



TMS KD10-002	 KYSTDESIGN AS www.kystdesign.no
Operators Manual	File ref.: TMS KD10-002 Operators Manual <hr/> Date of issue: 02.05.2019

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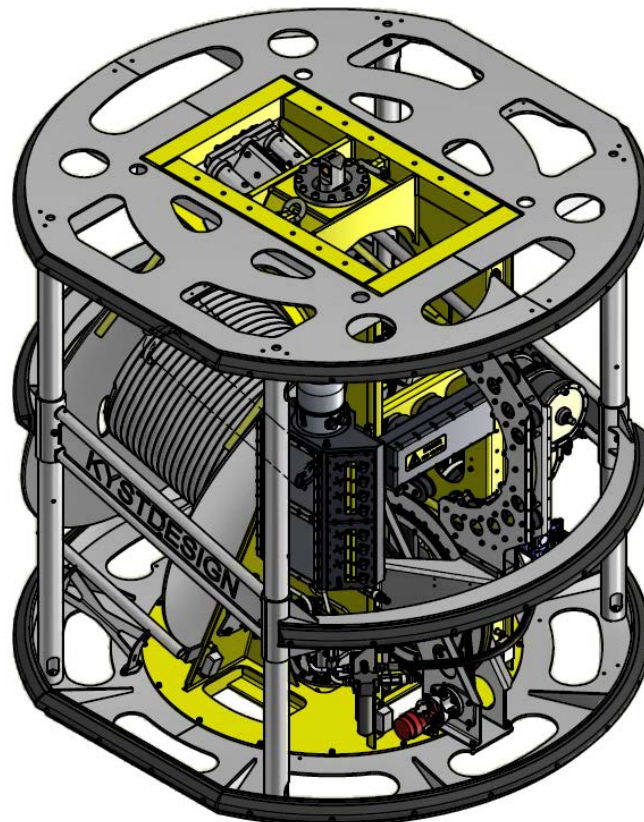
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1 Introduction

The KD10 TMS is an electro hydraulic Tether Management System (TMS) with tether capacity of 1000m Ø35mm tether. The TMS consists of the following main components:

1. Load bearing core frame in coated carbon steel
2. Latch for ROV interface
3. Tension Wheel
4. Load cell for tether force control
5. Spooling system
6. Drum with Lebus grooves
7. Protection Frame in coated aluminium including D-fenders
8. Lift point for LARS interface
9. Padeyes for Emergency Recovery
10. Hydraulic System
11. Control System including Junction Boxes
12. Slip Ring
13. Tether

The large diameter tension wheel together with tether force control and drum with Lebus grooves ensures gentle and reliable handling of the tether.

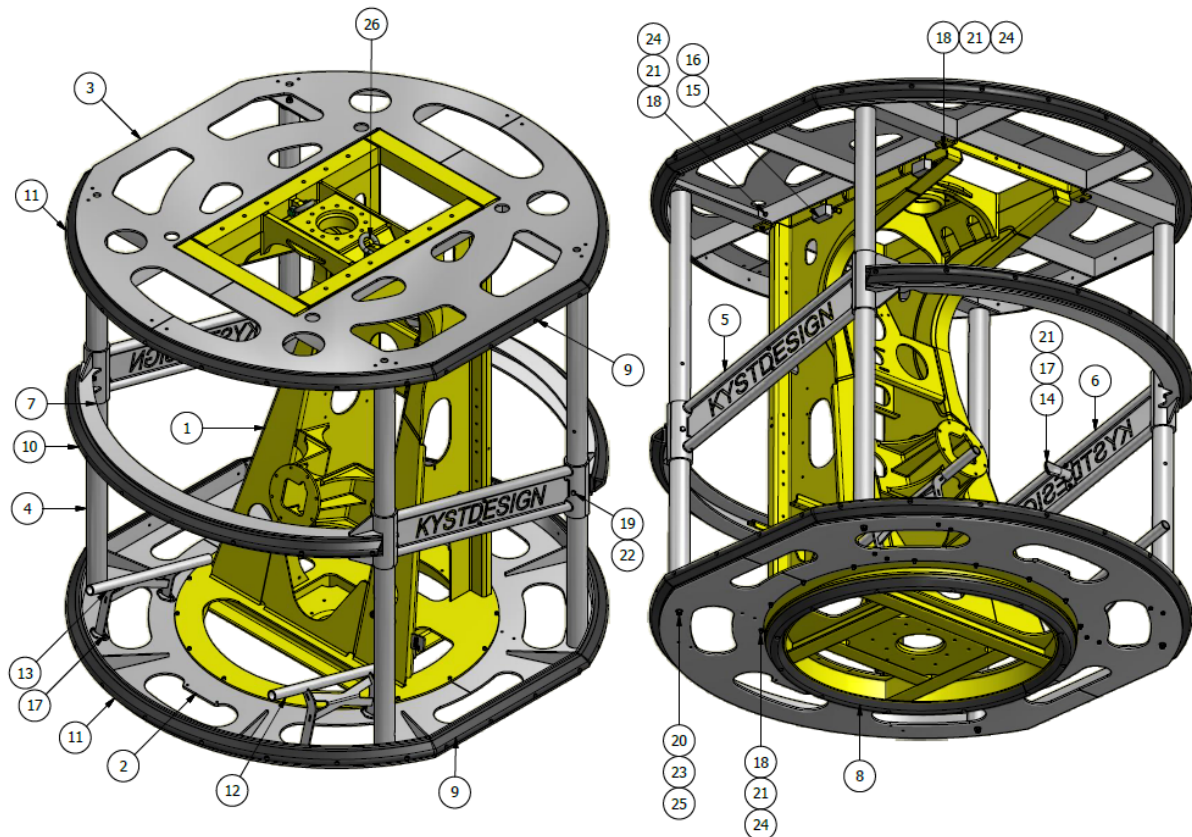


2 Technical Specification

Model code	KD-10
Drawing ref.	AF64-1001M03
Supplier	KYSTDESIGN AS
Max. Width	2590 mm
Min. Width	2380 mm
Height	2438 mm
Depth rating	3000 m
SWL lift point (LARS interface)	12000 kg
SWL latch (ROV interface)	10000 kg
Tether diameter	Ø 35 mm
Tether capacity	1000 m
Min. Tether Bending Diameter	900 mm
Weight in air including 1000m tether	3450kg
Weight submerged including 1000m tether	~1700kg
Hydraulic Fluid	Tellus S3M22
Power Supply	3kV/3ph/60Hz
Total Power	15 kW
Slip Ring	Focal 176-8091-04
Tether	RT566-TD-02E

3 Description of Mechanical System

3.1 Frame



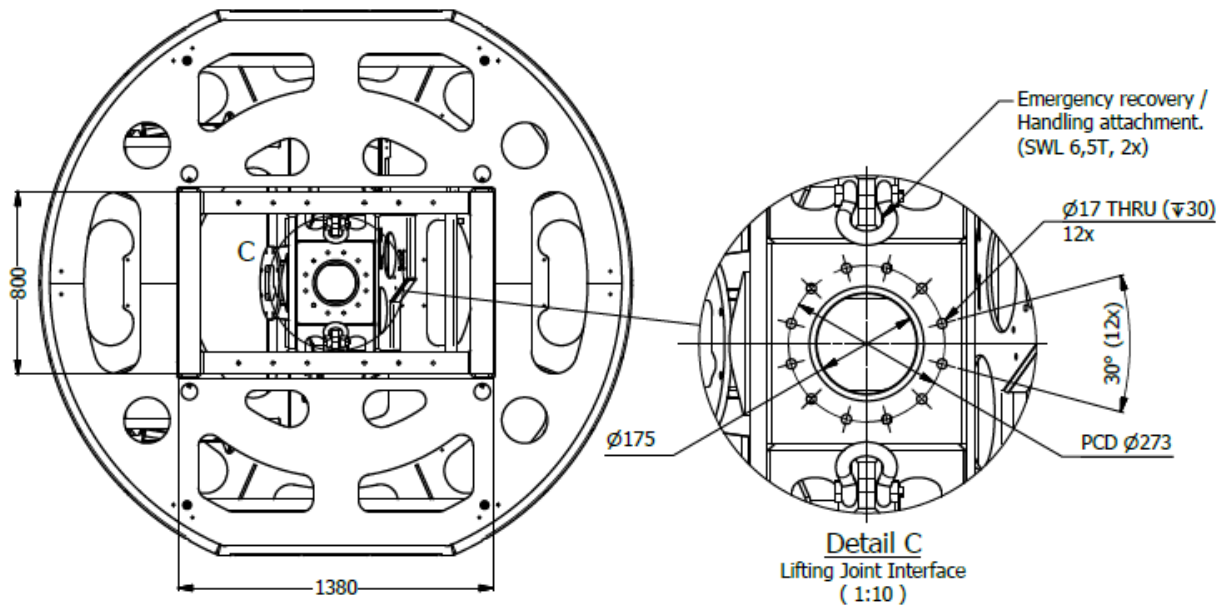
Drawing ref.: AF64-1010M01

The framework consists of the following main components:

1. A load bearing core frame (shown in yellow colour above) certified according to DnV standard for certification No.2.22, Lifting Appliances. This frame is made of carbon steel and painted according to NORSOK 501 system 7B with additional PUR top coat to achieve a wear resistant and shiny surface. The frame is equipped with 8off aluminium anodes for cathodic protection.
2. Protection structure (shown in grey colour above). This frame is made of powder coated aluminium. The horizontal mid sections is made for easy removal to ensure quick access to all components inside the TMS.
3. D-fenders (shown in black colour above) installed to absorb outer impacts and protect the framework from damage.

The framework is designed for lifting by means of three different lifting methods:

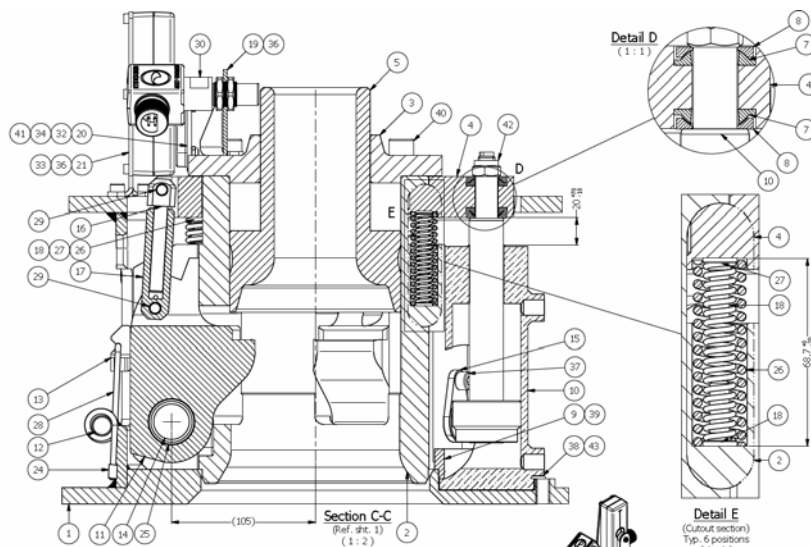
1. Lifting by a bullet connected to the PCD $\varnothing 273$ hole pattern. All holes to be used to achieve full SWL.
2. Lifting by 2x SWL 6,5T shackles. Both shackles to be used to achieve full SWL.
3. Lifting by the hole pattern 12x $\varnothing 18$ located in two lines with 700mm spacing. All holes to be used to achieve full SWL. This option is especially intended for interface with cursor based handling systems.



3.2 Latch

Drawing Ref.: AF64-1017M01

The Latch mechanism is a single-action failsafe click-in Lock with 3 off Latches (11), operated (lifting /tensioning and release) by means of 3 off hydraulic cylinders (10). The Latches (11) are positively self-locking due to pivot axis position and abut against the Latch Body (2) at the upper end, and could not be released under load (limited cylinder retraction force) nor in lifted/tensioned position (Latch (11) trapped inside the Housing (1))

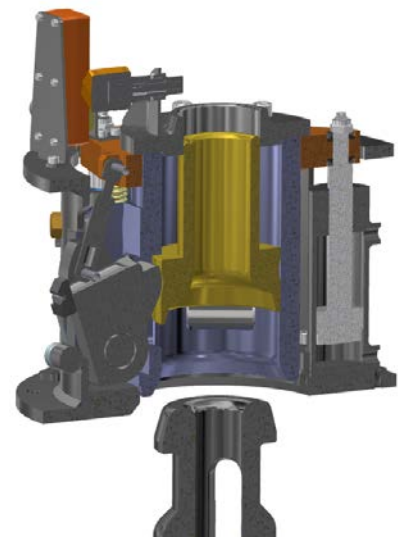



The Retainer Sleeve (5) is acting as a cable-guide, floating freely inside the Latch Body (2), activated only by gravity (approx. 5kg down) and the ROV Bullet (up). Under normal operation/ in a lower position, the Retainer Sleeve is holding the Latches (11) out/back in order to protect the cable from the Latches. In upper position, lifted by the ROV Bullet, the Retainer Sleeve is activating the "ROV Home" proximity switch.

The Latch Body (2) is landed and resting in the Housing (1) in its lower position, and is lifted by the Cylinders (10) via the Actuator Ring (4), Body-Top (3) and the bolted connection (32, 6 off M12), designed to carry the weight of the ROV (max 10T, cylinder $\varnothing 50 \times 3 \text{ea} \Rightarrow 11,7 \text{T}$ at 200 Bar). The Cylinders (10) are resting on the Housing (1) base flange, supported by the frame structure.

The Actuator Ring (4) is supported by springs (26+27, 6 off) against the Body (2), and will normally abut against the Body-Top (3) pulling out the Cylinder (10) Piston Rods approx. 20mm when the Cylinders (10) are deactivated /unpressured (open centre valve).

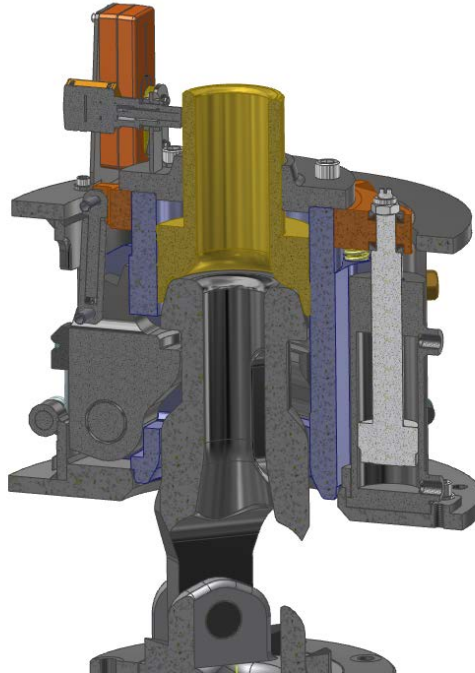
The Latches (11, 3 off) are forced inwards by means of Torsion Springs (28).



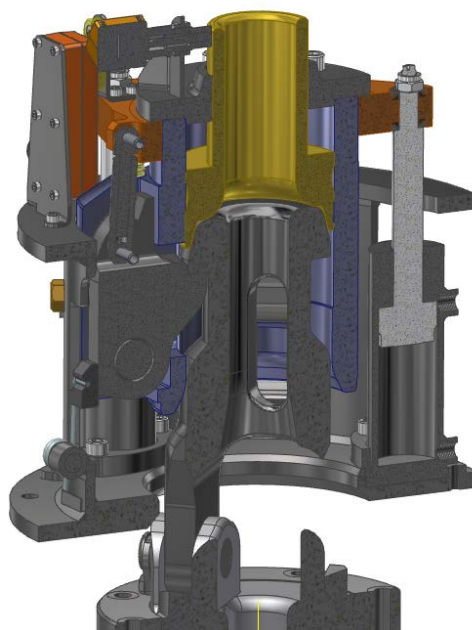
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ROV Bullet Approach:

With the Body (2) in the lower position and the ROV Bullet is approaching (upwards) pulled in by the cable, the Latches (11) will be pushed back by the Bullet when passing and returned by spring force, clicking into engagement under the head of the ROV Bullet.



With all Latches (11) fully engaged, the Body (2) could be lifted. Opposite, if one or more Latches are in a fully disengaged/outer position, the lifting will be prevented by an edge at the upper end of the Latch abutting against the upper edge of the Housing (1) slot. If the Latches are only partly engaged, the curved back of the Latch will slide against same edge and the Latch forced into full engagement during lifting.

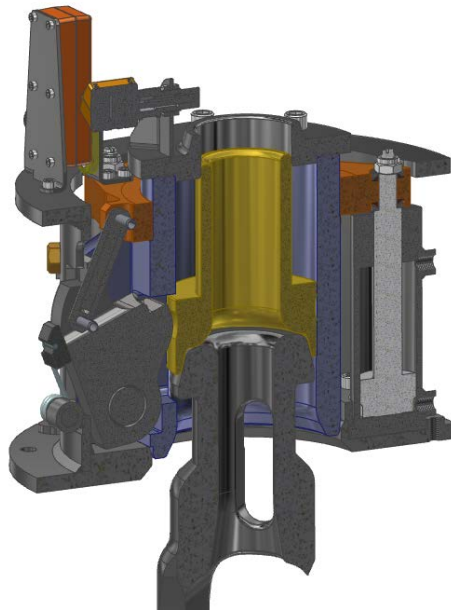


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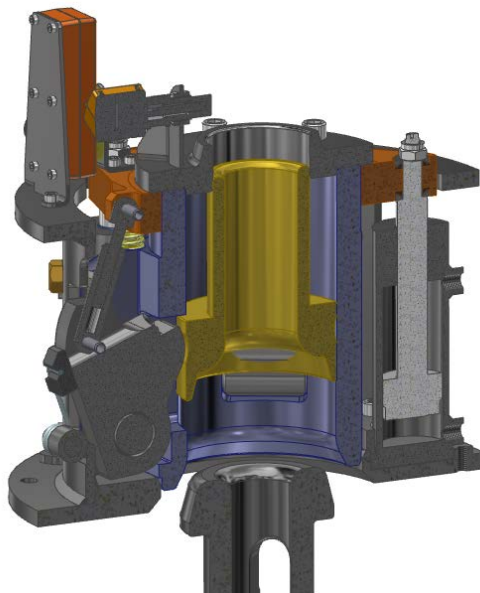
ROV Bullet Release:


Release of the Latch mechanism is activated by fully retracting the Cylinders (10), triggering the following action, provided the mechanism is unloaded;

- Pulling the Actuator Ring (4) downwards
- Lowering and allowing the Body (2) to land in the Housing (1)
- Compressing springs (26+27) eliminating spacing between Actuator Ring (4) and Body (2)
- Pushing down Release Rods (16+17) forcing the Latches (11) outwards, overcoming the Torsion Spring (28) force.

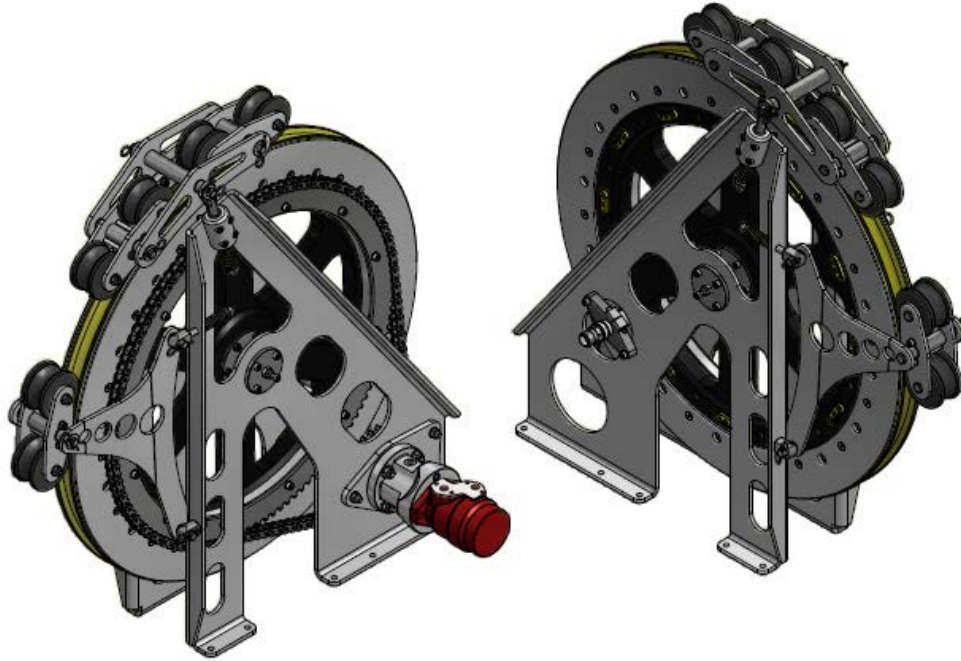


When the ROV Bullet is pulled out from the Locking Mechanism, the Retainer Sleeve (5) will fall down and prevent the Latches (11) from returning to «latched» position. When the Cylinders (10) are deactivated/depressurized, the Actuator Ring (4) will be lifted by the springs (26+27) and pull out the Cylinder Piston Rods approx. 20mm.



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3.3 Tension Wheel



Drawing Ref.: AF64-1015M01

The Tension Wheel function is to prevent slack tether between latch and drum, and to handle the tether gentle and safe in an area where impacts from the ROV can occur.

The Tension Wheel consists of a hydraulic powered cable wheel where a soft PUR cable groove combined with large diameter ensures good friction and gentle handling of the tether. Three spring loaded roller assemblies keeps the tether in place on the sheave.


The Tension Wheel contains magnets read by an encoder which makes it possible to count the tether length passing over the sheave.

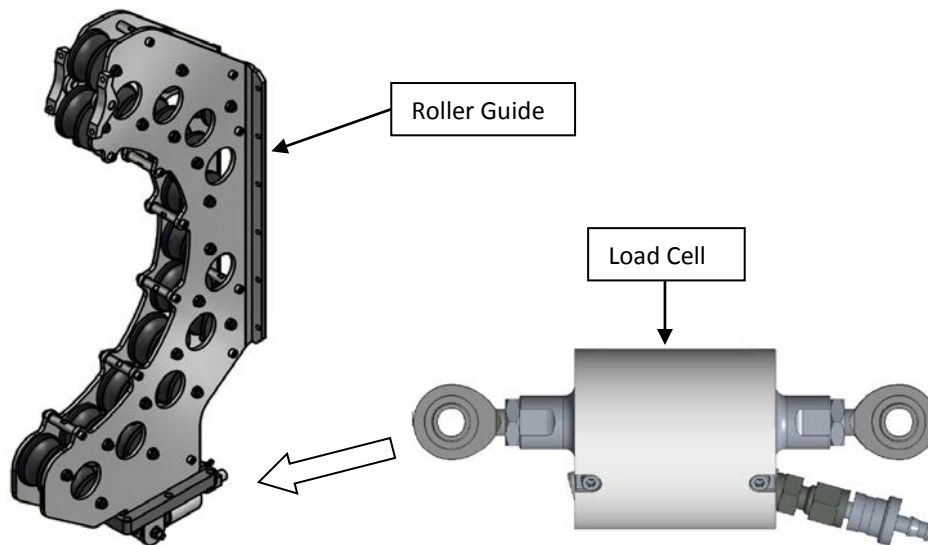
3.4 Roller Guide with Load Cell for Tether Force Control

Drawing Ref.: AF64-1016M01 & AF73-1000M01

The Roller Guide takes care of tether routing between tension sheave and the spooling system. The Roller Guide is hinged in top and in the bottom part there is a load cell for continuous monitoring of tension in the tether.

The Load Cell supplies tension data to the control system to achieve smooth and gentle handling of the tether.

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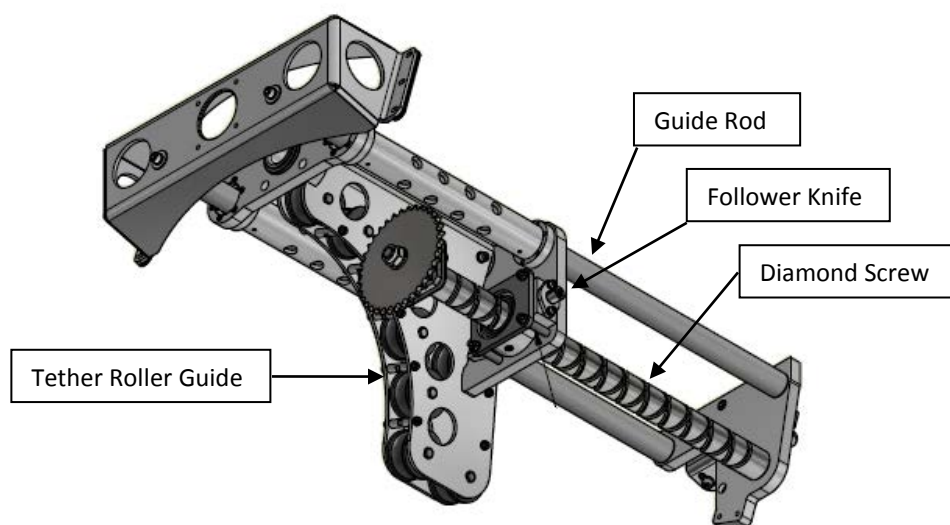



3.5 Spooling System

Drawing Ref.: AF64-1013M01 & AF64-1019M01

The Spooling System is based on a Diamond Screw driven through a chain transmission system by the drum hydraulic motor. The rotation ratio between the drum and the diamond screw is fixed, hence after proper calibration the spooling will be correct on all layers on the drum.

The Tether Roller Guide moves on two guide rods and is driven by the diamond screw through a Follower Knife.



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3.6 Drum with LeBus Grooves

Drawing Ref.: AF64-1012M01 & AF64-1019M01

The Drum is supported by a single bearing shaft and consists of a drum core with machined LeBus grooves for $\varnothing 35\text{mm}$ tether and bolted side walls.

The Drum has interface features for Slip Ring and Rotary Junction Box.

The Drum is driven by a hydraulic motor through a chain transmission system.

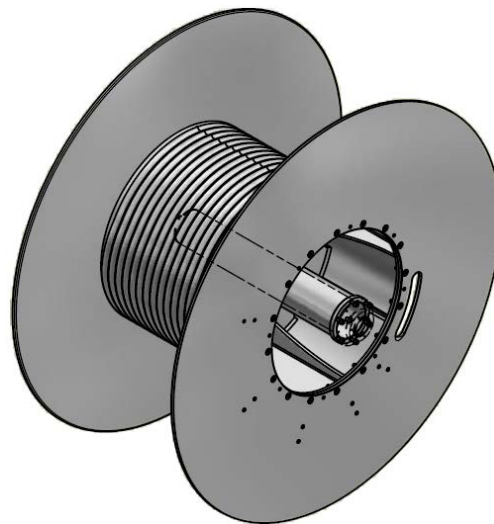
The Tether Capacity is as shown below:

Tether Capacity:

Tether OD35mm

@ 22 coils per layer / 13 layers

1. layer: 57,7m Accumulated 57,7m
2. layer: 61,9m Accumulated 119,6m
3. layer: 66,0m Accumulated 185,6m
4. layer: 70,2m Accumulated 255,8m
5. layer: 74,3m Accumulated 330,6m
6. layer: 78,5m Accumulated 409,1m
7. layer: 82,6m Accumulated 491,7m
8. layer: 86,8m Accumulated 578,5m
9. layer: 90,9m Accumulated 669,4m
10. layer: 95,1m Accumulated 764,5m
11. layer: 99,2m Accumulated 863,7m
12. layer: 103,4m Accumulated 967,1m
13. layer: 107,5m Accumulated 1074,1m

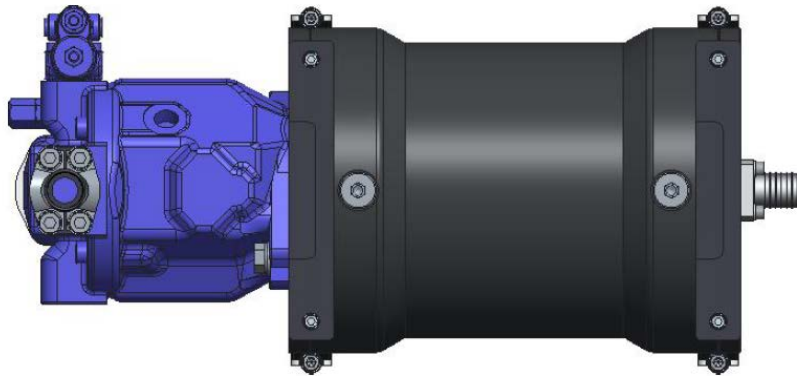


4 Description of Hydraulic System

4.1 Hydraulic Power Pack

Drawing Ref.: AF64-1030H01 & AF64-1030M02

The Hydraulic Power Pack consists of a 15kW electric motor and a hydraulic pump.



4.2 Pump Technical Data

Manufacturer	Bosch Rexroth
Model code	A10 VSO 28 DFR / 31 RPPA12N00
Hydraulic Fluid	Tellus S3M22
Design	Variable swash plate
Max pressures	Nominal 280Bar peak 350Bar
Type of operation	Pump in open circuit
Max displacement	28 cc/rev
Control device	Pressure / flow control (DFR)
Series	31
Direction of rotation	Clock wise (viewed on shaft end)
Seals	NBR
Shaft end	Ø22 with Parallel shaft key DIN6885, A6x6x32
Mounting Flange	Ø100 ISO 3019-2 (2 hole)
Pressure port B	SAE 3/4" 350bar (M10x1,5 – 17 deep)
Suction port S	SAE 1-1/4" 10bar (M10x1,5 – 17 deep)
Case drain port L	M18x1,5 – 12 deep
Control port X	M14x1,5 – 12deep
Weight in Air	16 Kg

4.3 Valve Pack

Drawing Ref.: AF64-1030H01 & AF64-1120M01

The hydraulic manifold is fitted with hydraulic valves and sensors for controlling and monitoring the latch system, tension wheel and drum.

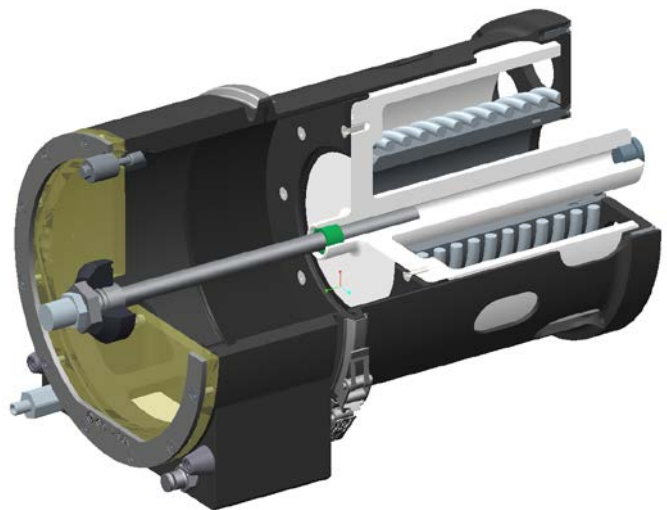
The Valve Pack also has space three additional valves for auxiliary equipment.


Manufacturer	Kystdesign AS	
Model code	AF64-1120	
Manufacturers Documentation	AF64-1030H01 AF64-1120M01 (General Assembly drawing) AF64-10-(serial no)-1000E01 (Wiring Diagram)	
Hydraulic Fluid	Tellus S3M22	
Relief valve setting	260-280 BAR	
Supply port P	¾" BSPP	
Return port T	¾" BSPP	
Latch OPEN	¼" BSPP	
Latch CLOSE	¼" BSPP	
Drum D-in	½" BSPP	
Drum D-out	½" BSPP	
Pump control port Pump Reg	1/8" BSPP	
Tensioner Tensioner	½" BSPP	
Sensor port Filter	¼" BSPP	
Comp Port Comp	¼" BSPP	
Service Ports A1-3 & B1-3	¼" BSPP	

4.4 Reservoirs

**Drawing Ref.: AF64-1030M04
AF64-1030M05**


The TMS is equipped with two 10L compensators, one manifold version acting as reservoir for the hydraulic circuit and one BSP version for compensation of the electrical system. The compensators compensates for variations in oil volume by a spring loaded piston which compresses a rolling diaphragm. Variations in oil volume are monitored by an analogue linear sensor.



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Manufacturer	Kystdesign AS
Model code	AF44
Manufacturers Documentation	AF44-1000M01 & AF44-2000M01
Hydraulic Fluid	Tellus S3M22
Volume	10L
Active Volume	9,43L
Pressure	0,25 – 0,35 Bar
Relief Valve	0,8 Bar
Weight	23,5 kg
Depth rate - Compensator	Full ocean depth
Depth rate – Linear Sensor	Project specific 3000 or 6000 msw
Linear Sensor	LT1949 up to 3000m depth. LF3181 for 3000-6000m depth

WARNING !	
<p>The compensator contains a compressed spring with the following spring force:</p> <p>Empty compensator (assembly / disassembly mode): ~1200 N</p> <p>Full compensator: ~2000 N</p> <p>Do NOT remove V-Clamp or Spring Retainer Plate before reading the opening instructions. To unfasten these items without controlling the spring force can result in serious injuries to personnel and equipment.</p>	

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5 Description of Control System

The TMS is run from topside control room using the same controls controlling the ROV. Pilot chairs joysticks and touch screen controls can be mapped to control TMS functions. See the operator manual volume 04, “Control Room and Software” for more details.

The TMS control system consist off topside TMS Mux, subsea TMS pod & cabinet, all controlled and monitored from the PXI using the same single serial line, mux channel T1. This enables to have TMS control combined with fibre diagnostics giving complete system control.

5.1 Topside TMS Multiplexer

Topside TMS mux is basically one “14 unit” euro rack box that fits into the KD-Con 4U fibre system. The unit contains a mother board with serial piggybacks and a fibre mux.

The fibre mux can handle 2x Pal / 3G-SDI video and 16 channels of serial, though only 6 channels are available for the TMS mux. Serial piggybacks can be RS232, RS485 or TTL. Std. setup only two piggybacks are fitted, one for the main link and one for the TMS el. Pan & Tilt.

The motherboard monitors the topside end of the fibre optics.

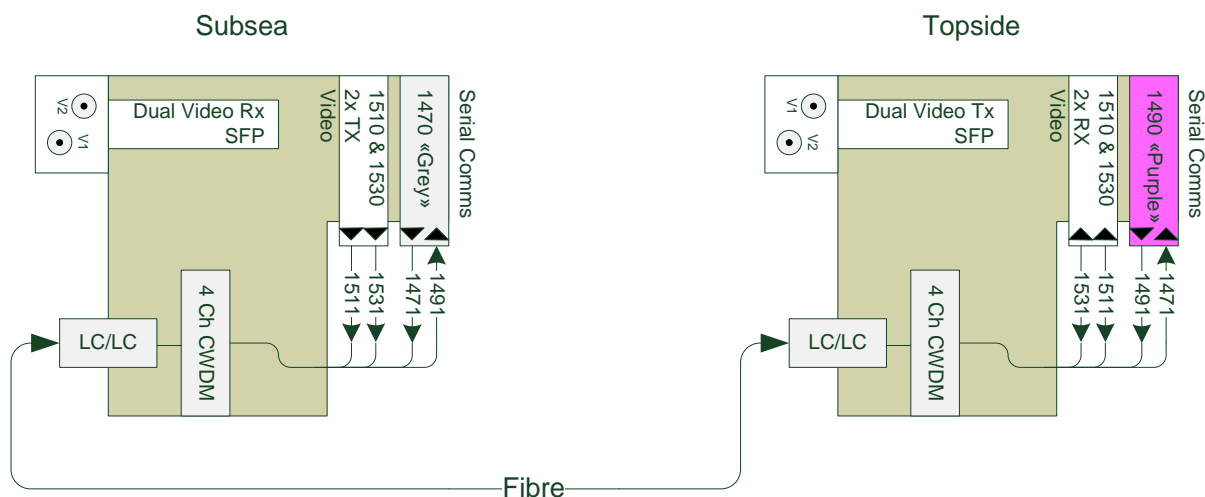


PLEASE NOTE !

Pay attention when assembling and disassembling piggybacks. Avoid damaging PCB tracks and connectors. The two multi pin connectors do have keying and locks that give a “click” when mated.

The TMS Mux has front LED diagnostic indicators. The power LED is lit when 12vdc power is present. There is also a red status LED which is not lit when status is ok, flashing slowly whenever there is a comms failure (surface link) and flashing fast whenever there is an internal card failure (signal short etc.). Use diagnostic software to examine any internal card failure further.

The fibre link is actually made up of 4 different colours paths running through 4Ch CWDMs. See pic. below.



One up and one down path are used by the serial mux. Two up paths are for video.

The topside mux has 3 front fibre LEDs, one for each colour up path. “V1” and “V2” are indicating status for video 1 and 2 fibre links. “C” gives comms (serial lines) fibre status.

The Video LEDs positioned underneath the fibre LEDs, indicates video being present subsea.


The serial lines have three status LEDs each. “P” indicates that there is a serial piggyback installed and being active. Note that for the serial channels 4-6, the “P” LEDs is mounted inside the box. Tx indicates that the port is locally transmitting out (up data) and Rx indicates that the port is locally receiving data (down data). Note that for the subsea mux this is opposite.

For the subsea mux Tx is down data and Rx up data. There must be piggybacks installed to make the corresponding LEDs active.

PLEASE NOTE !

The main link T1 LEDs will flash both on Rx and Tx even though there is no link to the TMS. This is because the PXI is polling fibre optic status from the Topside mux. The LEDs will flash more evenly when the subsea link is present.

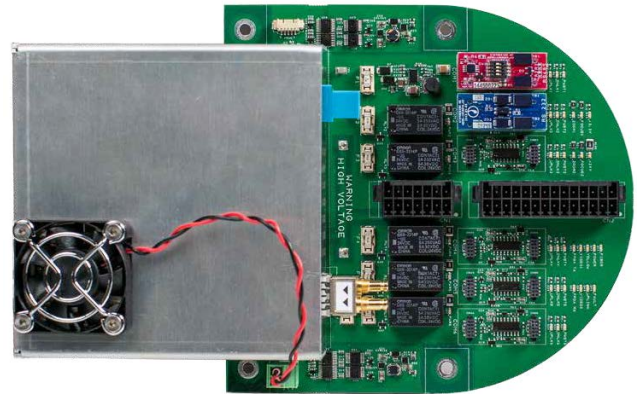
The Video LEDs indicate video being present subsea. Video may not be present topside due to video fibre link or SFP failure.

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5.2 TMS Control Pod

The topside TMS mux mating end is the subsea TMS Control board mounted inside the TMS control pod. The card has more or less the same building blocks as the topside mux box, but contains also power hold-up capacitors, relays and Focus & Zoom circuits to power and control TMS cameras and optional units like responders, depth sensors etc.

The TMS pod has max 4 connectors, std being one camera connector installed.



There is a fibre connector containing 4 fibres and a 13 lead penetrator linking the TMS control pod to the oil filled TMS cabinet.


PLEASE NOTE !

The serial mux metal container is connected to 0v (24vdc) and must be isolated from chassis GND.

WARNING !

The Hold-Up caps voltage mounted on the TMS Control board is ca 150vdc which can be fatal.

Hold-Up caps take time to discharge hence hi voltage will be present long time after power being turned off.

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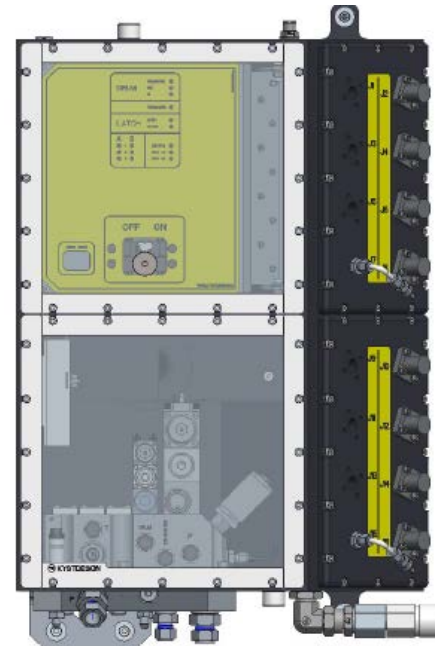
5.3 TMS cabinet

The TMS cabinet is an oil filled enclosure which contains the main 115vac subsea breaker, valves, hydraulic sensors, sensor and light connectors and pressure tolerant electronics.

The Breaker can be set using a handle mounted onto the front lid.

The electronics consist of a Driver Card mounted onto a TMS termination card, a Dual Light card and a 250w 24vdc power.

The Driver Card is controlled through the same serial line as the TMS pod and the topside mux. The Driver Card takes care of everything inside the control cabinet. It control the valves, the light card and read sensors like compensators volumes, pressure sensors, GFDs, temperatures, leaks etc.



5.3.1 Driver Card and TMS Termination Card

The Driver Card is stackable and a TMS terminal card is used to interface the sensors and valves to the driver card.

The Driver Card RS485 bus connection is galvanic isolated. In case of link failure all its outputs are switched off after 6 sec. (Dip setting).

The Driver Card contains 24 Pulse Width Modulated (PWM) outputs controlling proportional valves.

Totally 21 analog in (AI) and 3 digital in (DI) on each card can be SW configured for reading either 0-10vdc voltage signal or 0-20mA current signals. Each input has an individual solid state power relay supplying 24vdc sensor power.




PLEASE NOTE !

The driver card cannot galvanically isolate the sensor power and signal. Hence, a sensor GFD cannot be locally isolated.

The card does also have 4x PT100 inputs to read temperature signals.

The driver card and termination card has status LEDs. A steady blue main status led indicates that there is comms. A slowly flashing blue led indicates comms failure.

See the Driver Card datasheet for more driver card details.

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The TMS Termination Card has built in 115vac and 24vdc ground fault detection (GFD). It measures the 115vac level and current consumption.

PLEASE NOTE !
<p>Pay attention when assembling and disassembling a driver card stack. Avoid damaging PCB tracks and connectors. The two multi pin connectors do have keying and locks that give a “click” when mated.</p> <p>Use the read 115vac level to verify 3000vac transformer setup. TMS 115vac should be approx. 115vac.</p>

5.3.2 Dual Light Card

The Dual Light Card can operate 2 light outputs. Each output is dimmable and can supply up to 600w power each. Please note that only a 900VA TMS transformer is installed. Larger transformer is available upon request.

The light card outputs are overload and short circuit protected. If the protection circuit is triggered, a “Breaker Tripped” signal is engaged.

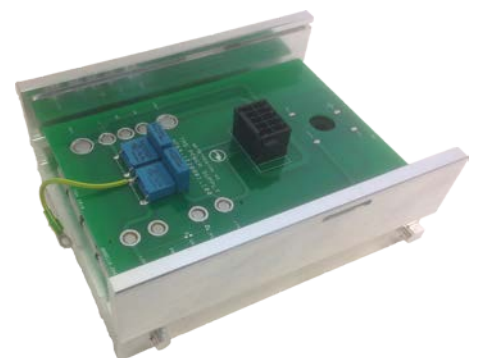
The tripped outputs are reset by simply turning the light output off and on again.

It is the Driver Card that controls and monitors the light card. Two driver card PWM signals set the light dimmer levels and one digital input reads the combined breaker tripped signal.




5.3.3 TMS 24vdc Power Supply

The TMS contain one single 24vdc power supply that supplies power to all electronics installed subsea. The pressure tolerant power supply is mounted inside the oil filled cabinet. It rectifies and smooth the 115vac input generating approx. 150vdc. The smoothing capacitors which are not pressure tolerant are installed inside the TMS control pod. The power supply has a 150vdc/24vdc DC/DC generating 250w 24vdc power.



WARNING !
<p>The Hold-Up caps voltage mounted on the TMS Control board is ca 150vdc which can be fatal.</p> <p>Hold-Up caps take time to discharge hence hi voltage will be present long time after power being turned off.</p>

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6 Operation of TMS

6.1 General

The system is powered by a single hydraulic pump run by a 3000v 3-phase electric motor. The control system is powered by a single phase 3000v / 115vac transformer.

The TMS main controllable parts are the drum that has flow, pressure/release control, the tensioner wheel with press control only and the latch which has a combined latch and stabilizer function.

System hydraulic pressure is set either by the tensioner or the drum pressure, which ever being the highest one + idle pressure. Hence, the system pressure is varying depending upon functions being run. This enables the system to run on a low pressure most of the time and just enough pressure for the different modes of operation.

The control system monitors and controls the pressure, flows and tension for the above functions to make the functions as smooth and controllable as possible.

Always use the TMS video camera to verify TMS operation.

6.2 Latching and Unlatching

The TMS latch is a combined latch and ROV stabilizer. See “Latch” section above where the latch is described in details.

The latch has a single hydraulic cylinder function that change role depending upon its vertical position.

Fully extended in the upper vertical position the latch is “parked” where the latches are physically locked and the ROV is stabilized against the TMS frame. The Latch body is lifted inside a “locking tube” retaining the latches. Check valves keeps the latch in its parked position. A “Latch Open” command will release the ROV stabilizer function and move the Latch Body down to its resting position.

At approx 20% Latch position the latch is “Ready” meaning that if empty it’s ready to dock. In this position the Latch Body has landed and resting in its lower position. The hydraulic function changes its function and no hanging load is transferred onto the cylinders. i.e. Any further cylinder retraction is purely done by hydraulic pressure. This pressure is set so that no hanging load can be dropped.

At ca 0% position the latch is “open” and the bullet can be released.

If the “Home” indicator is lit during operation without having the bullet latched, it can either be faulty sensor or the sleeve being out. Try opening the latch and pay out tether. Stop and regain “Ready” by turning off the “Latch Open” command and wait.

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6.2.1 Latching and Unlatching ON DECK

Latching Procedure (empty latch):

1. Turn off any latch valve open command and wait until the latch is in its “ready” position (spring loaded cylinders).
2. Position ROV under TMS so that the ROV Bullet with the best possible accuracy is aligned with the centerline of the TMS latch.
3. Lower TMS carefully while the ROV Bullet engages the TMS latch. Continue to lower TMS until TMS bumper is touching the ROV top (this to be sure that all three latches have engaged). When the bullet enters the latch, it pushes the internal latch sleeve upwards generating a “Latch Home” signal. The spring loaded latches move inwards generating a “Latch In” signal and locks the bullet.
4. Lift ROV a few cm to transfer load of ROV to the TMS latch.
5. Activate “Latch Up” and observe that the latch position increases and the ROV is stabilized against the TMS
6. Ensure that the latch enters “Parked” position to be sure that the latch is fully locked.

If the latch does not enter the “parked” position the latches may not be fully locked. If any of the three latches has not moved inwards they will block any further vertical movement. Release latch and try again.

Unlatching Procedure:

1. Lower cursor with ROV/TMS against deck. Stop lowering while ROV is in contact with the deck and the cursor load cell starts to show load reduction.
2. Engage “Latch Open” command to retract the latch.
3. Continue to lower cursor until the “Latch In” indicator is not lit and the latch position is “open”.
4. The “Latch Home” indicator goes off indicating that the Latch Sleeve has moved down. The sleeve keeps the latches in their outer position and protects the cable against the latches.
5. The cursor with TMS can now be lifted off the ROV.
6. Turn off any latch commands to make the latch ready for docking. The Sleeve is now held in lower position by the latch springs.(If any latch command is active, it will be switched off automatically after 5 minutes).

6.2.2 Latching and Unlatching IN SEA

Latching Procedure (empty latch):

1. Turn off any latch valve open command and wait until the latch is in its “ready” position (spring loaded cylinders).
2. Pay In tether while keeping the tether tight and straight underneath the TMS by manoeuvring the ROV.
3. When the bullet enters the latch it pushes the internal latch sleeve upwards generating a “Latch Home” signal. The spring loaded latches move inwards generating a “Latch In” signal and locks the bullet.
4. Check that the ROV is locked by thrusting down.
5. Activate “Latch Up” and observe that the latch position increases and the ROV is stabilized against the TMS
6. The latch enters “Parked” position and the latch is fully locked.

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If the latch does not enter the “parked” position the latches may not be fully locked. If any of the three latches has not moved inwards they will block any further vertical movement. Release latch and try again.

Unlatching Procedure:

1. Remove any hanging load by thrusting upwards against the TMS
2. Engage “Latch Open” command to retract the latch.
3. When the “Latch In” indicator is not lit and the latch position is “open” pull the bullet out by thrusting down.
4. The “Latch Home” indicator goes off indicating that the Latch Sleeve has moved down. The sleeve keeps the latches in their outer position and protects the cable against the latches.
5. Pay out tether.
6. Turn off any latch commands to make the latch ready for docking. The Sleeve is now held in lower position by the latch springs. (If any latch command is active, it will be switched off automatically after 5 minutes).

6.3 Paying Tether In and Out

The tensioner can only pull out cable and is run by pressure only. The drum can pay in and out and its flow & pressure combined release function can be set by the control system.

The tether load is measured by a load cell and combined with the drum and tensioner hydraulic functions, the TMS adapts to the current mode of operation.

PLEASE NOTE !
The release system adapts to cable left on drum. Hence, for correct operation it is important have a calibrated and functioning tether counter and total amount of cable installed on the TMS set in the system settings. Whenever new tether cable is installed or removed, adjust system settings accordingly.

See “Tensioner Wheel” and “Drum” section above where these units are described in details.

Idle (No pay in or out):


The system set the drum pressure to a safe release value depending up on cable left on drum. The tensioner pressure is just enough to keep the tether tight. The load cell is only monitoring system tension, is not part of system control.

Pay Out:

The tension is increased. The drum hydraulics is ramped to slowly start paying out cable. The load cell is only monitoring system tension, is not part of system control.

Pay In:

The tensioner is more or less disabled since the drum pulls the tether. The drum hydraulics is ramped to slowly start paying in cable. The load cell is now continuously monitoring system tension and used as an input for system control. If the load is above a pre-set value, the pay in function will go into a release state. The drum pressure will drop to a safe value and slowly start ramping up again whenever the load is below the release trig value again.

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7 Operation of Mechanical Sub-systems

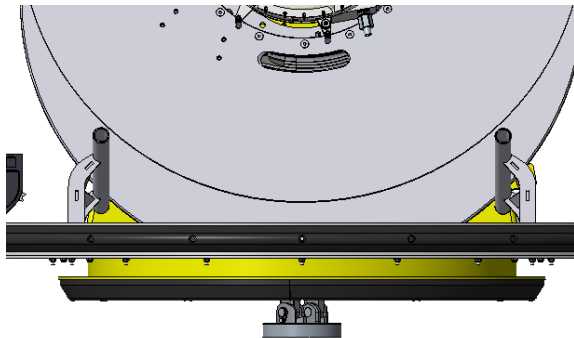
7.1 Adjustment of Spooling System

When installing a new tether on the drum, position the **tether exit hole** on the drum flange at its lowest position. Also position the **spooling mechanism** in its outer position.

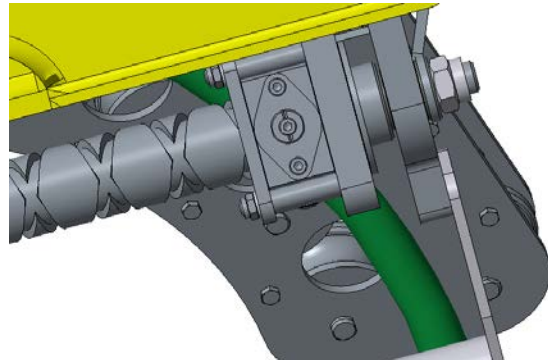
If the transmission chains between drum and spooling system is broken or has to be replaced, it is of outmost importance to ensure correct position of the spooling system when the chains are reinstalled.

Before any chains are removed, position of all actual sprockets should be marked to be able to keep them in same position during installation of new chains.


If a chain is broken it might be difficult to predict how the sprockets was positioned according to each other. In cases like this it might be necessary to pull out tether until it change direction for a new layer on the drum. Then the spooling system can be set to the same end position and the chains can be installed.



Tether exit hole in its lowest position

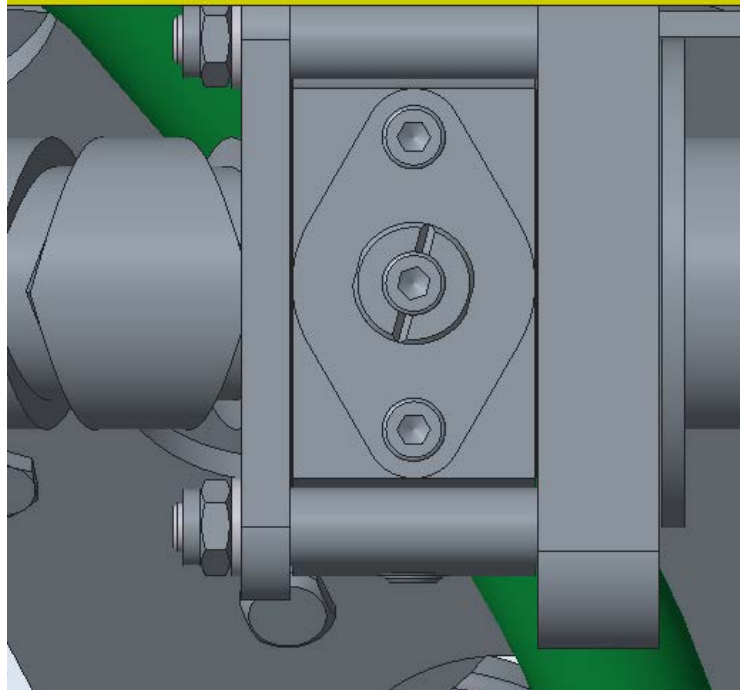



Spooling mechanism in outer position

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7.2 Follower knife Inspection / Replacement

Always observe the position of the spooling mechanism and the orientation of the slot in the follower release rod before dismantling. This is to ensure that the spooling mechanism moves in the correct direction.



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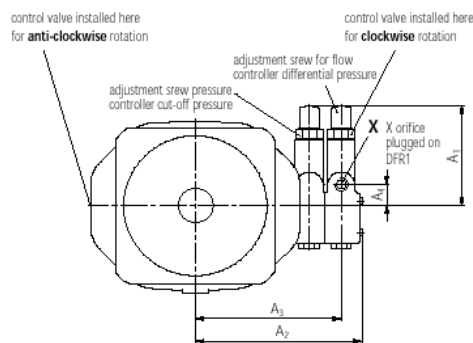
8 Operation of Hydraulic System

8.1 Operation of pump

8.1.1 Settings

Idle pressure	:	18-22 Bar
Operation pressure	:	200 Bar
Displacement	:	28 cc/rev
Flow	:	46 l/min @ 60 Hz 38 l/min @ 50Hz

8.1.2 Adjusting cut off pressure



When replacing the pump, always adjust the cut off pressure to minimum before starting the pump first time. Pressure adjustment to be performed according to the following steps:

1. Fit new pump and fill system with oil until compensator volume reads 90%
2. Turn adjustment screw fully counter clockwise
3. Start HPU
4. Turn adjustment screw clockwise until operational pressure is reached
5. Lock off adjustment screw with the locking nut

8.1.3 Pump Replacement

Pump replacements to be performed according to the following steps:

1. Drain electric motor for oil
2. Drain hydraulic system for oil
3. Disconnect the hydraulic hoses
4. Remove the two fixing bolts.
5. Check O-ring in the flange of the electric motor and replace if necessary.
6. Bolt replacement pump onto the electric motor
7. Install hydraulic fittings and hoses.

8. Fill up the hydraulic system and the electric motor with oil.
9. Bleed air from pump and electric motor.
10. Adjust pump cut off pressure as described in the previous chapter.

8.2 Operation of Valve Pack

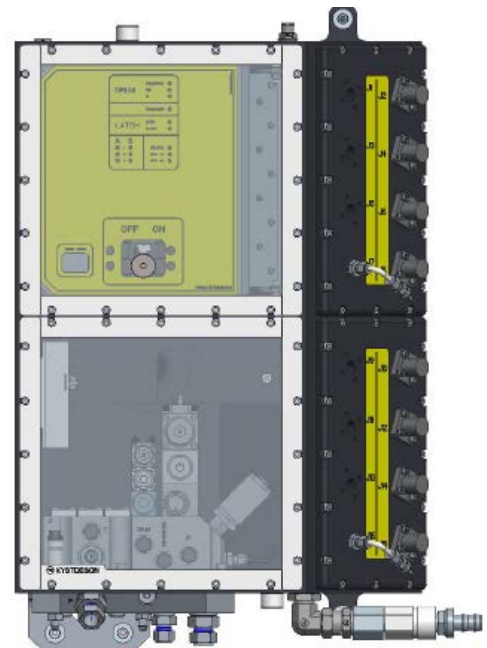
8.2.1 Opening & Closing the valve packs.

Opening

1. Drain oil through the quick release coupling at the bottom of the VP housing. Removing the relief valve located at the top of the housing will increase the oil flow.
2. Loosen all the lid bolts, remove the lid flanges holding the Lid.
3. Remove Lid

Closing

1. Clean the O-ring groove
2. Clean and inspect the O-ring for damages.
3. Lubricate the O-ring with a thin film of Molycote 111.
4. Reinstall the O-ring
5. Reinstall the lid and the lid flanges.
6. Tighten up the bolts with torque 6Nm
7. Fill up with Oil.



8.2.2 Replacing Hydraulic Valves

Cavity mounted valves

1. Drain the relevant hydraulic reservoir.
2. Disconnect the coil from the relevant connector on the diode board.
3. Remove the coil.
4. Remove the valve.
5. Check that cavity or mounting surface is clean and free from foreign matter.
6. Inspect the replacement valve for damages.
7. Check that all o-rings are in place and not damaged.
8. Insert valve into cavity and tighten up by hand.
9. Apply torque as specified in the table below.
10. Attach the coil and tighten up the nut/bolts with specified torque.
11. Connect the flying leads to the diode board.

Pos	Type	Torque		
		Cartridge	Coil nut	Coil Bolts
10	MVPPM22-220-G24-M35	50		2,6
13	WDPF A03 ADB V 5 G24 M35			2,6
16	WDPF A06 ADB V 32 G24 M35			2,6
20	BVSPM22-350	50		

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NG3 & NG6 Valves

1. Drain the aux hydraulic reservoir.
2. Disconnect the coil from the relevant connector on the diode board.
3. Remove the fastening bolts for that valve.
4. Clean the manifold surface before replacing the faulty valve, if this is a stacked assembly clean all sealing surfaces.
5. Also clean the fastening bolts before applying Aqualube to the threaded section.
6. Insert the fastening bolts and tighten until finger tight.
7. Use a torque wrench and tighten the bolts, **NG3 to 2,8Nm and NG6 to 5,5Nm.**
8. Connect the flying leads to the diode board.

8.3 Operation of the 10L Compensators

WARNING !	
<p>The compensators contain a compressed spring with the following spring force:</p> <p>Empty compensator (assembly / disassembly mode): ~1200 N</p> <p>Full compensator: ~2000 N</p> <p>Do NOT remove V-Clamp or Spring Retainer Plate before reading the below procedure. To unfasten these items without controlling the spring force can result in serious injuries to personnel and equipment.</p>	

8.3.1 Replacement of Linear Sensor


The linear sensor can be replaced without opening the reservoir. Just drain the compensator and unscrew the sensor.

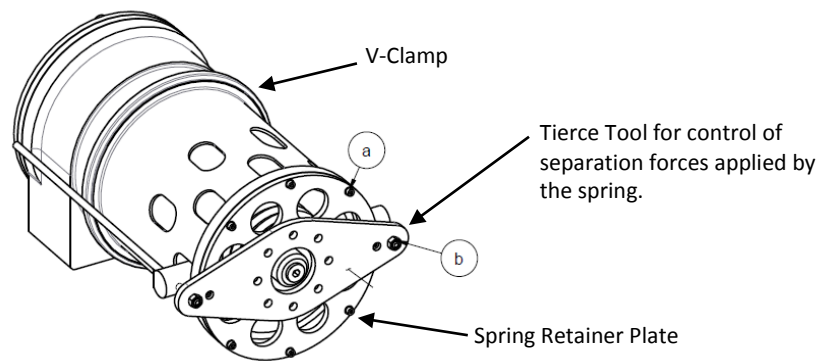
8.3.2 Disassembly of Compensator for replacement of rolling diaphragm and O-rings

NB! When loosening the bolts in the Spring Retainer Plate, the spring will push this plate by a force of ~1200N. The spring is fully extended after 350mm from “empty comp mode”.

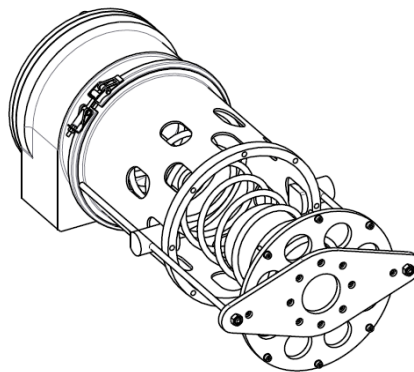
The below procedure is based on the use of a purpose made tool to control the separation force applied by the spring. This tool as shown on the below figures can be supplied by KYSTDESIGN.

1. Drain the compensator.
2. Disconnect compensator from the hydraulic circuit and move it to a clean maintenance area.
3. Install tool as shown on the below figure.

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4. Tighten up Tierce Rods (b).
5. Remove eight bolts (a) holding the Spring Retainer Plate.
6. Carefully untighten the Tierce Rods (b) while keep the spring retainer plate as parallel as possible with the bottom of the compensator to avoid buckling of the spring. Continue until the spring is fully extended.



7. Remove the tool and the spring.
8. Note the position of the V-Clamp lock. It is important to reinstall the V-Clamp with the lock in the same direction and position.
9. The V clamp can now be removed.

Note! When the compensator is disassembled, it is recommended to replace diaphragm and all O-rings by new ones.

10. Make sure that the new diaphragm and o-rings are clean and not damaged.
11. Grease o-rings and diaphragm flange with Molycote 111 or similar.

8.3.3 Assembly of Compensator

Assembly of the compensator to be done in reverse order of the steps in section 8.3.2.

Installation of the V-Clamp shall be according to the following instruction:

Make sure that both the inner surface of the V-Clamp and the mating flange is clean. Then lubricate the flange surface with a thin film of Molycote 111. Install the V-Clamp and torque up the locking nut to 10Nm. Use a lightweight hammer to tap gently on the surface of the V-Clamp while tightening the nut. This to overcome the static friction.

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9 Operation of Control System

9.1 Control Pod

9.1.1 Opening Control Pod


1. First bleed off any internal air pressure by opening the bleed plug
2. Loosen the three bolts securing the Control Pod lid and turn the associated locking brackets away from pod and then tighten the bolts again
3. Lift pod lid by gently pulling upwards while verifying that **no** wires or internal cabling are damaged.

9.1.2 Replacing Electronic Components

1. First turn the TMS instrument power off.
2. Wait to let Hold-Up caps have time to discharge.
3. Disconnect all electronic contacts.
4. Replace component.
5. Verify component set-up, dip switches etc.
6. If any rewiring has been performed, verify wiring against drawing.
7. Reconnect all connectors.
8. Verify connector's positions.
9. Turn on power.
10. Verify component function (s).

9.1.3 Replacing Subsea Connectors

1. Disconnect the connector wires from card terminals.
2. Loosen the subsea connector by removing its screws.
3. Pull the connector gently out verifying that no fibres or wires are trapped and damaged during this operation.
4. Clean the O-rings, the O-ring grooves and the sealing surfaces with an air gun or with a soft cloth.
5. Make sure the O-rings are undamaged, lubricate with a thin film of Molykote 111 before locating the O-rings in the O-ring grooves.
6. Clean the threaded connector holes with compressed air, and lubricate with Aqualube
7. Install the new connector by pulling its wire assembly gently in.
8. Terminate the wires to its terminals having all wires correctly marked
9. Verify wiring by against drawing.
10. Make sure that no wires are trapped.
11. Lubricate the new clean connector.
12. Verify the new connector by installing the subsea cables and turning on power.

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9.1.4 Closing Control Pod

1. Secure all components.
2. Secure inside cabling.
3. Clean the O-rings, the O-ring grooves and the sealing surfaces with an air gun or with a soft cloth.
4. Make sure the O-rings are undamaged; lubricate with a thin film of Molykote 111 before position the O-rings in the O-ring grooves.
5. Gently push the pod lid back on verifying that no wires etc. are trapped and the O-rings are not damaged.
6. Open the three pod locking-bracket bolts and twist the brackets, locking the lid.
7. Tighten the locking-bracket bolts.


Note:

Do not have the electronics on during any seal test. There is no cooling without air and the electronics can be damaged.

8. If installed in hot and “wet” conditions use dry air or nitrogen inside pod to avoid condensation.

10 Maintenance Schedule

Component	Part	Action	Interval
Electric Motor	Oil	Change	2000 Hrs.
Electric Motor	Rotor shaft bearings	Change	2000 Hrs.
Hydraulic System	Filters	Change	1000 Hrs

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11 Drawings


Doc.	Description	
AF64-1000M01	TMS KD10 Basic version	General Arrangement
AF64-1000M02	TMS KD10 Basic version	Assembly
AF64-1000M03	TMS KD10 Lifting Arrangement & Load Test	Test Information
AF64-1001M03	Configurations, Main TMS Control Overview	Assembly
AF64-1002M01	TMS with Cursor Top	Assembly
AF64-1002M03	Cursor Lifting Arr. & Load Test Information	Test Information
AF64-1002M10	Cursor Top	Assembly
AF64-1010M01	TMS KD10 Frame	Assembly
AF64-1011M01	Lifting Joint SWL 12T	Assembly
AF64-1012M01	TMS KD10 Drum Arrangement	Assembly
AF64-1013M01	TMS KD10 Spooling Device	Assembly
AF64-1015M01	TMS KD10 Tensioner Mechanism	Assembly
AF64-1016M01	TMS KD10 Roller Guide	Assembly
AF64-1017M01	TMS Latching Mechanism	Assembly
AF64-1018M01	TMS ROV Bullet Joint	Assembly
AF64-1019M01	TMS KD10 Spooling Drive Transmission	Assembly
AF64-1020M02 & 03	TMS Motor Extension	Assembly
AF64-1022M01	TMS KD10 Rotating JB	Assembly
AF64-1030H01	TMS Hydraulic Schematic	Schematic
AF64-1030M02	TMS Hydraulic System, HPU	Assembly
AF64-1030M03	TMS KD10 Hydraulic System, Filter	Assembly
AF64-1030M04	TMS Hydraulic System, 10L Reservoir	Assembly
AF64-1030M05	TMS Hydraulic System, 10L El. Comp.	Assembly
AF64-1030M06	TMS Hydraulic System, By-pass oil Filter	Assembly
AF64-1100M03	TMS Control Unit with 3000M Pod and extended JB	Assembly
AF64-1110M01	TMS Cabinets, Main Cabinet	Assembly
AF64-1110M07	TMS Cabinets, Lower Connection Plate	Assembly
AF64-1110M08	TMS Cabinets, Upper Connection Plate	Assembly
AF64-1120M01	TMS Control Unit, Valve Pack	Assembly
AF64-1130M01	TMS Control Unit, Stationary JB	Assembly
AF64-1150M01	TMS Control Unit, Control Pod 3000msw	Assembly
AF64-10-2-1000E01	TMS Electrical Single Line Diagram	Line Diagram
AF64-10-2-1110E01	TMS Power Wire Diagram	Wire Diagram
AF64-10-2-1110E02	TMS Cabinet Wire Diagram	Wire Diagram
AF64-10-2-1110E03	TMS Cabinet Wire Diagram	Wire Diagram
AF64-10-2-1130E01	TMS Termination Wire Diagram	Wire Diagram
AF64-10-2-1150E01	TMS El. Pod Wire Diagram	Wire Diagram

12 Hydraulic Data Sheets

Tag No.	Description
1	Pump A10VSO 28
2	10 litre Compensator
3	Check Valve C5V06
4	Pressure Relief Valve
5	Filter 15/40/80CN Series
6	Filter SDU H350
7	Latch Cylinder
8a	Hydraulic Motor 250 cc/rev. Italgroup
8b	Hydraulic Motor 34 cc/rev. Italgroup
9	Check Valve Series RK & RB
10	Proportional Pressure Reducing Valve
11	Shuttle Valve
12	NG3 Blanking Plate
13	NG3 Proportional Directional Valve
14	NG3 Pressure Reducing Valve
15	NG3 Non Return Valve
16	NG6 Proportional Directional Valve
17	NG6 Solenoid Poppet Valve
19	Pressure Sensor MBS 1200
20	Pressure Relief Valve
21	Temperature Sensor

13 Electric Data Sheets

Tag No.	Description
1	KD-Con TMS Multiplexer
2	TMS Subsea Controller
3	Driver Card
4	Breaker
5	DC/DC Converter
6	Pressure Relief Valve
7	Proximity Sensor
8	Magnet Position Transducer
9	Encoder
10	Load Cell
11	Electric Motor
12	TMS Slip-Ring
13	Tether

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14 Spare Part List