

linear autopilot drive type LD100

Jefa 100 KgM autopilot linear drive unit type LD100

The Jefa linear drive is a strong and compact autopilot drive and much more efficient than existing hydraulic and electro-mechanical linear autopilot drive units (for the why and how, please see our [Q&A page](#)). With a thrust of 400 Kgs on 250 mm centers it's much stronger than a human being (the max. output torque of 100 KgM is equivalent to 100 Kg force on the end of a 1 meter steering tiller) and is build for 24 hours per day continuous operation with a total weight of only 6,6 Kgs. The combination of the flat wound (pancake) electric motor with the ultra efficient planetary gearbox results in an extremely efficient drive unit to keep the battery charging time to the minimum. The drive can be used on boats from 20 to 45 foot l.o.a. (or up to 100 KgM rudder torque) equipped with a mechanical steering system that can be back driven.

The linear drive drives the rudder via the existing tiller arm or quadrant or via an independent tiller arm.

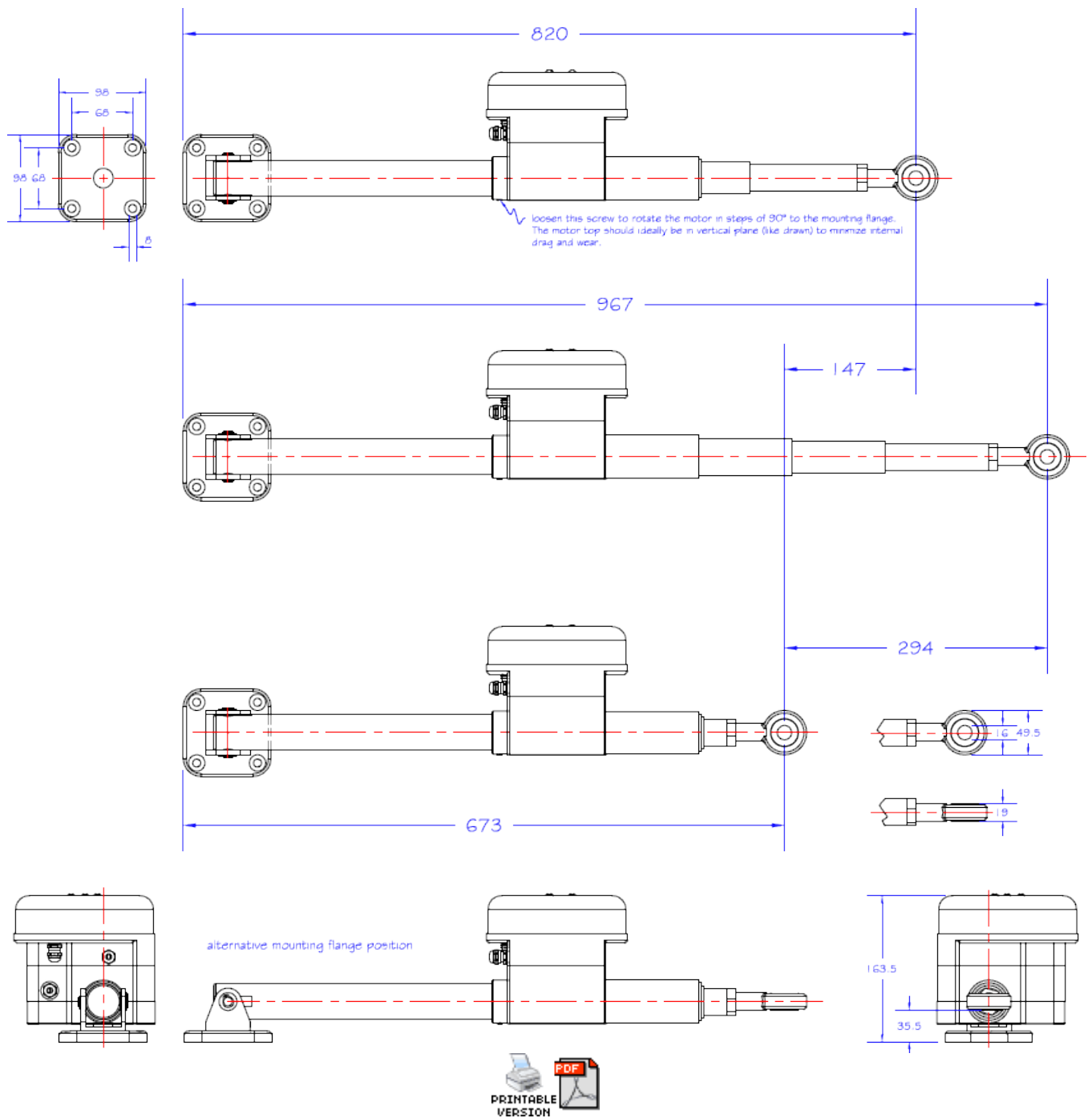


Please click on the picture for a larger view.

Due to the telescopic draglink, the overall dimensions are as small as possible. The below pictures show the two outer positions and the middle position. Please click on the pictures for a larger view.

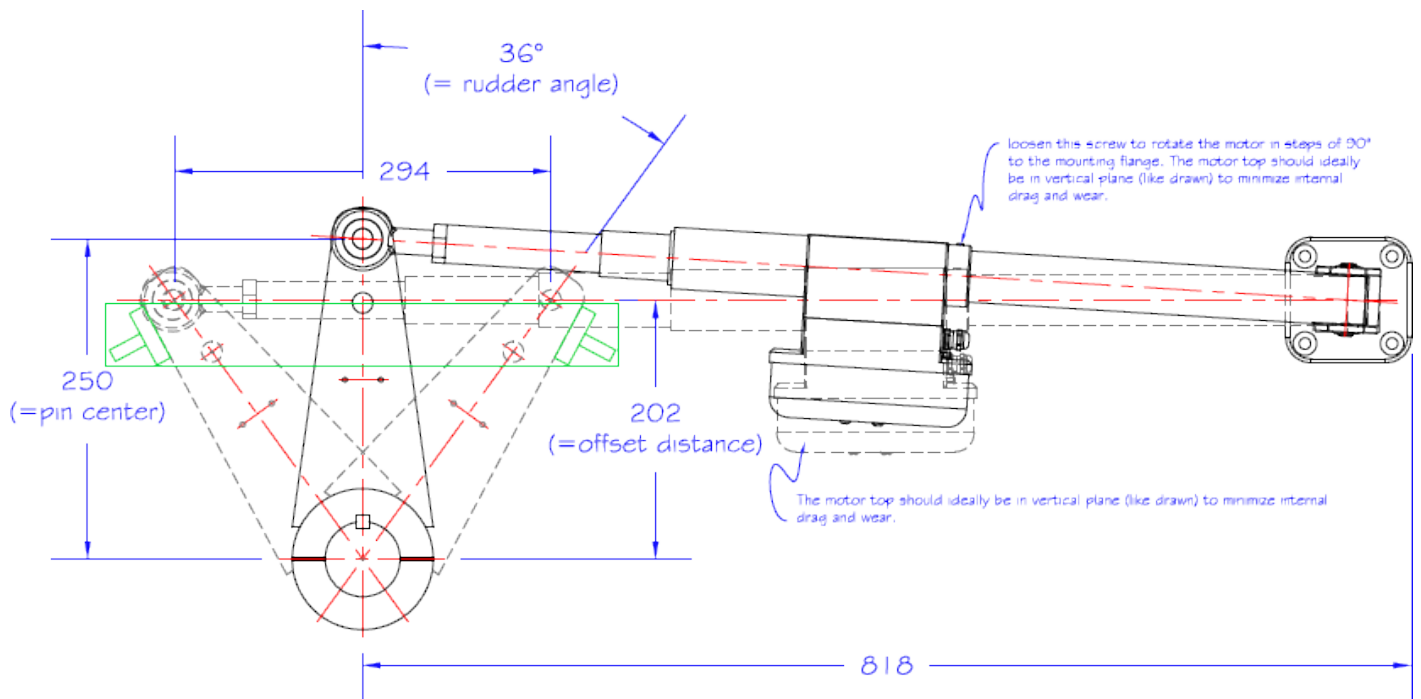


Main dimensions:



Please note that the drive can also be mounted upside down when the installation space requires this.

Correct mounting relative to the rudder stock:

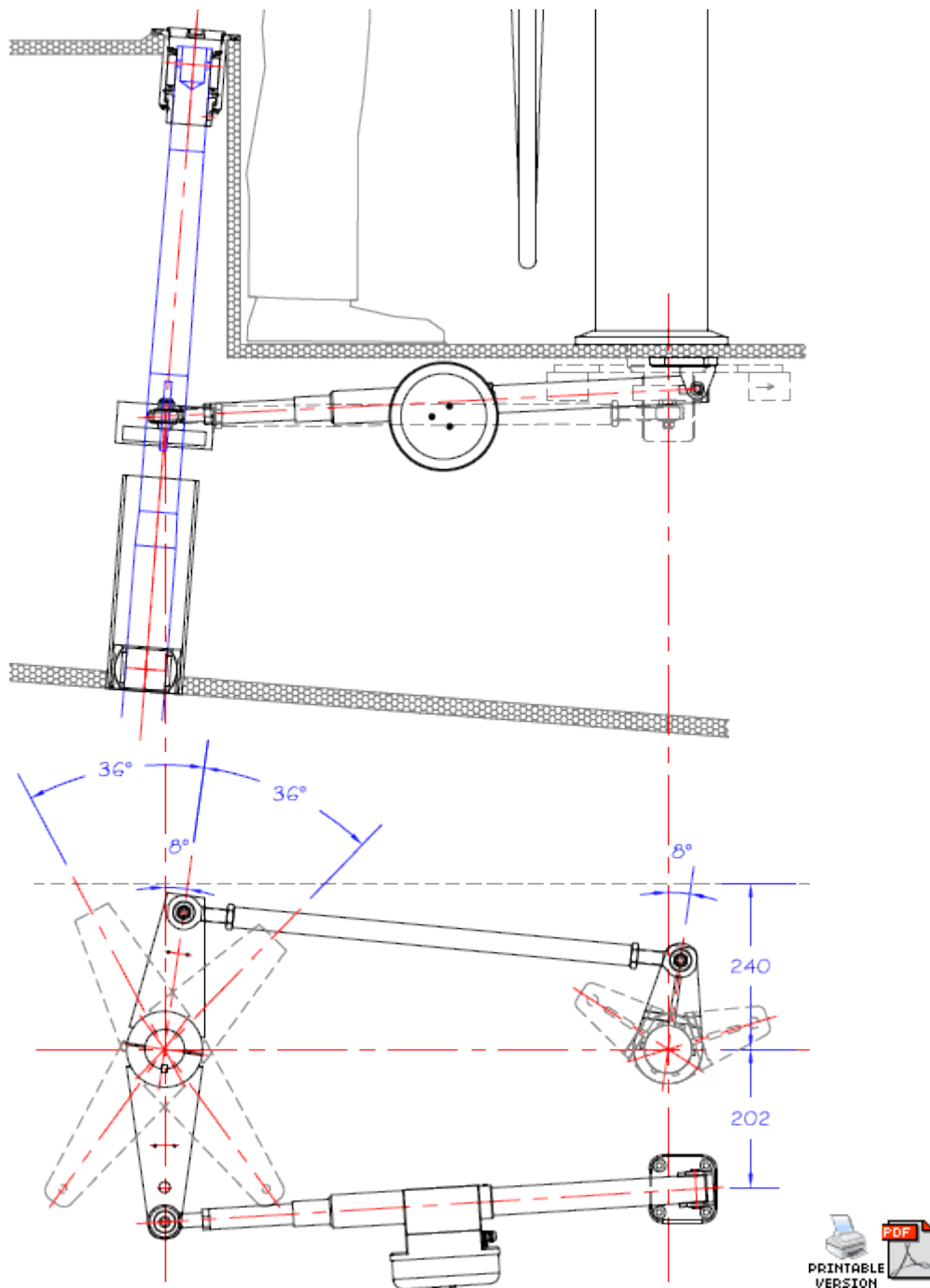


The above illustration shows the correct installation geometry of the linear drive. It's very important to check if correct rudder stops are fitted (shown in green) limiting the rudder travel to $2 \times 36^\circ$ (normal for wheel steered systems). The lack of correct rudder stops will cause the linear drive to act as travel limiter, resulting in damage to the internal gears. The linear drive has a maximum travel of 303 mm, so there is 4 mm of spare travel each side assuring a free run. It's advisable to mount the drive with the motor pointing sideways and not up or downwards (like in above illustration) as this position generates less friction and also less wear in time.

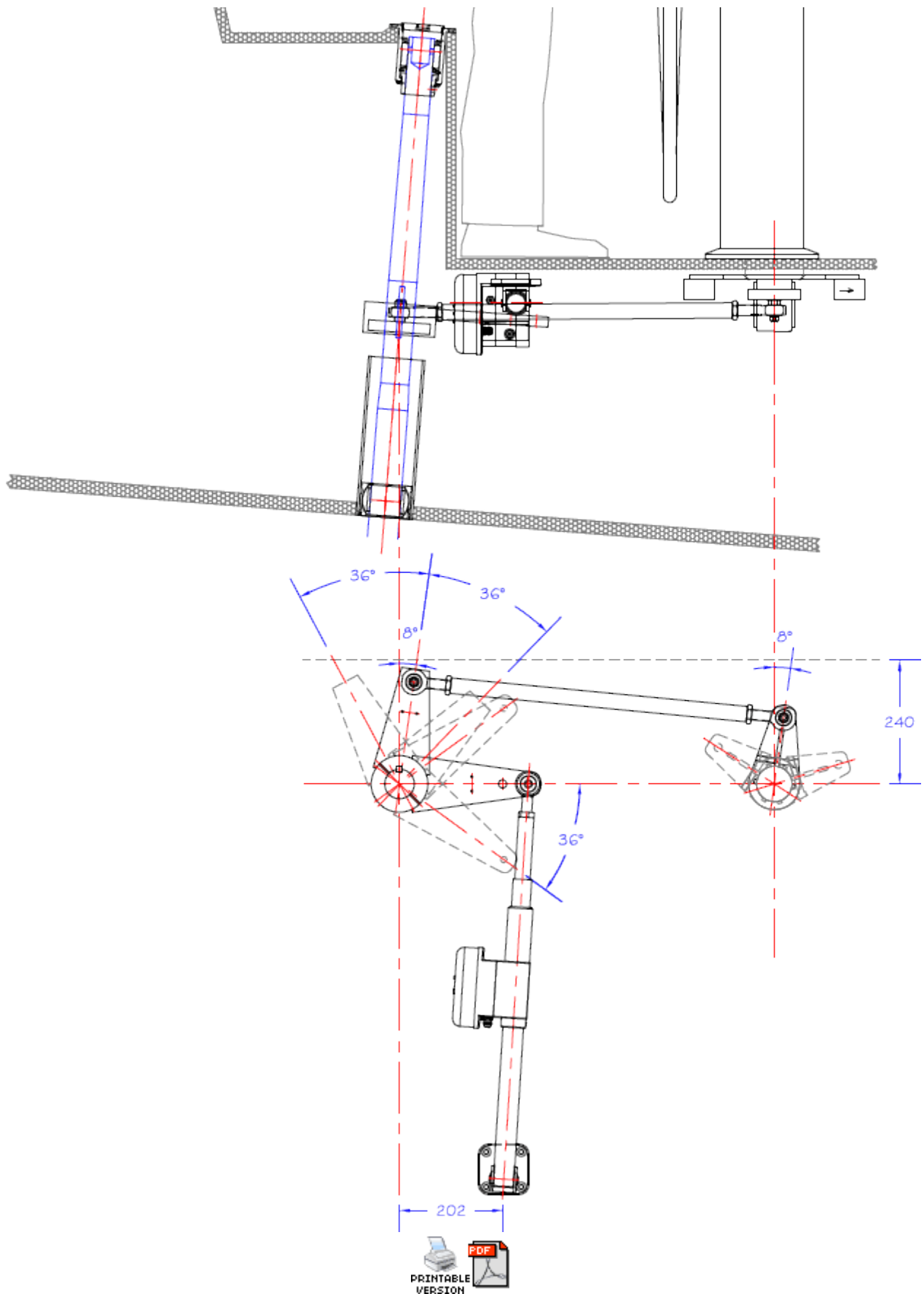
On most cable steered boats the rudder travel is $2 \times 40^\circ$ and on some tiller steered boats the rudder travel is even bigger. Please revert to the table at the right for the correct pin centres and offset distance in these cases. Please note that the maximum achievable rudder torque will be lower when shorter centres are used. For example: The maximum rudder torque for the 50° setup will be $192/250 \times 100 = 77 \text{ KgM}$ in stead of the 100 KgM with the 36° setup.

Some mounting possibilities:

rudder angle	pin centres	offset distance
36°	250	202
38°	239	188
40°	229	175
42°	220	163
44°	212	152
46°	204	142
48°	198	132
50°	192	125



The above illustration shows how a rack and pinion system can be combined with the linear drive on one tiller lever. This solution saves money and space.



The linear drive can point port or starboard, in front or aft of the rudderstock.

The construction:

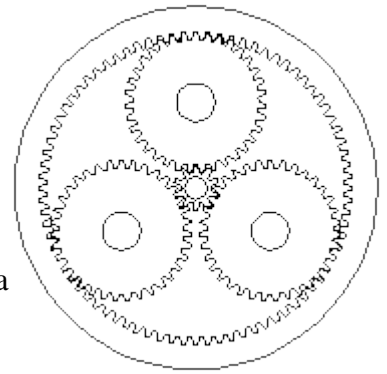
The above animation shows the setup of the linear drive. The drive can be separated in 4 main parts: The electric motor, the two step planetary gearbox, the electro-magnetic clutch and the final spur reduction gearbox. The Jefa linear drive has multiple advantages over existing integrated drive units. These advantages will be explained per section of the drive:

Electric Motor: The flat wound electric motor (pancake motor) used in the Jefa drive units is carefully selected for this application. Pancake motors have multiple advantages over normal electric DC motors:

- A large flat wound rotor to achieve a high starting torque and an immediate response to the autopilot speed control signal.
- A motor efficiency of 72,5% to achieve a minimal power consumption and maximal mechanical power output (compared to max. 50% efficiency of a normal DC motor).
- Compact main dimensions compared to achievable output.

Planetary gearbox: To achieve a correct rudder travel speed (hard over time) the electric motor has to be highly reduced in speed. Some autopilot drive producers use a worm reduction box, but the efficiency is extremely low as the gears rub each other. The Jefa linear uses a planetary gearbox which has following advantages:

- The highest possible efficiency compared to any other gearbox.
- All forces are equally spread over 3 gear teeth in stead of one allowing a much compacter and stronger solution.
- The forces and torques from the motor to the output shaft remain in the centre line of the drive unit, resulting in a higher efficiency and extremely reduces the loads on the housing and other internal parts.

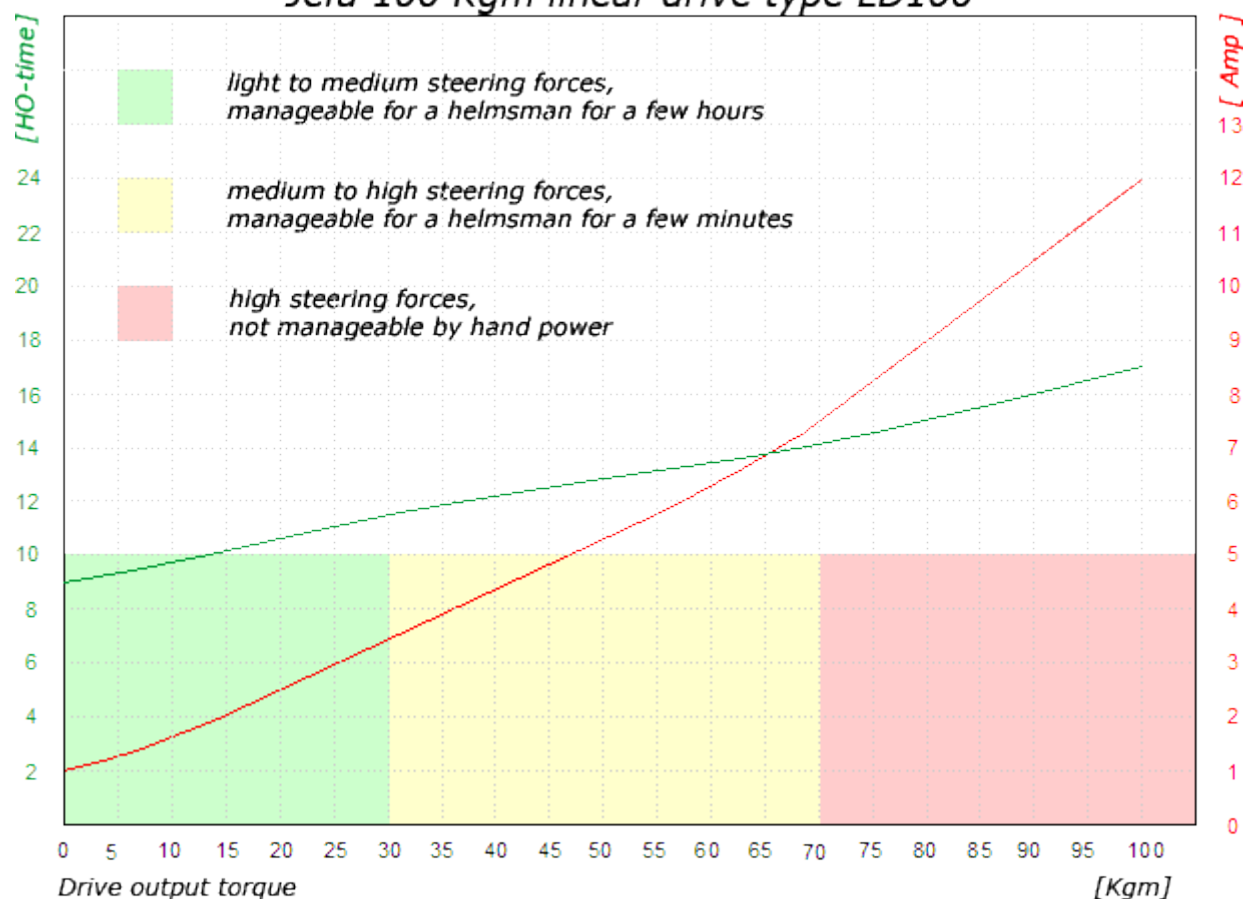


Electro magnetic clutch: On the moment the mechanical steering system on the yacht is manually operated, the autopilot drive has to be disconnected from the steering system. This is achieved with the electro-magnetic clutch and controlled automatically by the autopilot junction box. Jefa has developed a unique engagement clutch. The solution is based on a electrically operated spring loaded clutch pin that engage and disengage the outer gear ring of the planetary gear step. This solution has multiple advantages over the existing friction plate clutches:

- Less friction to back drive the unit.
- Lower power consumption (0.7 Amp. at 12 Volt). When the clutch isn't powered, it's disengaged and engaged when powered.
- The clutch doesn't wear in time.
- More compact than any friction clutch.
- When the autopilot is switched off, the helmsman isn't suddenly confronted with the full rudder torque, but has to put loading on the wheel to equalize the forces so the the clutch can disengage, making the manual take over much safer.

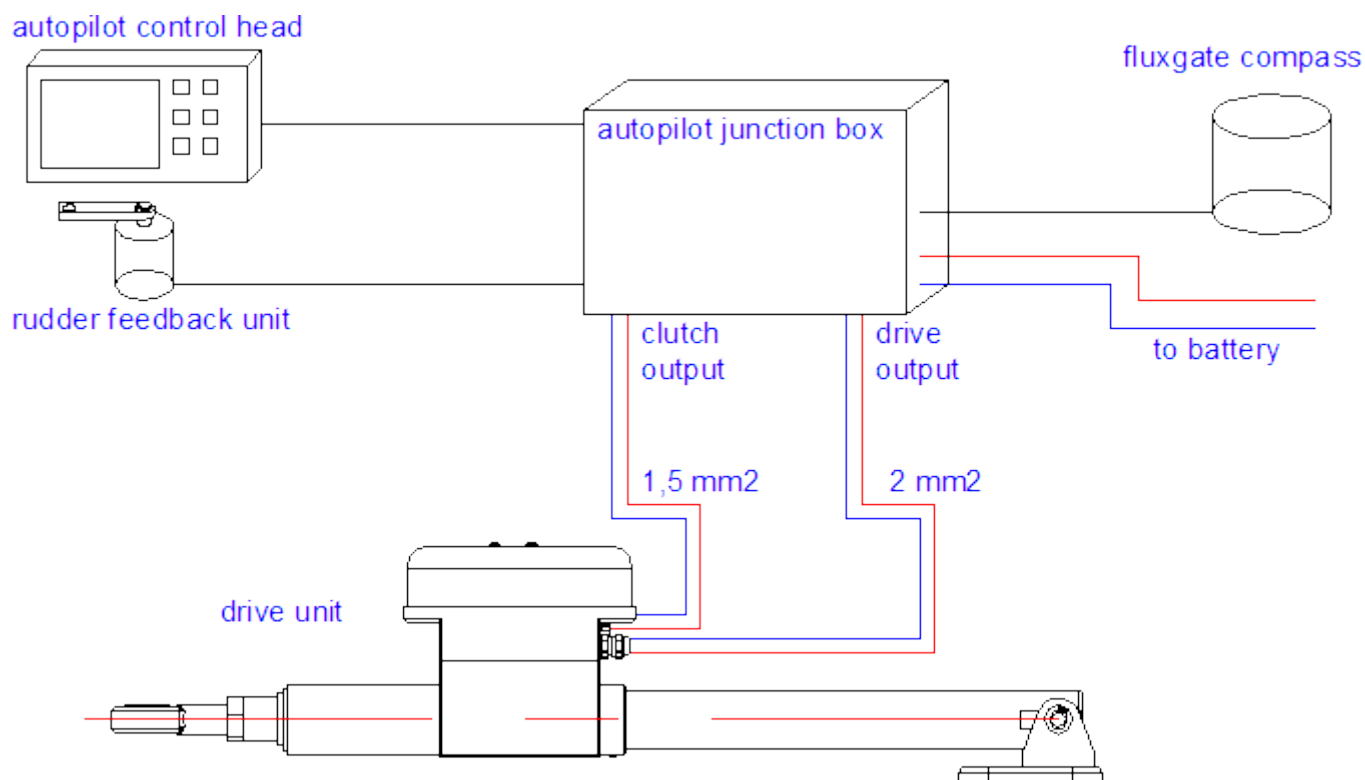
The performance:

Jefa 100 Kgm linear drive type LD100



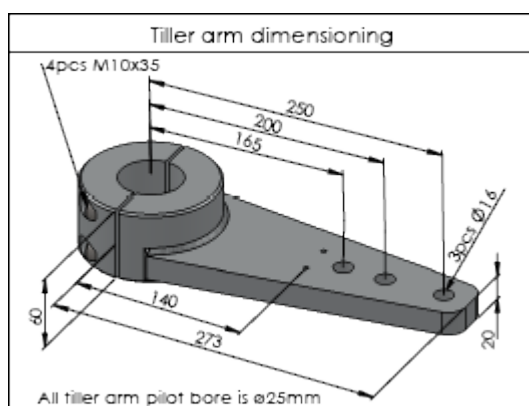
This performance table shows the relation between the consumed power and the output power and how quick this is done (hard over time). The red line shows the output torque against the needed amperage. The green line shows the hard over time (time to travel 72° of rudder travel) of the drive relative to the output torque. Also visible is the strength of the drive unit related to man power. The unit is much stronger than a human being and can last much longer but one should note that when the unit is operated in the red zone, something is wrong with the trim of the boats and the sails should be adjusted to achieve lower rudder torques. The above table shows that the Jefa linear drive will steer the yacht even in the worst possible conditions. As the drive will mostly operate in the left green zone and will not continuously rotate, the average power consumption on 12 volts is 1 to 2 amps.

Connections:



This illustration shows the minimal components for a working autopilot configuration. Jefa autopilot drives work together with all major autopilot electronics. The connection of the Jefa autopilot drive to the autopilot junction box is quite simple. The two 1.5 mm² red and black wires have to be connected to the plus and minus of the autopilot clutch line. This will make sure that when the autopilot user engages the autopilot on the control screen, the clutch will engage and allow the autopilot motor to drive the rudder. The two 2 mm² red and black wires have to be connected to the autopilot drive output connection. Now the Jefa autopilot drive is integrated into the system.

Tiller specification form



[Please click this](#) to open the tiller lever specification form in Adobe PDF. This is a great help to specify a tiller arm. Please send the form to us.

Compatibility in 12 Volts.

Following table shows the maximum rudder torques that can be generated by the Jefa linear drive in combination with various autopilot junction boxes.

Autopilot junction box 12 Volt version.	Max. output (Amp.)	Rudder torque (KgM)
Garmin GHP12 sailboat APS (*1)	40	100
Simrad AC12	12	100
Simrad AC42	30	100

Raymarine ACU-200 (*2)	15	100
Raymarine ACU-400 (*2)	30	100
NKE gyropilot 2 RVP (*3)	25	100
Furuno Navpilot	not advisable due to lack in speed control and dynamic braking see this page	
B&G H5000 Pilot (*4)	30	100
B&G Triton Pilot - Low Current	identical to Simrad AC12 - see above	

(*1) A special Garmin version of the direct drive is available under code number DU-LD-12/GA. The Garmin rudder feedback unit is integrated and special Garmin cables and plugs are wired to the drive unit.

(*2) An internal rudder feedback unit is available for this pilot which saves installation time and a separate fundament for the external rudder feedback is not required. See below pricelist for the surcharge.

(*3) Please read the special installation instructions for the clutch available on our FTP server via [this direct link](#).

(*4) From software release 1.1.84 onwards. Older H5000 pilots should be software upgraded. For a complete list of compatible B&G autopilots please [follow this link](#).

Pricing

Jefa linear drive unit type LD100		
Part No.	Description	Price in Euro
DU-LD-12	Linear drive 100 KgM - 400 Kg thrust, 12 volts	€ 1.606
DU-LD-12/GA	Linear drive 100 KgM, incl. Garmin rudder feedback and cables	€ 1.732
DU-LD-RFB1	LD integrated rudder feedback for Garmin and NKE autopilots (10 kΩ)	€ 74
DU-LD-RFB2	LD integrated rudder feedback for Raymarine autopilots (5 kΩ)	€ 74

The linear drive is delivered including a Ø16 mm tiller pin and in some cases you will need a [tiller arm](#).