly (COURSE)
20104253	Toothed wheel with shaft
44117224	Push button switch SW1, SW2, SW3 (MPD)
20103784	Actuator for SW1, SW2, SW3
44190114	Gasket O-ring 3 mm
44116796	Voltage regulator LM340 LAZ 5 IC1
20171328	F200 front panel (keypad)

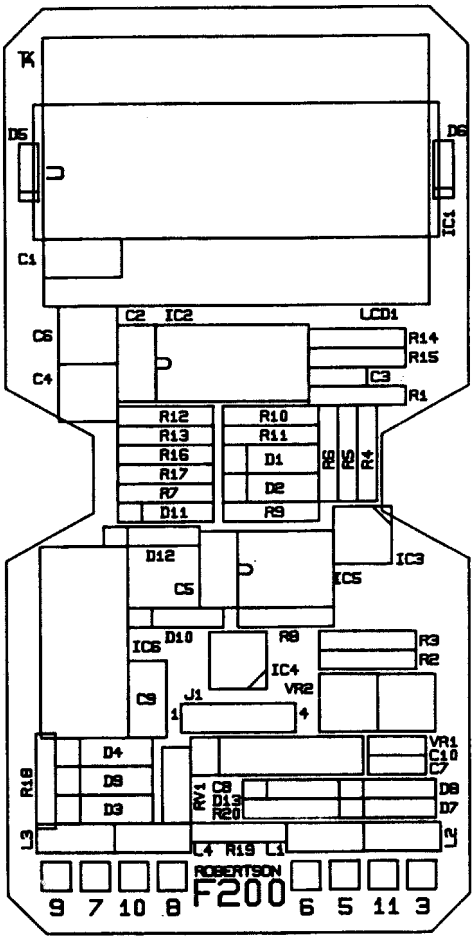

Fig. 7-5
F200-40 Component reference

7.7 S9 Steering Lever

23601800	S9 Non Follow Up steering lever
23601859	Lever with actuator shaft
44125631	Cable gland PG16
44190114	Gasket O-ring 3mm 0.6m
23601875	Coil spring
44153872	Steel ball 0.5 mm
23601834	Centring spring
44125599	Microswitch V-15-1A5
44116812	Diode 1N4006

7.8 FU91 Steering Lever

23603004	FU91 Steering Lever
23603020	FU91 Front Panel 45 DEG.
23603137	FU9X Handle ass'y w / actuat. shaft
23600703	Handle
44155497	Handle Knob
23603061	FU9X Window (X2)
23603087	FU9X PCB ass'y
23603129	FU9X Zero point bracket
44158442	Latching switch
44158459	Lamp lens, Green
44158467	Lamp 14V / 80mA
44158475	Element
44125631	Cable Gland PG16 MF
44190114	Gasket, Neoprene Dia 3 mm, 560 mm
44158418	Dimmer potentiometer, 2.2K
22013221	RF100 potentiometer with leads
23603053	FU9X cogwheel
23603277	FU91 / 92 PTTC switch ass’y

7.9 S35 NFU Steering Lever

23241144	S35 PCB Assy
44125599	Micro switch
23240096	Spring
44190114	Gasket
44140796	Cable gland

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8 DRAWINGS

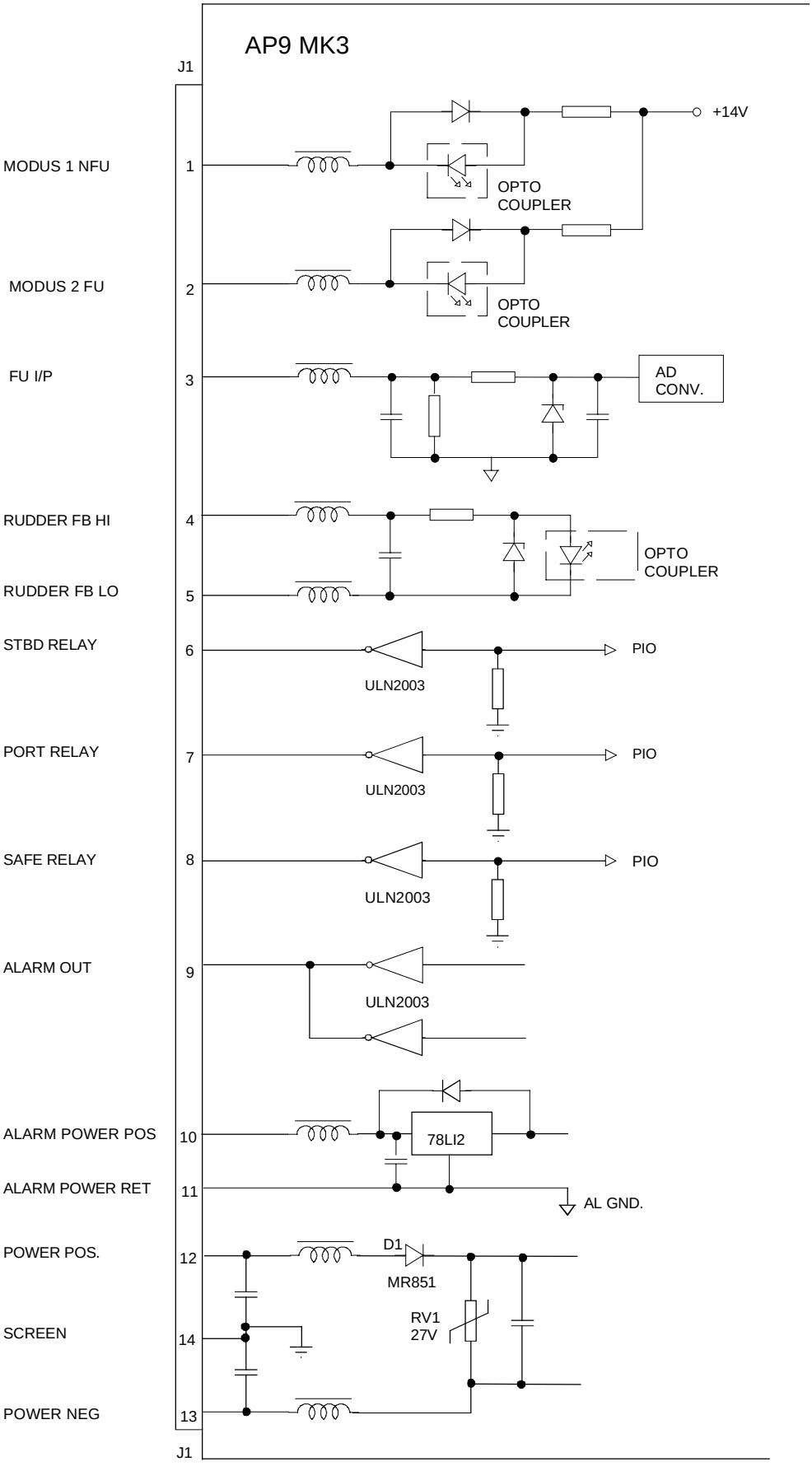


Fig. 8-1
J1 - Input/output signal references

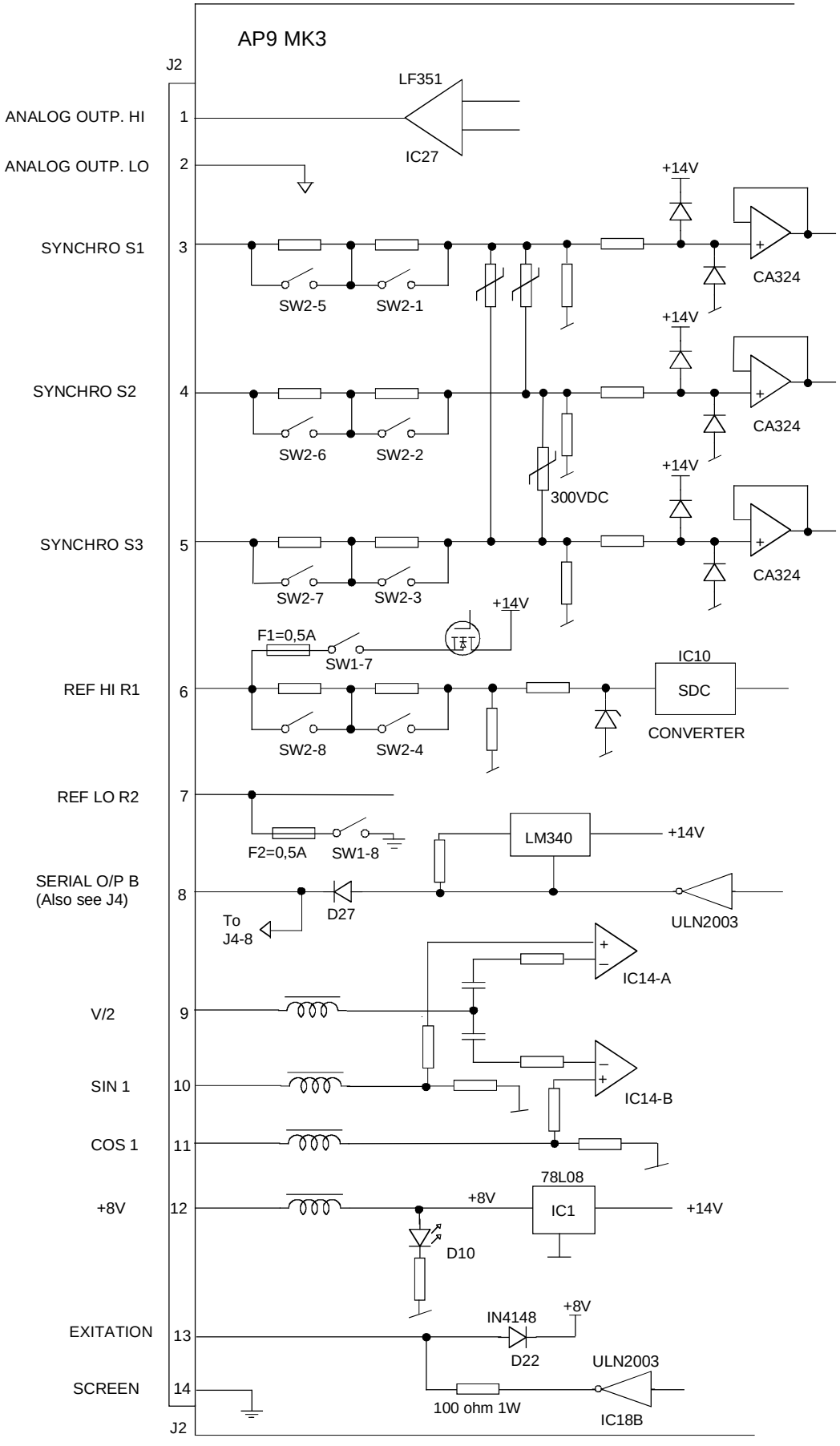


Fig. 8-2
J2 - Input/Output signal references

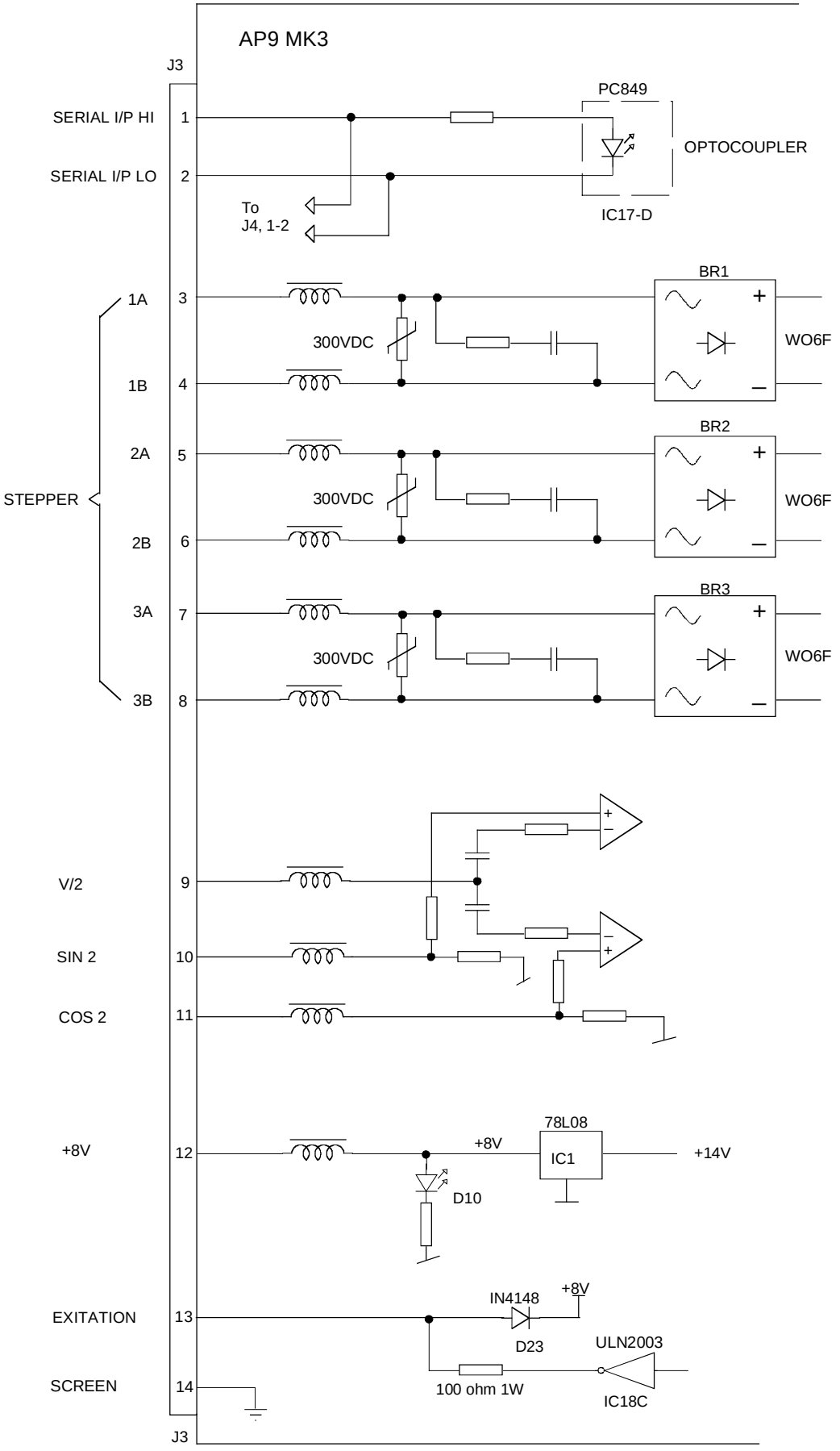


Fig. 8-3
J3 - Input/Output signal references

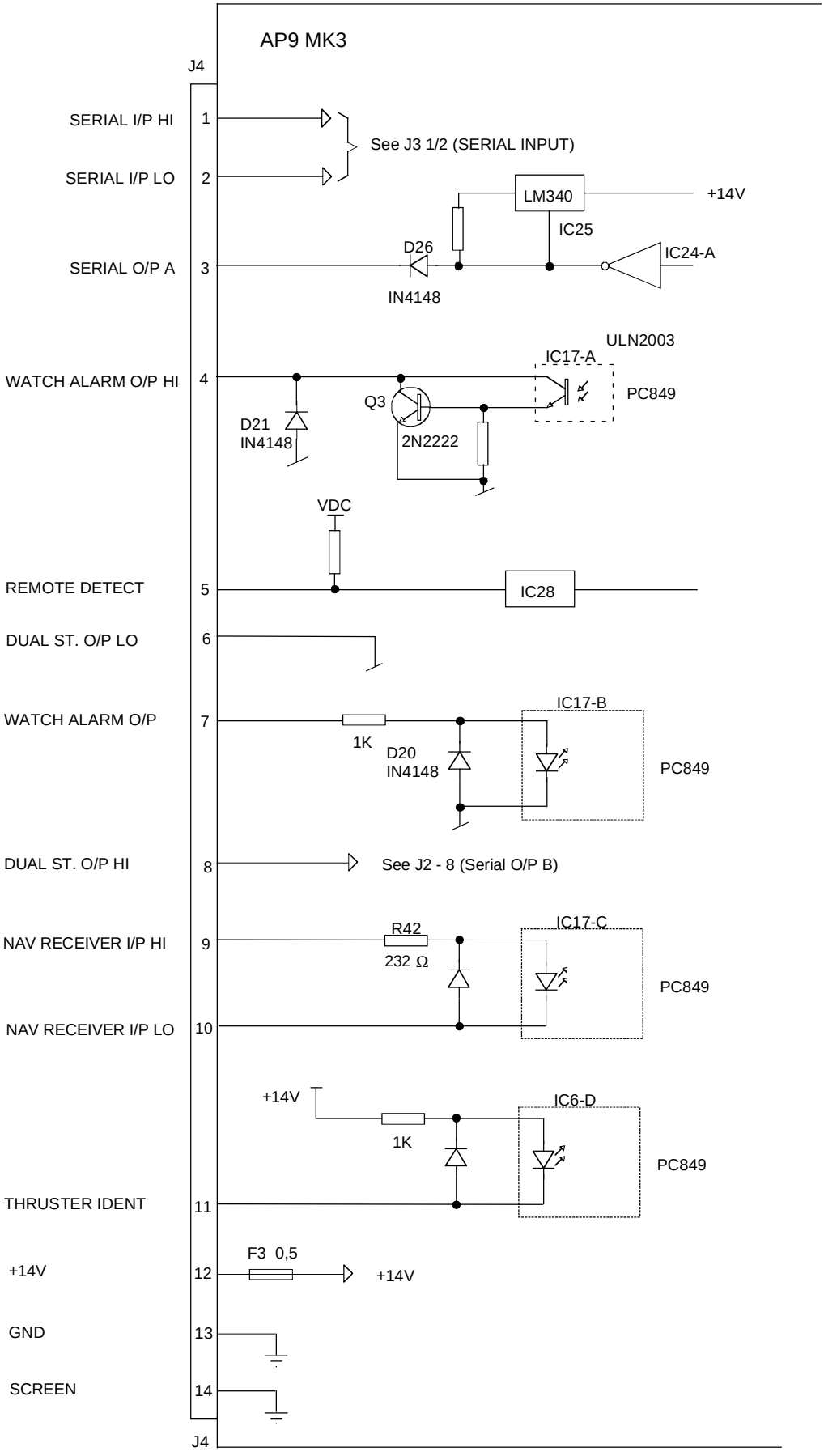


Fig. 8-4
J4 - Input/Output signal references

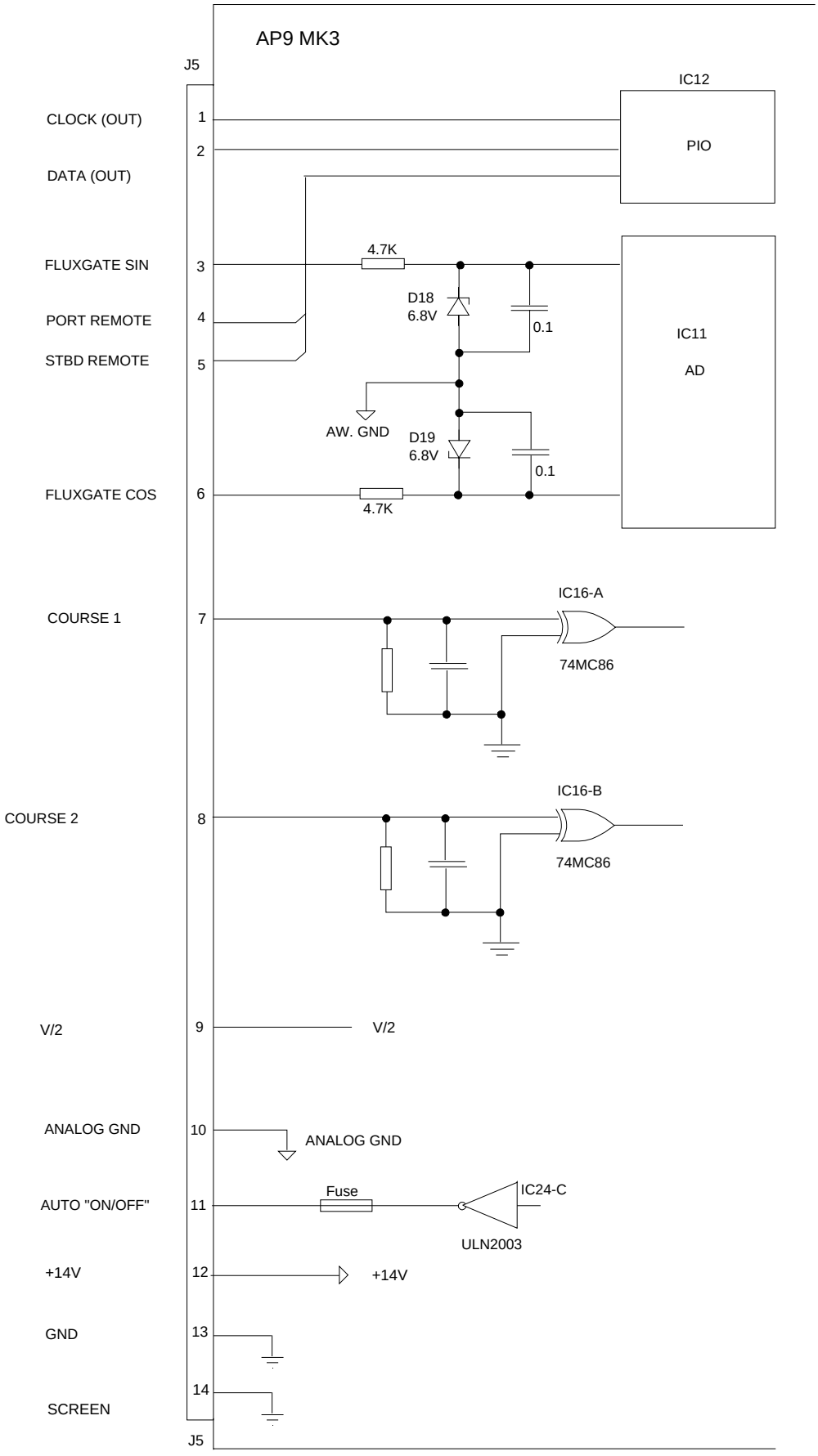


Fig. 8-5
J5 - Input/Output signal references

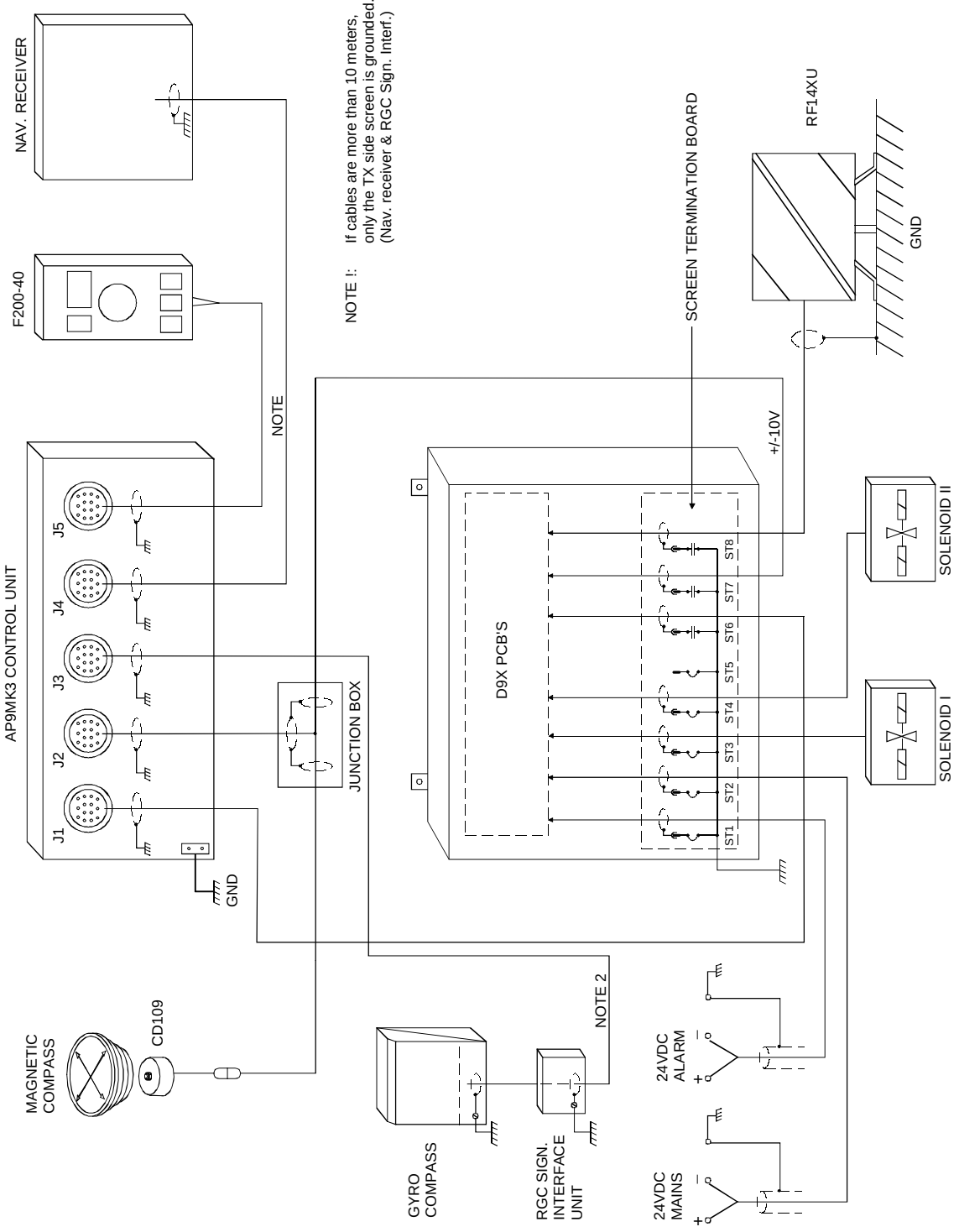


Fig. 8-6
Screen Termination

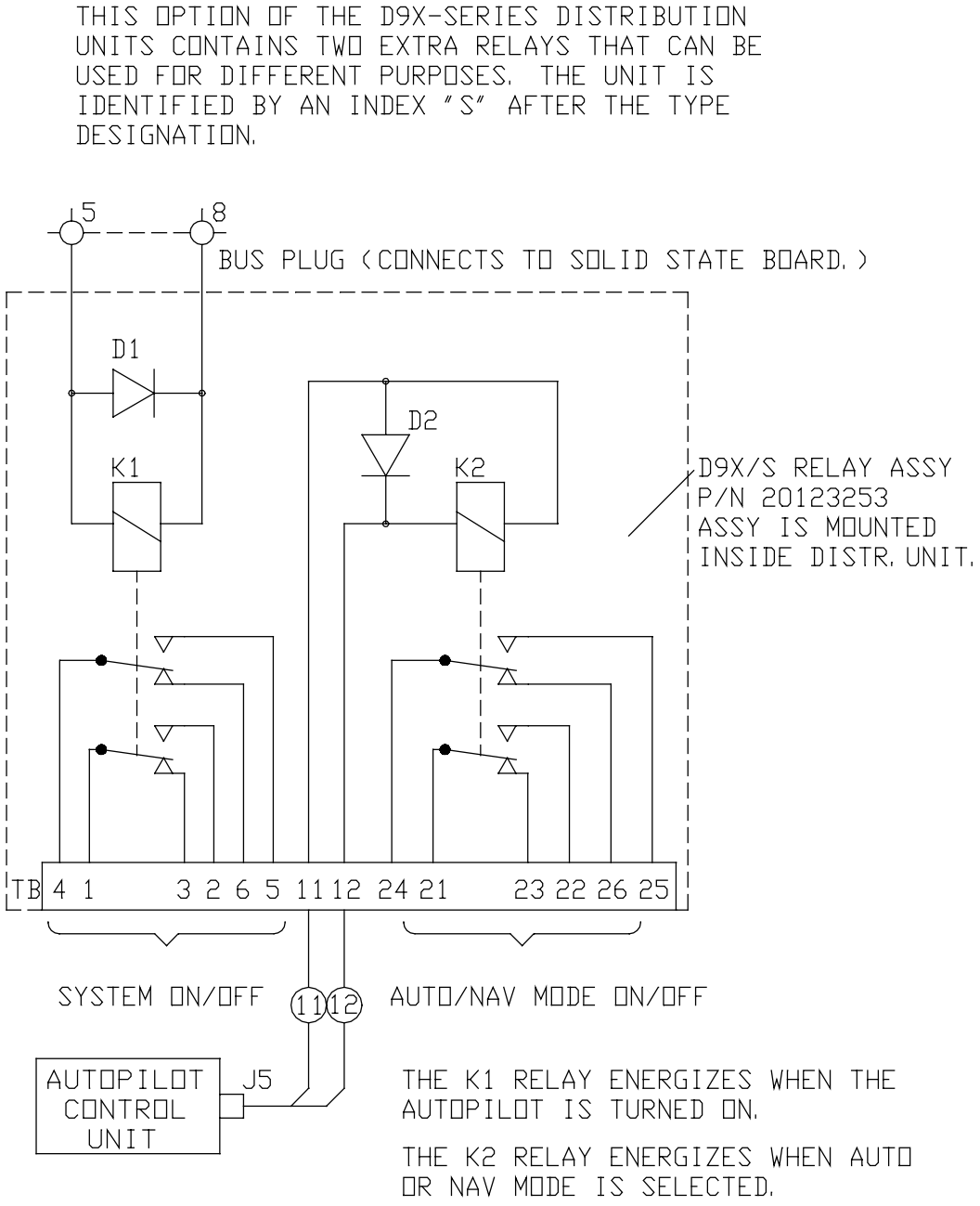


Fig. 8-7
D9X/S Series Distribution Units (Optional version)

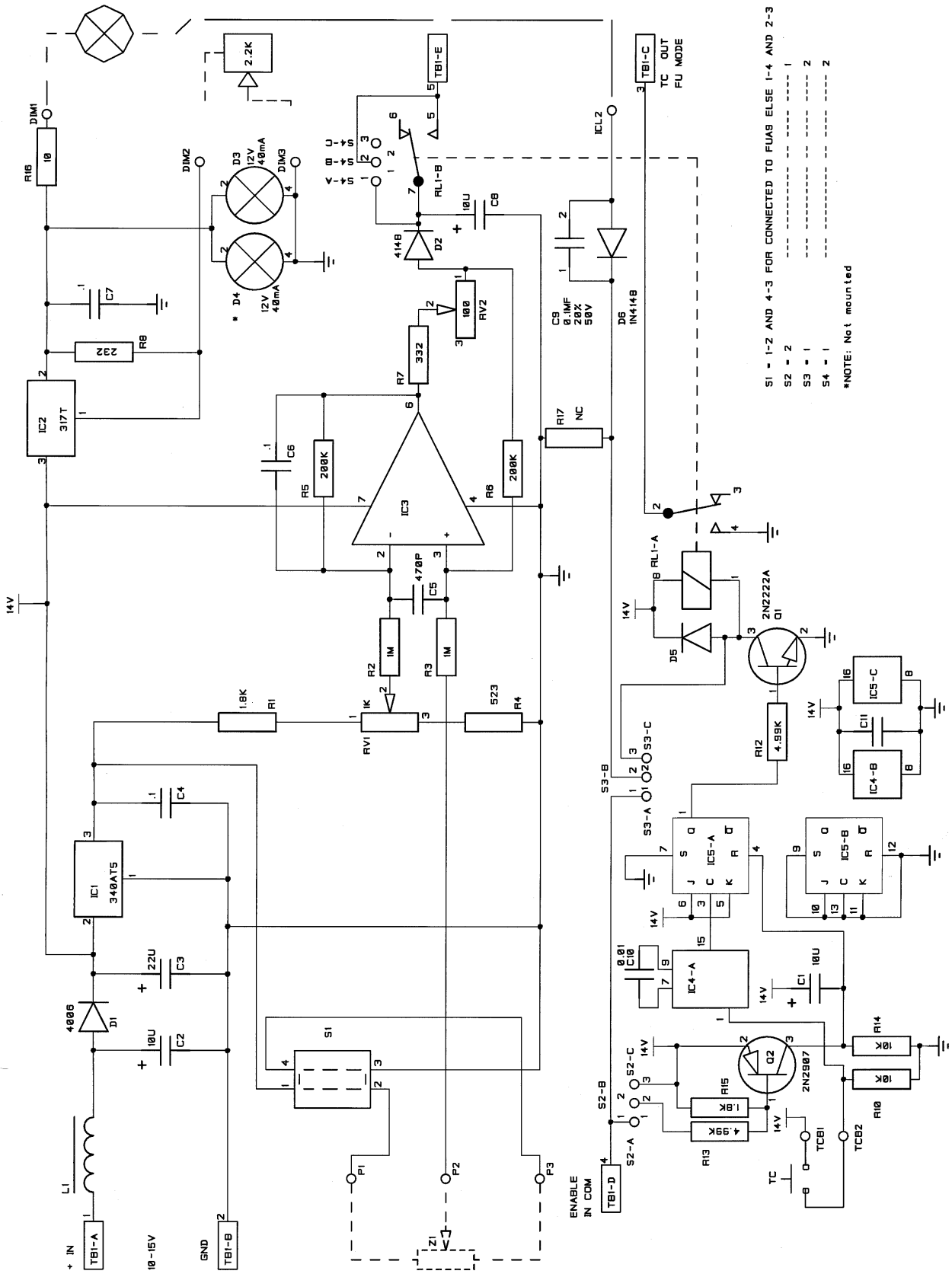


Fig. 8-8 FU9X - Circuit Diagram
(N3-360308C)

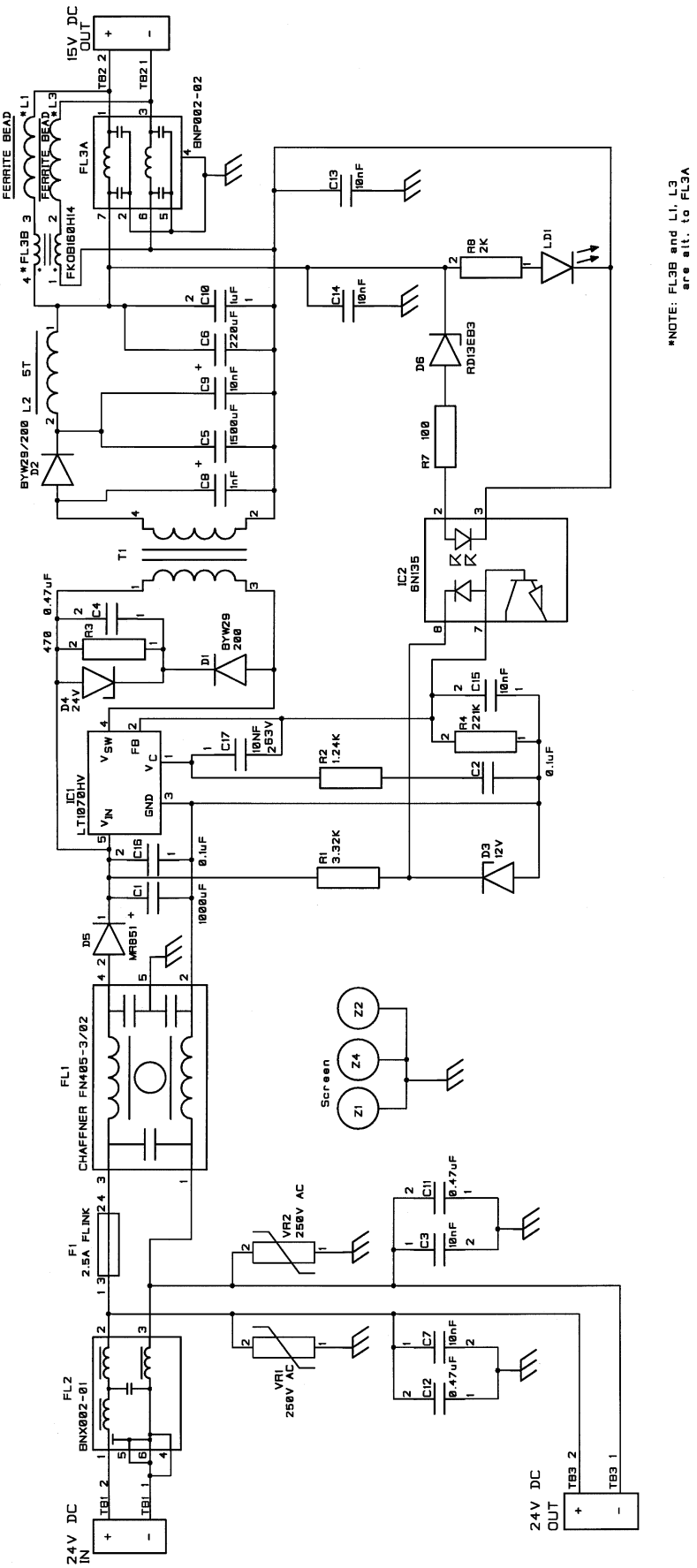


Fig. 8-9 D9X Power Supply - Circuit Diagram (Drw. No. N3-012812G)

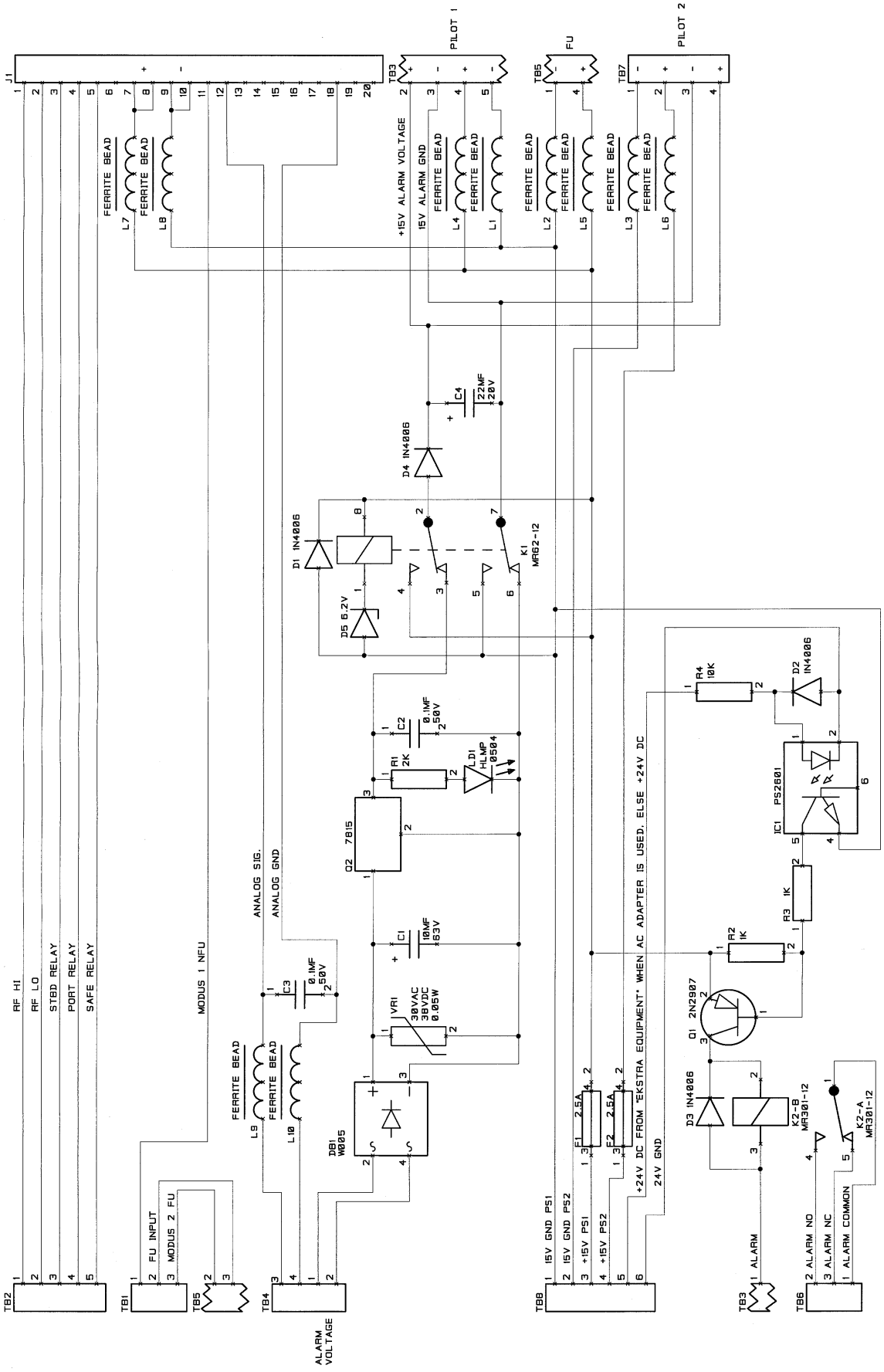


Fig. 8-10 D9X Interconnection Board – Circuit Diagram (Drw. No. N3-012813B)

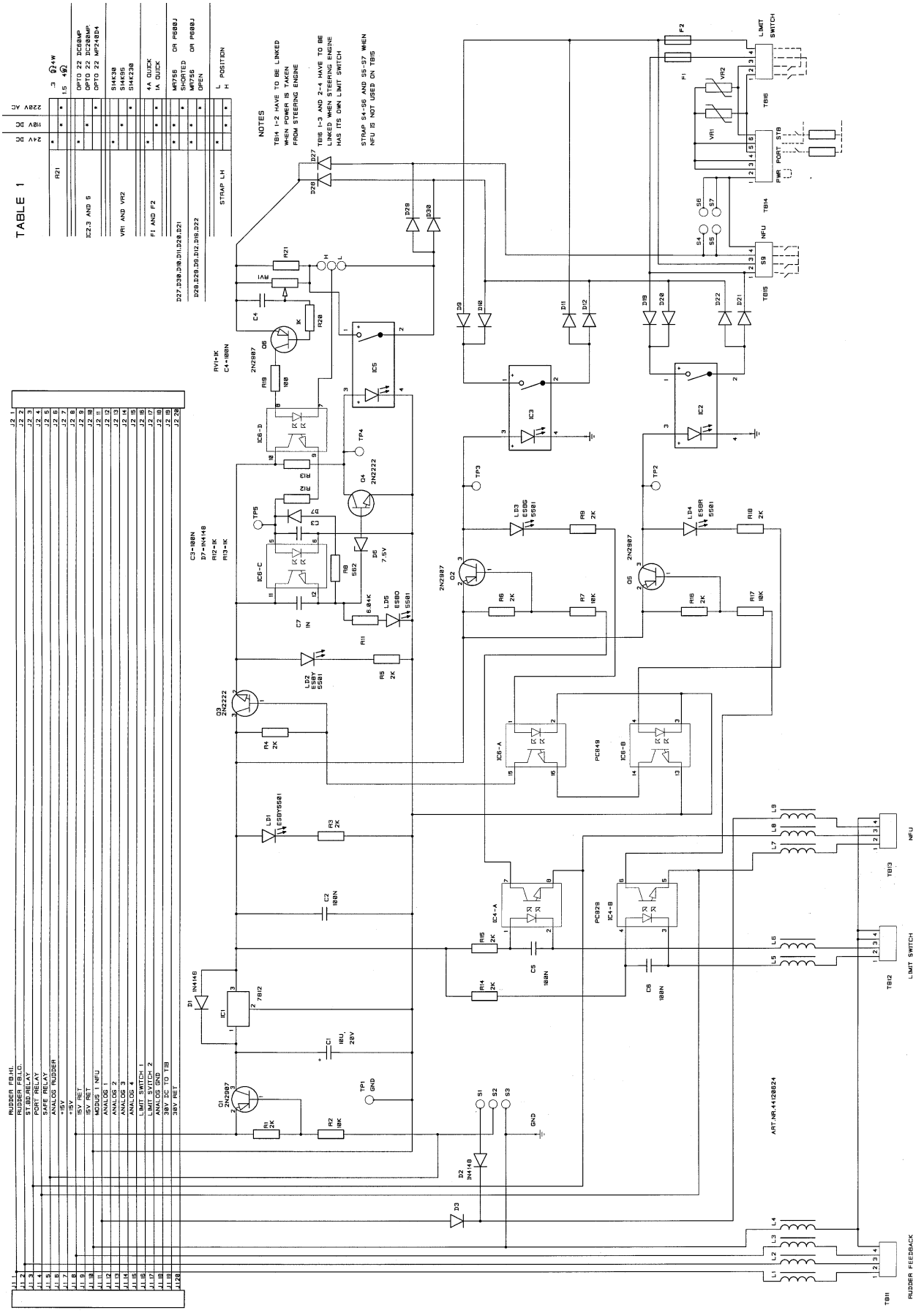


Fig. 8-11 D9X Solid State Board, Universal Type – Circuit Diagram
Drw. No. N1-012815D

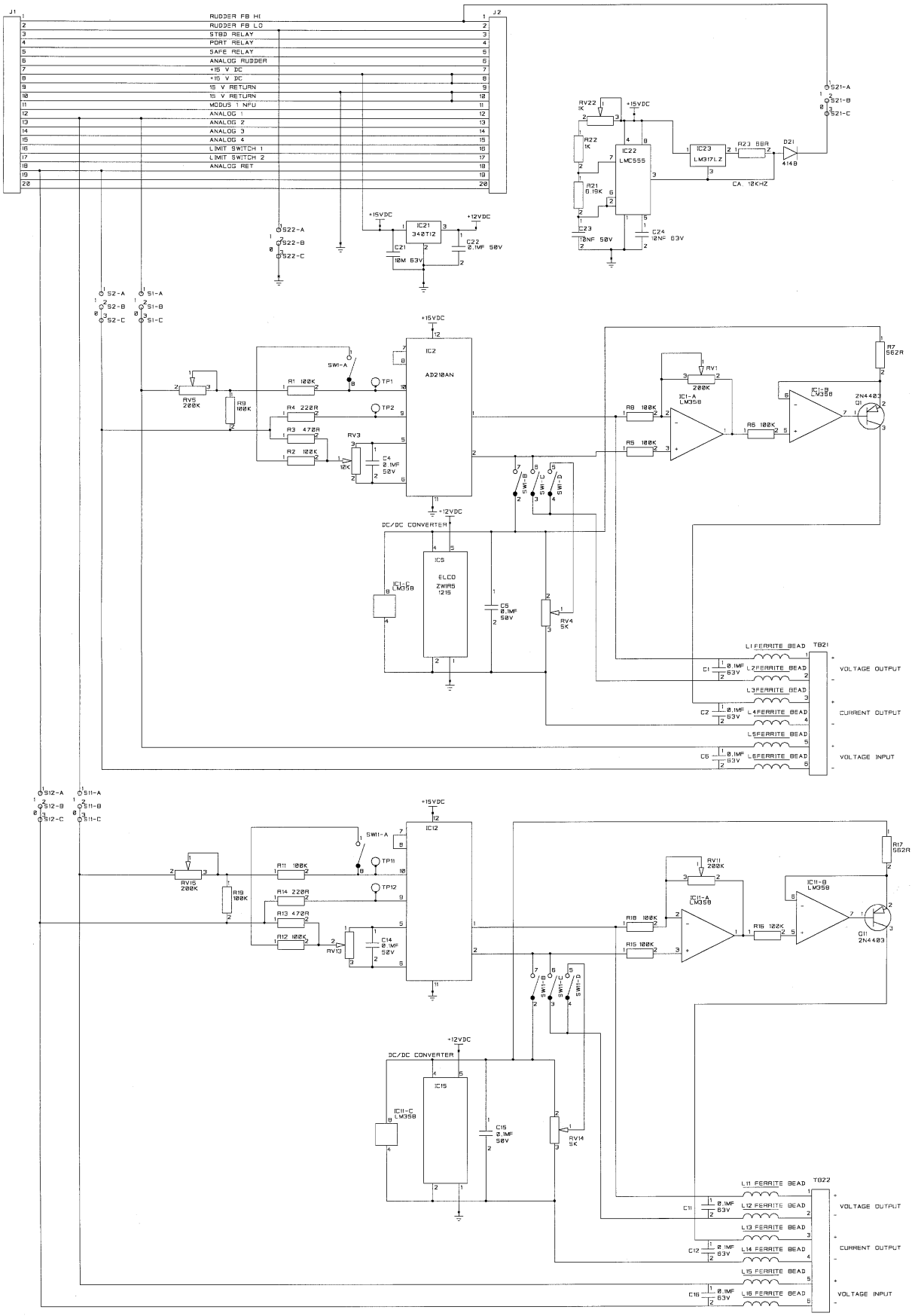


Fig. 8-12 D9X Dual Analogue Board – Circuit Diagram (Drw. No. N1-012816E)

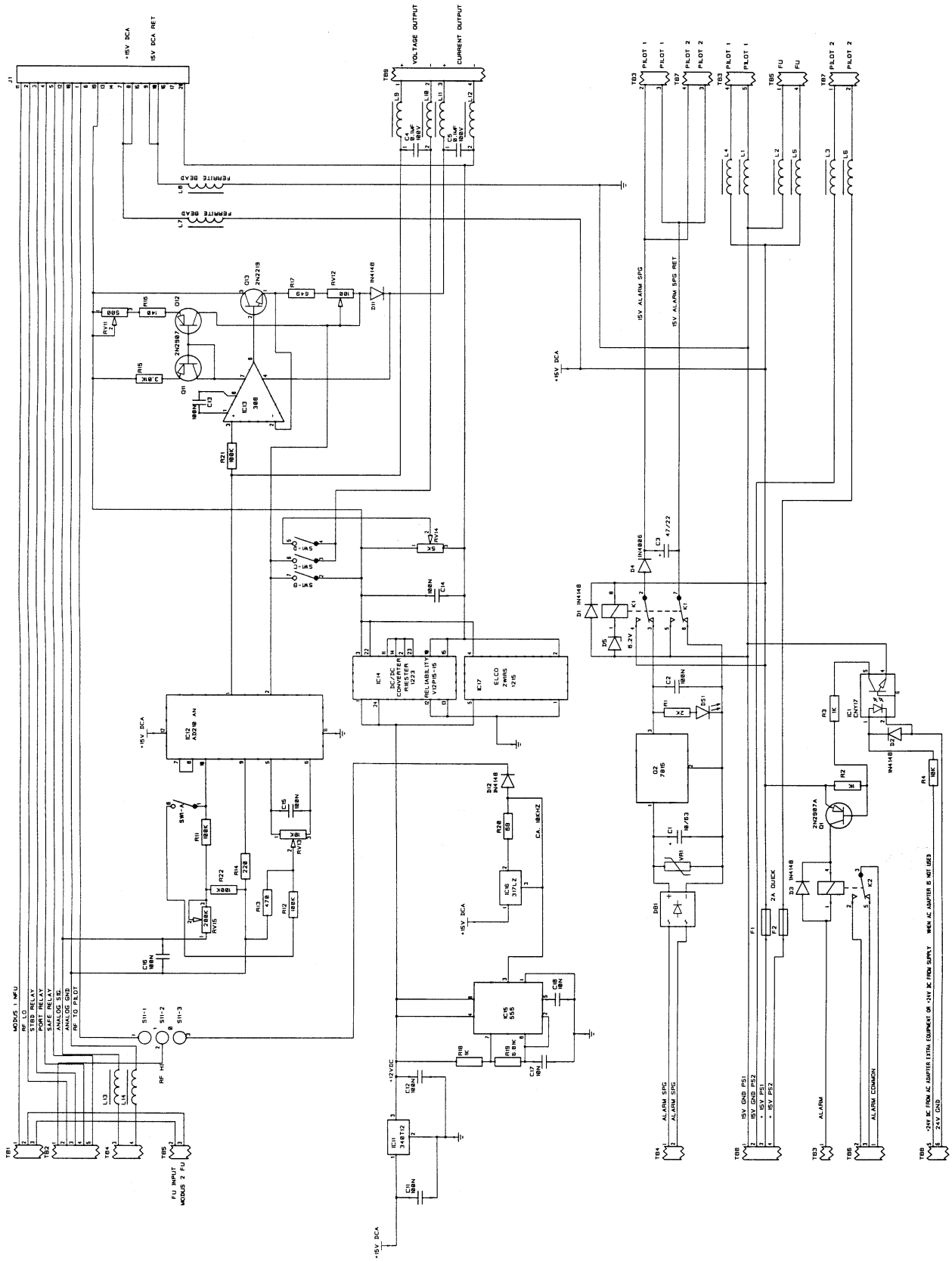
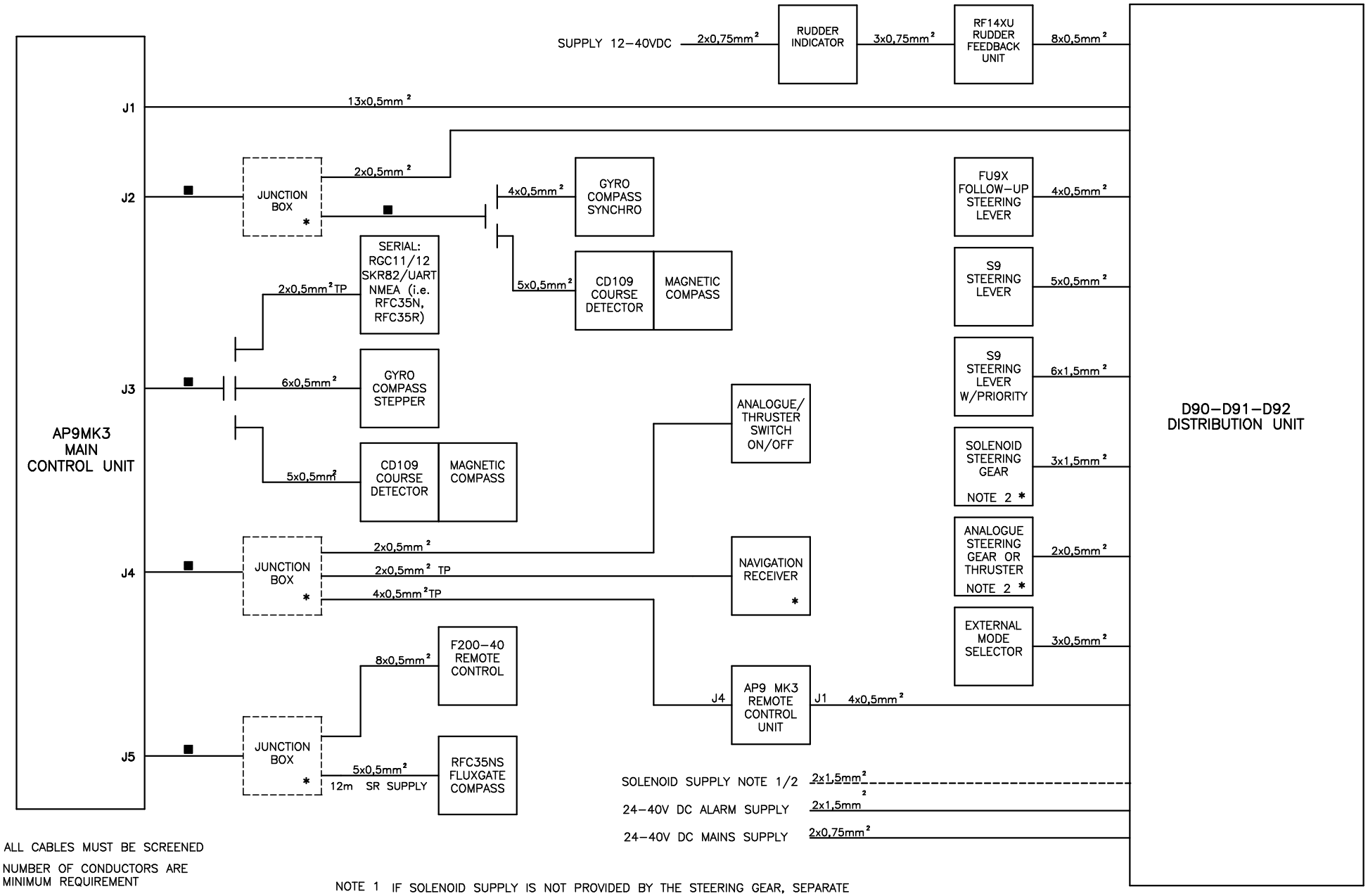


Fig. 8-13 D9X Thruster Interface Board – Circuit Diagram (Drw. No. N1-012818C)



ALL CABLES MUST BE SCREENED

NUMBER OF CONDUCTORS ARE MINIMUM REQUIREMENT

■ = NUMBER OF CONDUCTORS ARE IDENTICAL WITH THE SUM OF CONDUCTORS CONNECTED

TP = TWISTED PAIRS

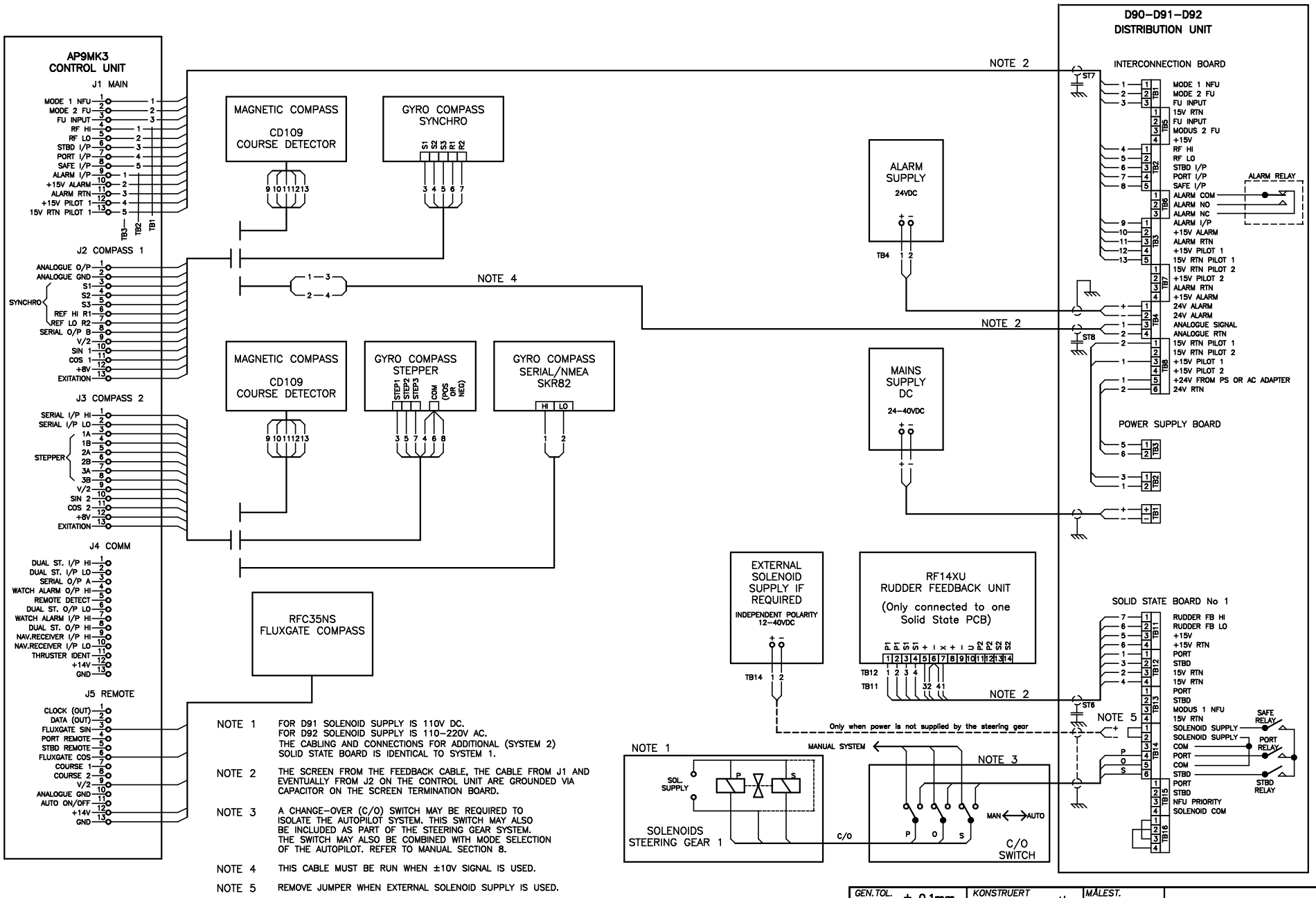
* = NOT SUPPLIED BY SIMRAD ROBERTSON

NOTE 1 IF SOLENOID SUPPLY IS NOT PROVIDED BY THE STEERING GEAR, SEPARATE SUPPLY CAN BE CONNECTED TO THE DISTRIBUTION UNIT.

NOTE 2 CABLING OF ADDITIONAL STEERING GEAR IS IDENTICAL TO THE ONE SHOWN.

REV:	NO:	DATE:	SIGN:	PAGE(S):
REV: C	NO: 3746	DATE: 201000	SIGN: JVS	PAGE(S):
REV: B	NO: 3350	DATE: 101299	SIGN: JVS	PAGE(S):

GEN. TOL. GEN. TOL. ± 0.1mm	KONSTRUERT ORIGINATOR Thorvald	MÅLEST. SCALE	Simrad Robertson AS EGERSUND NORWAY
GEN. RUHET GEN. FINISH	KONTROLLERT VERIFIED	TRACET 020999 DRAWN Nordahl	
AP9 MK3 **External Cabling Diagram**		ANT. SIDER I NBR OF PAGES 1	GODKJENT APPROVED DATO DATE
		A0 A1 A2 A3 A4 SIDE PAGE 1 AV OF 1	N3-017111 REV. C



NOTE 1 FOR D91 SOLENOID SUPPLY IS 110V DC.
FOR D92 SOLENOID SUPPLY IS 110–220V AC.
THE CABLING AND CONNECTIONS FOR ADDITIONAL (SYSTEM 2) SOLID STATE BOARD IS IDENTICAL TO SYSTEM 1.

NOTE 2 THE SCREEN FROM THE FEEDBACK CABLE, THE CABLE FROM J1 AND EVENTUALLY FROM J2 ON THE CONTROL UNIT ARE GROUNDED VIA CAPACITOR ON THE SCREEN TERMINATION BOARD.

NOTE 3 A CHANGE–OVER (C/O) SWITCH MAY BE REQUIRED TO ISOLATE THE AUTOPILOT SYSTEM. THIS SWITCH MAY ALSO BE INCLUDED AS PART OF THE STEERING GEAR SYSTEM. THE SWITCH MAY ALSO BE COMBINED WITH MODE SELECTION OF THE AUTOPILOT. REFER TO MANUAL SECTION 8.

NOTE 4 THIS CABLE MUST BE RUN WHEN ±10V SIGNAL IS USED.

NOTE 5 REMOVE JUMPER WHEN EXTERNAL SOLENOID SUPPLY IS USED.

GEN. TOL. GEN. TOL. ± 0.1mm	KONSTRUERT ORIGINATOR	MÅLEST. SCALE	Simrad Robertson AS
GEN.RUHET GEN.FINISH	KONTROLLERT VERIFIED	TRACET 020999 DRAWN	EGERSUND NORWAY
AP9 MK3 External Wiring Diagram		ANT. SIDER I NBR OF PAGES 1	GODKJENT APPROVED DATO DATE
		A0 A1 A2 A3 A4 SIDE PAGE 1 AV OF 1	N3-017115 REV. G

REV: G	NO: 3350	DATE: 020999	SIGN:	PAGE(S):

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R

S

T

W

10 APPENDIX

Appendix A: Approvals

DET NORSKE VERITAS

EC TYPE-EXAMINATION CERTIFICATE

Application of: Council Directive 96/98/EC of 20 December 1996 on Marine Equipment, as amended, issued as "Forskrift om Skipsutstyr" by the Norwegian Maritime Directorate.

CERTIFICATE NO. MED-B-725
This Certificate consists of 3 pages

This is to certify that the product

Auto-pilot (heading control system)

with the type designation(s)

AP9 MK3

Manufactured by

Simrad Robertson AS
Egersund, Norway

is found to comply with the requirements in the following Regulations/Standards:
Annex A.1, item No. A.1/4.16 and Annex B, Module B in the directive and as applicable SOLAS 74, Regulation V/19, IMO Res. A.342 (IX) as amended by MSC 64(67) Annex 3, IMO Res. A.694(17) and A.813(19), and ISO/TR 11674, EN 61162-1 and EN 60945

Further details of the product and conditions for certification are given overleaf.

Place and date
Høvik, 2000-06-16
for DET NORSKE VERITAS
REGION NORGE AS

Mindor Sjåstad
Manager, Certification of Products and Personnel

Notified Body No.:
0434

This Certificate is valid until
2005-06-30

Arve Lepsøe
Surveyor

DNV local office:
DNV Stavanger

Notice: The certificate is subject to terms and conditions overleaf. Any significant changes in design or construction of the product, or amendments to the Directive or Standards referenced above may render this certificate invalid. The product liability rests with the manufacturer or his representative in accordance with Council Directive 96/98/EC, as amended.
The Mark of Conformity may only be affixed to the product and a Declaration of Conformity may only be issued when the production/product assessment module referred to in the council directive, is fully complied with.

Cert. No.: MED-B-725
Case No.: TAA2974
File No.: A.1/4.16
844.80

Product description

Unit:	Art. No.	SW Versions
AP9 MK3 Control Unit	20169199	V1R3
D9X Distribution Unit:		
Version D90	20125001	
Version D91	20125407	
Version D92	20125704	
Version D93	20126009	
RF14XU Rudder Feedback Unit	22501647	

Applications/Limitations

- A gyro-heading repeater shall be provided being immediately readable during operation of the autopilot (heading control system).
- The off course monitor shall receive heading information from a source independent of the steering control source.
- A change over control from automatic to manual mode shall be provided.

Type Approval documentation

- Performance test report for EU type approval, AP9 MK3 Autopilot, Doc. No.: TA No.-147, 1999-06-14
- Instruction Manual AP9 MK3 Autopilot Rev. C, 1999-09-03.
- Type Testing of SIMRAD AP9 Adaptive Autopilot system, DNV Report No.96-1013
- EMC Test report, Doc. No. 199949289, Autopilot System

Tests carried out

- Environmental tests, IEC 60945 3rd Edition
- Performance tests, ISO TR 11674
- Serial Interface tests, IEC 61162-1

Marking of product

SIMRAD ROBERTSON AS,
AP9 MK3

Cert. No.: MED-B-725
Case No.: TAA2974
File No.: A.1/4.16
844.80

Mark of conformity

The manufacturer is allowed to affix the Mark of Conformity ⊙ according to Article 11 in the Council Directive 96/98/EC on Marine Equipment and issue a Declaration of Conformity, only when the module D or E or F of Annex B in the same directive is fully complied with.

Module D: The quality system for production and testing shall be approved by the Notified Body.

Module E: The quality system for inspection and testing shall be approved by the Notified Body.

Module F: Compliance of the products to type as described in this EC Type-Examination Certificate must be verified by the Notified Body who also shall issue a Certificate of Conformity.

End of Certificate

DET NORSKE VERITAS * 1864 *

DET NORSKE VERITAS

QS - CERTIFICATE OF ASSESSMENT - EC

Application of: Council Directive 96/98/EC of 20 December 1996 on Marine Equipment, as amended, issued as "Forskrift om Skipsutstyr" by the Norwegian Maritime Directorate.

CERTIFICATE NO. MED-D-129

This Certificate consists of 2 pages

This is to certify that the Quality System for the product

Auto-pilot (heading control system)

with product designation(s) as specified in the Appendix to this certificate

Manufactured by

Simrad Robertson AS

Egersund, NORWAY

is found to comply with the requirements applicable to it.

The quality system for the product, defined in Annex A.1, section 1, Item No. A.1/4.16 has been assessed with respect to the procedure of conformity assessment described in Annex B, Module D in the directive.

Limitations:

Modifications made to the Quality System shall immediately be reported to Det Norske Veritas AS in order to examine whether this Certificate remains valid. Annual periodical audits will be held to verify the validity of the certificate.

Place and date
Høvik, 2000-06-16
for DET NORSKE VERITAS
REGION NORGE AS

Mindor Sjåstad
Manager, Certification of Products and Personnel

Notified Body No.:
0434

This Certificate is valid until
2005-06-30

for Arve Lepsøe
Surveyor

DNV local office:
DNV Stavanger

Notice: The certificate is subject to terms and conditions, if any, overleaf. Any significant changes in design or construction of the product, the quality system or amendments to the Directive or Standards referenced above, may render this certificate invalid. The product liability rests with the manufacturer or his representative in accordance with Council Directive 96/98/EC, as amended.

Cert. No.: **MED-D-129**
Case No.: TAA2774
File No.: A.1/4.16
844.80

APPENDIX, Rev. No. 0

to QS - CERTIFICATE OF ASSESSMENT - EC, CERTIFICATE NO. MED-D-129

Product designation	*EC Type-Examination Cert. No.*	*DNV Case no.:*	*DNV QS Assessment Report dated*
AP9 ADAPTIV	MED-B-664	TAA2974	1999-05-28
AP2000 TRACK	MED-B-664	TAA2974	1999-05-28
AP9 MK3	MED-B-725	TAA2974	1999-05-28

The manufacturer complies with the Council Directive 96/98/EC on Marine Equipment and is allowed to affix the Mark of Conformity followed by the DNV identification number 0434 and the two last digits of the number of the year in which the product is produced.

Example: ⊙ 0434/00

The manufacturer shall issue a Declaration of Conformity for each product with reference to the EC Type–Examination Certificate and this QS – Certificate of Assessment – EC.

Place and date
Høvik, 2000-06-16

for Arve Lepsøe
Surveyor

11 SALES AND SERVICE WORLDWIDE (000929)

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MarineLine:
Leisure market

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