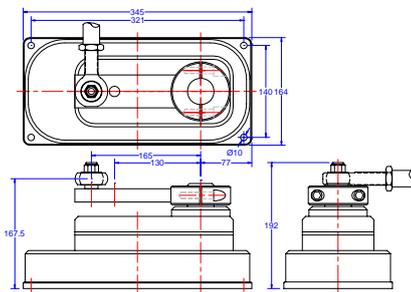


## Jefa 150 KgM direct autopilot drive type DD-1

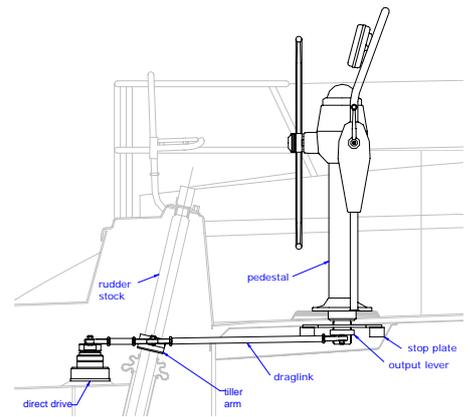
The Jefa direct drive type 1 is an extremely strong and compact autopilot drive and much more efficient than existing hydraulic and electro-mechanical autopilot drive units. It's much stronger than a human being (the max. output torque of 150 KgM is equivalent to 150 Kg force on the end of a 1 meter steering tiller) and is build for 24 hours per day continuous operation with a total weight of only 12 Kgs. The combination of the flat wound (pancake) electric motor with the ultra efficient planetary and spur 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 30 to 45 foot l.o.a. (or up to 150 Kgm rudder torque) equipped with a mechanical steering system that can be back driven. Due to the electro mechanical clutch, the direct drive can be back driven with the force of a finger tip leaving the mechanical steering as sensitive as without drive unit.



### Main dimensions:

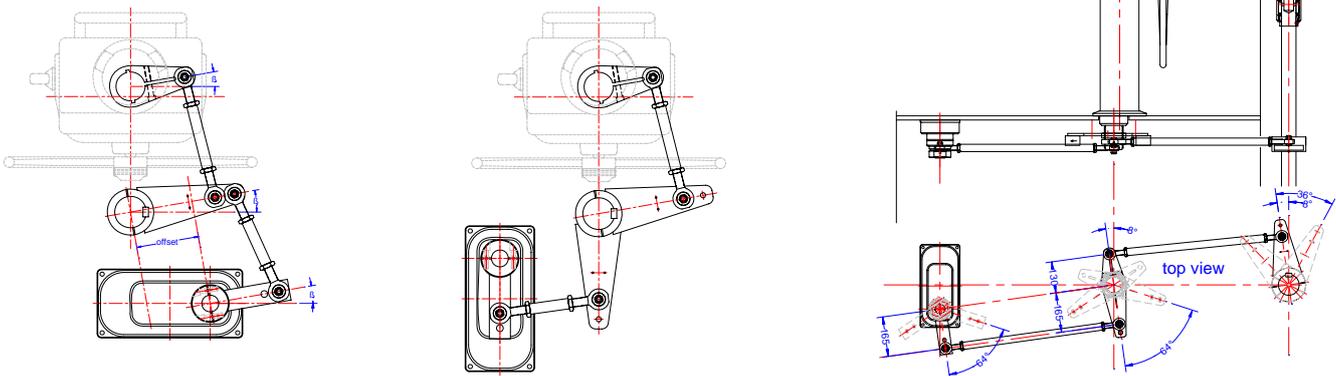


The Jefa 150 KgM direct drive type 1 is very compact with a length of 345 mm, a width of 164 mm and a height of 192 mm. As space is always a problem on sailing yachts, the direct drive unit can be mounted as close as 250 mm from the rudderstock even upside down.

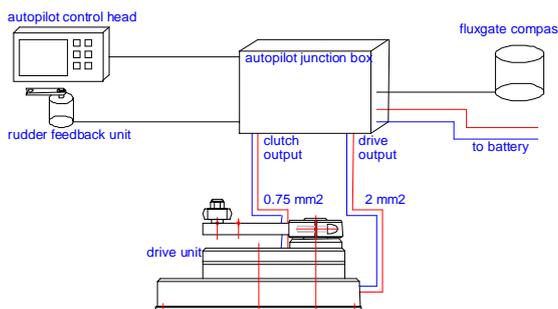


### Mounting variations:

The direct drive drives the rudder via a draglink and the existing tiller arm or quadrant or via an independent tiller arm. The drive can be mounted behind or next to the rudderstock, driving the rudder directly or in front of the pedestal driving the rudder via the pedestal.

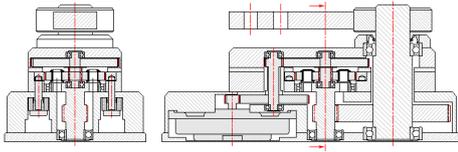


### Electrical connections:



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 0.75 mm<sup>2</sup> 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 steering system. The two 2 mm<sup>2</sup> red and black wires have to be connected to the autopilot drive output connection.

## The construction:



This assembly drawing shows a cross section of the direct drive type I. The drive can be separated in 5 main parts: The electric motor, the two step spur gearbox, the planetary gearbox, the electro-magnetic clutch and the final spur reduction gearbox. The Jefa direct drive has multiple advantages over existing integrated drive units. These advantages will be explained per section of the drive:

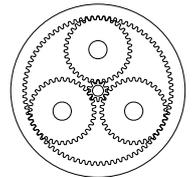
### Electric Motor:

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.
- Aluminium motor housing in stead of sheet steel plate to avoid corrosion.

### Planetary gearbox:

To achieve a correct rudder travel speed (hard over time) the electric motor has to be reduced in speed with a factor 750:1. Some autopilot drive producers use a worm reduction box, but the efficiency is extremely low as the gears rub each other. The Jefa direct drive type I uses a combination of a planetary gearbox and spur gear sets (one small gear and one big gear). The planetary gearbox has following advantages:



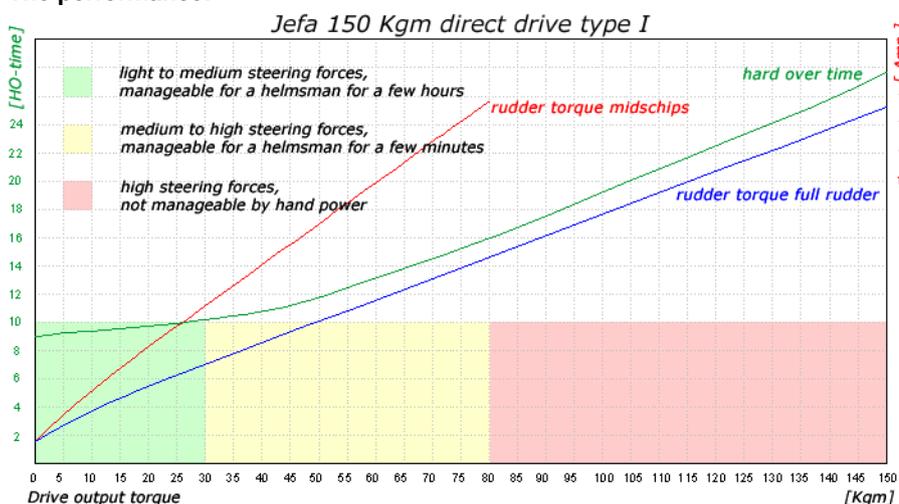
- The highest possible efficiency compared to any other gearbox.
- All forces are equally spread over 3 gear teeth in stead of one allowing a much compacter and stronger solution.
- The forces and torques from the motor to the output shaft remain in the centre line of the drive unit, resulting in a higher 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 and patented engagement clutch. The solution is based on two electrically operated spring loaded clutch pins 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 (1.2 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 equalise the forces so the clutch can disengage, making the manual take over much safer.

## The performance:



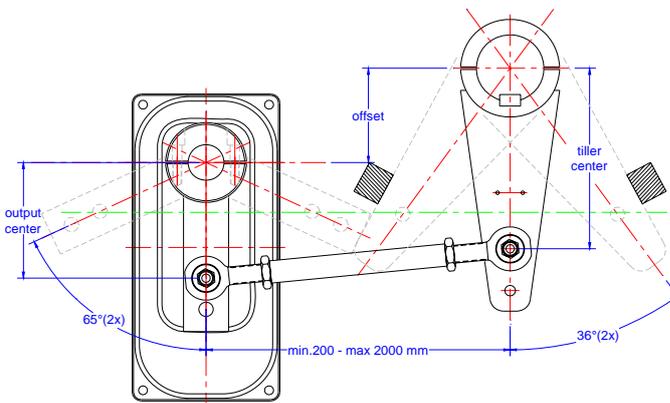
This performance table shows the relation between the consumed power and the output power. The red line shows the output torque against the needed amperage at midschips rudder and the blue line shows the output torque against the needed amperage at full rudder. The green line shows the hard over time (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 direct drive type I 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 2 amps.

**Mechanical installation:**

The direct drive uses "wide angle geometry". The result of this is 128° travel of the output lever and 72° travel of the tiller lever. To achieve an equal travel of the drive in port and starboard, the centre point of the output lever needs an offset to the rudderstock centre. The offset depends on the used lever centres. Following table shows the correct offset distances:

Operating centres in mm valid for 72° (2x36°) rudder travel.		
Output centre	Offset distance	Tiller centre
130	106	200
165	127	250



**Compatibility in 12 Volts:**

Following table shows the maximum rudder torques at midships and full rudder that can be generated by the Jefa 150 KgM direct drive type 1 in combination with various autopilot junction boxes. The hard over time (HO-time) states the time it takes the drive to travel the full 72 degrees of rudder travel when the speed control of the pilot is set to maximum speed.

Autopilot junction box 12 Volt version.	Max. output (Amp.)	Rudder torque midships (KgM)	Rudder torque full rudder (KgM)
Simrad AC10	10	60	115
Simrad AC20	20	80	150
Simrad AC40	overpowered, do not use		
B&G H1000 *2	25	80	150
B&G H2000 ACP-1	25	80	150
B&G H2000 ACP-2	overpowered, do not use		
Raymarine S1	15	80	150
Raymarine S2	20	80	150
Raymarine S3	overpowered, do not use		

\*2 Please use part number h1000-CUW specially made for Jefa drives, equipped with dynamic braking. Don't use the standard h1000.

Please feel free to contact your local distributor (see for an overview our website [www.jefa.com](http://www.jefa.com) section dealers) with any questions you may have. An extended installation guide of the Jefa direct drive type 1 is available for download from our website.



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