

**RC/MS
RUDDERCONTROL
MOTORSTARTER SYSTEM
FOR
Synchronizing of Twin-rudder**

November 2001

**Operation
&
installation
manual**

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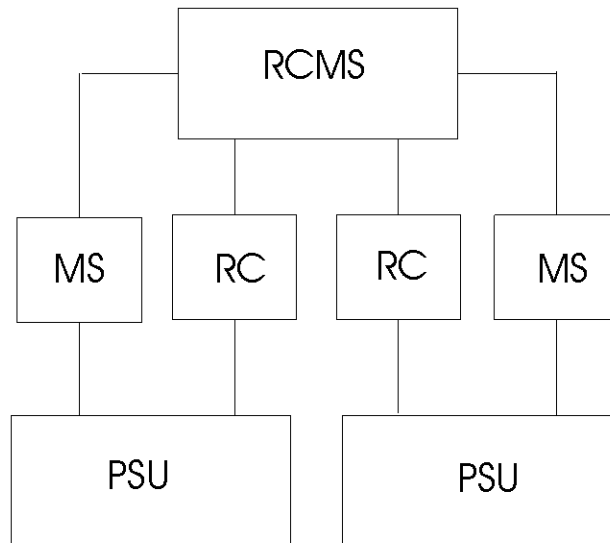
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System Description

1 Rudder Control system and Motorstarter system - a brief description.

This manual describes the the Electronic Rudder Control System and Motor Starter System from Scan-steering.

A complete system is shown in 0. It consists of one Bridge Remote Control (RC/MS) for the rudder control and the motor starter, two Rudder Drivers (RC) for control of magnetic valves, two Electronic Motor starters (MS) for control of electrical motors and pump - stations, and two feed back's (FBH) for measuring the rudder angle.



The electronic system is divided into a Rudder Control system and an Electronic Motorstarter system for electrical motors that drives the oil pumps in the hydraulics.

The Rudder Control system consists of one Bridge Remote Control, two Rudder Drivers that controls the magnetic valves, and two Feed Back's that returns rudder angle signals.

The starter system consists of a Bridge Remote Control and two Electronic Motor Starters.

Remark: The Bridge Remote Control for the Electronic Motor starter and Rudder Control is physically placed in the same box.

The Rudder Control:

The two Rudder Drivers, respectively called system A and B, are working independent. This means that a failure in one system does not affect the other. The interconnections between the two systems are implemented with photo couplers giving total electric separation.

The systems can be operated from the steering-gear room if the connection between the Bridge Remote Control and the Rudder Drivers fails.

The Rudder control system operates two independent rudder synchronized in NFU and pilot mode.

Remark: Although we switch the systems On or Off, the power supply to the electronic circuits isn't switched on and off. It is necessary to have the power switched on all the time to keep the logic operative.

The Motorstarters:

The two Motor starters, called I and II, are working independently. Therefore a failure in one system will not affect the other. Meanwhile a special built-in function provides an automatic upstart of one electrical motor, if power to the other disappears.

The motor starters can be operated from the steering-gear room if the connections between the Bridge Remote Control and the Motor starter fails.

The Bridge Remote Control

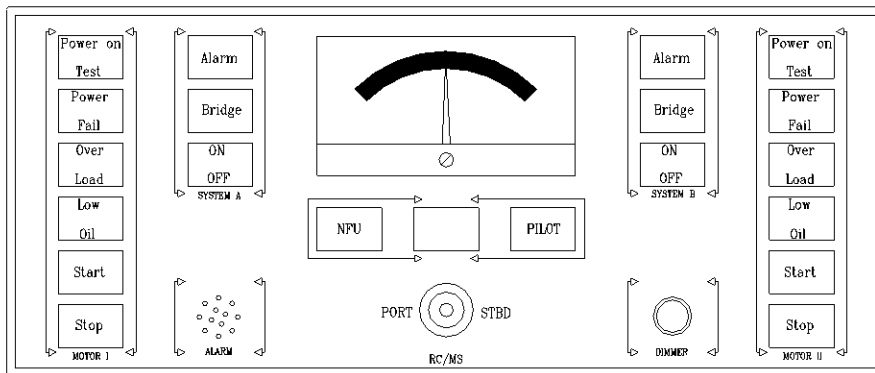
2 Bridge Remote Control

The Bridge Remote Control can control System A and System B. These two Rudder Drivers are fully equivalent. Through this control the rudder can be controlled by a tillerswitch, or an autopilot, or the system can be made de-active and allow other equipment to take over the rudder control functions.

The Bridge Remote Control also controls the two Motor Starters (respectively I and II).

The front panel for the Bridge Remote Control is shown below.

The Remote Control has to be placed on the bridge.



2.1 The Rudder Control part:

When power is applied to one of the RCs a background light is turned on in the RC/MS panel. There is also light in the rudder angle indicator. The light in the rudder angle indicator can be dimmed with the "Dimmer"-key.

Each Rudder Driver system (System A and System B) are controlled by 3 buttons:

- ON-OFF (green/red): This button is used to activate the system. The system is on when the green light is on. The system is off with red light in "OFF"
- BRIDGE (green): When this button is activated and the light is turned on the system can be controlled from the bridge. Otherwise the system is controlled from the steering-gear room.
- ALARM (green): In case of low power supply to the rudder control system, or the voltage of the extra battery (NiCd-battery) is low, this lamp is lit and an acoustic alarm sounds. The acoustic alarm can be switch off by pushing the Alarm-button. When the power supply is restored, or a new NiCd-battery is mounted, the alarm is reset by pushing the alarm-key again.

For both systems there are 3 operating modes controlled by common keys placed under the rudder angle indicator. These modes are:

- NFU (green) : Non-Follow-Up. In this mode the rudder is controlled using the steering switch (joy-stick) placed in the bridge remote control¹. The system is put into NFU-mode when power is applied.
- DE-SYNC (green) : De-Sync. The control of the magnitic valves is turned off, but the rudder control system is still active.
- Pilot (green) : In this mode the rudder is controlled only by the autopilot. Even if one of the systems (A or B) is active none of them will affect the rudder. If one or both of the systems was controlled from the steering-gear room (light in Machine-key, see page 15) the control is automatically transferred back to bridge.

¹ It is possible to have supplementary steering switches (joy-sticks). These can also be used when the Bridge Rudder Control is in NFU-mode.

2.1.1 Alarms

The Alarm can be triggered for two reasons:

- a) The power supply for a RC is broken.
- b) The voltage of the extra battery is low.

The first alarm is very serious. Without 24 V supply it is impossible to command the rudder. If one RC-system of some reason breaks down, the other one should be switched on immediately by pressing "ON" and pressing an operating mode key for the wanted mode.

The extra battery (a 9 V NiCd rechargeable battery cell) is used to supply the circuit when the main 24 V DC supply is missing.

The alarm-circuit also supervise this battery-voltage. If this voltage comes below 7.9 V the Alarm is activated. This alarm indicates that the battery should be exchanged with a new one.

The two failures (missing 24 V power or battery fail) can be distinguished from each other by controlling an indicator on the Rudder Control PCB in the steering gear room. If the diode marked LB is lit, then the battery is defect, and must be exchanged.

2.1.2 Test of lamps and alarm

The lights and the alarm can be tested by pressing the key "Power on/Test" for the motorstarters.

2.1.3 Operation

NFU-mode: Turn on system A or B. Push the NFU-key. At this point there should be light in ON, BRIDGE and NFU (all green lights). In this mode the tiller switches can be used.

Pilot-mode: Just push the PILOT-key. It doesn't matter if the systems A or B are switched on or off. In this mode the autopilot is in control of the rudder.

De-Sync mode: The rudder control will be de-activated and the rudders can be controlled independent from separate steering controls.

If one system is already switched on, a shift between different operating modes can be made by just pushing the key with the wanted mode.

It is recommended to keep system A or B switched on all the time while sailing.

2.1.4 Configuration

To allow the system to operate together with pilot some jumpers must be setup at the printed circuit board in the Bridge Remote Control.

A suitable jumper setup will be made from factory according to the customers requirements.

The control relay in the Bridge Remote Control is open, when the function mode is in "PILOT".

2.2 The Motor Starter part

Each motorstarter (Motorstarter I and motorstarter II) is controlled by 6 buttons:

STOP (red):	A push on this button stops the motor. The button will light up when the motor is stopped.
START (green):	A push on this button starts the motor. The button will light up when the motor is running.
LOW OIL (yellow):	An alarm that indicates that the oil level in the tank is low.
OVER LOAD (yellow):	An alarm that indicates an overload of the power unit.
POWER FAIL (red):	An alarm that indicates a power fail.
POWER ON/TEST (green):	Indicates that the phase sequence and all power applied to the Motor Starter System is all right. The button also provides a test feature. A push on the button makes it possible to test the indications and alarm functions.

2.2.1 Failures and alarms

The motorstarter is capable for generating 3 alarms:

POWER FAIL alarm (red): lights when

- a) the power (24 V DC) to the power unit disappears.
- b) there is a fail in the supply to the control-circuit. The power from the main battery is missing or below 19 V.
- c) the voltage of the extra battery is low.

LOW OIL alarm (yellow):

lights when the oil level in the tank are below minimum.

OVER LOAD alarm (yellow):

lights when the power unit consumes more power than recommended. If this fail stands a longer period the el-motor can be damaged seriously.

None of the alarms commands the power unit to stop. But a fail caused by missing DC power (24V) will stop the power unit as there are no power for the el-motors.

Meanwhile, The Motor Starter System is provided with a special feature: If the DC power supply for one power unit fails, the other one will automatically start up.

In cases where an automatic start occurs, the START and STOP indications will follow the new state.

The circuit used to detect a power fail has an in-built time delay to prevent errors in cases where the power is off for just a moment.

An alarm is visual in the front panel of the motorstarter. In the Bridge Remote Control it is both visual and acoustic. The acoustic alarm can be reset by activating the key corresponding to the alarm. The alarm however will only disappear (the light turns off) when the error causing the alarm is repaired and the key again is activated as an acknowledgment for the repair.

If the fail causing the alarm is repaired or it disappears before the first activation of the key then the alarm circuit will be reset by the first push.

2.2.2 An example of a low oil failure

Let us give an example of the function in case of a failure fx. low oil level:

When the sensor in the oil tank reaches a certain level the LOW OIL LEVEL signal is becoming active. This triggers the circuit which switch on the light in the LOW OIL and also the acoustic alarm (in the Bridge Remote Control).

When the key LOW OIL is pushed the acoustic alarm stops but the light in the alarm remains on.

After refilling the oil tank the level sensor deactivate the LOW OIL LEVEL signal but without resetting the alarm. The alarmlight LOW OIL will only disappear when the key LOW OIL is pushed a second time. This is the acknowledgement for the "repair" of the error.

2.2.3 The control-circuit

To help faultfinding there are two light emitting diodes (LED) on the print board. The green LED (marked DC) is on when there are power from the main battery. This is also the case when the power is below 19 V. The red LED (marked AC) lights when the power to the power unit el-motor is on.

The power supply from the main battery or the extra battery is supervised by the controlcircuit. If the voltage of the main battery is below 19 V or the voltage of the extra battery is below 8 V a POWER FAIL occurs. In the last case all the indications are switched off because the extra battery has only a limited capacity.

If the power from the main battery is shut off for some known reason the extra battery has to be disconnected to prevent an alarm caused by the missing power. Also if the main supply is switched off for a longer period the extra battery must be disconnected to prevent a total discharge.

The Rudder Control Unit

3 Rudder Driver circuit

This circuit is controlling and driving the solenoid valves that controls the rudder movement. The circuit also contains the logic to prevent the rudder from reaching its physical limits.

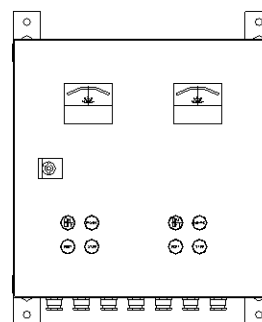
The Rudder Driver unit (in which the printed circuit boards for system A and B are installed) makes it possible to control the rudder without influence from the Bridge Remote Control. Normally the rudder control system includes two identical Rudder Drivers (according to 0).

3.1 Operation

The front panel of this unit is shown in figure 1. From the front panel the system can be activated and controlled.

The system is activated by pushing the On-Off-key. When the lamp is on the system is active.

Figur 1: Front panel of Rudder Driver.



When the steering-gear is to be operated from the steering-gear-room the Machine-key has to be pushed. The steering-gear can be operated when there is light in the Machine-key.

It is only possible to get the control to the steering gear room when the system is in NFU.

Calling the control to Machine automatically change the operation mode to NFU.

By pressing Stbd the rudder goes to starboard and pressing Port drives the rudder to port. This operation equals the NFU-mode operation from the bridge remote control.

The rudder can only operate within some electronic adjusted limits. When the rudder reaches one of the limits the power to the solenoid valves are automatically shut off.

At the front panel there is a rudder angle indicator working when power is applied to the system.

The Rudder Angle Transmitter

4 Rudder Angle Transmitter

ADJUSTMENT OF FEED-BACK UNIT

Set steering gear in mid-ship position.

The 2 screws holding the top of the feed-back to the shaft must be loosened and the shaft can now be adjusted using a screw driver.

Measure voltage between E(+) and G(-) on SSE255 feedback PCB (approx. 7.5 – 8V DC).

Half of the actual voltage indicate mid position (mid-ship position of steering gear).

Measure between F and G on SSE255 and adjust the shaft of feed-back so obtain half voltage (3.5 – 4.0V). Fasten top of feed-back to the shaft by tightening the 2 screws.

Turn steering to max starboard and adjust voltage between F and G to approx. 7V DC (using "Gain" potentiometer on SSE255). Higher voltage gives higher sensitivity (smaller movement of rudder).

Turn steering gear to max port and measure between F and G (approx. 1V DC). Check center (possible adjustment of max. 3-4 deg. of each side can be made by potentiometer "center" on SSE255).

1 Synchronizing of Twin-rudder

1.1 System A

Set rudder in mid-ship position

Turn on system A (turn off system B)

Measure between test point TP4(+) and TP9(-) on SSE210 rudder control PCB A-system

Turn the rudder until 3 V DC is measured.

Now measure between test points TP8(+) and TP9(-) on **System "B"** SSE210 rudder control and adjust with P3 (FFU sensitivity) until a voltage of 3V DC is obtained.

1.2 System B

Set rudder in mid-ship position

Turn on system B (turn off system A)

Measure between test point 4(+) and 9(-) on SSE210 rudder control PCB B-system

Turn the rudder until 3 V DC is measured.

Now measure between test points 8(+) and 9(-) on **System "A"** SSE210 rudder control and adjust with P3 (FFU sensitivity) until a voltage of 3V DC is obtained.

2 Adjustment of Rudder Angle Indicator

2.1 System "A"

2.1.1 Set rudder in mid-ship position

Measure on KL4 between pin 16(-) and 17(+) on system "A" (SSE240 PCB in "RC" Rudder control).

Adjust P8 (Zero) on PCB SSE210 to 0.0V DC

2.2 System "B"

2.2.1 Set rudder in mid-ship position

Measure on KL4 between pin 16(-) and 17(+) on system "B" (SSE240 PCB in "RC" Rudder control).

Adjust P8 (Zero) on PCB SSE210 to 0.0V DC

The Motor Starter Unit

5 Electronic Motorstarter

This section describes the operation and function of the motorstarters. The motorstarter controls and supervises the electric motors (power units) for the steering gear.

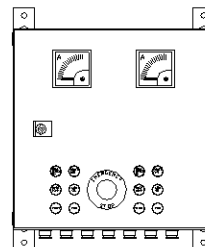
5.1 Operation

The front panel of the Electronic Motor starter unit is shown in 2. From the front panel the electric motors can be controlled without influence from the Bridge Remote Control.

The panel contains of a set of keys and an instrument for each motor starter, as well as an emergency stop.

A motor can be started by pushing the START-key. When the motor is started the key will light up. Similar to this the electric motor can be stopped by using the STOP-key which in that case will light up.

Front Panel of Motor Starter



Four keys have connection to the alarm circuit. A POWER-ON/TEST key and three alarm keys.

When the POWER-ON/TEST key is lighted up this indicates that power is switched on to the system. By pushing the key, it can be tested that all the alarms are functioning. Doing that, all the alarm keys will light up in case of proper function. In the Bridge Remote Control the alarm keys will also light up as well as an acoustic alarm will sound. The alarms can be reset when the TEST key is released and by pushing the alarm keys one by one.

The three alarm keys indicates alarms in case of POWER FAILure, LOW OIL and OVER LOAD. If one of these alarms arise the reason that caused the alarm must be cleared at once. When the problem is solved the alarm can be reset by pushing the concerned alarm key.

The instruments on the front plate are ammeters. These ammeters provides a steady indication of the current used by the electric motors.

5.2 General construction

The motor starter is build up by two circuits: A control circuit and a driver-circuit, both electrically separated.

The driver-circuit directly drives the contactor thereby switching the el-motors (power units) on and off. The control-circuit supervises the el-motors and oil-tanks and in case of a failure an alarm is given.

The motor starter can be connected with one or more remote controls which are identical with the motor starter except for the emergency stop and the ammeter.

The motor starter is equipped with one emergency stop button. If wanted it is possible to connect more emergency stops. Because of the way the system works it should be noticed that:

If there are to be done any work near the steering gear power unit the emergency stop must be activated (pressed in) and remain in this position until all work has been finished.

The motor starter has to be supplied with power from the ships main battery (24 V DC). Beside this an extra battery (a Ni-Cd rechargeable battery) is connected to the control-circuit which supplies the control-circuit in cases where the power from the main battery disappears. The capacity of this battery is enough for supplying the control-circuit in 10 minutes. This battery enables the motor starter to give an alarm in the case of a missing main supply.

In a system with two power units each controlled by its own motor starter the two motor starters can be connected such that a power fail in one system automatically starts the other power unit (in case it is not running already). When power is restored the el-motor starts automatically again. The two starters are still separated electrically.

Installation and Test

6 Installation and test

This section gives details regarding the installation of the Rudder Control System and the Motorstarter System. It also contains a test procedure used after installation.

6.1 General comments

The Bridge Remote Control is connected to the Rudder Control unit and the Motor starter unit as shown in Apendex A. This diagram also states the minimum dimensions of the cables used.

All cables, must be shielded and grounded.

After connecting the Rudder Control unit and the Motor starter unit to the Bridge Remote Control according to the wiring diagram, it must be checked that the power supply is correctly polarized.

Check if the Ni-Cd (rechargeable batteries) on the printed circuit boards are correctly mounted. (These are present in both the Rudder Control system and the Motor Starter system.)

The Motor starter needs no adjustments after installation. The necessary adjustments are made from factory.

The adjustments of the Rudder Control system have to be done in the Rudder Control unit, present in the steering gear room.

6.2 The Motor Starter system

No adjustments have to be made after installation. Be sure that the main powers are correctly connected.

- 1) Go to the Motor starter Unit in the steering gear room.
- 2) Start and stop motor I and II a few times and check for proper function.

6.3 The Rudder Control System

During the following points please refer Rudder driver PCB SSE210 in the Rudder Control Unit"

- 1) Put the rudder in mid-position. Use the steering wheel if its present. Else activate a magnetic valve (with an electrical motor running).
- 2) Switch on System A on the Rudder Control Unit in the steering gear room.
- 3) Adjust the Feedback units according to the instructions. Please refer to the special notes about the Rudder Angle Transmitter.
- 4) Press the STBD-key shortly. Check if the steering gear mechanically is going to starboard as well. If its going to port, exchange the wires 9 and 11 to the magnetic valves on System A. Make the exchange on the backplane PCB SSE255 in the Rudder Angle Transmitter.
- 5) Press the PORT-key shortly. Check if the rudder indicator on the front plate of the Rudder Control Unit goes to port as well. If not, move the jumper on the Rudder Feedback PCB according to fig. 3 in the special notes for the Rudder Feedback Unit.
- 8) Adjust the port limit. Press the PORT key to move the rudder to port. When the rudder stops the pre-adjusted limit is reached. (Avoid reaching the mechanical limits in the steering gear). The LED PL lights up. Now: Keep the PORT-key activated, and adjust the trimmer PL until the desired limit is reached.
- 9) Adjust the starboard limit. Press the STBD key to move the rudder to starboard. When the rudder stops the pre-adjusted limit is reached. (Avoid reaching the mechanical limits in the steering gear) The LED SL lights up. Now: Keep the STBD-key activated, and adjust the trimmer SL until the desired limit is reached.
- 10) Try a few times to move the rudder from border to border to make sure the limits are correctly adjusted. This also tests the function of the system concerning the steering gear room equipment.

Other adjustments:

- 11) The sensitivity of the Rudder Angle Indicator at the front of the cabinet can be adjusted by potentiometer RVL on SSE210.
- 12) Do the points 1 -11 on System B.

6.4 Adjustments in the Bridge Remote Control.

Please refer to drawing "Front PCB SSE220 in the Bridge Remote Control" in apendex A.

P1 adjusts the light in the Rudder Angle Indicator (the dimmer-button on the front plate).

P2 adjusts the sensitivity of the Rudder Angle Indicator,

P4 adjusts the background light in the front panel.

P5 adjusts the indication light.

Connection lists for the Rudder Control Unit

Connections for solenoid valves (KL1):

No.	Connection	No.	Connection
1	11 Valve B port	7	11 Extra Valve C Port
2	10 DC power valves	8	10 DC power valves
3	9 Valve B Stbd	9	9 Extra Valve C Stbd
4	11 Extra valve D port	10	11 Valve A Port
5	10 DC power valves	11	11 DC Power Valves
6	9 Extra valve D Stbd	12	9 Valve A Stbd

Connections for power (KL2):

No.	Connection	No.	Connection
1	Main supply +24VDC	2	Main supply 0VDC

Connections for rudder feedback (KL3):

No.	Connection	No.	Connection
1	A } Special Input	4	E } Rudder
2	B } used to syncro-	5	F } feedback
3	C } nize two rudders	6	G } signals

Connections of KL4 or KL5:

No.	Connection	No.	Connection
1	24 VDC supply	16	Rudder indic. angle
2	0 VDC supply	17	Rudder indic. ref
3	Alarm indication	18	Rudder indic. control
4	Bridge indication	19	Summer (Buzzer)
5	On indication	20	DC supply alarm
6	Off indication	21	Test
7	Alarm ack key	22	(Reserved)
8	Bridge key	23	Stbd from tiller switch
9	On-Off key	24	Port from tiller switch
10	NFU indication	25	Pilot relay
11	FFU indication	26	(Reserved)
12	Pilot indication	27	A (FFU supply +)
13	NFU key	28	B (FFU reference)
14	FFU key	29	C (FFU supply gnd)
15	Pilot key		



Connections to front panel ("Stik"):

No.	Connection	No.	Connection
1	Rudder indic. angle	14	Machine indication
2	Rudder indic. angle	15	On-Off key
3	Rudder indic. angle	16	On indication
4	Rudder indic. angle	17	
5	Rudder indic. ref.	18	
6	Rudder indic. ref.	19	
7	Rudder indic. ref.	20	
8	Rudder indic. ref.	21	
9	Stbd key	22	
10		23	24 VDC supply
11	Port key	24	24 VDC supply
12		25	Rudder indic. lamps
13	Machine key	26	0 VDC (GND)

Connections to remote RC/MS and external devices (KL):

No.	Connection	No.	Connection
1	GND	19	
2	DC SUPPLY ALARM	20	
3	SUMMER	21	
4	POWER ON	22	External emergency stop
5	POWER FAIL ALARM	23	External emergency stop
6	OVER LOAD ALARM	24	External emergency stop
7	TEST	25	External emergency stop
8	POWER FAIL ACK	26	Auxiliary 24 V DC
9	OVER LOAD ACK	27	Auxiliary 0 V DC
10	V _b (24 V DC)	28	24 V DC MAIN SUPPLY
11	LOW OIL ACK	29	0 V DC MAIN SUPPLY
12	START	30	
13	STOP	31	
14	LOW OIL ALARM	32	
15	START INDICATION	33	Oil level sensor 1
16	STOP INDICATION	34	Oil level sensor 1
17	DIMMER	35	Oil level sensor 2
18	V _{cc} (5 V DC)	36	Oil level sensor 2

Connections to local operation panel (ST)

No.	Connection	No.	Connection
1	 Connection to emergency stop	14	LOW OIL ALARM
2		15	OVER LOAD ACK
3		16	OVER LOAD ALARM
4		17	POWER ON
5	 Connection from emergency stop	18	TEST
6		19	POWER FAIL ALARM
7		20	POWER FAIL ACK
8	STOP	21	DC SUPPLY ALARM
9	STOP INDICATION	22	(not used)
10	START	23	Vb
11	START INDICATION	24	Vb
12	LOW OIL ACK	25	To emergency stop
13		26	From emergency stop

Connections to internal devices (HR1 or HR2):

No.	Connection	No.	Connection
1	24 V DC (from PSU)	10	Thermorelay (95)
2	0 V DC (from PSU)	11	Pow.failrelay N.C (16)
3	Contactora (A1)	12	Pow.failrelay com.(15)
4	Contactora (A2)	13	Pow.failrelay N.O (18)
5	Contactora (Aux com.)	14	Other starter (HRx 15)
6	Contactora (Aux N.C.)	15	Other starter (HRx 14)
7	Contactora (Aux N.O.)	16	Other starter (HRx 17)
8	Contactora (Aux N.C.)	17	Other starter (HRx 16)
9	Thermorelay (96)		

Note:

When no external emergency stops are used there has to be two short circuits between pin 22 and 23 respectively pin 24 and pin 25 in the plug to external devices.