

Manual Hydraulic Boom Outhaul

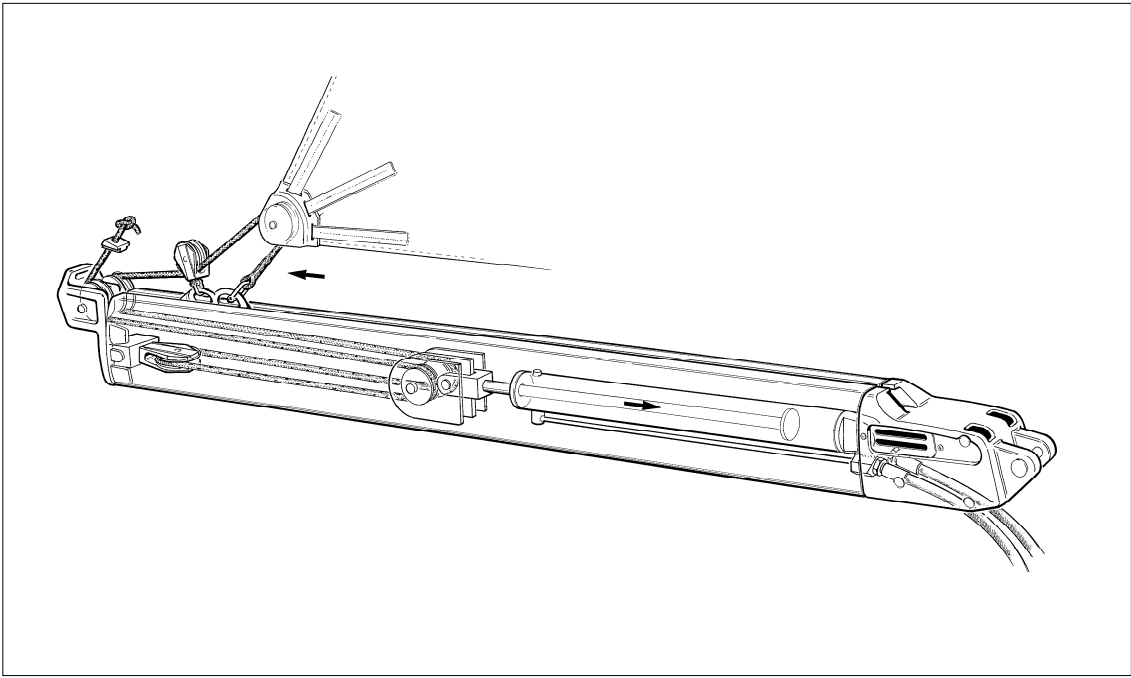


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1 Product description

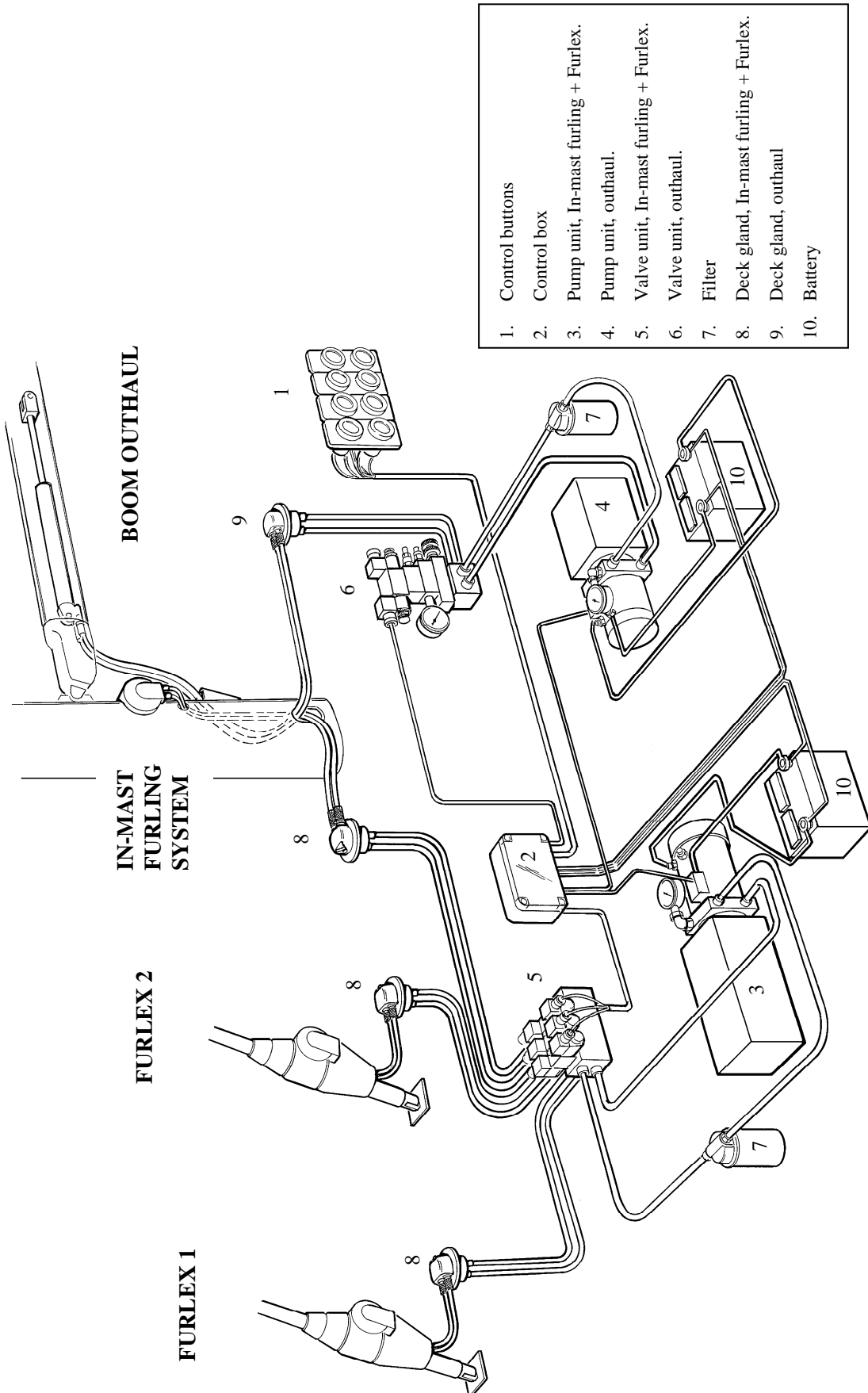
- The HYDRAULIC BOOM OUTHAUL provides the perfect complement to SELDÉN'S IN-MAST FURLING HYDRAULIC, the furling and reefing system for mainsails.
- The HYDRAULIC BOOM OUTHAUL enables one person to furl and unfurl, reef and trim the mainsail under full control purely by means of the control buttons in the cockpit.
- The design is based on Seldén's long experience of roller furling sails. The system is simple, reliable and rated for demanding conditions.
- It works by gathering the outhaul line inside the boom on a four-part tackle, which is moved by a double-acting hydraulic cylinder. The cylinder is operated via a separate hydraulic system, controlled by two buttons in the cockpit.
- In the unlikely event of power failure or control system malfunction, the mainsail can be furled manually. To unfurl the sail you need an emergency outhaul. This is optional.
- The main components of the HYDRAULIC BOOM OUTHAUL are:

No.	Product	Location
2	Electric control buttons	Fitted in the cockpit
1	Electric control box	Fitted inside the boat
1	Hydr.-pump unit, outhaul	Fitted inside the boat
1	Hydr. valve unit, outhaul	Fitted inside the boat
1	Hydr. filter	Fitted inside the boat
1	Outhaul line with block	Fitted in the boom
1	Hydr. cylinder	Fitted in the boom
2	Hydr. hoses with quick couplings	Fitted in the boom
1	Deck gland	Fitted on deck. For deck-stepped masts only
1	Mast gland	Fitted on the mast. For keel-stepped masts only
2	Hydr. hoses with quick couplings	Fitted in the mast. For keel-stepped masts only
1	Kit for venting the cylinder	Delivered separately
1	Manual	

- The battery, electric cabling, hydraulic hoses and other standard materials required for installing the system on board are not normally included.
- The system should be professionally installed.
- Seldén recommend a 24 volt direct current system on board boats with hydraulic rig systems.
- The HYDRAULIC BOOM OUTHAUL is mainly based on industry standard components which are relatively easy to dismantle. Read and follow these instructions carefully and we guarantee you many years of pleasurable use from your hydraulic boom outhaul.

2 Installation

Layout diagram: Deck-stepped mast



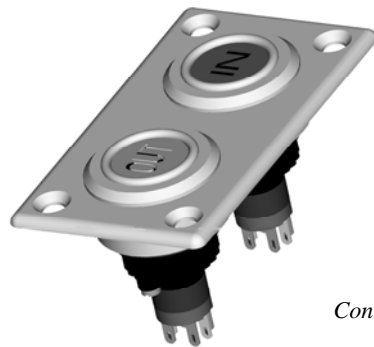
- The electrical and hydraulic systems should be professionally installed.
- Decide where the various units are to be fitted in the boat prior to installation. The following advice on installation provides a useful guide.

2.1 Boom

The boom is supplied complete with the hydraulic cylinder and outhaul line with block fitted. See diagram on Page 11. Fit the boom on the mast in the usual manner and connect the two hydraulic hoses from the boom to the mast gland (or deck gland) by means of the quick couplings. Please note that the boom is significantly heavier than standard booms of the same size.

2.2 Control buttons

The hydraulic boom outhaul and in-mast furling hydraulic are two separate systems which are operated simultaneously when furling and unfurling. To be able to operate them with one hand, the two OUT buttons must be mounted close together. The same also applies to the two IN buttons. Example:



Control buttons

The control buttons should be easily accessible by crew in the cockpit. A good solution is to mount the buttons on the wheel pedestal, with the OUT buttons on the starboard side and the IN buttons on the port side. The buttons are then within reach of both helmsman and crew and this reduces the risk of confusion. The control buttons are completely water-tight from outside, and have integral lighting for night operation. See page 36 for mounting instructions.

The electrical system is installed as shown on page 27-31.

2.3 Control box - 230 x 140 x 100

The layout and installation of the control box is shown on pages 27 - 31. The power supply for the control box is normally taken from the boat's electrical panel via a standard switch and fuse. The control box should be fitted close to the hydraulic valve unit, with the cabling entering the control box from underneath. The changeover switch in the control box should be pre-set to the separated position.

2.4 Pump unit

Positioning of the pump on the boat is optional; if it is close to the mast, only short hydraulic hoses are required, while a position close to the batteries means short electrical cables. The latter is favourable from the safety point of view. The tank should be placed longitudinally. To reduce pump noise, the pump unit should be mounted on rubber feet. All pump unit dimensions are given on page 33. Electric motor and fuse choice data on page 35.

Warning: Never operate the hydraulic pump when the reservoir is empty.

2.5 Hydraulic valve unit

When positioning the valve unit, allow space for valve adjustment access. This applies especially to the red emergency valve. To make functional checks easier, the valve unit and control box should be fitted close to one another. See page 25. The valve unit's principal dimensions are shown on page 34

2.6 Hydraulic filter

The hydraulic filter is fitted on the return line from the valve units to the hydraulic pump. **Ensure there is easy access for filter changing.**

2.7 Hydraulic hoses

Hydraulic hoses for installation below deck are not supplied. Use good-quality hydraulic hose which conforms to SAE 100R7 - ISO 3949. A minimum hose dimension of 3/8" and minimum bending radius of 125 mm is recommended (for 1/2" hose the min. radius is 175mm).

All hydraulic hoses on board must be firmly attached and must not under any circumstances come into contact with sharp edges which could damage them. Bear in mind that the hose vibrates and moves around to some extent when pressure is applied.

See page 32 for maximum working pressure.

It is very important not to allow any impurities to enter the hydraulic system during fitting. Clean all hoses carefully and use protective plugs on all open ends during installation. The hoses for the hydraulic cylinder are marked A and B. (Hose A is fitted on the port side of the boom).

The hose connections of the hydraulic valve unit are also marked A and B. The hoses must be connected to the correct coupling for the sail to remain in the unfurled position. If the hoses are crossed over by mistake, the sail will not remain in the unfurled position when sailing loads are applied.

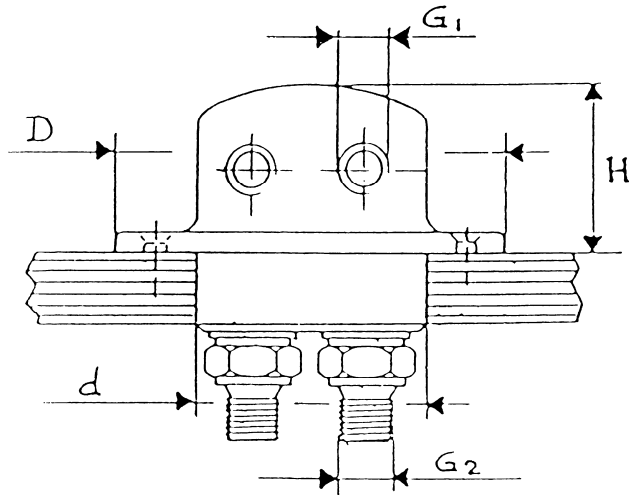
2.8 Batteries

The hydraulic outhaul requires a battery capacity of 300 Ah for a 24 volt system. This is a typical value for a 50' - 70' sailing yacht.

Important: The cable from the batteries to the hydraulic pump must be installed professionally. A short-circuit could cause a fire on board! Check that the positive and negative cables lie well apart and that the cable insulation is intact.

2.9 Deck gland

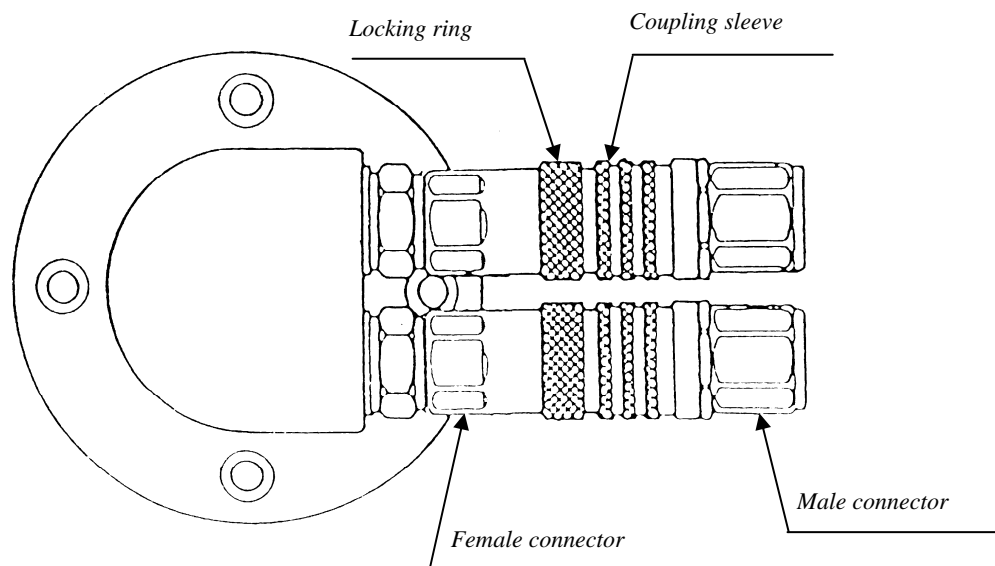
The deck gland is only used for deck-stepped masts. It serves as a through-deck fitting for the two hydraulic hoses to the boom. The deck gland comes in two sizes, a smaller size suitable for 1/4" quick couplings and a larger one for 3/8" quick couplings.



Boom	d	D	H	G1	G2
200/117	60	100	40	1/4	3/8
250/140	72	110	45	3/8	1/2
300/155	72	110	45	3/8	1/2

2.10 Quick couplings

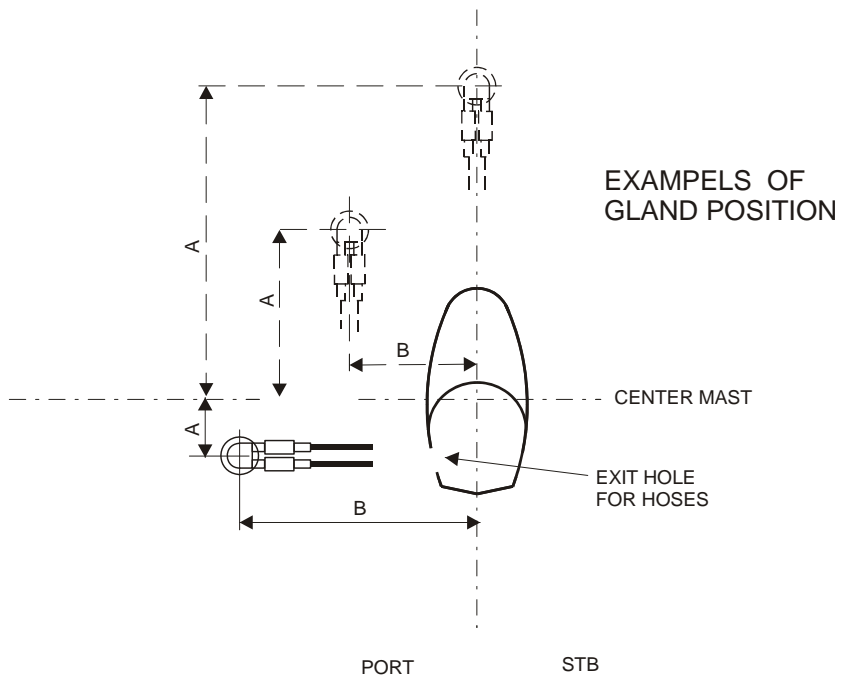
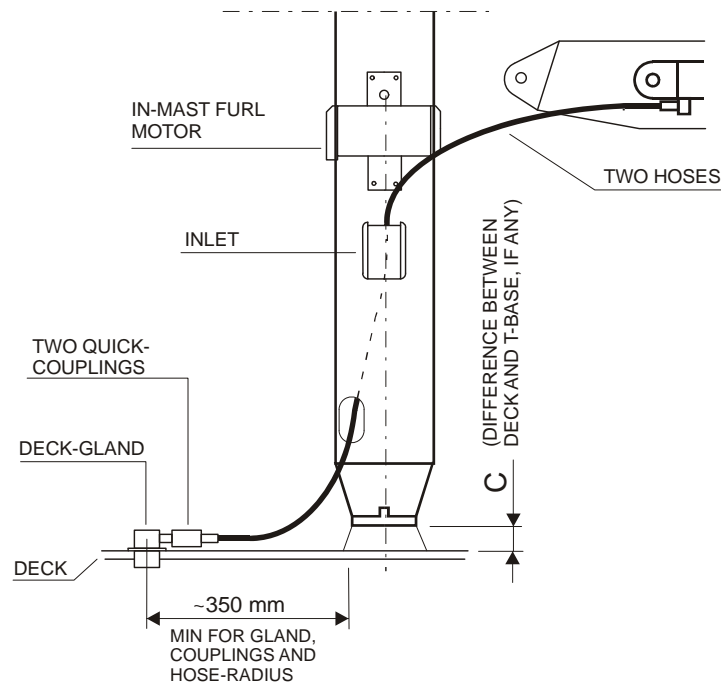
The quick couplings are disconnected by pushing the knurled coupling sleeves away from the coupling. The coupling sleeves have safety locks to guard against accidental disconnection. These are locking rings which are pushed towards the coupling sleeves following attachment and then rotated by roughly half a turn. The locks are released by turning the locking rings until they come undone. Always check that the quick couplings are locked! The quick couplings are made of acid-resistant steel. The female connector is fitted in the deck gland and the male connector on the hydraulic hose. Both the male and female connectors have self-closing valves which are effectively sealed on disconnection. Always fit protective plugs and sleeves when hoses are disconnected.



2.11 Deck-stepped mast

Below is shown the hose application for a deck stepped mast. The hoses are tailor-made for your boat, according to position of gland and your choice of exit hole side.

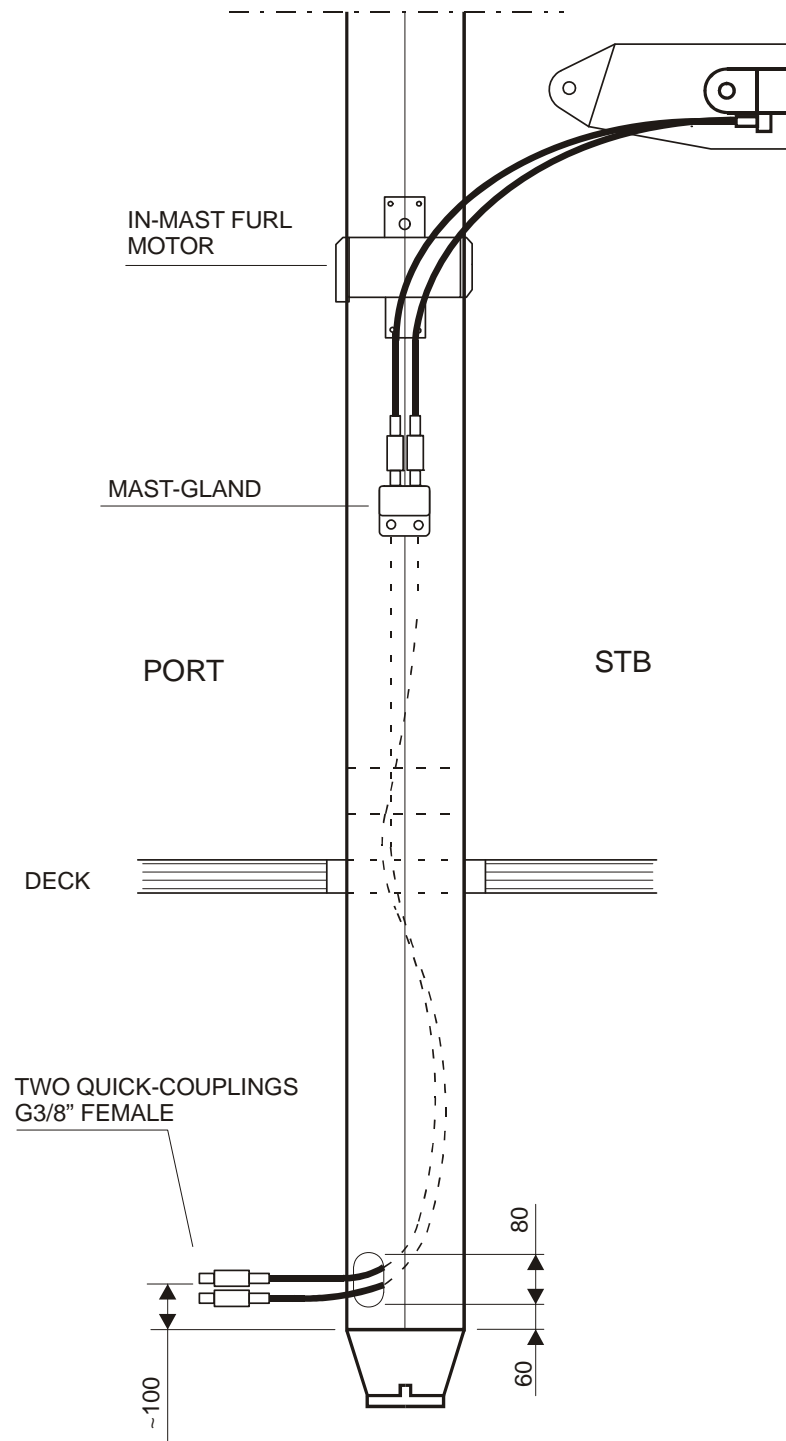
If your boat is equipped with Seldén hydraulic in-mast furling system, there is a separate gland on deck for the hoses from this motor.

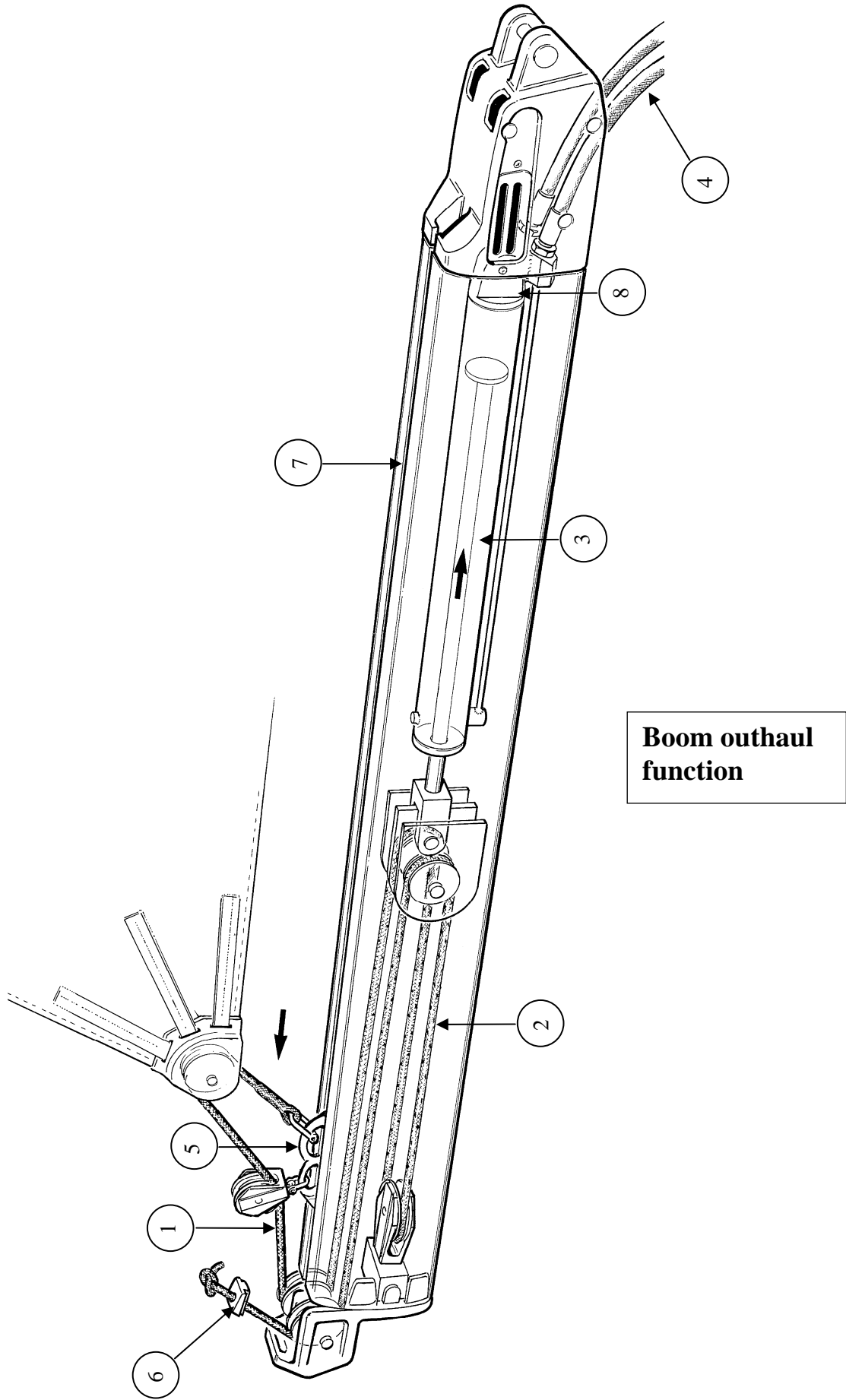


2.12 Keel-stepped mast

Below is shown the hose application for a keel stepped mast. The two pair of hoses are tailor-made for your boat.

If your boat is equipped with Seldén hydraulic in-mast furling system, these hoses will emerge from the same exit hole.





3 Function

3.1 Boom outhaul

See page 11.

One end of the outhaul line ① is shackled to the outhaul traveller ⑤. From there the outhaul line passes through a block in the sail, back to a block in the aft edge of the outhaul traveller and then to a four-part tackle ② inside the boom via a sheave at the boom end.

The other end of the outhaul line, which is accessible from outside, has a stopper knot ⑥.

The tackle ② is tensioned and slackened off by a double-acting hydraulic cylinder ③.

The hydraulic cylinder is operated via two hydraulic hoses ④ by a separate hydraulic unit located below deck. This is controlled in turn by the push buttons in the cockpit. In the forward end of the cylinder ③ there are two venting nipples, see detail below.

3.2 Hydraulic cylinder

The hydraulic cylinder is double-acting, with the piston being driven in either direction by the hydraulic oil. Since the hydraulic cylinder operates a rope tackle, it is only loaded in the direction of pull. The tractive force of the cylinder (N, Newton) is the actual hydraulic oil pressure (in bar, see manometer on valve unit) multiplied by the 28.2 cm² surface area of the hydraulic piston and again multiplied by 10.

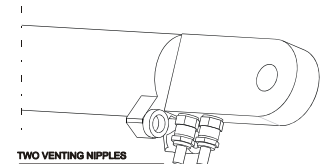
Example: 100 bar makes $100 \times 28,2 \times 10 = 28200\text{N}$.

The hydraulic cylinder is completely filled with oil on delivery. Air can enter the cylinder at the time of connection to the boat's hydraulic system. This may also happen if a leak occurs or if there is too little hydraulic oil in the reservoir. The air causes the hydraulic cylinder, and thus the outhaul line, to become elastic.

The hydraulic cylinder should therefore be vented when the system is fully installed.

3.2.1 Venting the hydraulic cylinder (boom mounted on the boat)

The cylinder is equipped with two venting nipples, one nipple for each end of the cylinder chamber. Both nipples are mounted underneath the boom, near the fore end. For 200- and 250-booms they are accessible by a hole, and for 300-booms you reach them through the taper cut. The nipples are designed as quick-couplings and they are protected by plastic caps.



1. Have the mainsail furled in the mast, and locate the venting kit (plastic can with attached clear hose and quick connect valve)
2. Unfasten the shackle holding the outhaul line in the traveller and unthread the outhaul line from the mainsail block and traveller.
3. Make sure the needle in the venting-valve is in backward position (turn knob counterclockwise). Attach the hose-end to the bottle and place the can securely. Connect the venting-valve to the nipple furthest from the mast. **NOTE:** Check that the thin line on the quick-connector is in place, it is necessary when connecting/disconnecting it.
4. Lower the aft end of the boom so that the fore end of the boom is higher than the aft end.
5. Press the BOOM IN button and at the same time pull the exposed end of the outhaul line until no more line emerges from the boom end. The hydraulic cylinder has then reached its outer end position.

6. Open the venting-valve by turning the knob clockwise. Press the BOOM IN button until the oil, flowing through the transparent hose, contains no air-bubbles anymore. Close the venting-valve (turn knob un-clockwise).
NOTE: When running the cylinder back and forth, make sure the outhaul line is stretched to prevent it from jamming inside the boom.
7. Disconnect the venting-valve and connect it to the other nipple (closest to the mast).
8. Raise the aft end of the boom so that it is positioned higher than the front end.
9. Press the BOOM OUT button and slacken the outhaul line until the hydraulic cylinder reaches its inner end position.
NOTE: It might be necessary to attach an extension line to the outhaul line to feed it into the boom. Normally this is not required.
10. Open the venting-valve. Press BOOM OUT button until there are no air-bubbles in the oil. Close the venting-valve.
11. Disconnect the valve and put the protection caps back on the nipples.
12. Check the oil level in the power pack, add oil if needed.
13. Refit the outhaul line to the mainsail.

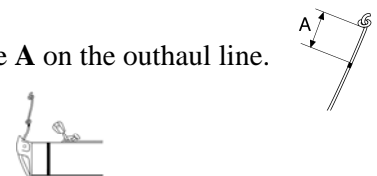
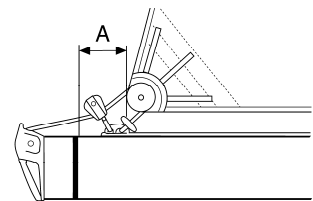
3.3 Outhaul line

The outhaul line is an HMPE-line (Spectra/Dynema) to minimize stretch and give the maximum service life. The outhaul line supplied is normally a little longer than required.

3.3.1 Adjusting the length of the outhaul line

To start: The mainsail must be completely unfurled from the mast and the outhaul line attached as shown in the diagram on page 11.

1. Slacken the mainsheet and boom vang to free the boom.
2. Press the BOOM OUT button. The hydraulic cylinder then retracts the outhaul line into the boom until the hydraulic piston reaches its inner end position. The sail is not normally sufficiently stretched at this stage and the outhaul line needs to be shortened accordingly.
3. Measure the distance **A** from the after-edge of the mainsail to the inner edge of the measuring mark.
4. Press the BOOM IN button. At the same time pull a few metres of outhaul line out of the boom by pulling at the stopper knot end, Page 11 pos ②.
5. Measuring from the underside of the stopper knot, mark the distance **A** on the outhaul line.
6. Make a new stopper knot (overhand knot) directly above the mark.
7. Check again as in ②. The sail should now be stretched to its maximum when the hydraulic piston has reached its inner end position. This guarantees that the sail can never be overstretched.



8. Cut the excess length from the outhaul line just above the new stopper knot and whip the end.
9. Remember that **it is not possible to lengthen** the outhaul line.

The outhaul line should be inspected several times a season.

Remove the shackle and attach a pilot line. Pull the outhaul line out by pulling on the stopper knot end. If the line is damaged, replace it. A new outhaul line is fitted with the aid of the pilot line. Use a pilot line of at least 5 mm diameter.

NOTE! If the outhaul line breaks inside the boom, it will be necessary to dismantle the boom to fit a new outhaul line.

3.4 Hydraulic assembly

The basic mode of operation of the assembly is shown in the circuit diagram on page 32.

Weight of pump unit: 12 kg excl. oil.

The hydraulic assembly consists of three separate units, a pump unit (page 15 and 33), a valve unit (page 34) and a filter. The hydraulic assembly is rated to drive one function at a time. Several functions can each be driven individually if the pressure and flow produced by the pump unit are sufficient for the respective function. The hydraulic assembly is constructed simply from high-quality standard components.

3.5 Oil change

In normal use we recommend the oil is changed every four years in conjunction with a filter change. The tank contains 8.8 litre horizontal position and 7.4 litre vertical position.

The supplied oil is a mineral hydraulic oil, see product information on page 38. One section of Swedish standard "SS 155434" is about mixing hydraulic oils of different origin, quality and manufacture.

Abstract: Different hydraulic fluids of the same category, containing same or different basic fluids, are not supposed to be mixed as they generally do not mix without changing the properties. The properties of the mixture are often inferior than the properties of the pure products.

Important: It is good hydraulic hygiene practice to ensure that no impurities enter the hydraulic system.. When disconnecting the quick couplings, always use the protective plugs and sleeves supplied.

3.6 Hydraulic filter

The hydraulic filter is an intermediate pressure filter for maximum 110 bar and 25 l/min. The filtration standard is 10 microns. The bypass valve opens at 6 bar. Change the filter replacement element every four years.

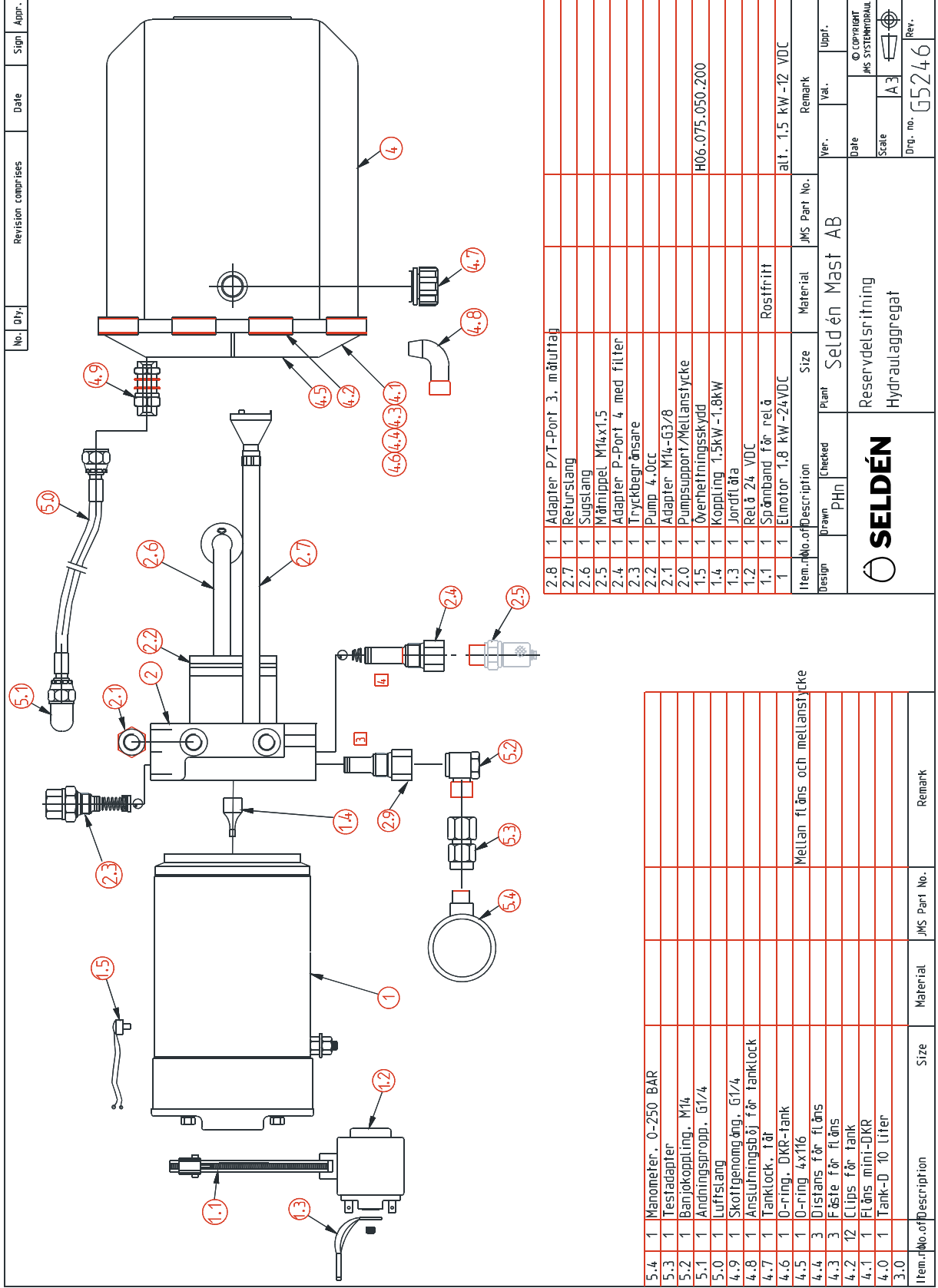
3.7 Pump unit

The illustration on page 15 shows the component parts.

The electric motor is a high efficiency, compound-wound 12/24V DC motor with a low current consumption. The motor's starter solenoid has silver-plated contacts to cope with high loads.

The electric motor is rated for intermittent use - see electric motor data on page 35. If used continuously, the motor temperature will rise until the integral temperature sensor interrupts the control circuit to the starter solenoid and the motor stops. The temperature sensor completes the circuit again automatically when the temperature has dropped.

The motor drives a hydraulic oil pump located inside the oil reservoir. Motor, pump and reservoir are connected to an adapter. The pump line pipe P=1 and return line pipe T=2 are then connected to the adapter. A manometer and a pressure relief valve are fitted on the adapter.



No. Dnr.	Revision comprises	Date	Sign. Appr.
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2.8	1	Adapter P/T-Port 3. mätflöj						
2.7	1	Returslang						
2.6	1	Sugslang						
2.5	1	Mättrippel M14x1.5						
2.4	1	Adapter P-Port 4 med filter						
2.3	1	Tryckbegränsare						
2.2	1	Pump 4.0cc						
2.1	1	Adapter M14-G3/8						
2.0	1	Pumpsugport/Mellanstycke						
1.5	1	Överhettningsskydd					H06.075.050.200	
1.4	1	Koppling 1.5kW-1.8kW						
1.3	1	Jordfäta						
1.2	1	Relä 24 VDC						
1.1	1	Spännband för relä						
1	1	Elmotor 1.8 kW-24VDC					alt. 1.5 kW-12 VDC	
Item.No.	Mo.	of Description	Size	Material	JMS Part No.	Remark		
Design	Drawn	Checked	Plant	Seldén Mast AB			Ver.	Val.
				Reservdelserifining			Date	Uppf.
				Hydraulaggregat			Scale	© COPYRIGHT
							A3	JMS SYSTEMTEKNIK AB
							Drig. no.	Rev.
							G5246	

Item.No.	of Description	Size	Material	JMS Part No.	Remark
5.4	1	Manometer, 0-250 BAR			
5.3	1	Testadapter			
5.2	1	Banjokoppling, M14			
5.1	1	Andningspropp, G1/4			
5.0	1	Luffslang			
4.9	1	Skottgenomgång, G1/4			
4.8	1	Anslutningsböj för tanklock			
4.7	1	Tanklock, för			
4.6	1	O-ring, DKR-tank			
4.5	1	O-ring, 4x16			
4.4	3	Distans för fläns			
4.3	3	Fäste för fläns			
4.2	12	Clips för tank			
4.1	1	Fläns mini-DKR			
4.0	1	Tank-D 10 liter			
3.0					
Mellan fläns och mellanstycke					

3.8 Pressure relief valve

The pressure relief valve is used to set the maximum pump pressure in the hydraulic system. The maximum clew force F_{Pump} is thereby also set in the sail. The setting of the pressure relief valve on delivery is shown in the table on page 19.

Max. F_{Pump} is required to be able to trim (flatten out) the mainsail on a close reach at the same time as the sail is sheeted in tightly. Bear in mind that the outhaul can be tensioned using less force if the sheet is eased off during trimming.

Before you set and test the required maximum clew force F_{Pump} on your boat, consult your sail maker as to what is most suitable for your mainsail.

Recommendation:

Set the pressure as low as possible. This reduces the risk of overstretching the sail and means a lower maximum electrical current. The correlation between pressure (bar) and electrical current (I amp) is shown on page 35.

3.8.1 Setting the pressure relief valve

To start: The mainsail is furled into the mast.

1. Press the BOOM IN button to slacken off the outhaul line.
2. Disconnect the quick couplings of the hydraulic hoses to the boom.
3. Press the BOOM OUT button briefly for 2 to 3 seconds. The electric motor and hydraulic pump are now put under maximum load. All the oil is pumped through the pressure relief valve back to the reservoir.
4. The manometer on the pump unit immediately shows maximum pressure. One person reads off the manometer at the same time as another person presses the control button.
5. Unscrew the cap nut for the pressure relief valve adjusting screw; see pos. 2.4 on page 33. A little oil may now leak out of the adjusting screw, as the cap nut and an accompanying sealing ring act as a seal for the adjusting screw.
6. Set the desired pressure using the relief valve adjusting screw.
 Clockwise rotation = pressure increases
 Anti-clockwise rotation = pressure decreases.
 If the pressure is too high: Start by unscrewing the adjusting screw (anti-clockwise rotation) a few turns.
 Start the pump unit (see 3) and read off the manometer (see 4) which should now show a value which is too low. Then increase the pressure to the desired value.
7. Fit the sealing ring and cap nut. Tighten this so that the valve is sealed.
8. Check the maximum pump pressure set once more on the pump unit manometer.
9. Reconnect the quick couplings on the hydraulic hoses to the boom.

3.9 Hydraulic valve unit

The valve unit consists of four valves fitted in a block, see drawing on page 34.

Valve	Position
Directional valve	31
Overcentre valve	33.2
Flow control valve (optional)	34.1 & 34.2
Emergency valv	35
Non return valve	33.1

Recommendation:

On delivery all adjustable hydraulic valves are set to suit your boat. No adjustment should normally be needed. Nevertheless, this manual provides a detailed description of how to precede for those who wish to understand how the hydraulic boom outhaul works and who wants to have the option of adjusting it.

IF IN ANY DOUBT, CALL IN AN EXPERT!

3.9.1 Directional valve, pos. 31

The valve changes the direction of the oil flow to the hydraulic cylinder, causing it to move out or in. The valve is controlled by the BOOM OUT and BOOM IN buttons. The valve has electromagnetic actuators. The electrical contacts for the actuators are fitted with LEDs which illuminate when the control button is pressed in. The valve can be operated manually by applying pressure e.g. with a small screwdriver to a centre hole in the end of the respective actuator.

3.9.2 Overcentre valve, pos. 33.2

The overcentre valve holds the hydraulic cylinder in position during sailing. It also safeguards against overloading the mainsail. On delivery the valve is set to a nominal pressure (see table on page 19). If this pressure is exceeded, for example if a very strong squall hits the sail, the valve opens automatically and slackens off the outhaul line so that the load on the sail does not exceed the set value. This is a signal that the mainsail should be reefed.

In bad weather, when the clew force may be considerably greater than the maximum outhaul force, it may be necessary to ease off the mainsheet a little if you wish to tension the outhaul further.

Consult your sail maker regarding the maximum permitted clew force F_{wind} in the mainsail.

If the boat is heeled at 30° under mainsail alone, the clew force F_{wind} is close to the maximum force which should be permitted.

Adjusting the overcentre valve

To start: The mainsail is furled into the mast

1. Undo the shackle of the outhaul line in the outhaul traveller and unthread the outhaul line from the mainsail block and outhaul traveller.
2. Press the BOOM OUT button and slacken off on the outhaul line until the hydraulic cylinder reaches its inner end position.
WARNING! It may be necessary to attach an extension line to the outhaul line to feed it into the boom. This should not normally be required.
3. Determine the desired max. F_{wind} and calculate the corresponding oil pressure P_{wind} as shown on page 19.

4. Set the pressure relief valve P_{Pump} to approx. " $P_{\text{wind}} + 10$ " bar, as shown on page 16.
NOTE: For 24v, the maximum permitted " $P_{\text{wind}} + 10$ " = 200 bar.
 Press only the BOOM OUT button very briefly, and then release the button.
5. The manometer on the valve unit now shows the residual pressure in the hydraulic cylinder.
6. Set the desired pressure P_{wind} by adjusting the screw of the overcentre valve.
 Clockwise rotation = pressure decreases.
 Anti-clockwise rotation = pressure increases
7. Press BOOM OUT and check that the valve unit's manometer shows the desired pressure P_{wind} .
8. Return the pressure relief valve P_{Pump} to its original value, see page 16.

3.9.3 Flow control valve, pos. 34.1 & 34.2 (optional)

The speed of the hydraulic cylinder BOOM IN and BOOM OUT can very easily be set individual using the adjusting knob on the valve. The valve is set at the maximum speed on delivery.

NOTE: Choking will cause effect loss.

3.9.4 Emergency valve, pos. 35

This is normally closed, and only opened if you wish to furl the mainsail manually. The valve has a red control knob and a similar locking knob. Do not over tighten the knobs, or the valve will be difficult to open.

Clockwise rotation = closed

Anti-clockwise rotation = open

3.9.5 Non return valve, pos. 33.1

This valve keeps the oil from draining back to tank. The valve is set and should not be adjusted.

4 Calculations

4.1 Clew force F in mainsail

F is the resultant force in the clew, see page 21. The clew of the mainsail can be loaded in principle in two different ways.

1. The hydraulic boom outhaul gives a clew force F_{pump} . The maximum clew force F_{pump} is set by means of the pump unit **pressure relief valve**, see page 16. The hydraulic pressure produced by the pump can be read off on the pump unit manometer.
2. The wind force and mainsheet force produces a clew force F_{wind} . The maximum clew force F_{wind} is limited by the valve unit's overcentre valve, see page 17. The wind force produces a hydraulic oil pressure in the hydraulic cylinder which can be read off on the valve unit manometer.

The table below shows the maximum pressure to which the valves are set on delivery, and the corresponding maximum clew force F is calculated according to the formulae below.

Boom	Relief valve		Overcentre valve	
	Manometer pump unit P_{pump} Bar	Max F_{pump} Newton	Manometer valve unit P_{wind} Bar	Max F_{wind} Newton
200	100	11200	130	22880
250	130	14560	150	26400
300	160	17920	190	33440

4.1.1 Calculating F_{pump}

1 bar = 14.50 psi

1 N = 0.225 lbf

$F = \text{Pressure} \times \text{piston area} \times \text{gear change} \times \text{friction losses}$

$F = P \times 28.2 \times 0.5 \times 0.8 \times 10 \text{ N} (1 \text{ kp} \approx 10 \text{ N})$

$F = P \times 112 \text{ Newton}$

4.1.2 Calculating F_{wind} .

$F = \text{Pressure} \times \text{piston area} \times \text{gear change} \times \text{friction losses}$

$F = P \times 28.2 \times 0.5 \times 1.25 \times 10 \text{ N} (1 \text{ kp} \approx 10 \text{ N})$

$F = P \times 176 \text{ Newton}$

4.1.3 Calculating the force in the outhaul line f .

Since the outhaul line has two parts to the mainsail: $f = 0.5 \times F$

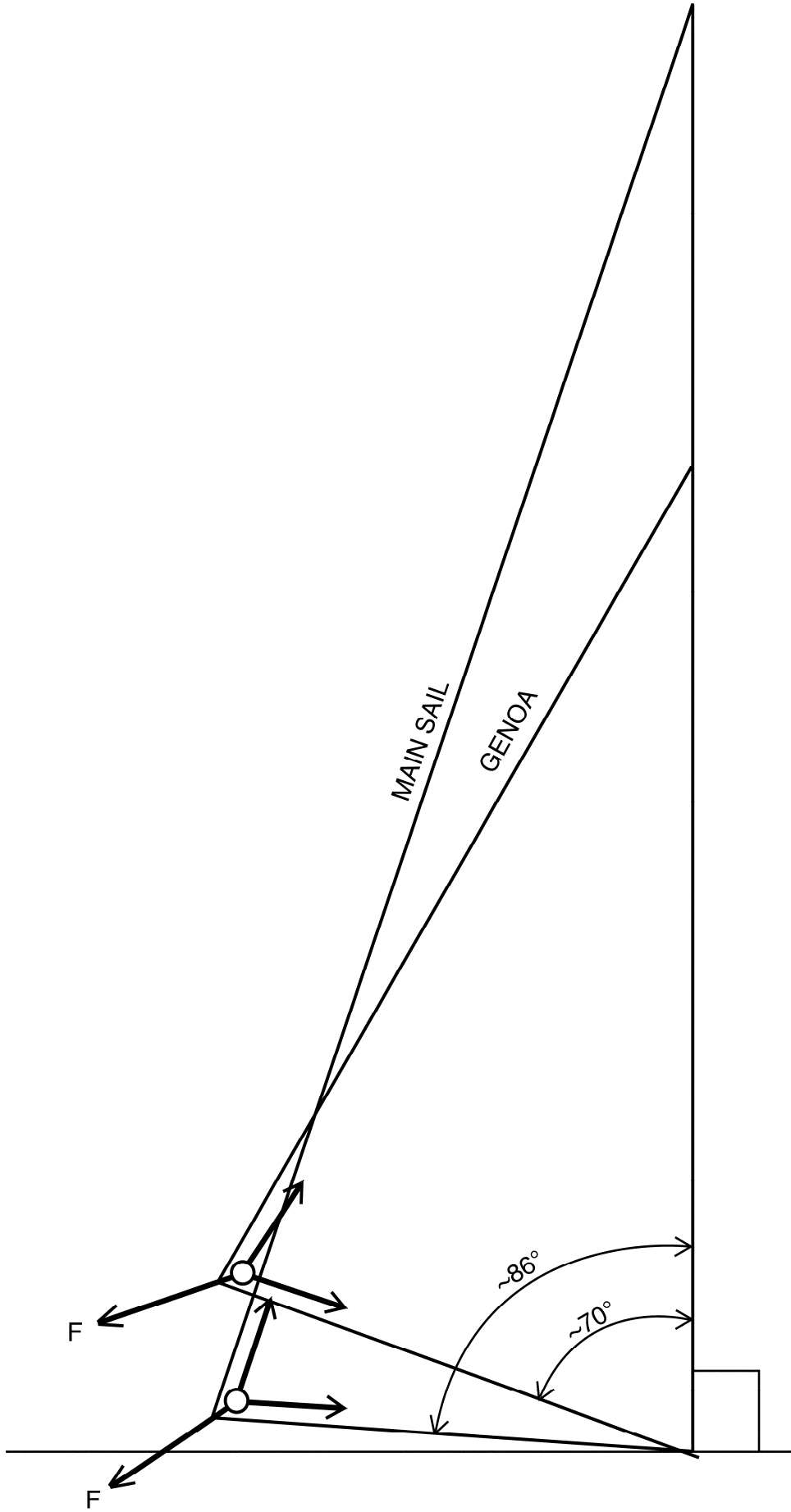
5 Operation

5.1 General advice on furling mainsails

For a better understanding of how to furl and unfurl your mainsail, it may be compared with a furling genoa. The aim in both cases is to furl the sail on the furling extrusion so that it forms a tight and even roll. However, there are significant differences:

1. The genoa extrusion is inclined at an angle of approx. 17° , while the mainsail extrusion is almost vertical. Consequently, the mainsail is more prone to hang down due to its weight, forming diagonal creases during the furling process. This is not normally a problem, and can be avoided by applying slight pressure to the outhaul line and at the same time making use of any side wind. This will smooth out the sail, and help to achieve a satisfactorily furl. Subsequent unfurling will also be much easier.
2. The mainsail is furled into a restricted space inside the mast, while the genoa is furled freely around the extrusion. It is therefore **very important** to unfurl the mainsail in the correct manner. To unfurl the mainsail, it is necessary to rotate the furling extrusion clockwise inside the mast and **simultaneously pull the sailcloth out of the mast using the outhaul line**. If this is not done, the sail will unroll inside the mast, making a large diameter slack furl. There is then a serious risk of the sail becoming jammed inside the mast. Naturally this risk does not exist with a genoa.
3. A main influence on the furling technique is the shape of the sail (see diagram on page 21). The diagram shows the approximate direction of the outhaul force to achieve **an even tension in the sailcloth**. The forces in the leech and the foot are equal, which is **fundamental** to achieving a satisfactory furl. This is particularly important when unfurling the mainsail. In this case the clew should always be located **freely above** the outhaul traveller to enable the outhaul force to be distributed evenly in the sailcloth. In general, the higher the clew in the sail, the easier it is to achieve an even tension in the sailcloth. Compare this with the position of the clew in the genoa. A tack angle of 86° maximum is recommended. A mainsail with $E = 6$ m and a tack angle of 86° has its clew 0.4 m above the boom in the furled position. In the unfurled position, when the clew is pulled in towards the traveller, the boom is inclined upwards by 4° . If the mast is then inclined 1° aft, the boom will be inclined at an angle of 3° from the horizontal.

The points above apply generally to furling mainsails, whether operated manually or with the aid of hydraulics.



COMPARISON

MAINSAIL -
GENOA

5.2 General advice on operation

The hydraulic boom outhaul and in-mast furling hydraulic are two separate systems which are operated simultaneously when furling and unfurling. With a little practice and experience, it is easy to learn how to operate the various control buttons. It is important at first to be careful to watch what is happening to the mainsail and not be in too much of a hurry. Remember that it is easy to interrupt a manoeuvre before something happens simply by releasing the control buttons.

Read this manual carefully so that you understand the basic principles. Then try out for yourself how best to control your mainsail.

Inside the control box is a changeover switch with the settings separated or integrated.

1. Separated

The functions MAIN OUT and MAIN IN, and BOOM OUT and BOOM IN, are controlled separately. Furling or unfurling is carried out by pressing two out or in buttons at the same time.

2. Integrated

The functions MAIN OUT and BOOM OUT are linked in the MAIN OUT control button. The functions MAIN IN and BOOM IN are linked in the MAIN IN control button. When unfurling use only MAIN OUT, and when furling use only MAIN IN. To trim the outhaul use the BOOM OUT or BOOM IN control button.

Start by operating the mainsail in the **separated** position until you think it is functioning satisfactorily. Then try the **integrated** position and see whether this makes it easier to operate for you.

5.3 Fitting the mainsail

Set the changeover switch in the control box to **separated**.

1. Fit the mainsail according to the instructions in the in-mast furling manual.
2. Apply some tension to the clew block to avoid creasing, then press the MAIN IN button and furl the mainsail into the mast so that only the clew is left exposed.
3. Fit the outhaul line as shown in the diagram on page 11.
4. Initially screw the outhaul traveller stop down (Page 11, item7), initially approx. 1 m behind the clew. The position of the stop may then be adjusted until the clew force **F** has the most effective angle of pull when unfurling commences.

5.4 Unfurling the mainsail - Separated

Set the changeover switch in the control box to **separated**.

1. Press the BOOM OUT button so that the outhaul line is tensioned properly.
2. Then press the MAIN OUT and BOOM OUT buttons simultaneously. The buttons should be fitted so that it is possible to operate them with one hand; (see Installation). The outhaul line should pull the sail out of the mast at the same time as the in-mast furling hydraulic unfurls the sail.

Please read the **General advice on furling mainsails**, page 20, point 2. If the system is correctly speed-matched, the MAIN OUT and BOOM OUT buttons can be kept pressed in until the sail is completely unfurled, otherwise operate the button for the function which takes priority and let the following function catch up.

Recommendation:

Mark the mainsail clearly at the point by the luff which shows when the sail is completely unfurled. See the hydraulic in-mast furling manual (Furlin manual), page 20.

5.5 Trimming the outhaul

Set the changeover switch in the control box to separated or integrated.

Mainsail outhaul:

- Tension the outhaul by pressing BOOM OUT.
- Slacken off by pressing BOOM IN.
- In heavy weather, when the clew force F_{wind} may be considerably greater than the maximum clew force F_{pump} , you will need to ease the mainsheet a little if you wish to tension the outhaul further. See page 19.

5.6 Furling the mainsail - Separated

Set the changeover switch in the control box to **separated**.

1. Press the BOOM IN button to slacken off the outhaul if this has been tensioned tightly.
2. Then press the MAIN IN and BOOM IN buttons at the same time. In principle, furling is controlled in the same way as unfurling. See also page 20. Stop furling in good time to ensure that the clew is not furled into the mast, as it may become jammed.

5.7 Unfurling the mainsail - Integrated

Set the changeover switch in the control box to **integrated**.

1. Press the BOOM OUT button to tension the outhaul line, then release the button.
2. Press only the MAIN OUT button.

5.8 Furling the mainsail - Integrated

Set the changeover switch in the control box to **integrated**.

1. Press the BOOM IN button to slacken the outhaul line, then release the button.
2. Press only the MAIN IN button.

5.9 Operating the mainsail manually

To operate the mainsail manually in the event of a loss of power or oil pressure:



1. Set the safety valve on the deck gland for the in-mast furling hydraulic to "winch handle".(See in-mast furling-manual)
2. Then insert the winch handle into the in-mast furling drive unit.
3. Open (anti-clockwise rotation) the red locking nut and red control knob of the emergency valve. The valve is fitted in the hydraulic valve unit for the boom outhaul.
4. The mainsail can now be furled manually using the winch handle.
5. The mainsail can be unfurled again with the winch handle, but the outhaul line must then be pulled in at the same time. This is best done by pulling in the outhaul at the stopper knot (Page 11, item 6).

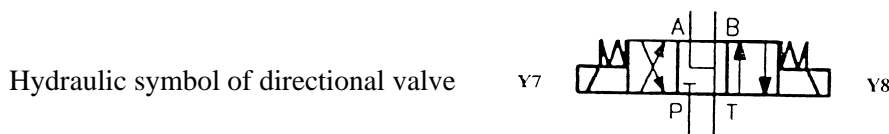
WARNING!

**NEVER LEAVE THE WINCH HANDLE IN THE DRIVE UNIT.
IT WILL ROTATE VERY RAPIDLY IF THE HYDRAULIC MOTOR IS STARTED.**

6 Checks

6.1 Functional check of operating circuit

1. If the hydraulic system is **completely** installed:
Undo the quick couplings on the hydraulic hoses to the boom. This is done to prevent the hydraulic cylinder from moving. The hydraulic pump pumps the oil back to the reservoir via the pressure relief valve. The electric motor is then at maximum load. You should therefore carry out brief functional checks so as not to risk increasing the motor temperature too much.
2. If the hydraulic system is **not** completely installed:
Remove the battery cable from the electric motor so that this does not start. This is very important, as if the electric motor is operated when the reservoir is empty, the hydraulic pump will be damaged.
3. Operate the control switch from the boat's electrical panel. The green pilot lamp on the control box **should now be illuminated**. The green lamp shows that the control box is switched in.
4. Set the changeover switch in the control box to **separated**.
5. Press the BOOM IN button. Three functions are then activated simultaneously. (See the circuit diagram).
 - Relay K8 in the control box. Relay K8 has an LED which is illuminated when the control button is pressed in. This is clearly visible through the plexiglass cover of the control box.
 - The actuator Y8 on the directional valve. An LED in the terminal contact is illuminated when the button is pressed in. The hydraulic symbol of the directional valve  should now be visible
 - Electric motor solenoid 2 on the electric motor. A perceptible switching noise is heard.
6. Press the BOOM OUT button. The following three functions are then activated simultaneously.
 - Relay K7
 - Actuator Y7 - hydraulic symbol visible. 
 - Electric motor solenoid 2



6.2 What to check for if the outhaul line becomes slack

In very strong wind conditions, the overcenter valve is intended to open (see 3.9.2), but if the outhaul loses tension when sailing under moderate wind conditions, the following checks are recommended.

1. Check oil level in the powerpack
2. Check the system for oil leakage, above and below deck.
3. Check that the Emergency Valve (Pos 35 on the drawing, see section 7.4) is closed. This valve does not normally come loose, or leak. If you open it, note that it shall be closed by hand force only, it is a needle valve and may be damaged if overtightened.

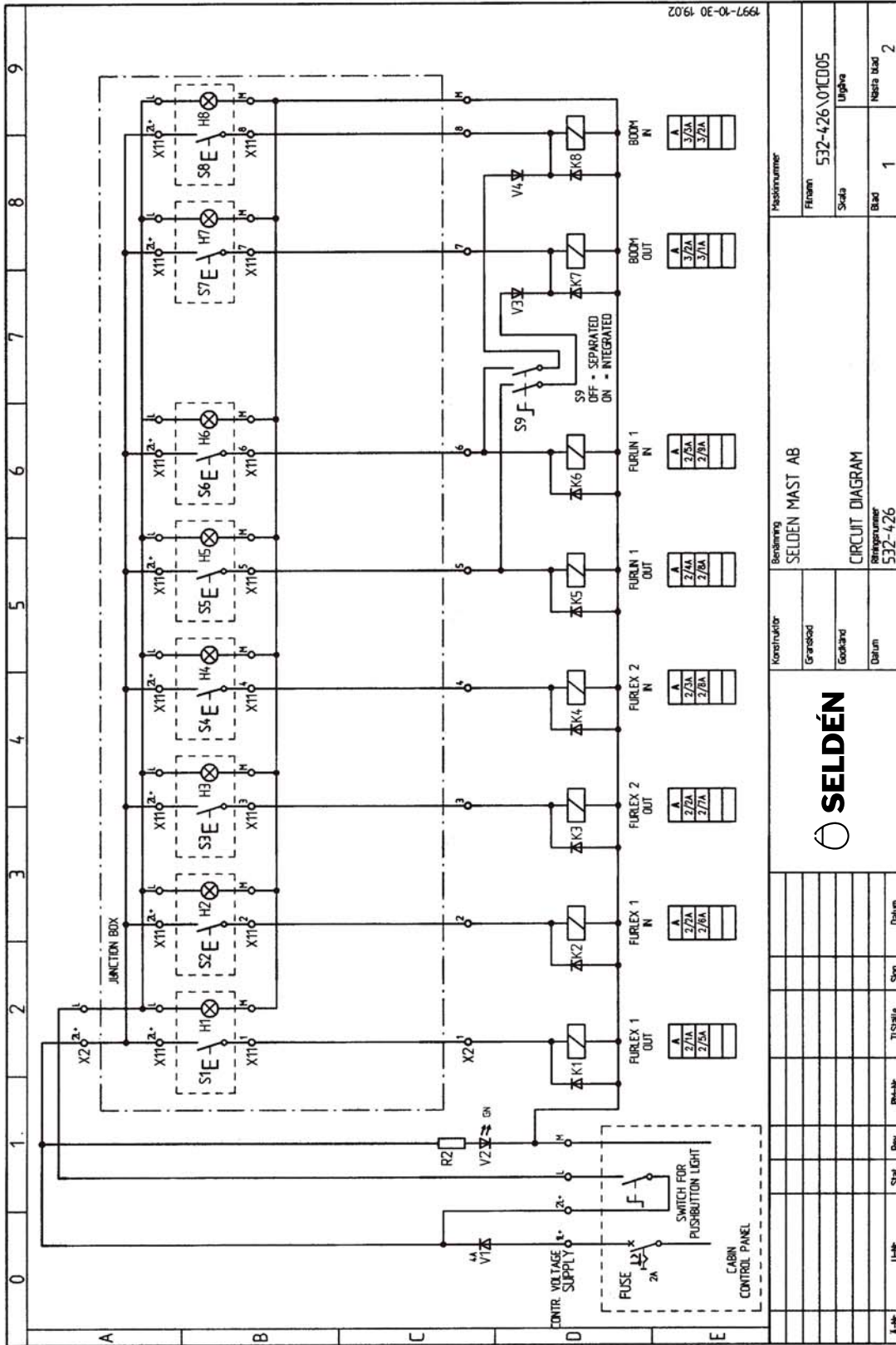
4. Remove any air from the outhaul system by venting it according to section 3.2.1
5. The overcenter valve (Pos 35 on the drawing ,see section 7.4) is probably failing, letting oil from the hydraulic cylinder pass into the tank. This can be caused by dirt in the system, or a mechanical failure in the valve. We recommend changing it, contact your Selden representative for instructions .

6.3 General advice on hydraulic equipment

1. Always switch off the main switch to the pump unit when working on the hydraulic system.
2. For your own safety!
Before dismantling or disconnecting the hydraulic system:
Always check first that there is no residual hydraulic pressure in the system. Both manometers should show 0 bar.
3. Cleanliness is critical to the reliability of a hydraulic system. For example, teflon tape, flax and similar sealing materials must not be used, as there is a high risk of loose particles entering the hydraulic system.
4. Try to minimize oil spillage when dismantling the system. One solution is to disconnect the quick couplings to the boom. This prevents the hydraulic oil in the hydraulic cylinder from leaking out.

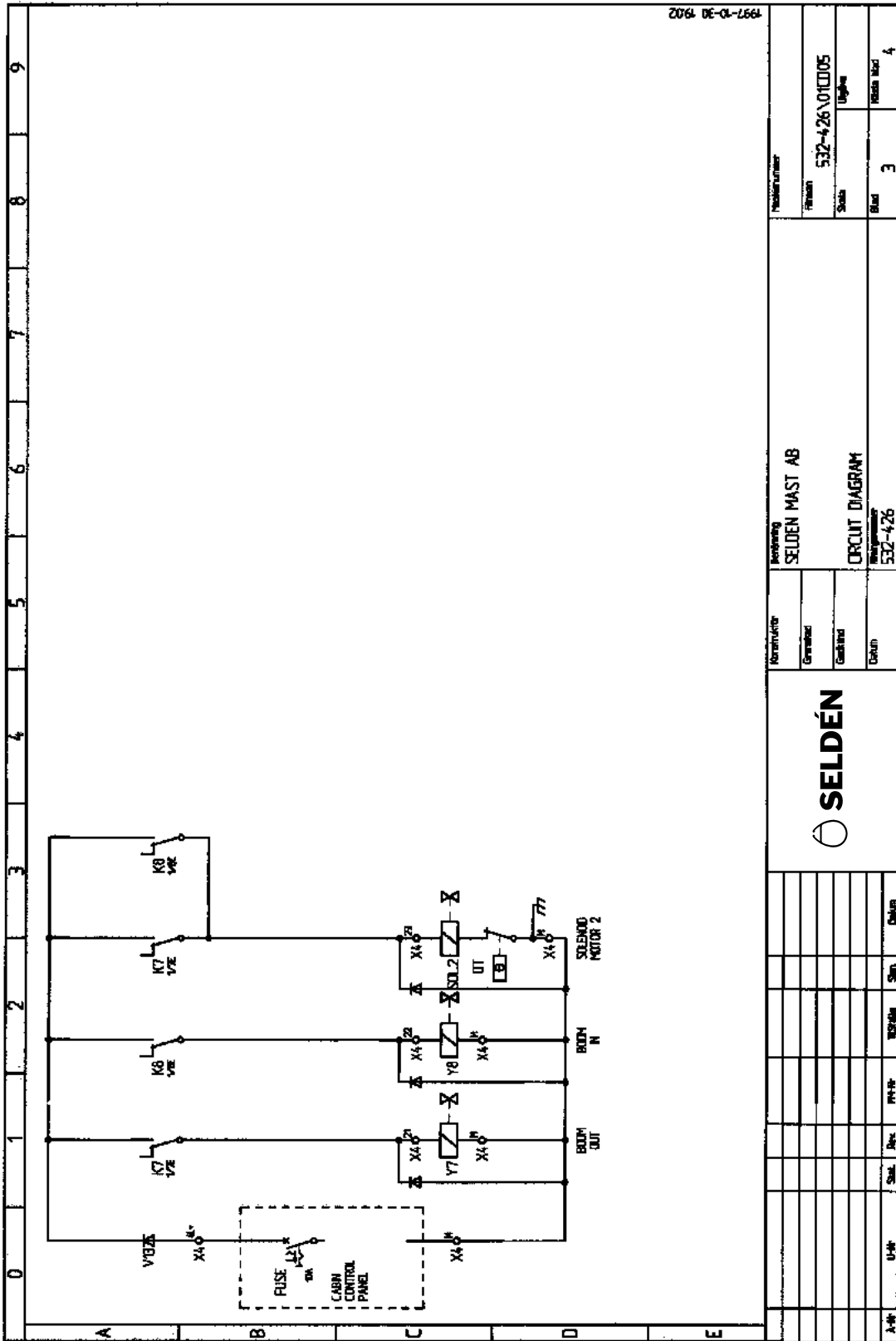
7 Appendix

7.1 Control box



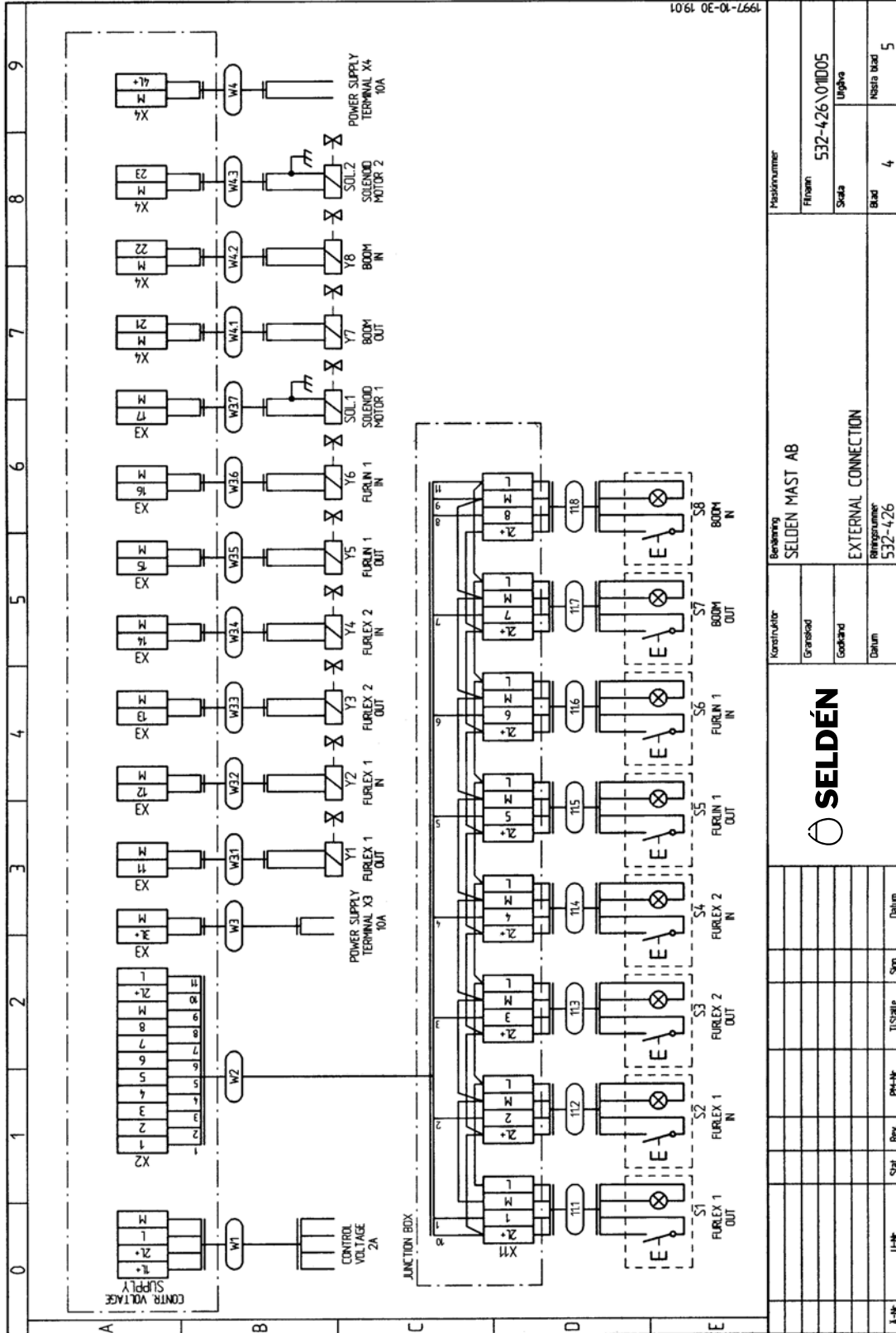
SELDÉN		Konstruktör		Benämning		Maskinnummer	
		Grännskad		SELDEN MAST AB		Filnamn	
		Godskand		CIRCUIT DIAGRAM		532-426\01CD05	
		Datum		Skapningsnummer		Skala	
				532-426		1/1a	
						Blad	
						1	
						Nästa blad	
						2	

1997-10-30 1902



1997-10-30 1902

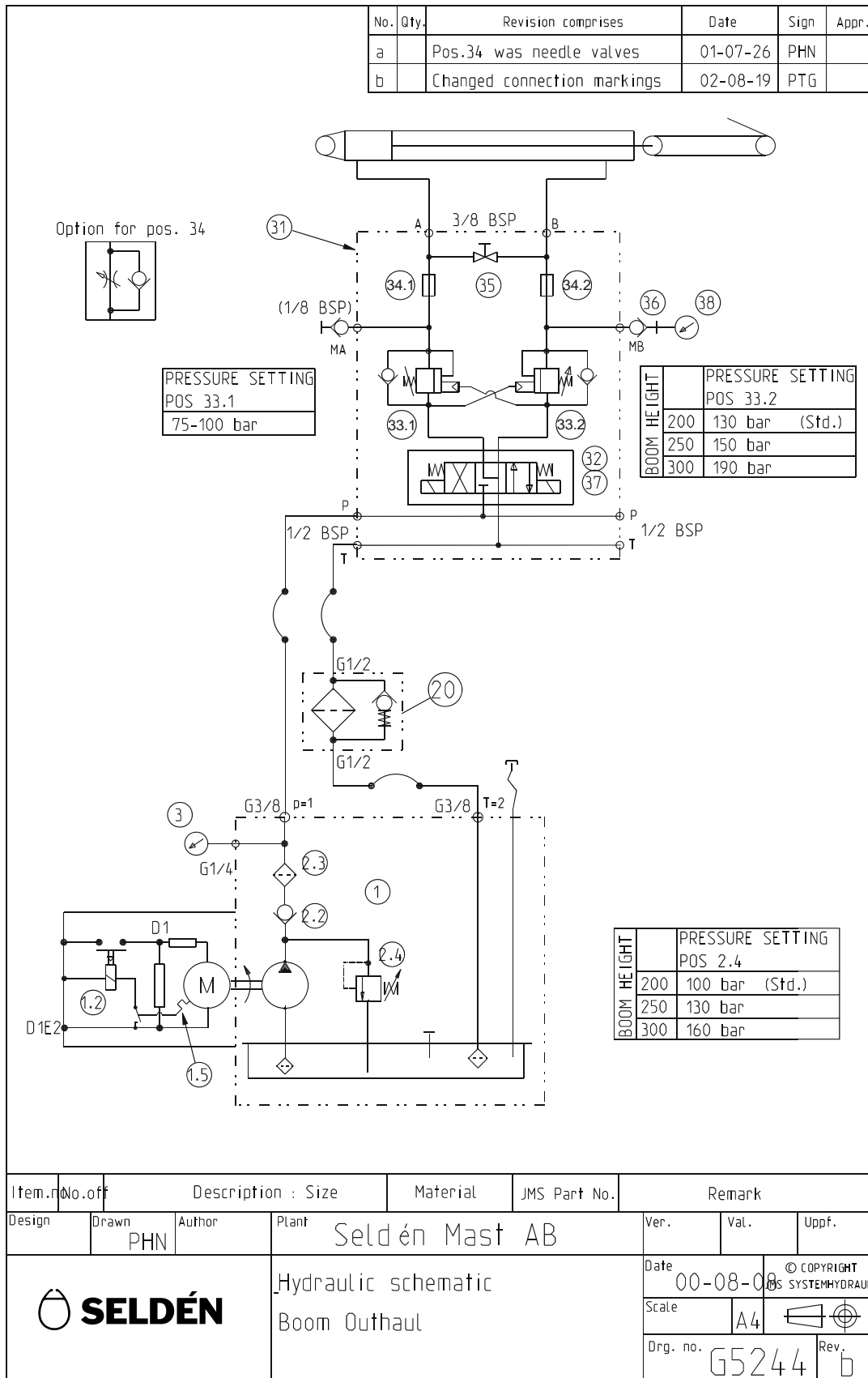
		Nominwerte Genutzt Geplant Dehnt		Bezeichnung SELDEN MAST AB		Maschinennummer 532-426\010005	
				ORCUT DIAGRAM		Blatt 3	
				532-426		Blatt 4	



1997-10-30 1901

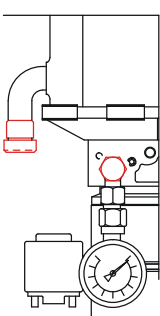
SELDÉN		Benämning SELDÉN MAST AB		Passivnummer 532-426\010005	
		Konstruktor Granskad Godkänd		Status Uppgåva	
		Datum 532-426		Blad 4	
		EXTERNAL CONNECTION		Nöjesblad 5	

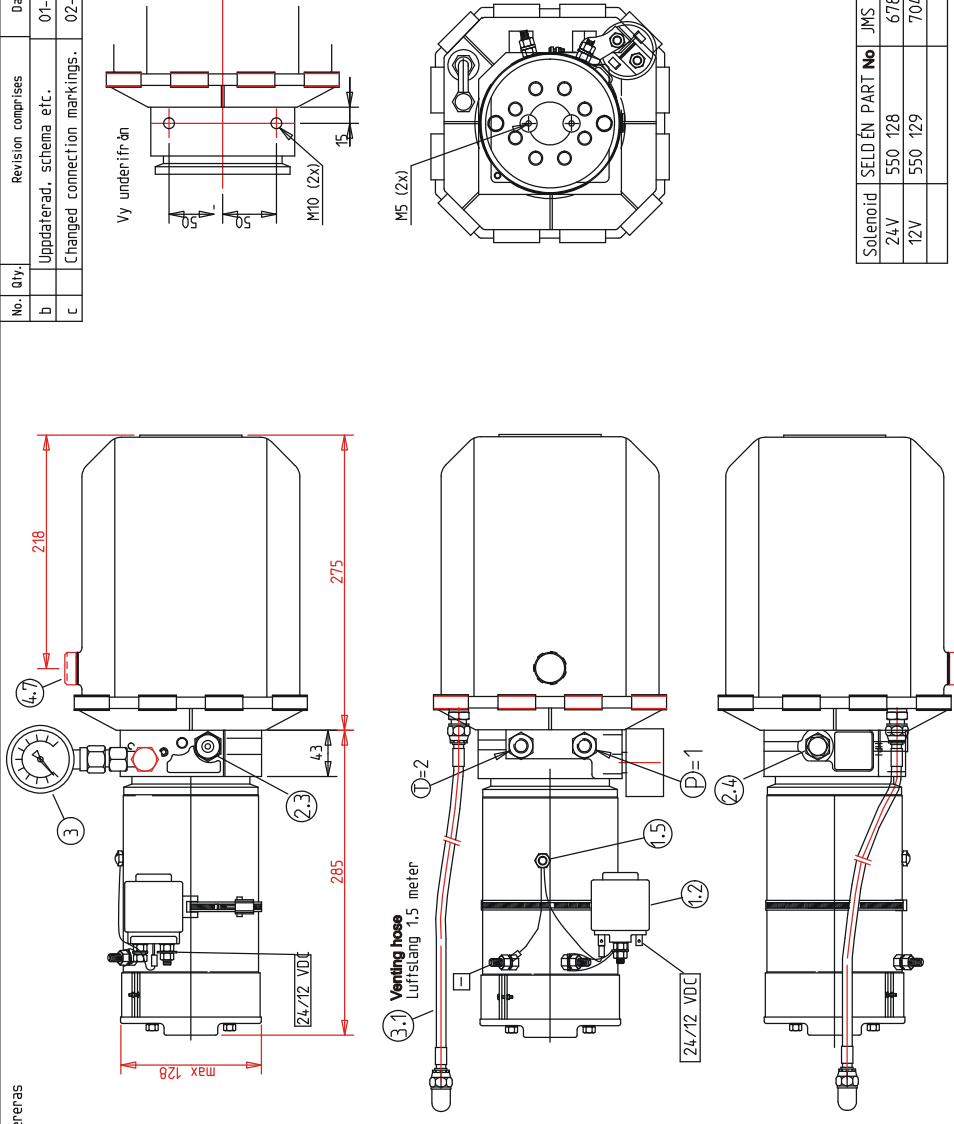
7.2 Hydraulic schematic Boom Outhaul



7.3 Outline & Assembly drawing Hydraulic power pack

Råd för påfyllning och tät plugg skall medlevereras





Dimensions: 218, 275, 285, 4.3, 4.7, 15, 50, 50, max 128, 24/12 VDC, 1.5 meter, 2.3, 3, 3.1, 1.2, 1.5, 2.4, P=1, T=2, 2.2, 2.4, 63/8, P=1, 61/4, 63/8, T=2, 1, 2.3, 2.2, 2.4, M, 1.5, D1E2, D1E2

Callouts: 3.1 Venting hose Luftslang 1.5 meter, 2.3, 3, 4.3, 4.7, 15, 50, 50, max 128, 24/12 VDC, 1.5 meter, 2.3, 3, 3.1, 1.2, 1.5, 2.4, P=1, T=2, 2.2, 2.4, 63/8, P=1, 61/4, 63/8, T=2, 1, 2.3, 2.2, 2.4, M, 1.5, D1E2, D1E2

Item No.	Description	Checked	Plant	Size	Material	JMS Part No.	Remark
	PHN		Seldén Mast AB				

Ver.	Val.	Uppr.
01-04-02	A3	

Date: 01-04-02 © COPYRIGHT SÄLDEN SYSTEMHYDRAULIK AB
Scale: A3
Orig. no.: G5245 C

No.	Dty.	Revision comprises	Date	Sign	Appr.
b		Uppdaterad, schema etc.	01-09-14	PHN	
c		Changed connection markings.	02-08-19	PTG	

Solenoid	SELDÉN PART No	JMS PART No:
24 V	550 128	67875
12V	550 129	70441

Item No.	Description	Checked	Plant	Size	Material	JMS Part No.	Remark
	PHN		Seldén Mast AB				

Ver.	Val.	Uppr.
01-04-02	A3	

Date: 01-04-02 © COPYRIGHT SÄLDEN SYSTEMHYDRAULIK AB
Scale: A3
Orig. no.: G5245 C

7.4 Outline & Assembly drawing Boom Outhaul Valve Pack

No. a	Qty. 1	Revision comprises Pos.34 was needle valves	Date 01-07-26	Sign PHN	Appr.
-----------------	------------------	---	-------------------------	--------------------	--------------

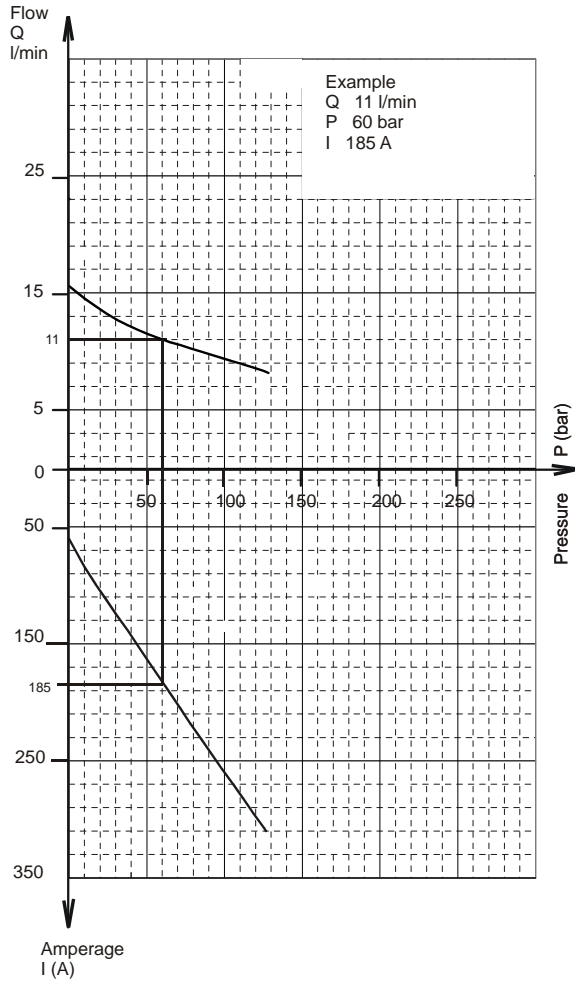
SOLENOID VALVE PART	JMS PART No:
24V	550 130 67874
12V	550 131 70442

PRESSURE SETTING	PRESSURE SETTING
POS 33.1	POS 33.2
75-100 bar	130 bar (SH.)
	200 250 300 190 bar
	BOOM HEIGHT

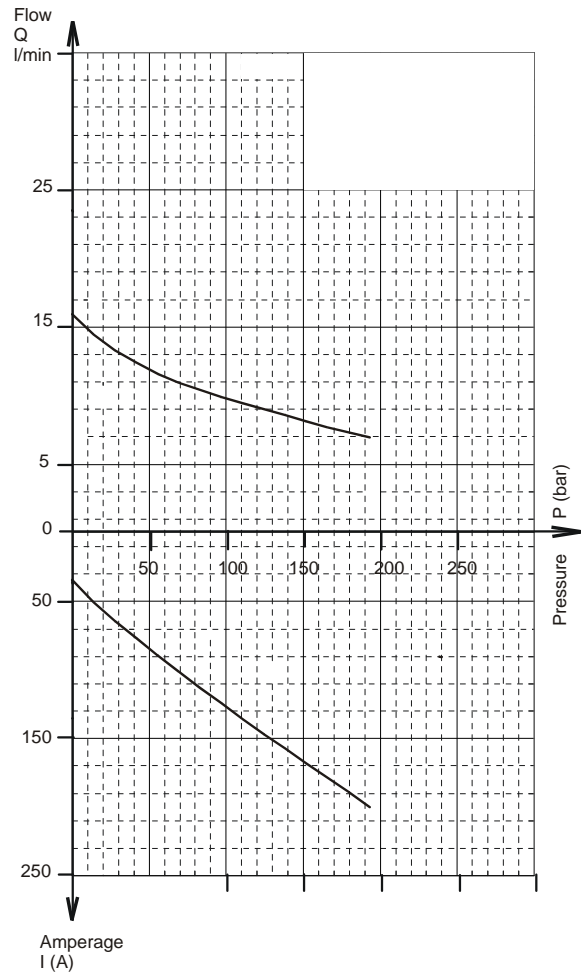
Item No. 1	Description Block	Size AA 6262-T6	Material	JMS/Q Part No.	Remark
Design PHN	Drawn PHN	Checked	Plant	Ver. PH0112	Updt.
SELDÉN			Outline & Assembly drawing Boom Outhaul Valve Pack		
			Date 991218 Scale 1:2 Rev. A.3		
			Orig. no. JMS-1187 Rev. G5000 A		

7.5 Electro – hydraulic characteristics

Direct current motor
nominal power 1,5 kW 12V

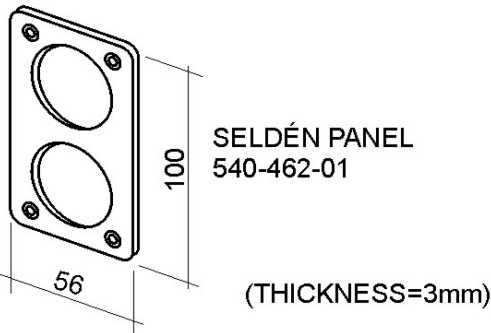
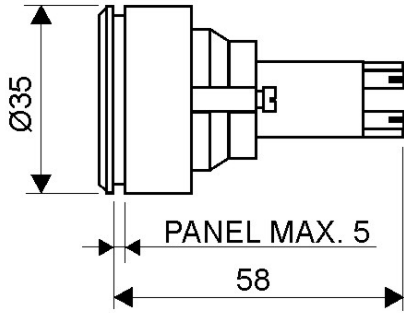


Direct current motor
nominal power 1,8 kW 24V

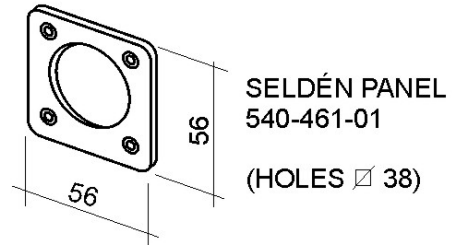
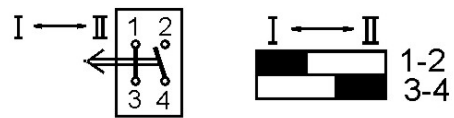
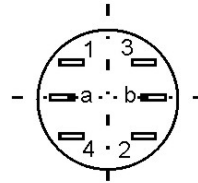


7.6 Illuminated Pushbutton (IP 67) \varnothing 35mm

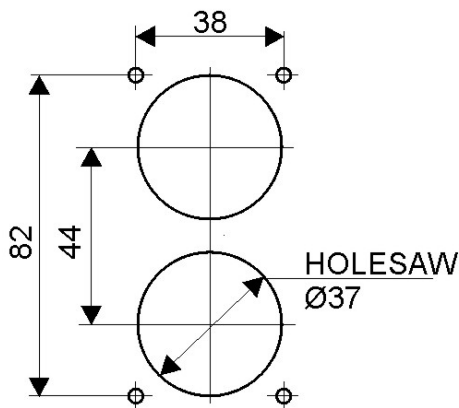
**ILLUMINATED PUSHBUTTON
(IP 67)**



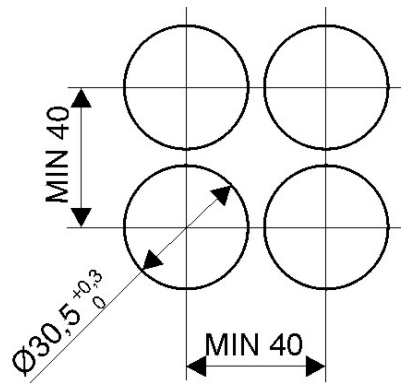
**PLUG-IN TERMINAL
2,8 x 0,5**



**MOUNTING DIMENSIONS WITH
SELDÉN PANEL 540-462-01**

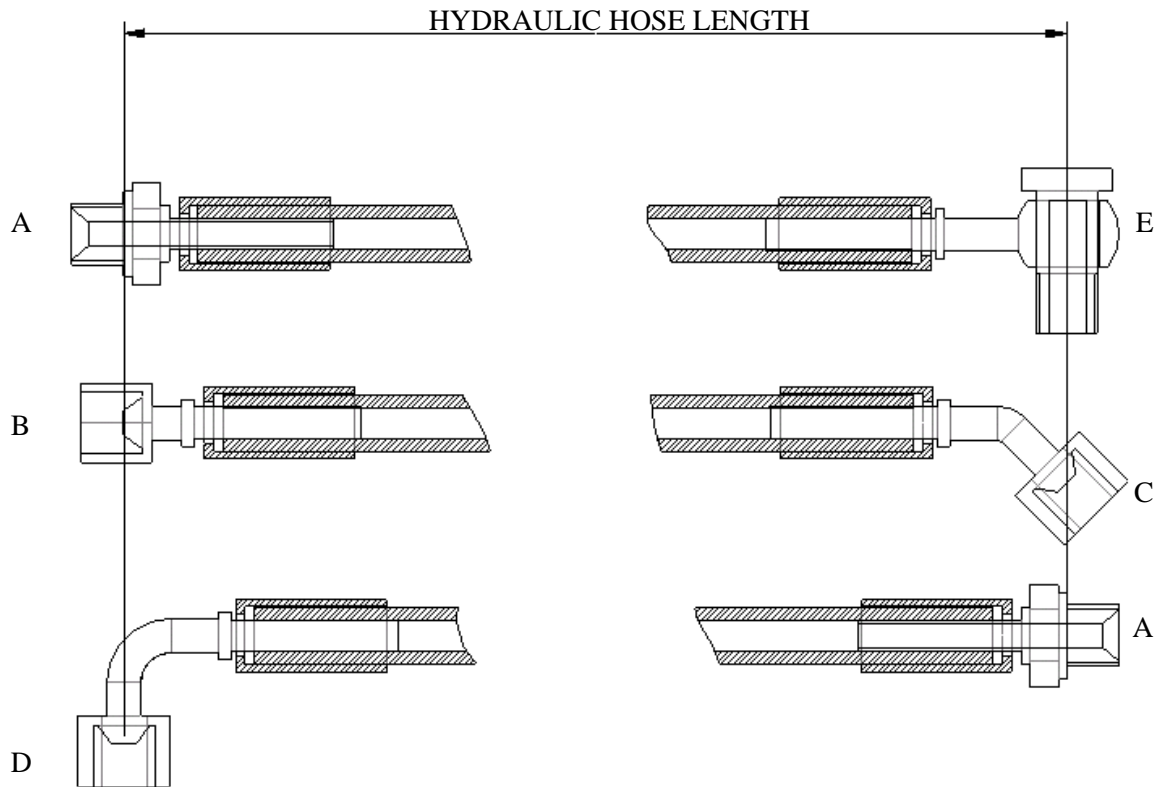


**MOUNTING DIMENSIONS
WITHOUT PANEL**



7.7 Definition of Hose Length

The illustration below indicates how to measure the length of hydraulic hoses. These couplings are the most common and they might appear in different combinations on one hose. The couplings are attached to the hose by a pressed clamp and they are not removable. Couplings B, C and D have swivel nuts, so please measure from the center of the cone.



A = HYDR. COUPLING MALE 0°

B = HYDR. COUPLING NUT 0°

C = HYDR. COUPLING NUT 45°

D = HYDR. COUPLING NUT 90°

E = BANJO COUPLING

7.8 Data Sheet; Hydraulic Oil

Name of product: Norsk Hydro Hyndla Hydraulic Oil 46
Type of product: Highly refined mineral oil, with supplements to improve the features
Company: Norsk Hydro Olje AB
Address: Box 273 25
102 54 Stockholm
Sweden

This hydraulic oil is used in boom outhauls produced from may 2005.

For safety information on the product, please contact Seldén Mast.

DINGHIESKEELBOATSYACHTS

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