INSTRUCTION MANUAL

Simrad HLD350 MK2
Simrad HLD2000 MK2L
Hydraulic Linear Drive

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Instruction Manual

This manual is intended as a reference guide for correctly installing and maintaining the HLD350 MK2 and HLD2000 MK2 Hydraulic Linear Drives.

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

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

Instruksjonsmanual

Denne manualen gir veiledning om installasjon og vedlikehold av de hydrauliske drivenhetene HLD350 MK2 og HLD2000 MK2.

For å få en forståelse av drivenhetens virkemåte og funksjon i et autopilotsystem bør manualen leses grundig.

Sammen med ditt system følger et garantikort. Dette må fylles ut av installatør og sendes inn for at garantien skal være gyldig.

Document revisions

Rev	Documentation department		Hardware/Software design		Project/Product Management	
	Date	Sign	Date	Sign	Date	Sign
–	07.97	N.G.	07.97	I.K.	07.97	Th.H.
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Document history

Rev. – First edition

Rev. A New edition including MK2 versions

Rev. B Added measurement on figure 1. Adjusted figure 5.

Rev. C New environmentally friendly synthetic hydraulic oil, page 5, 6 and 7. Corrected quantity for Pos.8 Bearing bush on fig. 11 from 1 to 2 and description of P.N. 44165918 on page 23. Distributor list updated.

Rev. D New motors, type Lemac. Added colour on the o-ring at pos. 6, page 21 to avoid mix up. Minor corrections in text.

Rev. E Corrected part no. for RPU80 on page 19. Updated with new autopilot computers.

Contents

Innhold

1 GENERAL

HLD350 MK2 and HLD2000 MK2 are hydraulic linear drives designed for boats with mechanical steering systems such as wire and cable steering (Edson, Whitlock, Teleflex).

The HLD is a compact, assembled unit, consisting of a reversible hydraulic pump, a balanced hydraulic cylinder, by-pass valve and oil tank.

Because of the direct connection to the rudder, the hydraulic linear drive can be used even if the hand steering should fail. This can be an important safety factor.

The by-pass valve makes it possible to use the helm with little back drive force when the autopilot is switched off.

The HLD350 MK2 and HLD2000 MK2L supersede the previous HLD350 and HLD2000L models. This manual also includes HLD2000 MK2D. This model is based on the same main parts as HLD350 MK2, but uses the HLD2000 MK2LD motor.

The MK2 versions were introduced in April 1998. The cylinder has a slightly increased diameter and requires a modified piston assembly and piston sealing. Otherwise the MK2 versions are identical to the previous HLD350 and HLD2000L. The modified units have got a MK2 added to the type designation on the product label and applies from the following serial numbers and onwards.

The basic specifications are:

Art. no.	Ser. no.	Description
21113303	545H36	HLD350 MK2 (200 mm stroke)
21113311	545H36	HLD350 MK2S (split version)
21113360	4154H69	HLD2000 MK2L (long version, 340 mm stroke)
21113386	4154H610	HLD2000 MK2LS (long, split version)
21113345	3383H68	HLD2000 MK2D (dual cylinder version, 200 mm stroke)
21113402	4154H611	HLD2000 MK2LD (long dual cylinder version)

In this manual HLD is used as a general term for all models. The MK2 designation is added only when specifically required for parts identifications.

All HLD models are supplied with environmentally friendly synthetic hydraulic oil with designation of type Hydralen 32 (viscosity 32 cSt). This oil can without problem substitute/blend with ordinary hydraulic oil with equivalent viscosity (between 15 and 40 cSt)

GENERELT

HLD350 MK2 og HLD2000 MK2 er hydrauliske lineære drivenheter beregnet for båter med mekaniske styresystemer som kabel- og wirestyring (Edson, Whitlock, Teleflex).

Den består av en kompakt sammenbygget enhet som inneholder reverserbar hydraulisk pumpe, balansert hydraulisk sylinder, by-pass ventil og oljetank.

På grunn av den direkte tilkoblingen til roret vil den lineære drivenheten kunne brukes selv om håndstyringen skulle svikte, noe som gir større sikkerhet.

Når autopiloten er avslått eller mister spenningen, vil by-pass ventilen åpne slik at roret kan beveges uhindret ved hjelp av den mekaniske styringen.

HLD350 MK2 og HLD2000 MK2L etterfølger de tidligere modellene HLD350 og HLD2000L. Manualen omhandler også HLD2000 MK2D. Denne modellen baserer seg på samme hoveddeler som HLD350 MK2, men bruker samme motor som HLD2000 MK2LD.

MK2 versjonen ble introdusert i april 1998. Sylinderen har en noe større diameter og krever et modifisert stempel og stempelforing. Ellers er MK2 versjonene identiske med HLD350 og HLD2000L. Modifiserte enheter har fått tilføyd MK2 på produktmerkelappen og modifikasjonen er gjort gjeldende fra følgende serienummer:

Art. nr.	Ser. nr.	Beskrivelse
21113303	545H36	HLD350 MK2 (200 mm slaglengde)
21113311	545H36	HLD350 MK2S (delt utgave)
21113360	4154H69	HLD2000 MK2L (lang utgave, 340 mm slaglengde)
21113386	4154H610	HLD2000 MK2LS (lang, delt utgave)
21113345	3383H68	HLD2000 MK2D (dobbel sylinder, 200 mm slaglengde)
21113402	4154H611	HLD2000 MK2LD (lang, dobbel sylinder)

I denne manualen brukes HLD som en generell betegnelse for alle modeller. MK2 er kun brukt når det er behov for å identifisere deler.

Alle HLD modeller leveres med en syntetisk, miljøvennlig hydraulikkolje av typen Hydralen 32 (Viskositet 32 cSt). Denne oljen kan uten problem erstatte/blandes med vanlig hydrolikkolje med tilsvarende viskositet (mellom 15 og 40 cSt).

2 TECHNICAL SPECIFICATIONS

2.1 Standard version

Motor voltage: ..... 12V DC

Max. current HLD350/2000L: 10/20A

Average power consumption: ..... 40 – 60 W

Peak thrust HLD350/2000L: ..... 350kp / 500kp

Continuous duty HLD350/2000L: . 250kp / 390kp

Max. speed HLD350/2000L: ..... 10 sec./17 sec. full travel (Adjustable in the autopilot electronics)

Stroke: ..... 200mm / 340mm

Overall length with piston in middle position: ..... 578mm / 858mm

Dimensions: ..... See fig. 1

Hydraulic oil: ..... Hydralen 32, High quality environmentally friendly, synthetic hydraulic oil.

Alternative oil: ..... Norol HM32, Shell Tellus 27, Esso HP15 and Yukong Supervis AW32/X32.)
Viscosity 15-40 cSt at 40°C.

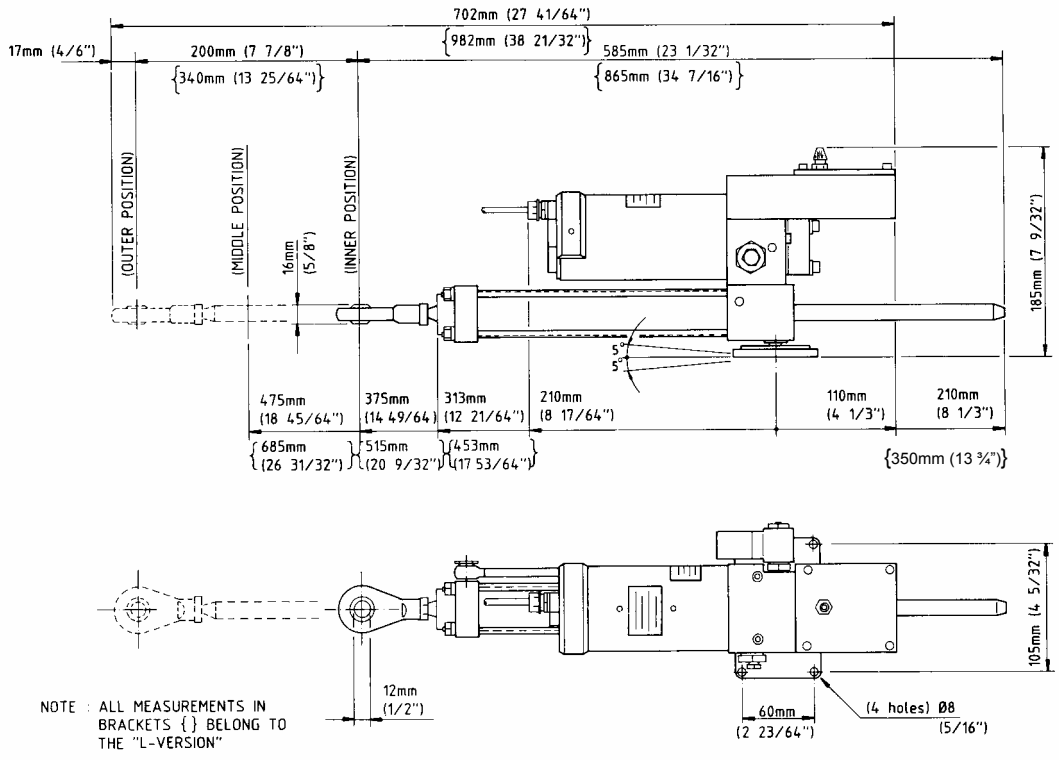


Figure 1 HLD dimensions (shown with Fracmo motor)

2.2 Split version

To obtain good flexibility in the installation of the HLD, a split version is available.

The hydraulic cylinder and the motor/pump-unit are made as separate units with provisions to connect hydraulic hoses between the two. Modifications have been made on the pump housing for this purpose.

The split version is available with standard (200 mm) or long stroke (340 mm) and with hose lengths of 1 m (3 ft).

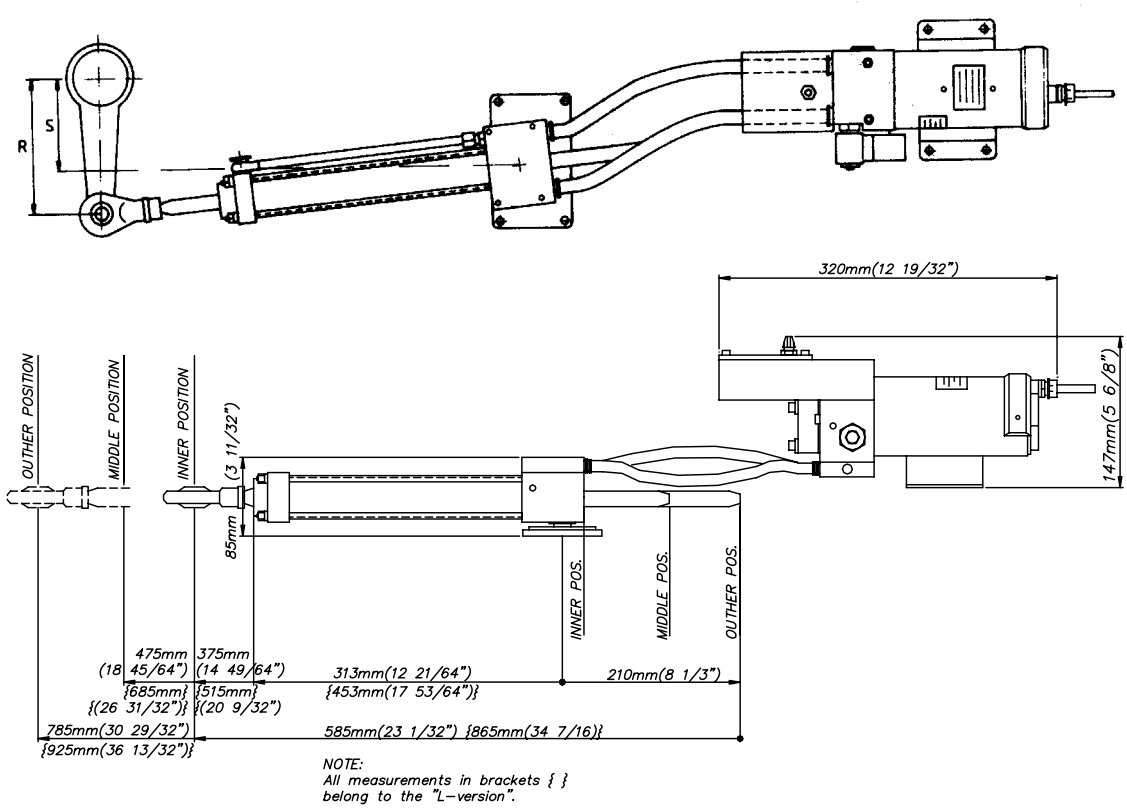


Figure 2 HLD Split version (Shown with Fracmo type motor)

For å oppnå best mulig fleksibilitet ved installasjon er enheten tilgjengelig i delt utgave.

Hydraulisk sylinder og motor/pumpeenhet er laget som separate enheter for sammenkobling ved hjelp av hydraulikk-slanger. I denne forbindelse er det gjort små modifikasjoner på de to enhetene.

Delt utgave kan leveres både med standard slaglengde (200 mm)og med lang slaglengde (340 mm), og med slanger på 1,0 m.

2.3 Dual cylinder version

This model meets the requirement for increased torque without increasing the radial forces on the rudder stock.

It combines a powerful reversible pump (RPU300) with two cylinders having the standard stroke or long stroke. 4 flexible hoses of 1 m (3 ft) connect the pump to the cylinders.

By connecting the cylinders as shown, the radial forces are balanced out, whilst a double torque has been achieved.

The dual cylinder version is for 24V DC operation only.

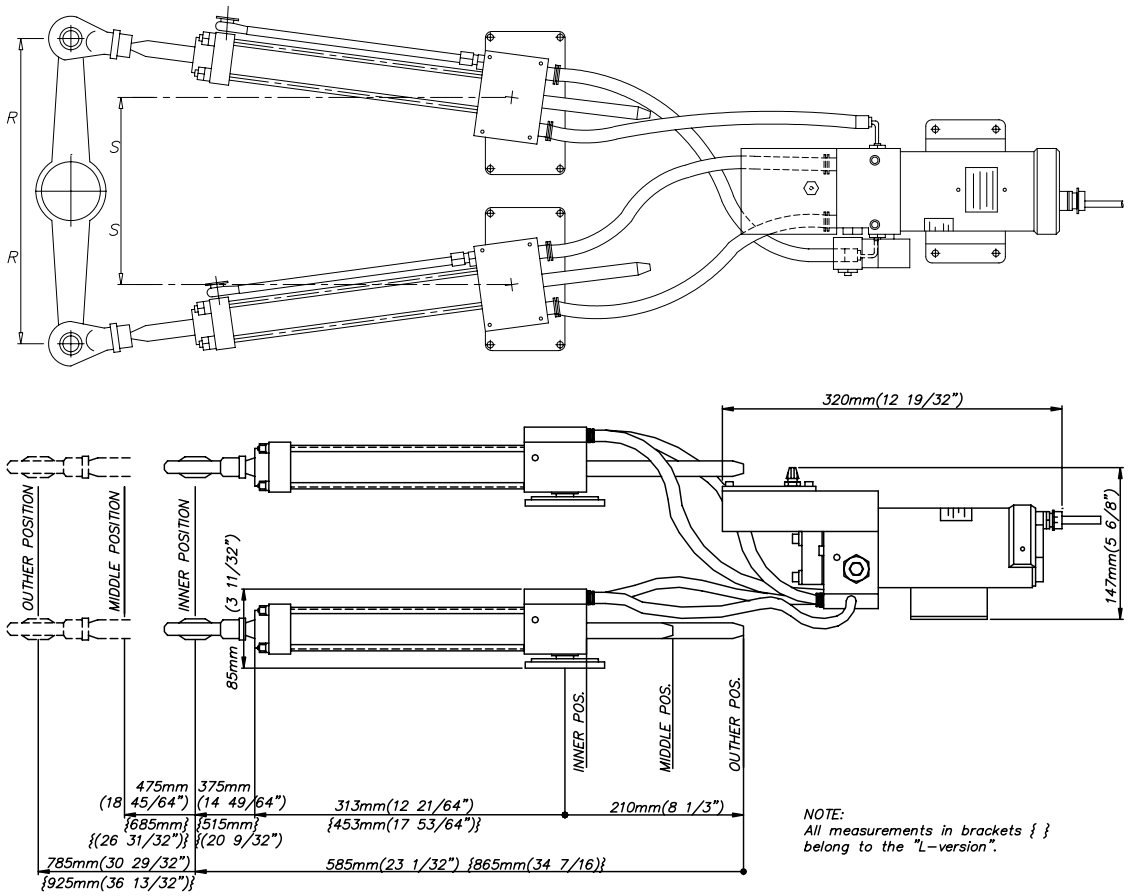


Figure 3 HLD Dual cylinder (Shown with Fracmo type motor)

Denne utgaven med doble sylindere er utviklet for å øke dreiemomentet uten å øke de radielle kreftene som virker på rorstammen.

Den kombinerer en kraftigere reverserbar pumpe (RPU300), med to sylindere med standard slaglengde, eventuelt med lang slaglengde. 4 oljeslanger på 1 m forbinder pumpen med sylindrene. Ved å montere sylindrene som vist på figuren får man balansert de radielle kreftene, samtidig som dobbelt dreiemoment oppnås.

Den doble sylinderversjonen er kun beregnet for 24V DC.

2.4 Comparison chart for HLD MK2 versions

MODEL	MOTOR VOLTS	AUTOPILOT COMPUTER/ JUNCTION UNIT	MAX STROKE mm (in.)	PEAK THRUST kg (lb.)	MAX RUDDER TORQUE Nm (lb.in.)	HARD-OVER TIME sec. (30% load)	PWR. CON-SUMP.	TILLER ARM mm (in.)
HLD350 HLD350S	12V	AC10, J3000X	200 (7,9)	350 (770)	610 (5400)	12	3,5-10 A	175 (6,9)
HLD2000L HLD2000LS	12V	AC20, J300X	340 (13,4)	500 (1100)	1460 (12850)	12	5-16 A	298 (11,7)
HLD2000D	24V	AC20, J300X	200 (7,9)	1050 (2310)	1800 (15900)	9	5-16 A	175 (6,9)
HLD2000LD	24V	AC20, J300X	340 (13,4)	1050 (2310)	3180 (28000)	15	5-16 A	298 (11,7)

Steering gear interface: Connects to quadrant or tiller.

1. *The autopilot computer/junction unit steps down the motor voltage when operating from 24V or 32V mains.*
2. *The specified computer/junction unit is necessary to achieve max drive unit capacity.*
3. *Recommended operational thrust or torque is 70% of listed value.*
4. *Typical average power consumption is 40% of listed maximum value.*

Rortilkobling: Kobles til kvadrant eller rorkult.

1. *Autopilotcomputeren/koblingsenheten regulerer ned motorspenningen ved 24V eller 32V nettspenning.*
2. *Spesifisert computer/koblingsenhet er nødvendig for å oppnå maksimal kapasitet fra drivenhet.*
3. *Anbefalt skyvkraft eller moment ved drift er 70% av oppgitt verdi.*
4. *Gjennomsnittlig effektforbruk er typisk 40% av oppgitt maksimumsverdi.*

3 INSTALLATION

Refer to table in section 2.4 to verify that appropriate HLD model is selected for your boat.

If there is any doubt as to whether HLD350/HLD2000L can be installed, this can be clarified by undertaking the calculations shown in the appendix.

3.1 Mechanical installation

Rudder and actuator rod is set to midposition. To obtain maximum and smooth thrust over the actuator's complete stroke, the HLD should be installed in accordance with fig. 6. The distances R and S for different rudder angles are found in the diagram in fig. 4 and 5.

The HLD should be fitted with the enclosed safety connector between actuator and tiller to ensure quick disconnection in emergency situations.

Note ! *Drill and tap the rudder tiller (M12x1.75) to secure the bolt firmly.*

Caution ! ***Do never install the unit upside down! (The air valve should be facing upwards.) The HLD must be installed horizontally only. No more than ±5 degrees tilt is allowed at any position, as illustrated on figure 1. The HLD should not act as an end stop for the rudder.***

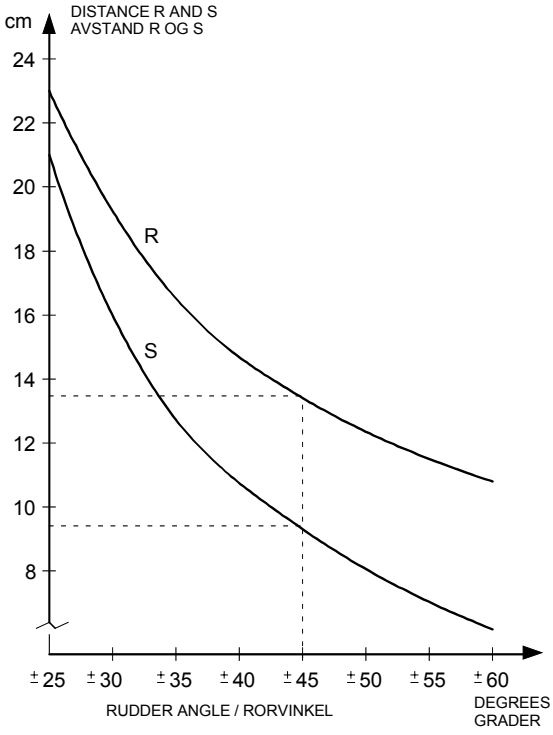


Figure 4 HLD350 Installation diagram

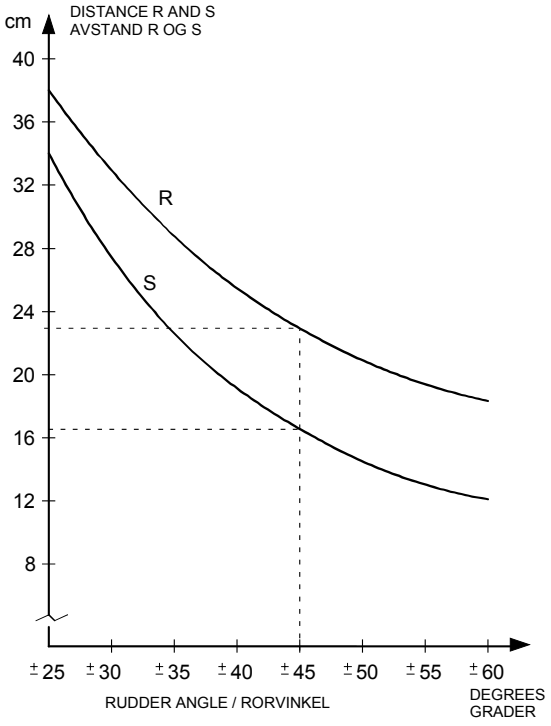


Figure 5 HLD2000L Installation diagram

Remove the valve cap on the tank when the unit is installed.

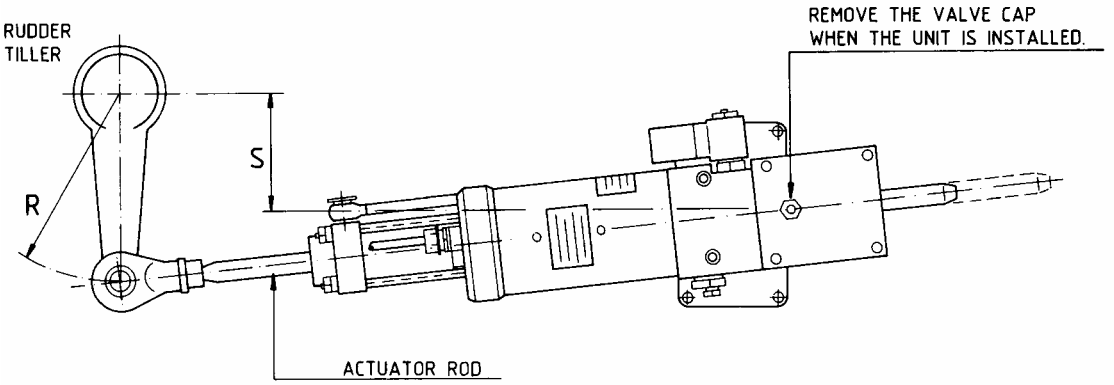


Figure 6 HLD Installation

3.2 Electrical connection

AC10/AC20 Autopilot Computer, J300X/J3000X Junction Unit

The HLD is connected to the autopilot via AC10, AC20, J300X or J3000X according to the following diagram:

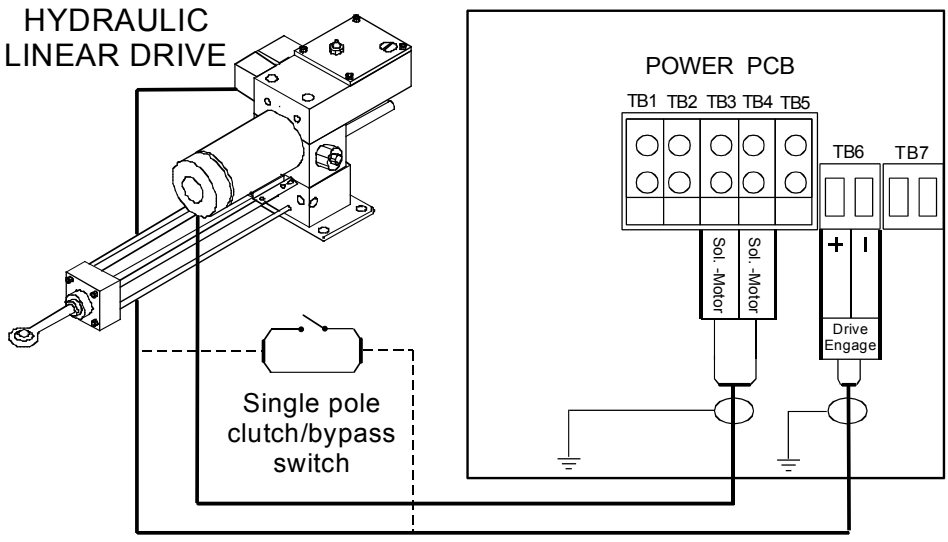


Figure 7 HLD connection to ACXX and J3XX

J101A Junction Unit

The HLD can also be connected to previous models autopilots using the J45A, J101A or J1000 Junction units. The Junction Unit controls the current to the motor and the bypass valve. The Junction Unit also has built-in speed regulation of the HLD, which allows rudder speed

adjustment (i.e. the steering performance of the boat when autopilot steering) after installation of the system.

Note that for the HLD350 (not the HLD2000L) the trim potentiometer RV1 in J1000/J101A/J45A should be adjusted to approx. 2/3 of full C.W. position.

The J1000/J101A/J45A also has a built-in current limiter to prevent overload of the motor (Max. current is 20A).

Motor/bypass connection

The bypass valve is connected to terminal 13 and 14 in J45A/J101A/J1000, and is polarity independent.

The motor is connected to terminal A and B in J45A/J101A/J1000. Interchange of A and B will change the direction of rotation.

Cable for the motor supply voltage from the ship mains must be at least 2x4mm^2 (AWG10), and fused according to the table enclosed with the J101A/J1000.

INSTALLASJON

Kontroller mot tabellen under seksjon 2.4 at riktig HLD model er valgt.

Er det tvil om hvorvidt HLD350 eller HLD2000L skal velges, kan dette klargjøres ut fra beregningene som er vist i tillegget bak i manualen.

Mekanisk installasjon

Plasser stempelstang og ror i midtstilling. HLD monteres slik fig. 6 viser for å få maksimal skyvkraft langs hele stempelstangens vandring. Avstandene R og S ved de forskjellige rorvinkler finnes i diagram fig. 4 og 5.

HLD er utstyrt med hurtigkopling mellom stempelstang og rorkult som tillater hurtig frakobling i nødssituasjoner.

Bruk M12x1,75 gjengetapp og gjeng opp i rorkult.

HLD må aldri monteres opp ned! (Lufteventil på tank skal peke oppover). Enheten må monteres horisontalt, og slik at avviket fra horisontalplanet aldri overstiger ±5 grader, slik som illustrert på fig. 1. HLD må ikke monteres slik at den fungerer som endestopp for roret.

Husk å skru av ventilhetten på tanken etter at enheten er montert.

Elektrisk tilkobling

AC10/AC20 autopilotcomputer,

J300X/J3000X koblingsenhet

HLD kobles til autopiloten via AC10, AC20, J300X eller J3000X i henhold til fig. 7.

J101A koblingsenhet

HLD kan også kobles til tidligere autopilotmodeller som bruker J101A eller J1000 koblingsenheter. Koblingsenhetene kontrollerer strømmen til motoren og by-pass ventilen. Koblingsenheten har også innebygget hastighetsregulering av HLD, noe som gir anledning til å justere rorhastighet (og dermed båtens styreegenskaper med autopilot) etter at systemet er installert.

Ved bruk av HLD350 (gjelder ikke HLD2000L) bør trimme-potensiometer RV1 i J45A/J101A/J1000settes til ca. 2/3 av fullt område.

I J45A/J101A/J1000er det også innebygget en strømbegrenser som hindrer overbelastning av motor (maks. strøm er 20A).

Kobling av motor/bypassventil:

Bypassventil kobles til terminal 13 og 14 i J45A/J101A/J1000 og er polaritetsuavhengig.

Motoren kobles til terminal A og B i J45A/J101A/J1000. Ombytting av A og B vil snu motorens dreieretning.

Kabel for motorspenning fra båtens fordelingsskap må være minst $2x4mm^2$ og sikret i.h.h.t. tabell vedlagt i J45A/J101A/J1000.

4 CONSTRUCTION AND PRINCIPLE OF OPERATION

The HLD is delivered completely assembled with tank, reversible hydraulic pump and a balanced hydraulic cylinder. The HLD is therefore a completely closed system.

4.1 Tank

The tank is machined out of solid aluminium and all necessary oil ways are drilled out.

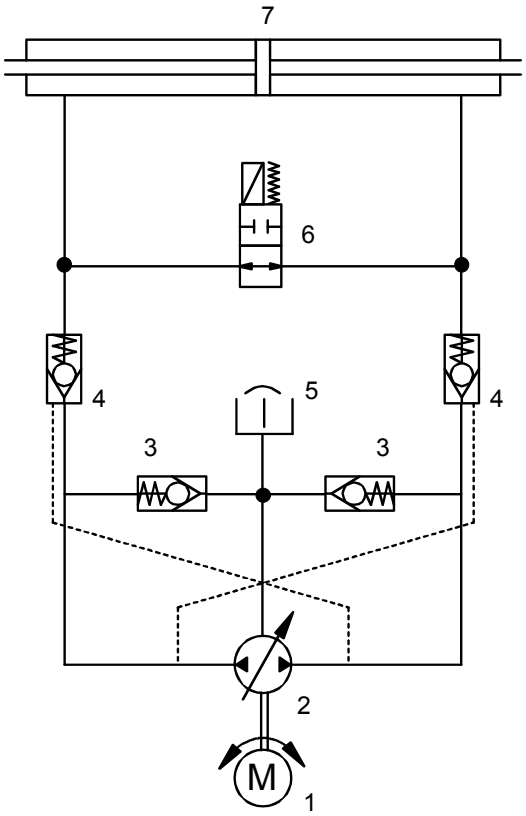
A bypass valve is mounted in the tank, to allow the mechanical steering system to be used, when the autopilot is not in operation.

The bypass valve is a standard ON/OFF solenoid valve, normally open.

When the autopilot is in STBY mode, the solenoid valve will be in open position.

When AUTO or NAV mode is selected, the solenoid valve will be in closed position.

The solenoid valve opens immediately when the autopilot is switched off, and handsteering is allowed.



Functional diagram

1. Electrical motor (Elektromotor)
2. Gear pump (Tannhjulspumpe)
3. Suction valve (Innsugingsventil)
4. Check valve (Tilbakeslagsventil)
5. Oil tank (Oljetank)
6. By-pass valve (By-pass ventil)
7. Hydraulic actuator (Hydraulisk sylinder)

Previous versions

An early version of HLD350 and HLD350S did not have check valves. The following serial no. codes can identify it: H30 (HLD350) and H31 (HLD350S).

The principle of operation was similar to that of HLD2000L. The (suction) valves, however, operated as combined suction and (non-return) check valves controlled by internal pressure and direction of oil flow. The resulting effect was a smoother check valve operation as

compared to the ones with separate check valves. It should be observed however, that this version does not have the extra protection against internal leakage (bypass) as the models with separate check valves.

4.2 Reversible Hydraulic Pump

The pump consists of valve block, reversible gear pump, pressure operated check (non-return) valves, electric permanent magnet motor, suction valves and slide.

The pump is reversible, i.e. the motor changes direction of rotation and the gear pump delivers oil to that side of the rudder cylinder dictated by the signal from the autopilot. When the motor is running, the pressurised (or delivery) side will hold both check valves open, using direct oil pressure upon the valve on the delivery side. This oil pressure is also used to push a slide to open the valve on the suction side.

When the motor stops, the spring in the check valve on the suction side returns the slide to the neutral position. Both check valves are now closed and the rudder cylinder locked. Both sides of the gear pump are able to suck oil from the tank through the suction valves.

4.3 Hydraulic Rudder Cylinder

The rudder cylinder consists of the cylinder itself, actuator, actuator rod, ball joint and base plate.

The actuator rod runs through the cylinder. The actuator area is identical on both sides, and this balances the cylinder.

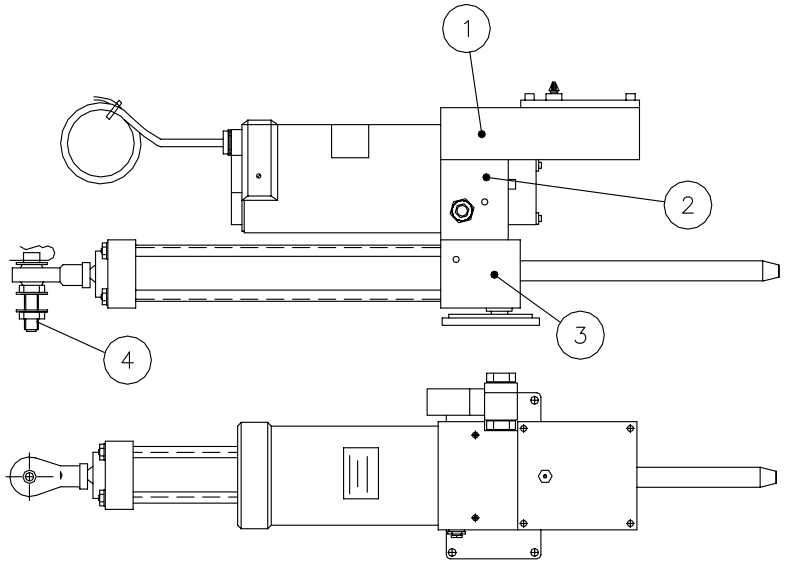


Figure 8 HLD Assembly drawing (N3-111832)
(Shown with Fracmo type motor)

KONSTRUKSJON OG VIRKEMÅTE

HLD leveres komplett sammenbygget med tank, reverserbar hydraulisk pumpe og balansert hydraulisk sylinder. Den arbeider dermed i et lukket system.

Tank

Tanken er frest ut av massiv aluminium og nødvendige oljeløp er utboret.

I tanken er det montert en bypass-ventil for at det mekaniske styresystemet skal kunne brukes når autopiloten ikke er i bruk.

Bypass-ventilen er en standard Av/På magnetventil som normalt er åpen.

Magnetventilen er åpen når autopiloten er i STBY og lukket når autopiloten er i AUTO eller NAV. Ventilen åpner umiddelbart når autopiloten slås av slik at håndstyring kan benyttes.

Tidligere versjoner

En tidligere versjon av HLD350 og HLD350S har ikke tilbakeslagsventil. Denne versjonen identifiseres med følgende serie nr. kode: H30 (HLD350) og H31 (HLD350S).

Betjeningsprinsippet var tilsvarende som for HLD2000L. Innsugnings-ventilene fungerte imidlertid som kombinerte innsugings- og tilbakeslagsventiler kontrollert av det interne trykket og retningen av oljestrømmen. Effekten av dette var en jevnere sperrefunksjon sammenlignet med enheter med egen tilbakeslagsventil. Denne versjonen gir imidlertid ikke den ekstra beskyttelse mot intern lekkasje som den med egen tilbakeslagsventil gir.

Reverserbar hydraulisk pumpe

Pumpen består av ventilblokk, pumpeenhet, motor med permanente magneter, tilbakeslagsventiler og sleide.

Pumpen er reverserbar, dvs. at motoren kan endre dreieretning og tannhjulspumpen vil levere oljen enten til den ene eller andre enden av rorsylinderen, avhengig av signalene fra autopiloten.

Når motoren går, vil pumpens trykkside holde begge de trykkstyrte tilbakeslagsventilene åpne. Tilbakeslagsventilen på trykksiden åpnes direkte av oljetrykket, mens den på sugesiden blir åpnet av en sleide som skyves over av oljetrykket på trykksiden.

Når signalet fra piloten opphører, vil fjæren i tilbakeslagsventilen på sugesiden trykke sleiden tilbake til nøytralstilling. Begge tilbakeslagsventilene vil da være lukket. Den hydrauliske sylinderen

er dermed låst. Begge sider av tannhjulspumpen kan suge fra tank via innsugningsventiler.

Hydraulisk rorsylinder

Rorsylinderen består av sylinderrør, stempelstang med stempel, endestykke og fot.

Stempelstangen er gjennomgående. Stempelarealet er likt på begge sider, og sylinderen er dermed balansert.

5 PARTS LIST

5.1 Linear drive units and main parts

Refer to Figure 8.

Pos.	Part no.	Description
	21113303	HLD350 MK2 Hydraulic linear drive complete, stroke 200 mm
	21113311	HLD350 MK2S Hydraulic linear drive complete, stroke 200 mm, split version
	21113360	HLD2000 MK2L Hydraulic linear drive complete, stroke 340 mm
	21113386	HLD2000 MK2LS Hydraulic linear drive complete, stroke 340 mm, split version
	21113345	HLD2000 MK2D Hydraulic linear drive complete, stroke 200 mm, dual cylinders
	21113402	HLD2000 MK2LD Hydraulic linear drive complete, stroke 340 mm, dual cylinders
1	21112826	Tank assembly 12V (standard) Option: 24V (voltage to be specified)
2	21112859	Pump assembly complete with motor (12V)
		Motor parts (LEMAC)
	44170199	RPU80 Lemac motor (HLD350/HLD350S) (Substitutes RPU80 Fracmo motor)
	44177525	RPU160 Lemac motor (HLD2000L/HLD2000LS) (Substitutes RPU100 Fracmo motor)
	44169845	Brush for RPU80/160 Lemac motor, C8386 9x6x18,2mm
	44170132	Brush cap for RPU80/160 Lemac motor
	44169993	RPU300 Lemac motor, 24V (HLD2000D/HLD2000LD) (Substitutes RPU300 Fracmo motor, 24V)
	44170116	Brush for RPU300 Lemac motor, short type, 12,7x7,94x12mm
	44170108	Brush for RPU300 Lemac motor, long type, 12,7x7,94x19mm
	44170124	Brush cap for RPU300 Lemac motor
		Parts for Fracmo motors:
	44163228	Brush cap RPU80/160 Fracmo – Type I
	44163236	Brush cap RPU80/160 Fracmo – Type II

	44161933	Brushes for RPU80 motor
	44133056	Brushes type CB156 for RPU100 Fracmo (spade connector)
	44136356	Brushes type CB174 for RPU100 Fracmo (male/female connector)
3	21113287	HLD350/2000 MK2 (D) Hydraulic cylinder ass'y
	21113279	HLD2000 MK2L Hydraulic cylinder ass'y
4	21109228	Emergency release pin complete

5.2 Tank assembly

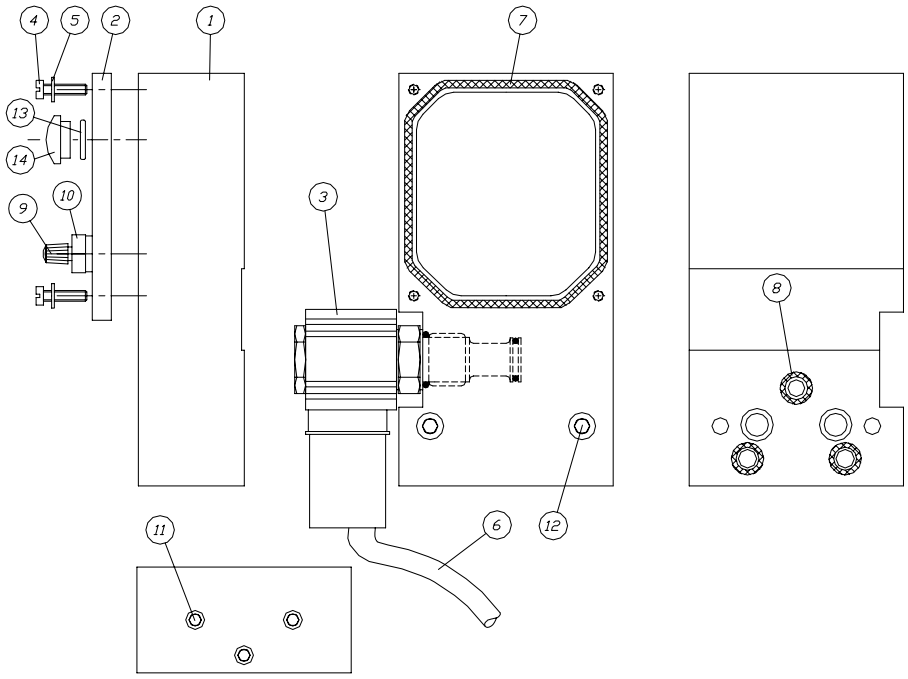


Figure 9 HLD Tank assembly (N3-111282C)

Pos.	Qty	Part no.	Description
1	1	21112891	Tank
2	1	21112800	Cover for tank
3	1	44156537	Solenoid valve 12V, complete
		44157634	Coil 12V
		44156594	Solenoid valve 24V, complete
		44157626	Coil 24V
4	4	44150555	Screw sock. Head M4x16
5	4	44150274	Washer M4
6	1	21112834	Cable
7	1	44154672	O-ring Ø85,34x1,78

8	5	44154839	O-ring 8,73x12,29x1,78
9	1	44153773	Valve with cap
10	1	44154128	Nipple Ø6 R 1/4
11	3	44154565	Set screw M8x8
12	2	44154458	Screw sock. head M6x40
13	1	44157790	O-ring Ø10,82x1,78
14	1	44157774	Blind plug PG7
15	1	44157865	O-ring Ø14,00x2,00
16	1	44157873	O-ring Ø16,36x2,21

5.3 Pump assembly

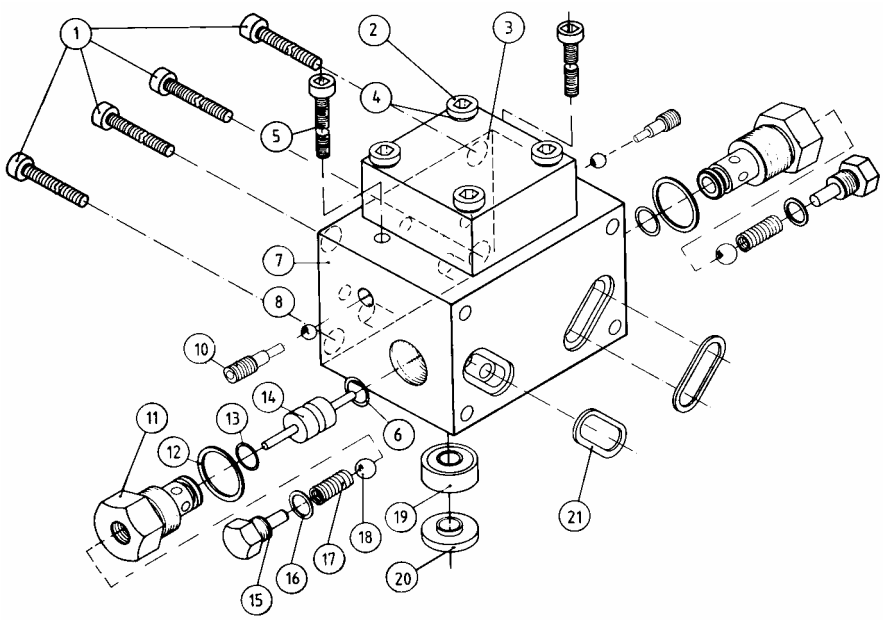


Figure 10 Pump assembly

Pos.	Qty.	Part no.	Description
1	4	44149912	Screw sock. Head M5x60
2	4	44152775	Screw sock. Head M6x35
3	1	21101191	Pump cover
4	4	44150050	Split washer M6
5	2	44149912	Screw sock. Head M5x60
6	1	44154656	O-ring Ø9,25x1,78 silicon, red
7	1	21109038	Valve block
8	2	44118552	Steel ball Ø6,35
10	2	21112933	Grub. screw sock. head M8
11	2	21100276	Valve housing

12	2	44149706	Copper Washer Ø20/24x1,5
13	2	44149649	O-ring 9,25x1,78 Nitrile
14	1	21100268	Slide
15	2	21100292	Plug
16	2	44148146	Copper washer Ø10,2x14x1
17	2	21100193	Spring
18	2	44149656	Steel ball Ø8
19	1	44149722	Oil seal 8x22x7
20	1	21100185	Support ring
21	2	44154888	O-ring Ø18,77x1,78

5.4 Cylinder assembly

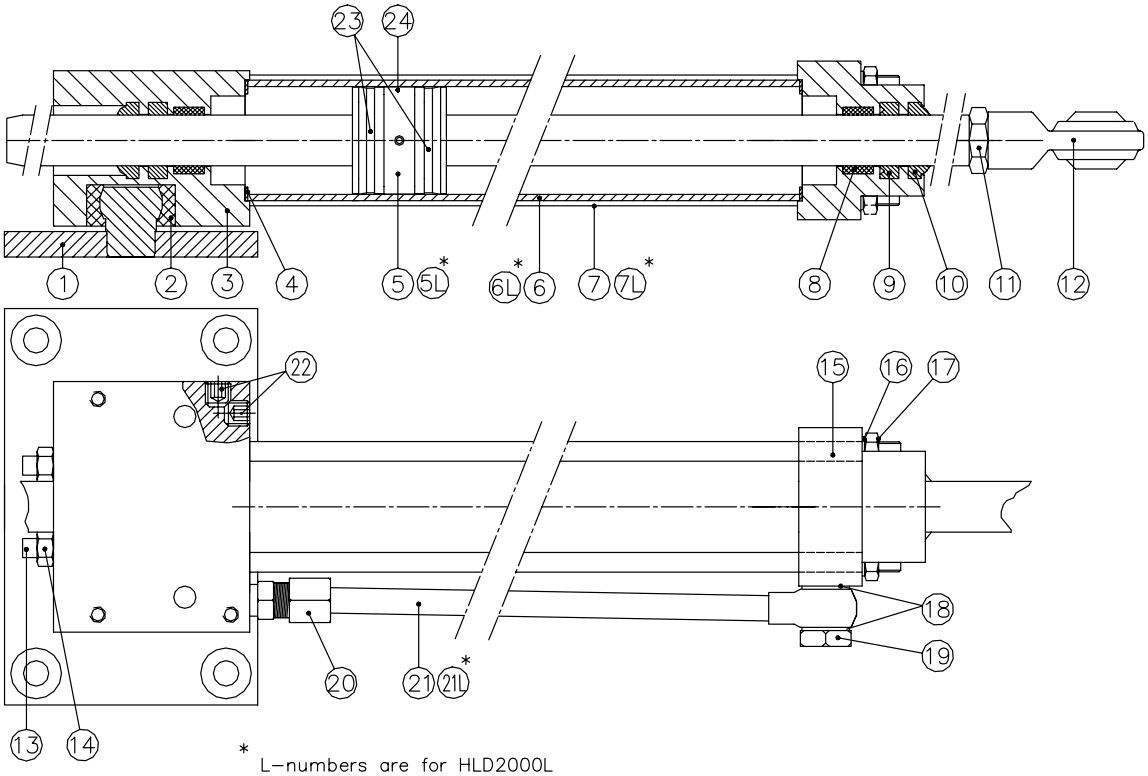


Figure 11 Cylinder assembly (N3-111284A)

Pos.	Qty.	Part no.	Description
1	1	21215991	Base plate complete
2	1	21219019	Plastic bearing
3	1	21112768	Back end piece
4	2	21219027	Gasket
5	1	21112867	HLD350 Piston complete

5	1	21113063	HLD350 MK2 Piston complete
5L	1	21113253	HLD2000L Piston complete
5L	1	21113071	HLD2000 MK2L Piston complete
6	1	21112974	Cylinder
6L	1	21112982	Cylinder
7	4	21109111	Studs
7L	4	21112024	Studs
8	2	21112917	Bearing bush
9	2	44156578	Oil seal 16x24x5,5
10	2	44156586	Cleaner Ø16x24x7,4
11	1	44140076	Nut M12
12	1	21113295	Ball joint Ø12xM12
13	2	44150035	Set screw M6x6
14	2	44150043	Nut M6
15	1	21112784	End piece
16	4	44150050	Washer M6
17	4	44150068	Nut M6
18	2	44148039	Copper washer 12x16x1,5
19	1	44165892	Hollow screw M12x1,5 single
20	1	44165900	Clamping ring coupling M10x1x8
21	1	21113030	Pipe with banjo coupling
21L	1	21113055	Pipe with banjo coupling
22	2	44154565	Set screw M8x8
23	2	44165918	Nut ring UM 35-25-5
24	1	21113048	Bearing bush

6 APPENDIX

6.1 Calculation of the force against the rudder

1. When the rudder torque is known.

The rudder torque is usually obtained from the boat builder.

To find the force against the rudder, the length of the rudder tiller must first be known. This can be calculated from the formula:

$$R = \frac{l}{\sin a} \text{ (m)}$$

where R = rudder tiller length

a = one half of the rudder angle

l = one half of the stroke length(0.10m/0.17m)

The force F against the rudder is calculated from the formula:

$$F_r = \frac{M}{R} \text{ (kp)}$$

where

F_r = rudder force
M = rudder torque (kpm)
R = rudder tiller (m)

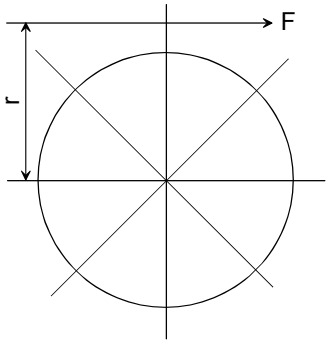
Use the table on page 10 to find the appropriate drive unit. If the boat is going on cruises for several days, it is recommended to select a unit where Fr not exceeds 70% of listed max. thrust.

2. When the rudder torque is unknown.

First the helm torque must be found. The following measurements/calculations must be carried out:

At full speed ahead and the rudder hard over, find the maximum force F required to turn the helm by using a spring balance.

Measure the radius r of the helm. The helm torque is calculated from the formula:



$M_r = F \times r$ (kpm)

M_r = helm torque
F = helm force (kp)
r = helm radius (m)

To convert the helm torque to rudder torque the turn-over ratio must first be found:

$$I = \frac{360T}{2a}$$

i = turn-over ratio
T = numbers of turn (hard over-hard over)
a = one half of the rudder angle

Now we can find the rudder torque from the formula:

$M = M_r$ x i (kpm)

M = rudder torque
M_r = helm torque (kpm)
i = turn-over ratio

When the rudder torque is known, use the same procedure as for point 1 to find the rudder force F.

Example:

The helm force is measured to 6.5kp and the radius to 0.3m. Number of turns from hard over to hard over is 3 and the total rudder angle is 90 degrees.

Put into the formula: M_r = 6.5kp x 0.30m = **1.95kpm**

Turn-over ratio: $i = \frac{360x3}{2x45}$ = **12**

Rudder torque: M = 1.95kpm x 12 = **23.4kpm**

Length of rudder tiller $R = \frac{0{,}10}{\sin 45}$ = **0.14m**

(HLD2000L: $R = \frac{0{,}17}{\sin 45}$ = **0.24m**)

The length of rudder tiller should be reduced to 0.135m (0.23m), to avoid the HLD acting as an endstop for the rudder.

Rudder force $F_r = \frac{23{,}4kpm}{0{,}135m}$ = **173kp**

(HLD2000L: $F_r = \frac{23{,}4kpm}{0{,}23m}$ = **102kp**)

As 173kp (102kp) is less than 350kp the HLD350 MK2 can be installed.

TILLEGG

Beregning av kraften som virker på roret

1. Når rormomentet er kjent

Rormomentet kan i de fleste tilfeller opplyses av båtprodusenten.

For å finne kraften på roret i kp, må vi først vite hvor lang rorkulten er. Denne finnes ved hjelp av formelen:

$$R = \frac{l}{\sin a} \text{ (m)}$$

der R = rorkult

a = halve rorvinkelen

l = halve slaglengden (0.10m/0.17m)

Kraften F_r på roret finnes nå ved hjelp av formelen:

$$F_r = \frac{M}{R} \text{ (kp)}$$

der

F_r = kraften som virker på roret
M = rormoment (kpm)
R = rorkult (m)

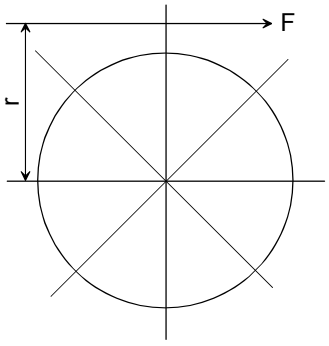
Bruk tabellen på side 10 for å finne den aktuelle drivenheten. Det anbefales at Fr ikke overstiger 70% av den oppgitte skyvkraft dersom båten skal seile kontinuerlig i flere døgn.

2. Når rormomentet er ukjent

Først må vi finne rattmomentet. Følgende målinger/beregninger utføres:

Fest en fjærvekt til rattet og mål den maksimale kraften F som skal til for å dreie rattet når båten går med full fart og med roret nesten i borde. Mål radien r på rattet. Rattmoment regnes ut etter formelen:

$M_r = F \times r$ (kpm)



M_r = rattmoment
F = kraft på rattet (kp)
r = radien på rattet (m)

For å regne om rattmoment til rormoment må først omsetningsforholdet finnes:

$$I = \frac{360T}{2a}$$

i = omsetningsforhold
T = antall rattørn (borde til borde)
a = halve rorvinkel

Nå finner vi rormomentet med formelen:

$M = M_r$ x i (kpm)

M = rormoment
M_r = rattmoment (kpm)
i = omsetningsforhold

Når rormomentet nå er kjent brukes samme fremgangsmåte som under punkt 1.

Eksempel:

Kraften F på rattet måles til 6.5kp og radien til 0.3m. Antall tørn fra borde til borde er 3 og rorvinkelen er totalt 90 grader.

Sett inn i formelen: M_r = 6.5kp x 0.30m = **1.95kpm**

Omsetningsforholdet er: $i = \frac{360x3}{2x45}$ = **12**

Rormoment: M = 1.95kpm x 12 = **23.4kpm**

Lengde av rorkult $R = \frac{0{,}10}{\sin 45}$ = **0.14m**

(HLD2000L: $R = \frac{0{,}17}{\sin 45}$ = **0.24m**)

Lengden av rorkult bør reduseres til 0,135 m (0,23 m) slik at HLD ikke virker som endestopp for roret.

Kraften på roret $F_r = \frac{23{,}4kpm}{0{,}135m}$ = **173kp**

(HLD2000L: $F_r = \frac{23{,}4kpm}{0{,}23m}$ = **102kp**)

Da 173kp (102kp) er mindre enn 350kp kan HLD350 MK2 installeres.

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Some importers represent only specific market segments according to the following codes:

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Coastal and Fishery market
Recreational:
Leisure market

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