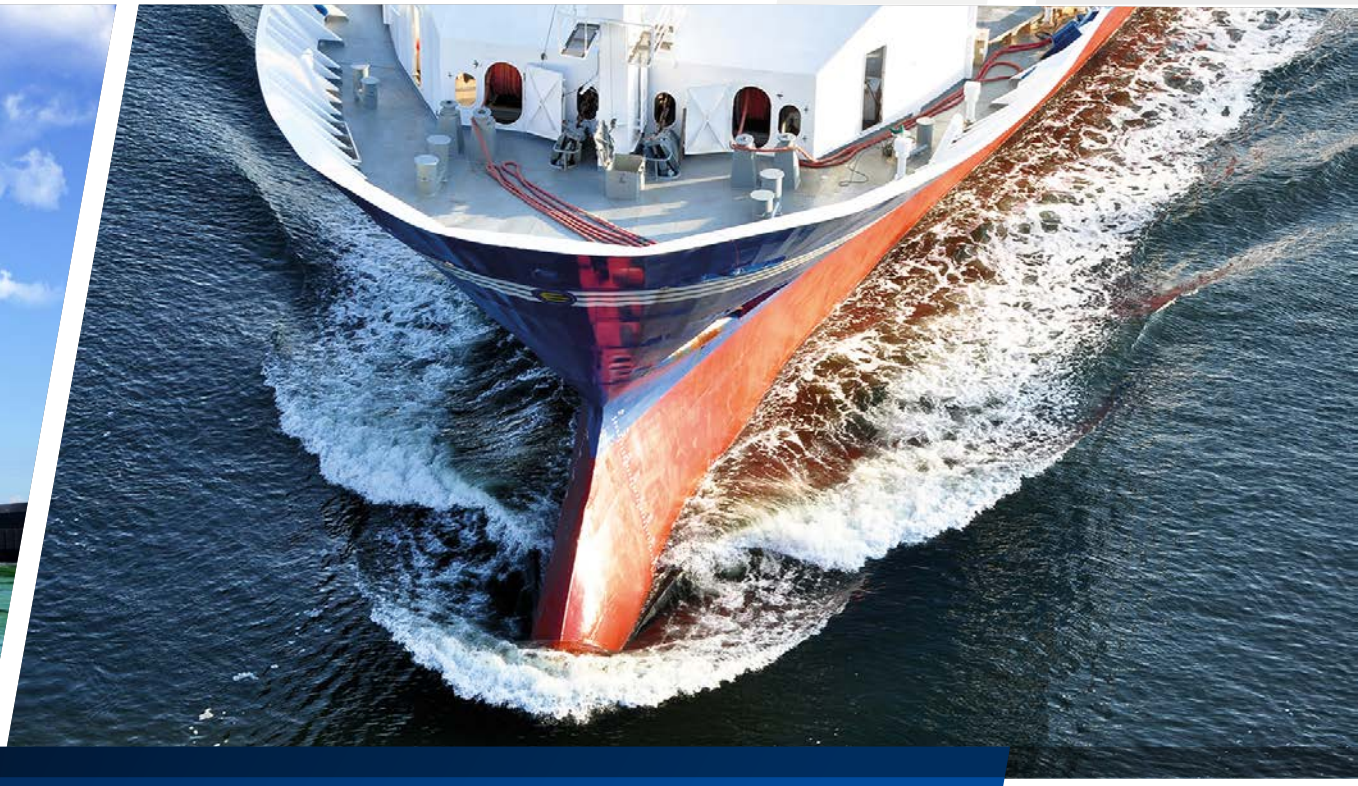
RegalRexnord™



KMS – HYDRAULICALLY OPERATED MULTI-DISC CLUTCH

FOR MARINE TRANSMISSIONS

Stromag™

PRODUCT CATALOG

Stromag™

DECADES OF EXPERIENCE

Across Industries and Applications

Founded in 1932, Stromag™ has grown to become a globally recognized leader in the development and manufacture of innovative power transmission components for industrial drivetrain applications.

Stromag engineers utilize the latest design technologies and materials to provide creative, energy-efficient solutions that meet their customer's most challenging requirements.

Stromag's extensive product range includes flexible couplings, disc brakes, limit switches, an array of hydraulically, pneumatically, and electrically actuated brakes, and a complete line of electric, hydraulic and pneumatic clutches.

Stromag engineered solutions improve drivetrain performance in a variety of key markets including energy, off-highway, metals, marine, transportation, printing, textiles, and material handling on applications such as wind turbines, conveyor systems, rolling mills, agriculture and construction machinery, municipal vehicles, forklifts, cranes, presses, deck winches, diesel engines, gensets and stage machinery.

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RegalRexnord™

Hydraulically operated Multi-Disc Clutch for marine transmissions

CONTENTS

With the publication of this document, all information on hydraulically operated multi-disc clutches for marine transmissions in publications dated earlier is only valid to a limited extent.

We reserve the right to make changes to the dimensions and design.

Stromag products comply with the DIN ISO 9001 quality standard.

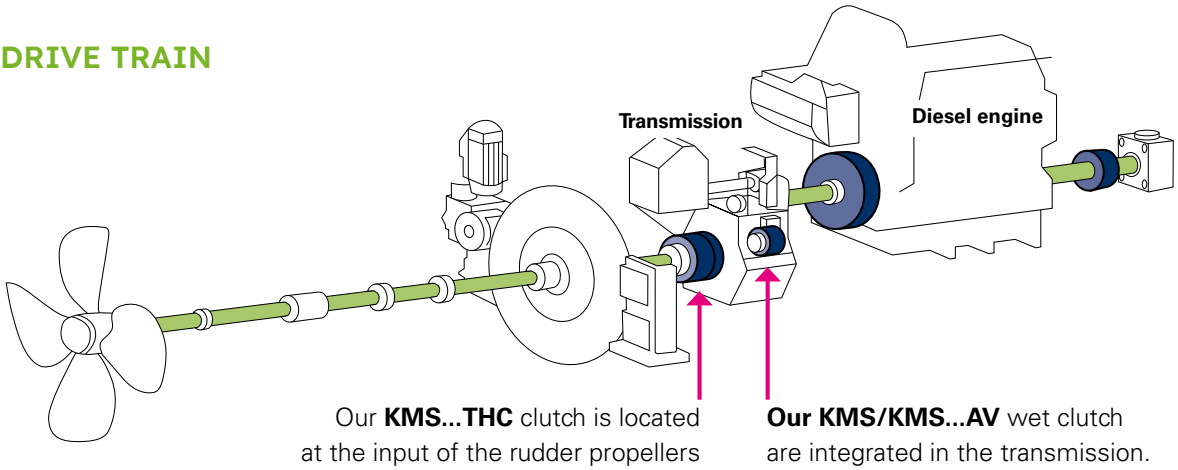
MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

AREAS OF APPLICATION

The clutches shown in this catalog are for marine drive applications. Marine drives can be both the main drive of the ship's propeller and PTOs such as generators. The various clutch series have been developed for individual requirements. This means that all ship propellers can be accelerated and synchronized with the drive unit. The auxiliary drives (Power Take Off) or also auxiliary drives (Power Take In) can be safely engaged and disengaged with the clutches installed in the transmission unit. All clutch series listed here are approved by the classification bodies.

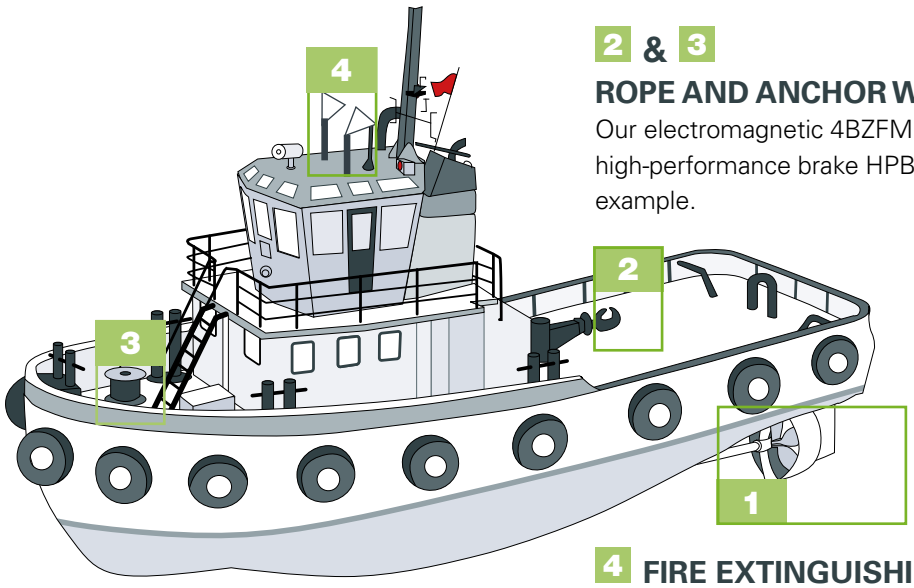
DRIVE TRAIN



Our **KMS...THC** clutch is located at the input of the rudder propellers outside the transmission.

Our KMS/KMS...AV wet clutch are integrated in the transmission.

OTHER STROMAG PRODUCTS FOR MARINE APPLICATIONS



Information on this is available in the corresponding catalogs or you can contact us directly.

2 & 3

ROPE AND ANCHOR WINCHES

Our electromagnetic 4BZFM brake or our electromagnetic high-performance brake HPB are used in cable winches, for example.

4

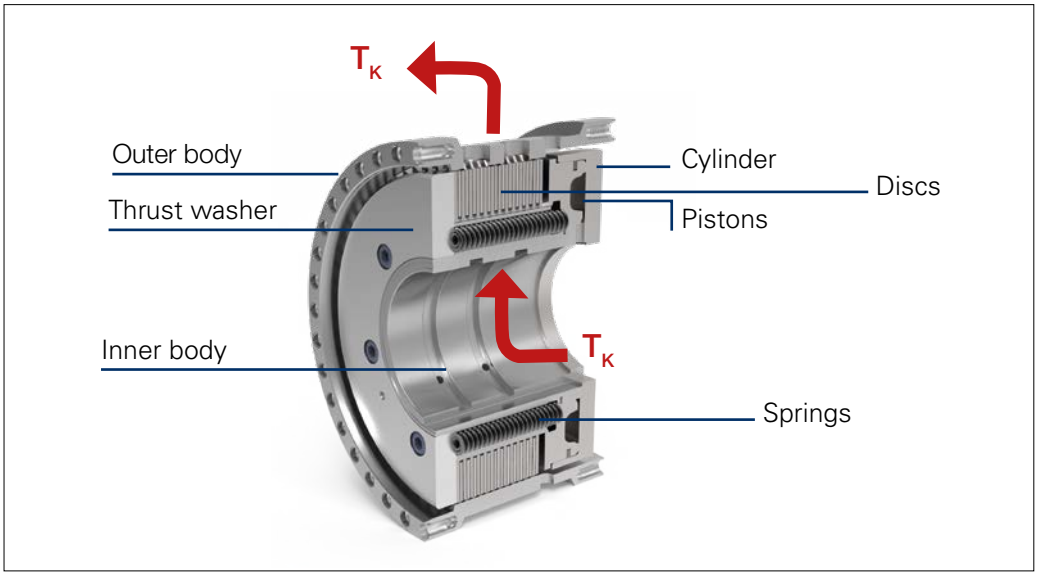
FIRE EXTINGUISHING PUMPS

To connect a fire extinguishing pump, our shiftable KHM clutches are combined with a TRI-R or Periflex® VN.

Hydraulically operated Multi-Disc Clutch for marine transmissions

CONSTRUCTION AND OPERATION

CONSTRUCTION:



GENERAL OPERATING PRINCIPLE OF CLUTCHES

Torque transmission in closed state.

The pressurized oil is supplied to the cylinder chamber of the clutch through a bore in the shaft. This causes the piston to press the disc pack against the thrust washer and close the clutch. Due to the resulting frictional connection between the inner discs and the outer discs, a torque can be transferred from the internal body to the external body.

Switching behavior during synchronization.

In principle, we recommend engaging the clutch in two steps, i.e. with a lower engagement pressure at which the drive train is synchronized under low load. Subsequently, a pressure increase to full operating pressure is necessary to be able to safely transfer the full drive power.

Torque interruption in open state.

When the pressurized oil is switched off, the torque transmission is ended and the helical compression springs bring the piston into its release position. The clutch is opened. The inner discs are made of steel and function as a spring. They selectively push the individual discs apart. Forced ventilation keeps idling heating as low as possible.

OPERATING PRINCIPLE OF WET CLUTCHES

Depending on the amount of heat generated by friction, oil fog cooling, splash oil cooling, immersion cooling or internal cooling is selected for wet-running multi-disc clutches. Cooling oils are used for lubrication and dissipation of heat generated by friction in the disc pack during clutch operation and idling.

Trouble-free operation, especially in terms of frictional behavior, depends to a large extent on the use of suitable oils. In the case of transmissions with multi-disc clutches, a compromise is sometimes necessary; oils that have special additives - favorable for high transmission loads - can be detrimental to the friction characteristics of the multi-disc clutch.

(see also chapter “Cooling oil requirements”).

MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

OPERATING STATES AND THEIR PARAMETERS FOR A REQUIREMENT SPECIFICATION

CLUTCH CLOSED

If the clutch is engaged or closed, it is operated at full operating pressure in order to be able to transmit the nominal clutch torque. The nominal coupling torque must be greater than the nominal system torque in accordance with the necessary safety factor. Impulse and peak loads must be taken into account depending on the type and operating principle of the machine.

Parameters:

- Nominal system torque (nominal speed / rated power)
- Operating overpressure
- Emerging alternating torques

CLUTCH IS OPENED

The back pressure forces to open the clutch must be greater than the sum of the seal friction force, the residual pressure in the hydraulic system (e.g. influenced by pipe resistance) and the piston force due to the centrifugal pressure (e.g. influenced by the speed) for the required disengagement speed.

Parameters:

- Speed
- Residual pressure in the hydraulic system
- Friction resistances
- Time to complete disconnection

CLUTCH IS OPENED

In the case of a multi-disc clutch, there is no complete disconnection of the friction surfaces when idling without special measures, in particular in the vertical mounting position. The amount of cooling oil present and the idling speed results in a residual torque or idling torque, which can continue to load the take-off with torque. The back-pressure forces must be correspondingly high, just as when opening the clutch, so that the clutch does not engage unintentionally.

Parameters:

- As far as possible free of residual torque
- Speed/relative speed (take off and take in)
- Centrifugal pressure in the piston chamber
- Cooling oil quantity
- Mounting position: vertical, horizontal

CLUTCH IS CLOSED (synchronized)

During the shifting process of a multi-plate clutch, heat is generated at the friction surfaces due to the torque transmitted during slipping. In the case of wet clutches (KMS/KMS...AV), this is dissipated by cooling oil. Decisive for the necessary shifting process is the cut-in speed at which the masses to be driven are to be accelerated and the load torque which counteracts the clutch torque. The duration of the switch-on process can be influenced in certain areas by the switch-on pressure but is also dependent on other boundary conditions such as the filling time of the piston. (See also chapter "Recalculation of the clutch with regard to frictional heat load").

Parameters:

- Mass inertias to be accelerated (concentrated on the clutch shaft)
- Switch-on speed
- Load torque
- Switch-on pressure
- Switching frequency
- Fill time

SUSTAINED SLIP

The continuous slip state is only found in wet clutches. The output speed (below the idling speed of the drive motor) can be continuously adjusted over a defined pressure range. The resulting generated heat is dissipated via appropriate quantities of cooling oil, so that continuous operation in this state is guaranteed.

Parameters:

- Torque
- Speed/differential speed of take off and take in
- Operating overpressure

COOLING OIL REQUIREMENTS

The cooling oil is necessary to dissipate the generated frictional heat when engaging the clutch. It also influences the shifting behavior, traction torque when idling, as well as the friction coefficient and thus the torque.

High viscosity results in long shift times because the oil is displaced more slowly from the friction surfaces, thus making excessive idling torque possible. A typical viscosity range is between 46...150 mm²/s at 40°C (up to 220 mm²/s in special cases). Additives in the oil must not significantly influence the frictional behavior, so that solid lubricants such as MoS2 must not be used. The oil should also have a high resistance to aging and heat, as well as good corrosion protection.

Further details and a list of tried-and tested oils can be requested from us.

MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

CLUTCH SIZE SELECTION

Where possible, the clutch size should be determined by us. It is based on the torque to be transmitted and the heat generated during shifting. The appropriate amount of cooling oil is determined based on this and taking into account the idle heat. It must be adapted to the relevant clutch size and the technical conditions of the individual application.

Determination of the required dynamic clutch torque

$$T_{Kdyn\ req.} = K_A \times T_{An}$$

$$T_{Kdyn} \geq T_{Kdyn\ req.}$$

$T_{Kdyn\ req.}$ required dynamic torque

T_{Kdyn} existing dynamic torque of the clutch

T_{At} nominal torque of the drive unit, calculated from nominal power and nominal speed

K_A **The safety factor depends on:**

- Work machine
- Impulse and peak loads
- Application (single or multi-drive)
- Technical guidelines of the acceptance company
- Ice class (Yes/No)

The minimum safety factor is:

$K_{A\ min.} = 1.3$

Recalculation of the clutch with regard to frictional heat load

The clutch selected with torque impulse factor K_A must be recalculated with regard to the frictional heat load generated.

If the permissible heat load is not sufficient, a clutch with a correspondingly higher permissible heat load must be selected, regardless of the factor K_A.

The following must be taken into account:

- Motor type
- Nominal motor power and speed
- Motor torque characteristic
- Mass moment of inertia of drive side with motor (before clutch)
- Clutch drive speed at start of shifting
- Switch-on strategy
- Desired acceleration time

- Total mass moment of inertia to be accelerated (gear and clutch parts, propeller shaft, propeller and water addition)
- Load torque or load torque characteristic curve during shifting
- Switching frequency

The heat calculation is carried out by us in-house, taking into account the permissible specific load values of the respective clutch size.

We can provide a results report on request.

Determination of the permissible continuous alternating torque

Avoidance of tooth flank lift-off

$T_{KW} < T_{Load}$

The continuous changeover torque must be lower than the respective load torque in all operating conditions so that no lift-off of the tooth flanks can occur (no torque zero crossing).

Exception: Rapid passage through the critical speed range.

Preventing mechanical overload

$T_{KW} \leq \pm (K_A\text{-}1) \times T_{An}$

$(K_A\text{-}1) \times T_{An}$ *is the difference between* $T_{Kdyn\ req.}$ and T_{An}

An alternating torque at this magnitude loads the clutch toothing with max. T_{Kdyn}, which is $\leq T_{Kdyn}$.

This means that the toothing is not overloaded.

Determination of the maximum clutch speed

The clutch selected with torque impulse factor K_A must be recalculated with regard to the frictional heat load generated.

If the permissible heat load is not sufficient, a clutch with a correspondingly higher permissible heat load must be selected, regardless of the factor K_A.

The max. permissible clutch speed must be checked on a case-by-case basis.

A distinction must be made between:

- Speed with clutch closed (comparison with n_{max} in data sheet)
- Speed with clutch open
  - Only the inner assembly rotates (comparison with n_{max} in data sheet)
  - Differential speed between outer/inner structure

MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

NOTES FOR THE DESIGNER

CLUTCH CONNECTIONS

To avoid oil leakage losses, the shaft fit m6 or n6 must be complied with for clutch fit H7. The clutch outer body must be properly fixed to the connection part and axially supported as also the clutch inner structure. All screws are secured with a screw locking liquid.

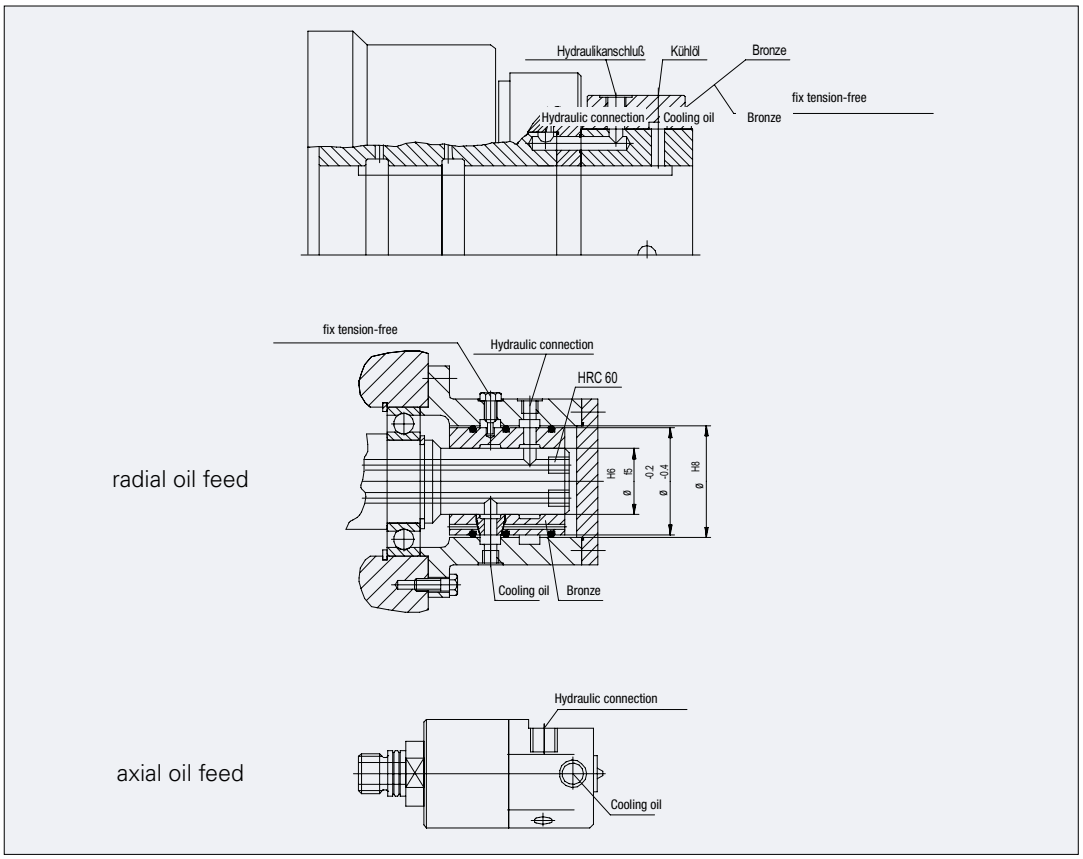
OIL FEED

The size of the hydraulic lines must be designed according to the stroke volume of the clutch and the line length. Sharp bends in the lines must be avoided. Cables that are too small impair the shifting behavior. The cooling oil supply lines (only for wet clutches) must also be sufficiently dimensioned to ensure optimal cooling of the disc pack. The metal piston rings we use (for wet clutches) allow a small amount of leakage oil to escape. This must be taken into account when determining the pump capacity. Corresponding feed devices are required to feed the hydraulic and cooling oil through the shaft. These can be arranged on the end face of the shafts or radially on the shaft. There are a variety of design options. Please contact us for special cases.

The axial oil feed is leak-free. A small leakage oil flow occurs in the radial oil feed, which must also be taken into account when selecting the size of the pump output. In general, it can be said that clutch and oil feed leakage quantity depends on the size, production tolerances, pressure, oil viscosity and temperature.

In individual cases, corresponding information must be requested.

EXAMPLES OF OIL FEED



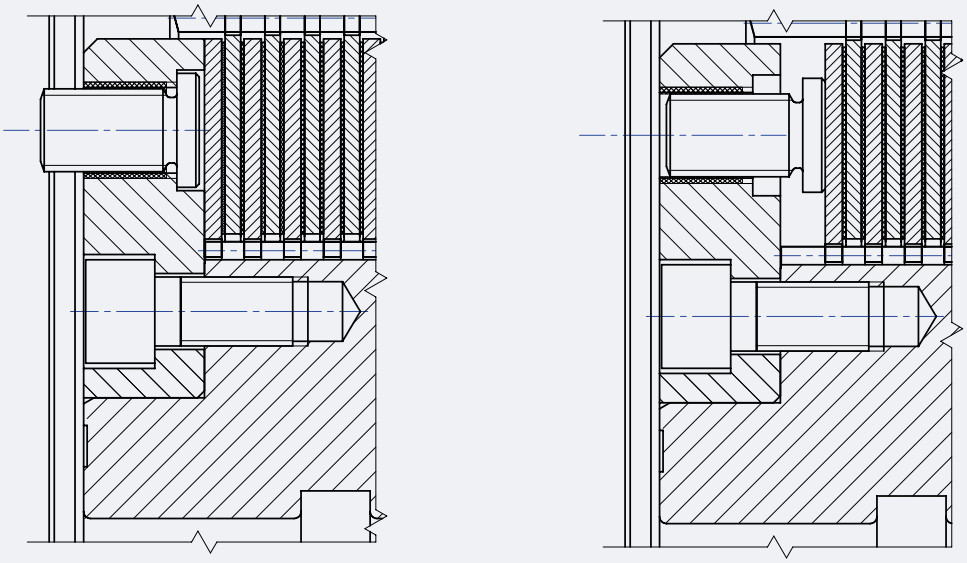
Hydraulically operated Multi-Disc Clutch for marine transmissions

MECHANICAL EMERGENCY MANUAL GEAR SHIFT

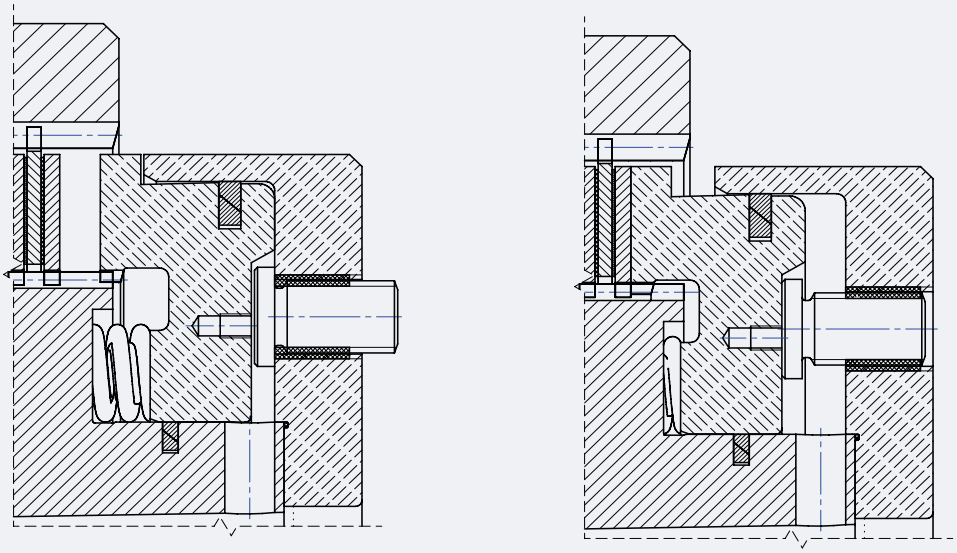
The clutches can be fitted with an emergency manual gear shift if necessary or if required by the approval body. The emergency shift screws on the cylinder or the thrust washer must be easily accessible. In an emergency, 50% of the static clutch torque can be transmitted via the emergency shift screws via a frictional connection.

EXAMPLES OF EMERGENCY MANUAL GEAR SHIFT

Thrust washer



Cylinder



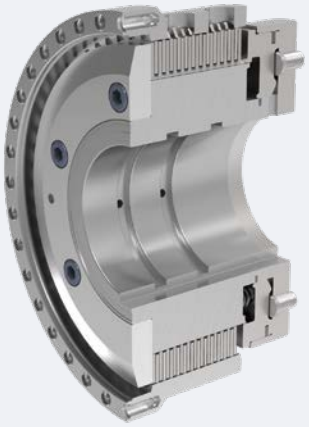
MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

WET CLUTCH SERIES

KMS

For high torques



Torque of
6000 to 315,000 Nm

- Dissipation of shifting heat via internal oil cooling
- Integrated in the transmission
- For large shaft diameters

KMS...AV

For high thermal loads

Torque of
22,000 to 315,000 Nm

- Dissipation of shifting heat via internal oil cooling
- Integrated in the transmission
- Higher thermal load capacity under the same torque as KMS

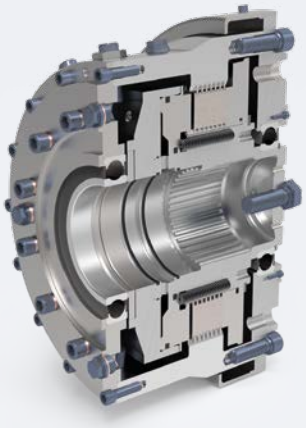
BENEFITS INCLUDE:

- Very favorable torque/weight ratio
- Low mass moment of inertia
- High thermal load capacity
- Long disc service life
- Low maintenance, possible disc wear is automatically compensated for by the piston travel
- Remote control
- Infinitely variable increase in oil pressure and thus impulse-free shifting
- Mechanical emergency shift mechanism in the event of failure of the pressurized oil supply

Hydraulically operated Multi-Disc Clutch for marine transmissions

KMS...THC

External with drive shaft connection



Torque of
1400 Nm to 22,500 Nm

- Does not require internal oil cooling
- Clutch housing for applications outside the transmission
- Protection due to closed clutch housing
- Direct connection (e.g.) of a PTO to the clutch housing

CLASSIFICATION (ACCEPTANCE)

The rules issued by the respective acceptance bodies must be observed in order for the acceptance body to accept a clutch.

A number of classification organizations prescribe a fail-safe system for the ship's main drive, which can be implemented, for example, with regard to the clutch, by means of a mechanical emergency manual gearshift.

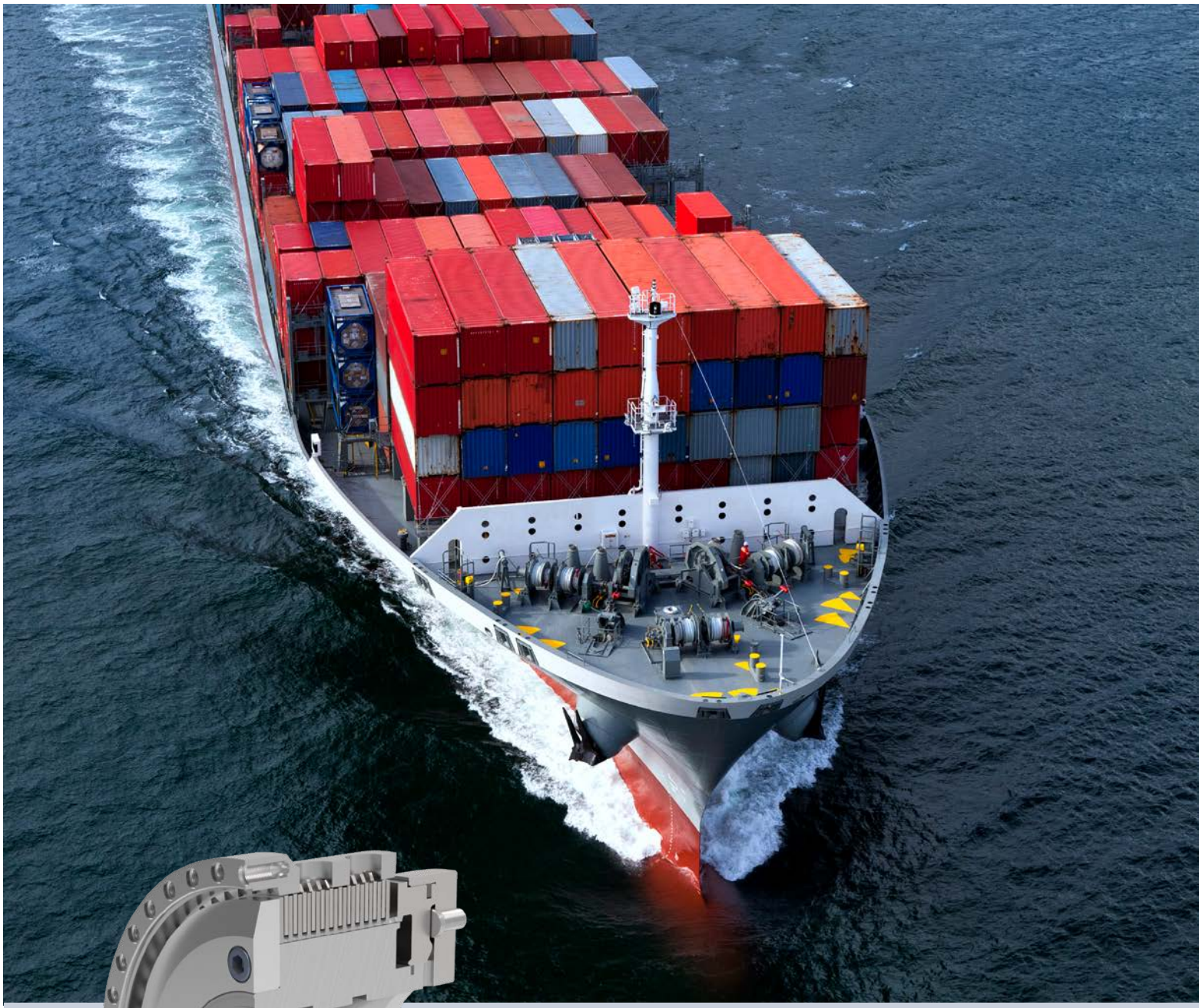
All KMS series have type approval

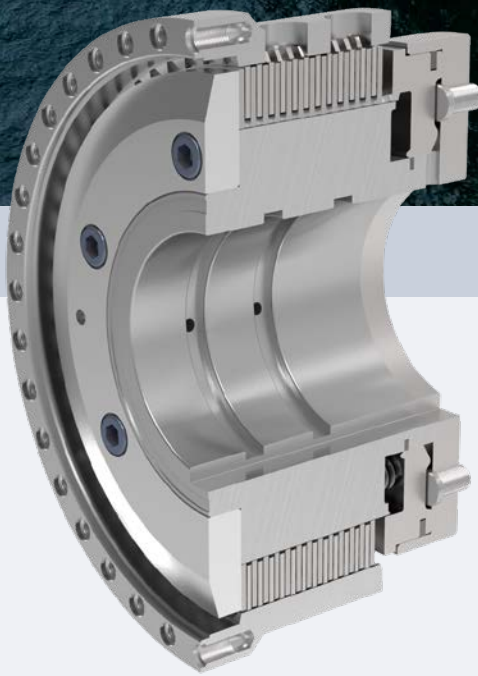
from a wide variety of acceptance bodies.

An individual acceptance of the clutches by special acceptance bodies can also be requested at any time.

MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions



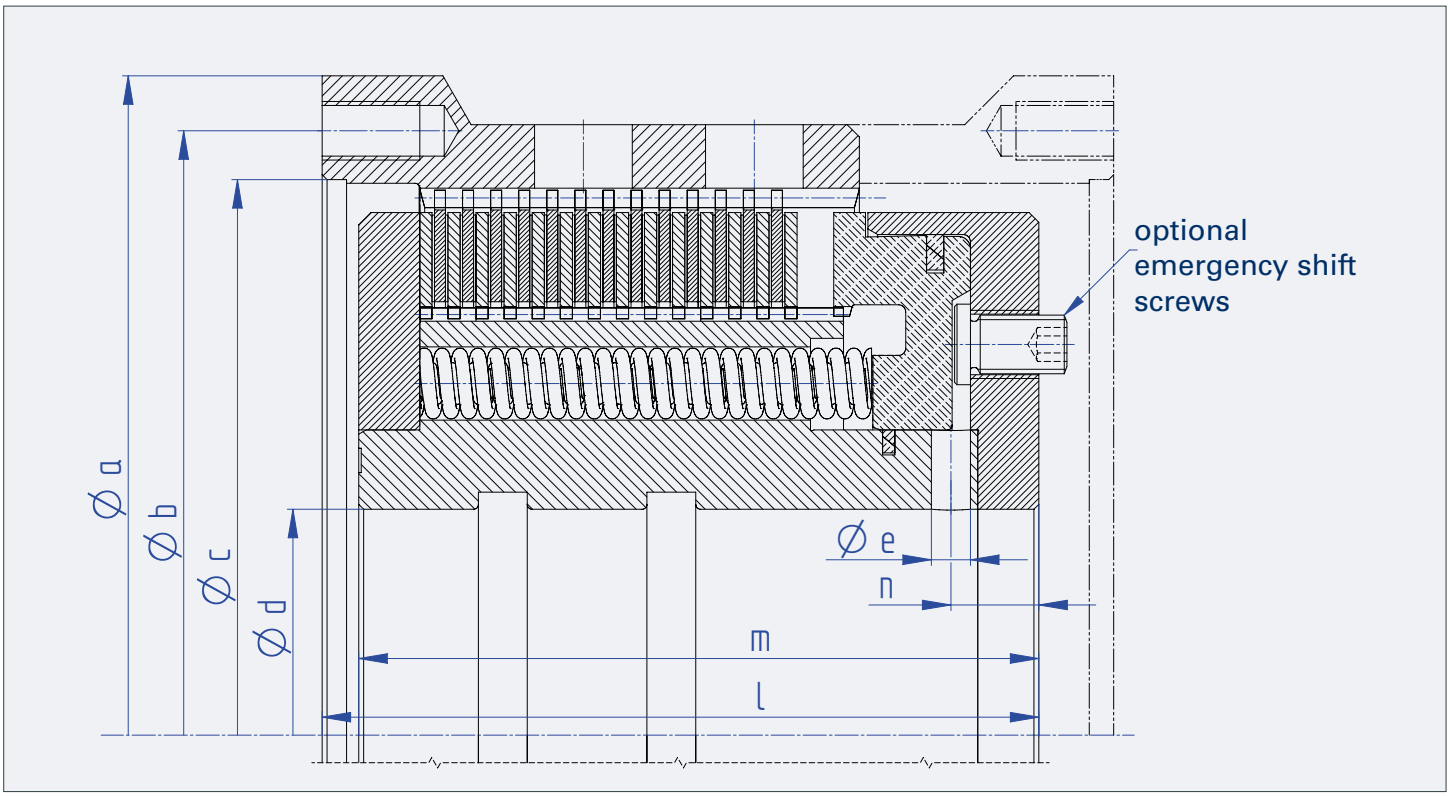


KMS

For high torques

- Dissipation of shifting heat via internal oil cooling
- Integrated in the transmission
- For large shaft diameters

Hydraulically operated Multi-Disc Clutch for marine transmissions

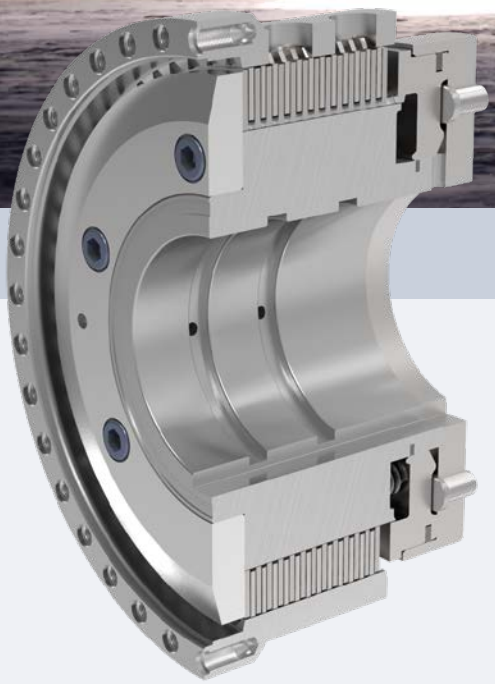


Clutch size KMS			600	800	1120	1600	2250	3200	4500	6300	9000	12500	18000	25000
Torque	$T_{dyn.}$	Nm	6000	8000	11200	16000	22000	32000	45000	63000	90000	125000	180000	315000
Operating overpressure bar			25[1)]											
Speed	$n_{max.}$	min^{-1}	2500	2600	2500	2200	2000	1600	1350	1300	1150	1050	950	700
Cooling oil quantity	min. max.	l/min l/min	4 12	7 24	7 22	8 28	10 30	13 44	15 50	19 63	24 78	30 97	43 142	62 200
Weight		kg	30	40	53	72	100	140	190	290	350	500	800	1150
Diameter	mm	a	245	270	300	330	365	420	455	525	560	620	775	890
		b	225	250	280	310	340	395	430	490	530	585	720	835
		c	210	235	260	290	320	370	405	455	500	550	665	780
		d	80	90	100	110	125	150	165	190	210	220	285	350
		e	8	8	8	8	12	12	14	16	16	18	20	22
Lengths	mm	l	145	155	165	180	195	220	245	275	305	355	370	410
		m	135	145	155	170	185	210	235	265	295	345	360	400
		n	17	19	19	23	25	27	32	36	42	46	56	55

1) Permissible operating pressure range 25 - 29 bar

MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

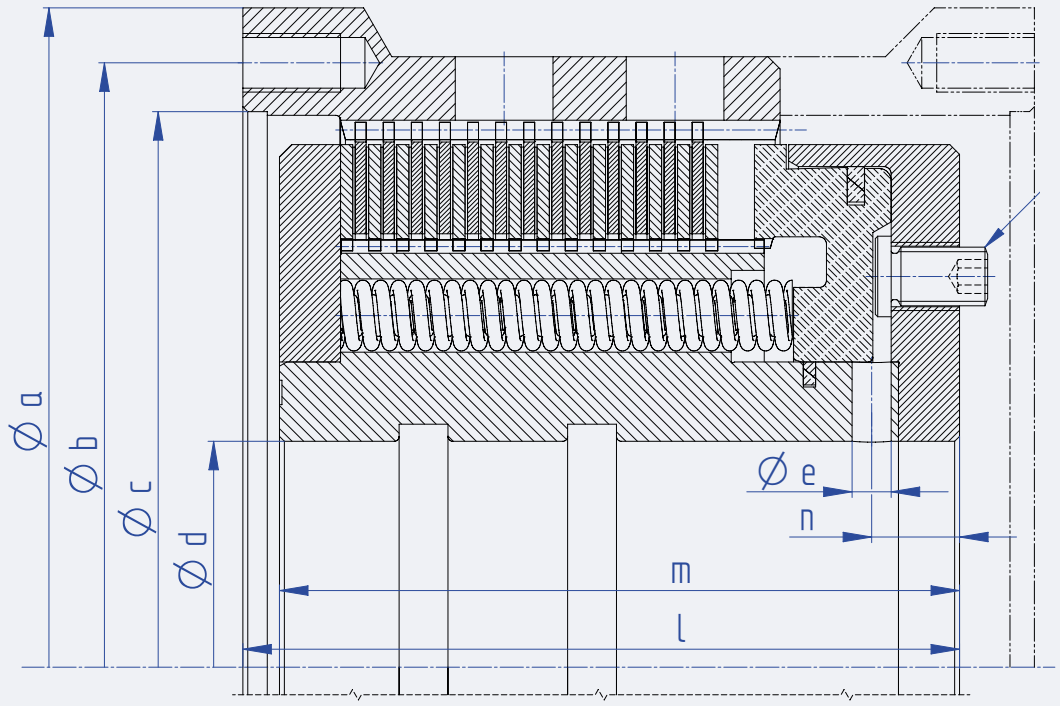


KMS...AV

For high thermal loads

- Dissipation of shifting heat via internal oil cooling
- Integrated in the transmission
- Higher thermal load capacity under the same torque as KMS

Hydraulically operated Multi-Disc Clutch for marine transmissions

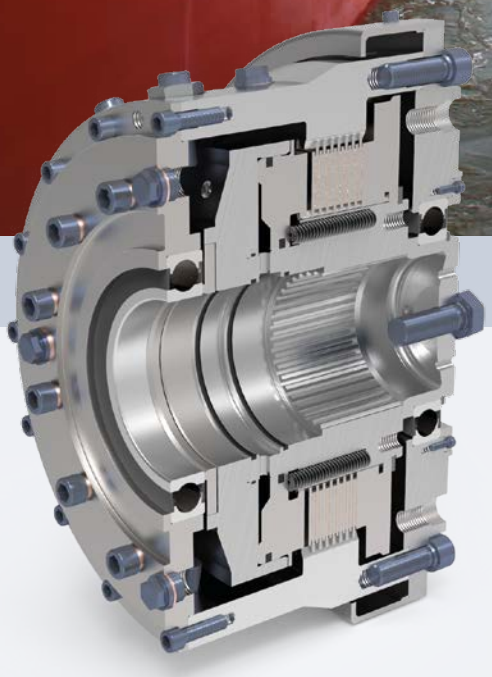


Clutch size KMS...AV			2250	3200	4500	6300	9000	12500	18000	25000
Torque	$T_{dyn.}$	Nm	22000	32000	41000	66000	90000	125000	180000	315000
Operating overpressure		bar	25[1)]							
Speed	$n_{max.}$	min^{-1}	1900	1800	1500	1400	1000	900	950	700
Cooling oil quantity	min. max.	l/min l/min	14 44	20 65	21 70	28 93	32 107	41 136	42 139	82 270
Weight		kg	70	148	185	290	365	500	620	1200
Diameter	mm	a	365	415	455	515	570	620	700	890
		b	340	390	430	485	535	585	660	835
		c	320	370	405	455	500	550	620	780
		d	120	125	165	165	200	220	245	300
		e	11	12	14	16	16	18	20	22
Lengths	mm	l	195	220	245	275	305	355	330	410
		m	185	210	235	265	295	345	320	400
		n	24.5	27	32	36	42	46	51	55

1) Permissible operating pressure range 25 - 29 bar

MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

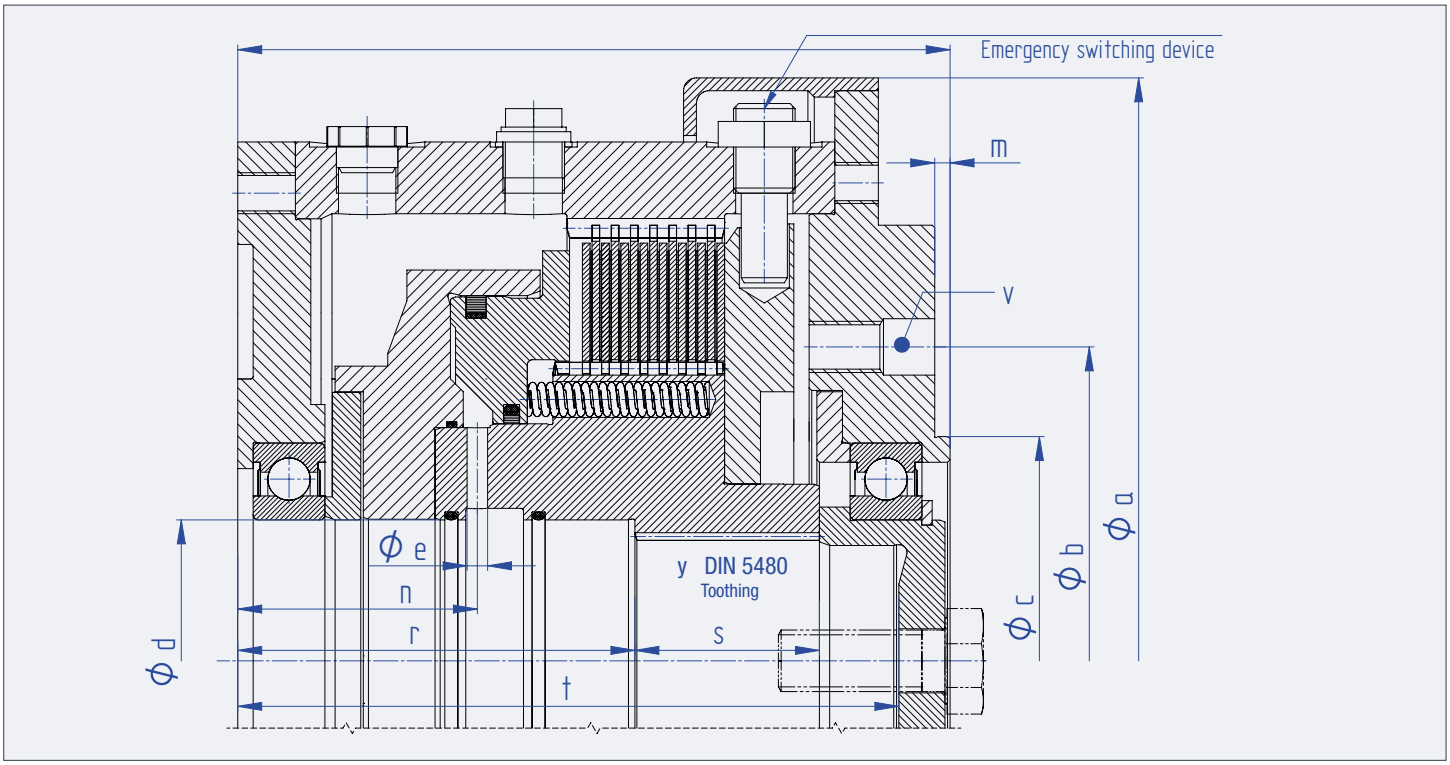


KMS...THC

External with drive shaft connection

- Does not require internal oil cooling
- Clutch housing for applications outside the transmission
- Protection due to closed clutch housing
- Direct connection (e.g.) of a PTO to the clutch housing

Hydraulically operated Multi-Disc Clutch for marine transmissions



Clutch size KMS...THC			140	240	370	690	990	1400	2250
Torque	$T_{dyn.}$	Nm	1400	2400	3700	6900	9900	14000	22500
Operating overpressure		bar	27[1]						
Speed	nmax.	min^{-1}	2100	1900	1900	1900	1900	1900	1900
Weight		kg	28	39	48	85	111	184	252
Toothing	DIN 5480	y	N 40 x 2 x 18	N 50 x 2 x 24	N 65 x 3 x 20	N 80 x 3 x 25	N 90 x 3 x 28	N 100 x 3 x 32	N 130 x 3 x 42
Diameter	mm	a	230	260	270	330	370	455	500
		b	130	155.5	155.5	218	245	280	345
		c	90 j6	110 j6	110 j6	140 j6	175 j6	175 j6	250 j6
		d	45 H7	55 H7	70 H7	85 H7	100 H7	110 H7	140 H7
		e	6	8	8	9	8	8	10
Lengths	mm	l	187	205.5	215.5	228	245	278	313
		m	2	2.5	2.5	5	6	6	5
		n	72	70	75	73	80.5	93.5	100.5
		r	111	110	121	120.5	130	155	161
		s	46	52	51	66.5	72	72	91
		t	177	187	195	212	228	258	290
Threaded holes		v	8xM12	8xM14	10xM16	8xM18	8xM20	8xM22	10xM24

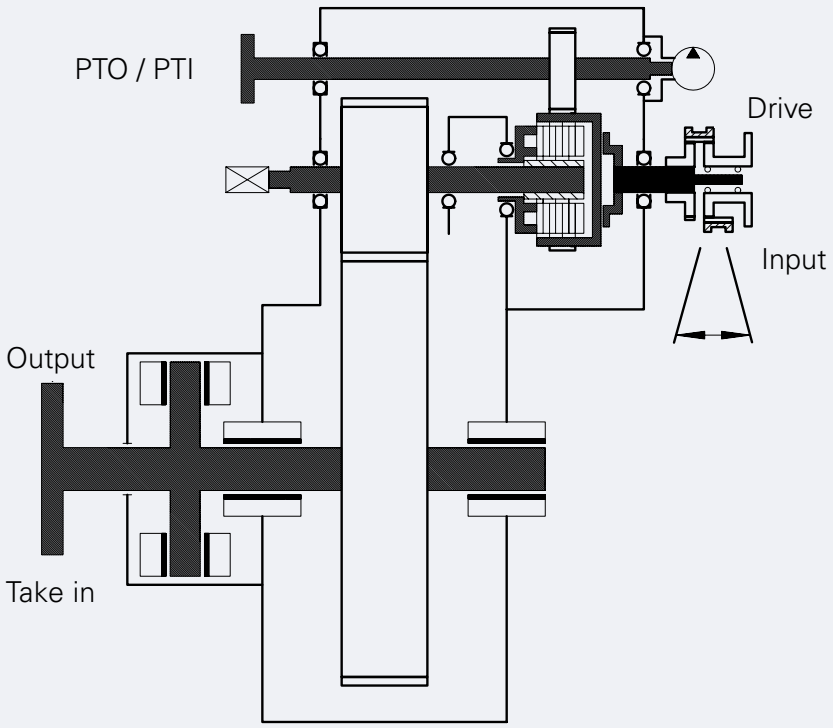
1) Permissible operating pressure range 27 - 28 bar

MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

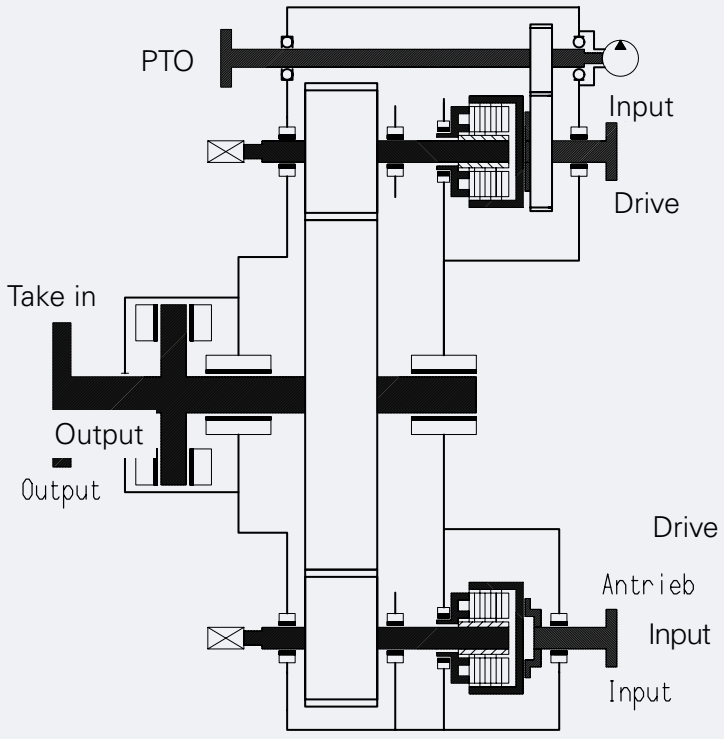
Examples of possible drive schemes with KMS clutches

Single In/Single Out with primary PTO/PTI



Drawing: Flender©

Double In/Single Out with primary PTO



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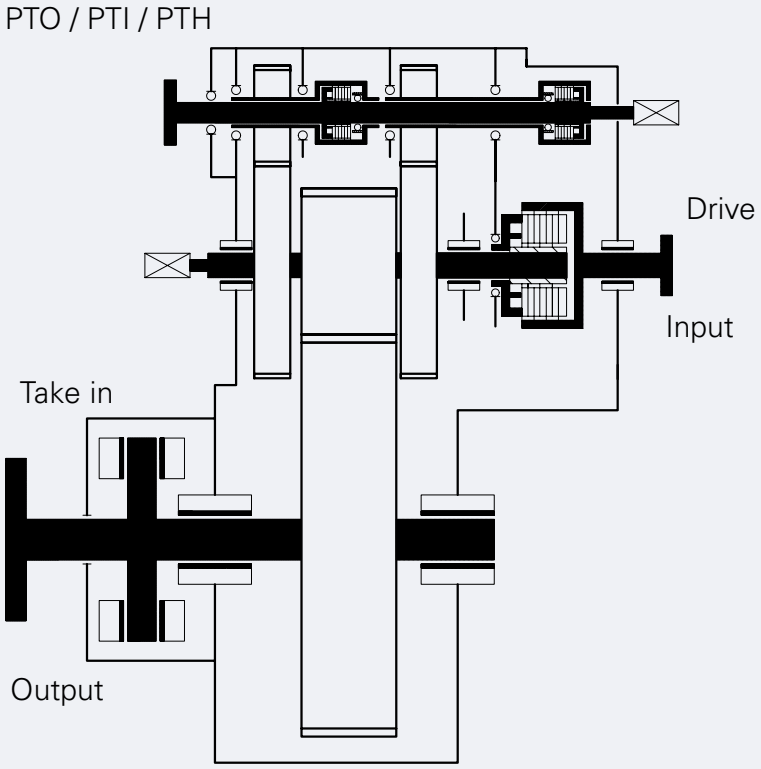
Hydraulically operated Multi-Disc Clutch for marine transmissions

Single In/Single Out with secondary PTO/PTI/PTH



MULTI-DISC CLUTCH

Hydraulically operated Multi-Disc Clutch for marine transmissions

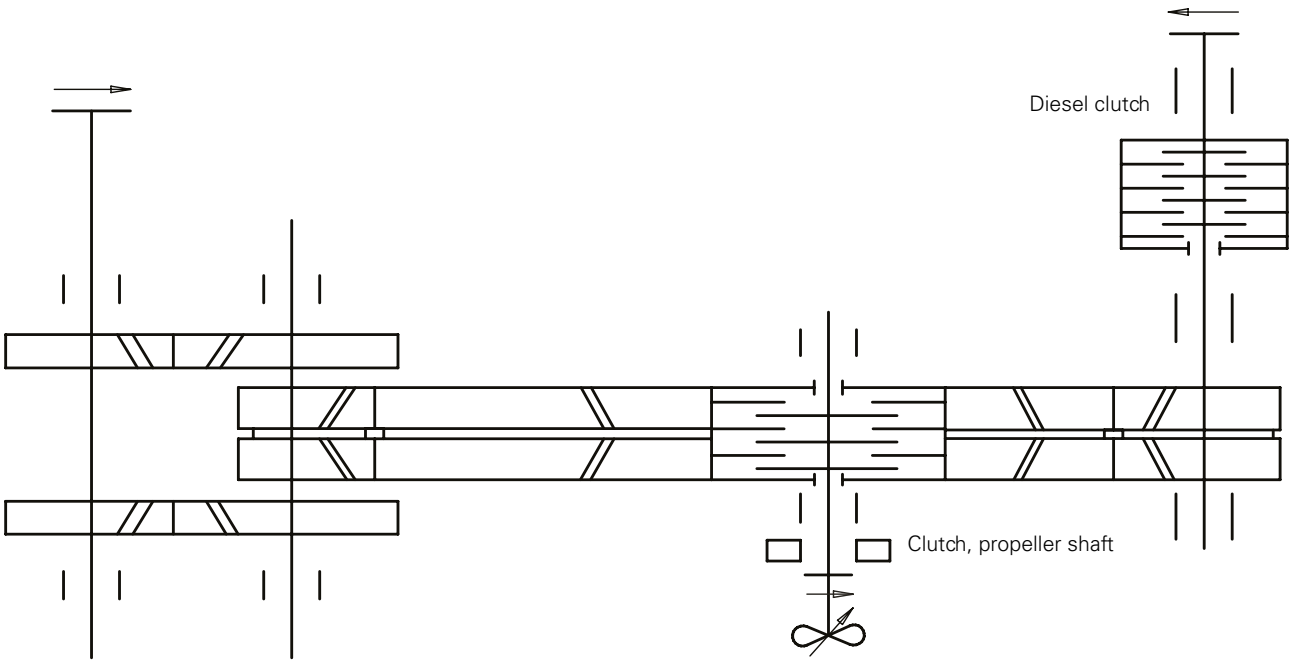
SPECIAL PROJECT: In addition to standard sizes, customer-specific solutions are also possible on request.

The following is an example of a customized solution, a marine transmission where a customized clutch size was used in addition to a standard clutch size.

The following drive diagram shows the clutches and their position in the drive train.

Clutch 1: Main drive of a diesel engine (diesel clutch)

Clutch 2: CPP [controllable pitch propeller] circuit (clutch propeller shaft)



Performance data	Main drive; Diesel clutch	Clutch, propeller shaft	Unit
Clutch type	KMS 18000 AV	KMS 160000	
Clutch torque T_{dyn}	210,000	1,300,000	[Nm]
Operating overpressure	27	27	[bar]
Speed	600	80	[min-1]
Weight	810	2018	[kg]
Outer diameter	700	1002	[mm]
Length	405	512	[mm]

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