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Proportional Amplifier for Analog Rudder Steering Control

- Torque motor
- Three-phase motor
- Proportional solenoid valve

Type 139-155 NG004 and NG005

OPERATION

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Proportional Amplifier for Rudder Steering Control

Operator Manual

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- Three-phase motor
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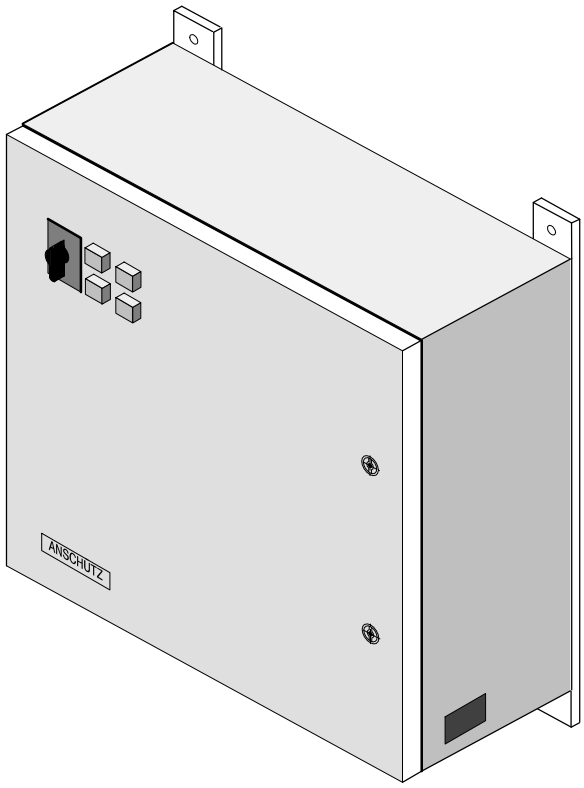
1 General

Unit overview

The proportional amplifier for analog rudder control (referred to for short as “proportional amplifier” in the following) is the central component of the rudder control system. It controls the hydraulic valves of the rudder machinery until the rudder actual value has reached the set value of the rudder.

The proportional amplifier operates as a constant regulator, i.e., the hydraulic valves are opened less as the control deviation diminishes and the rudder movement speed is reduced.

It can be controlled by 3-phase DC motors, torque motors or by proportional valves. In addition, there is an option for NFU operation from the bridge or via buttons on the proportional amplifier itself.



User manual

This current user manual includes all the operating procedures.

Service manual

There is also a service manual available in addition to this user manual. It includes:

- Information on installation and initial startup
- Information on care, maintenance and repair
- A description of the proportional amplifier

2 Notes on the operating instructions

Explanation of the symbols used

Lamp *off*

Lamp o*n*

Switch operation

3 Operation

3.1 General

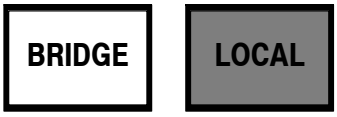
The proportional amplifier is operated from the bridge in normal operation (operation mode BRIDGE). Operation mode LOCAL is only used for servicing work or emergencies. The current operating mode is indicated at the bridge by a light.

3.2 Switching on

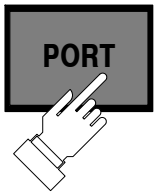
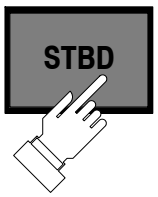
The proportional amplifier does not have its own ON/OFF switch. There are two options available to switch the unit on, and these must be determined during the planning stage:

1. Switching on the status contact “Pump ON”:
   The amplifier is given the same power supply as the rudder machinery. The amplifier is then activated by the status signal “Pump ON”.
2. Switching on via the mains power supply:
   Contact “Pump ON” is jumpered in the unit, and thus the amplifier is switched on when the power supply is switched on (via the pump selector switch).

3.3 Operation mode BRIDGE

Operation	Displays	Notes / Comments
		Operating mode switch in the BRIDGE position. The desired control mode (hand wheel, autopilot or tiller) can be selected from the bridge by means of the controller selector switch

3.4 Operation mode LOCAL

Operation	Displays	Notes / Comments
	BRIDGE LOCAL	Operation mode selector switch in the LOCAL position. Control is done by the buttons on the FU amplifier
	PORT STBD	The rudder moves to port as long as the button is held down until the rudder limit position is reached by pressing the PORT button.
	PORT STBD	The rudder moves to starboard as long as the button is held down until the rudder limit position is reached by pressing the STBD button.

CAUTION:

Switching into position “LOCAL” only in an emergency situation.
Rudder-commands from the bridge are no longer transmitted.
The lamp “LOCAL” at the bridge lights up.

3.5 Operation mode EMERGENCY

If the rudder machinery is provided with an emergency switch, it is possible to deactivate the proportional amplifier with the help of the switch.

3.6 Switching off

The proportional amplifier does not have its own ON/OFF switch. It is automatically switched off when the associated pump of the rudder machinery is switched off.

1. Pump selector switch to “Pump OFF”
   (The proportional amplifier is still supplied with power)
2. Turn off the power supply to the amplifier

4 Disturbed operation

Disturbed operation of the proportional amplifier is indicated at the alarm panel (e.g., NAUTOALARM unit) via potential-free contacts.

Alarm overview:

Display	Possible Cause	Effect in operation	Action	Comment
FU FAIL	– Failure of the power supply – CPU failure – Internal voltage failure (5V/±15V/+24V/+36V) – Overcurrent / short circuit	Operation in FU mode is not possible	– Select NFU operation or: – Switch over to the second set of rudder machinery	– The overcurrent monitoring unit works independently and is detected by software. Once the overcurrent has been detected, the amplifier is automatically reactivated. This procedure is repeated every 2 seconds; after 5 attempts “FU FAIL” is triggered. – Troubleshooting, correcting faults (see service manual 3975)
HYDRAUL. LOCK	FU MODE: – Actual value of the valve actuator does not reach the set value input	The set rudder angle is not reached The rudder does not move at the maximum possible rotational rate The valve is not opened and the rudder does not move	– Switch over to the second set of rudder machinery	– Change parameters “motor set / actual values” and “Delay time” (see service manual 3975)
	– Limit switch activated while FU-MODE	– Rudder reaches maximum position		– Check of adjustments of Hydraulic-lock-alarm (see sevice manual PA 14)
	NFU MODE: – No power flows through the current limiting resistance as the result of a “PORT / STARBOARD” rudder command			– Check the hydraulic system

Display	Possible Cause	Effect in operation	Action	Comment
STEERING FAILURE	FU MODE: – The actual rudder value does not reach the set value within the defined time and to a defined precision	The required precision cannot be reached.	– Switch over to the second set of rudder machinery	– The monitoring is also triggered if the limit switches in the rudder feedback are actuated. – Change parameters “Differential set / actual rudder values”, “Actual rudder movement speed” and “Delay time” (see service manual 3975) – Check the hydraulic system
WIRE BREAK	WIRE BREAKAGE: – There is a wire break at the following inputs:		– Switch over to second set of rudder machinery or:	– Correct the wire breakage
	– Hand wheel	Hand control not possible	– Change to NFU operation	
	– Autopilot	Autopilot control not possible		
	– Rudder feedback	Rudder control not possible	– Switch over to NFU tiller operation	

4.1 Failure indication and adequate action

4.1.1 Hydraulic Lock

Meaning:
Actor (Motor/Torquer/Valve) doesn‘t follow the amplifier command,

Reaction:
In case of “Hydraulic Lock” alarm, the alarm relay is activated and the alarm is indicated by an alarm unit on the bridge.
The Proportional Amplifier is not switched OFF.

The adequate action by the user is to switch OFF the pump of defective equipment and switch ON the secondary pump system.

Attention (the Proportional Amplifier is not switched OFF):
Hydraulic Lock reaction up to the year 2004: The Proportional Amplifier is deactivating the output – no rudder commands will be carried out while in hydraulic lock situation.
(Hydraulic Lock reaction after the year 2004: The software has been changed due to many false alarm situations).

4.1.2 Steering Failure

Meaning:
Set rudder command and actual rudder are compared continuously.
In case of “Steering Failure” the set rudder command is not carried out by the Steering System.

Reaction:
In case of “Steering Failure” alarm, the alarm relay is activated and the alarm is indicated by an alarm unit on the bridge.
The Proportional Amplifier is not switched OFF.
The adequate action by the user is switching OFF the defective Steering System (look from where the alarm is generated) and use the ‘Steering Selector Switch‘ to switch over to NFU–Tiller steering.

4.1.3 Wire Break

- Feedback Unit
- Handwheel

Meaning:
Interruption of cable connection between sensor and Proportional Amplifier.

Reaction:
In case of “wire break” alarm, the alarm relay is activated and the alarm is indicated by an alarm unit on the bridge.
Depending on the class regulation (2003) the reaction is different.
According to the DNV regulations, the rudder has to be fixed in the last position.

Adequate user reaction:
Use the ‘Steering Mode Selector Switch‘ and change the Steering Mode to NFU Steering.
Carry out the steering by NFU-Tiller.