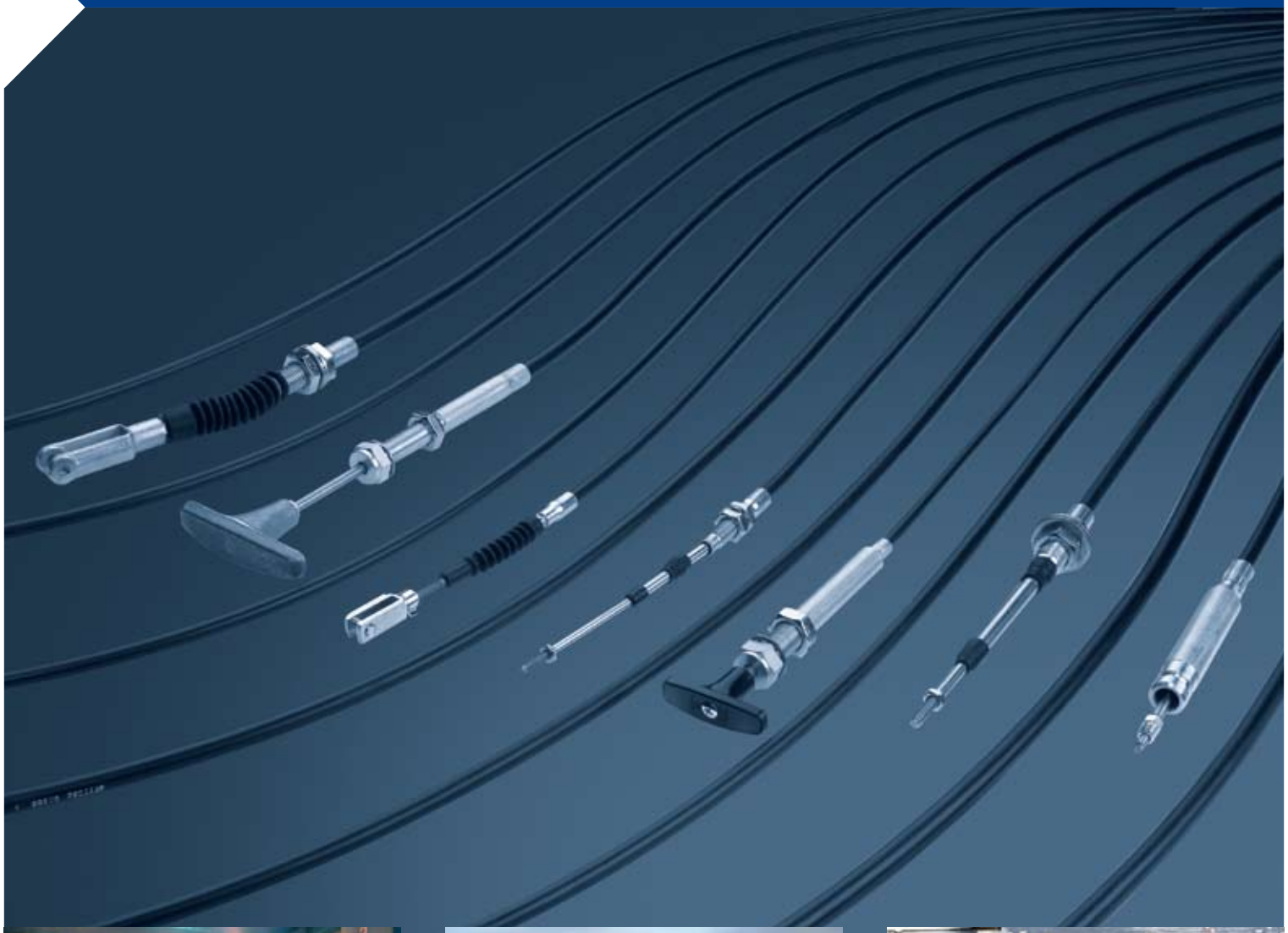
KONGSBERG
AUTOMOTIVE

Performing Reliably

Control Cable Technology



Cable Product Range:

We design and manufacture cables for the following applications:

- Push Pull
- Gear Shift
- Positive Lock
- Remote Valve Control
- Throttle Control
- Pull Release
- Brake Actuation
- Gear Change
- Engine Choke
- Hood Release
- Window Regulator
- Seating Adjustment

CABLE EXPERTISE

Kongsberg Automotive Power Products Systems cables are the industry standard for the world's most successful manufacturers of agricultural, construction and material handling equipment and on-highway vehicles.

Kongsberg Automotive has the widest range of mechanical motion control cables available in the world and manufactures its uniquely designed and developed cables to a common standard across the globe. Our strength originated over sixty years ago with the development of the helical cable for aircraft controls. Today cables are produced for a vast range of driver control products in a wide variety of applications. From light duty throttle cables for outdoor power equipment to heavy duty brake and transmission cables for trucks and buses, Kongsberg Automotive can provide the solutions to meet all your cable requirements.

SERVICE AND COMMITMENT

Kongsberg Automotive has the capability and resources to support global customers wherever and whenever required and to provide the control cable technology solution to maximise vehicle performance. Kongsberg Automotive offers a combined level of engineering support, test capability and product range that is unmatched in the market.

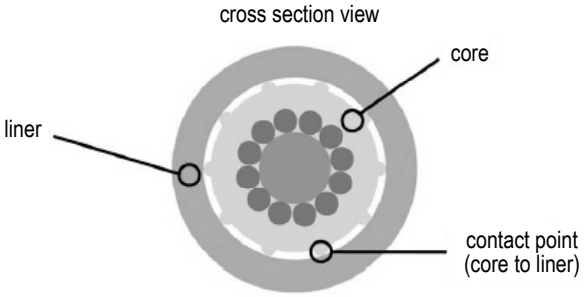
As a global company, Kongsberg Automotive has strategically positioned design and manufacturing facilities to provide local support to our worldwide customers.

Kongsberg Automotive cable products are also available through a network of independent local distributors. Our Assembly Programme System locations are licensed distributors with trained technicians. They use 100% Kongsberg Automotive components and processing to build custom control cable assemblies for supply to local customers. These locations specialise in providing rapid response for replacement cables or small OEM production needs.

SILVER LINE™ Cable

Kongsberg Automotive SILVER LINE™ cables are the market leading cable solution for demanding control applications.

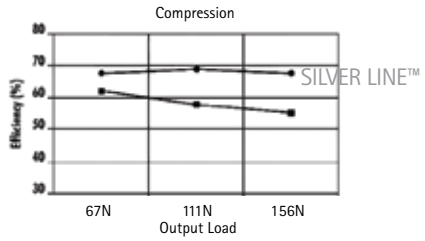
The unique SILVER LINE™ design incorporates a splined core. Ridges of the core allow a close fit with the cable's inner liner, but with minimal contact, so the core glides back and forth smoothly. The result - easy movement and minimum lost motion.

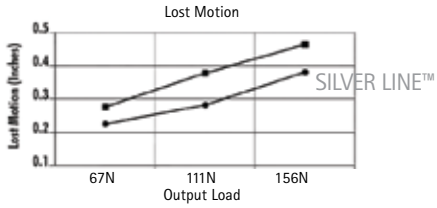


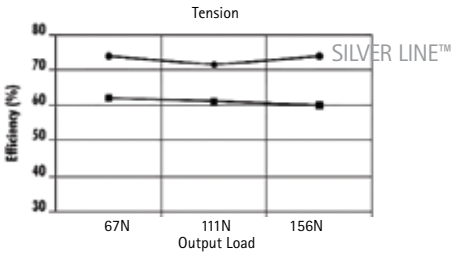
The SILVER LINE™ breakthrough design assures unparalleled smoothness and efficiency - with hardly any lost motion - even in the longest and most complex cable routings. This gives superior feel at the control in any vehicle and unparalleled performance.

- Cables are tested up to 1.3 million cycles, ensuring they perform reliably for an extended service life.
- All cables are lubricated for life and require zero maintenance.
- Available for 30, 40 & 60 series cables.
- Standard Operating temperature -40C to +100C.
- Double lip seals offer improved resistance to contamination ingress.

Kongsberg Automotive SILVER LINE™ cables are fully tested and proven in extreme conditions. The test data below shows how SILVER LINE™ out performs other industry standard control cables for both lost motion and efficiency. Competitor samples were obtained through established aftermarket sources. SILVER LINE™ Samples were randomly taken from ordinary production batches.







Features:

- Market leading durability
- Withstands the harsh demands of industrial vehicle applications
- Uniquely configured for low operating effort
- Precise actuation over long distances and in complex installations
- Common standards available globally through direct sales and distribution networks

Backlash

Backlash, which is apparent as lost motion under light push-pull input forces, is caused by the core member of the cable assembly moving from the inside to the outside of the bends in the cable with the change in direction of movement. It is a function of the clearance between the core and liner, the input force, and the total number of degrees of bend in the cable.

Cable Series	Maximum Backlash for 360°
20	3.1mm (.120 inches)
30	3.1mm (.120 inches)
40	3.8mm (.150 inches)
60	4.6mm (.180 inches)
80	5.8mm (.230 inches)

These figures are for input forces just sufficient to move the core. Lost motion, the sum of backlash plus core and conduit elongation (stretch and compression) will increase as cable length, degrees of bend, and loads are increased. The use of larger cable sizes for a given load will decrease the elongation portion of lost motion.

Temperature

Kongsberg Automotive cables, with standard lubricant, will operate at sustained temperatures from -40°C (-40°F) to + 99°C (210°F). For operation at temperatures up to a maximum of +150°C (300°F) consult Kongsberg Automotive Engineering, as high temperature conduit is available.

Efficiency

Efficiency, or the relationship between the required input force for a given output load is primarily determined by bends in the cable. The required input, or the available output, may be calculated by using the following formula:

Input Force = (Output Load) (Bend Factor)

Output Force = Input Force/Bend Factor

Total Degrees of Bend in Cable	90°	180°	270°	360°	450°
Bend Factors	1.2	1.4	1.6	1.8	2.0

Dynamic Seal™ with Lower Breakaway Force

All Kongsberg Automotive cables have patented Dynamic Seal rod seals. Their one-piece design was tested up to pressures of 3-5 bar after 1.3 million cycles. The seals are made from a proprietary thermoplastic composite impregnated with lifetime lubricant to minimise operating friction and reduce breakaway force by at least 30%. That translates into improved efficiency with reduced operator effort when Kongsberg Automotive cables are used.

Lifetime Lubrication

There are two sources of lubrication in Kongsberg Automotive cables, the lubricants impregnated in the core cover and the specialty lubricants applied to the core's exterior during manufacturing. The combination of these lubricants creates a low-friction environment that provides superior efficiency over the entire life of the cable, outlasting other cable designs.

Bend Radius

Kongsberg Automotive cables have recommended minimum bend radii to render optimum cable life. Installations requiring less than the optimum can easily be achieved but may shorten the cable's life.

Other variables affecting cable life include: output loads, cable length, and total degrees of cable bend in the installation. The sum effect of higher bend radii, lower loads, shorter lengths, and fewer degrees of total bend will all contribute to longer cable life.

Minimum Recommended Bend Radii

Cable bend radii should always be as generous as possible for maximum cable life and efficiency. The following are the minimum bend radii recommended. The life specified for the smaller bend radii reflects the fatigue life of the core.

Cable Series	Long life Minimum Bend Radius	150,000 Cycle Life Minimum Bend Radius
20	100mm	-
30	200mm	-
40	200mm	125mm
60	250mm	125mm
80	300mm	180mm

Maximum Recommended Input Loads

Recommended load ratings reflect the best balance between load and life characteristics. Cable operating life can be extended by utilising less than the maximum recommended load rating.

Infrequent, or momentary loads, may exceed recommended load ratings considerably without causing failure. This will however, shorten cable operating life.

Output Loads

1. Measure the force required to operate the object to be controlled (valve, throttle, PTO, etc.). For the best efficiency and longest operating life, install the cable so that it encounters the heaviest load in the "pull" mode of operation.

2. Using appropriate lever lengths, adjust the load and travel required to fall within load and travel capabilities of the cables.

The cable travel required to move a lever of a given length through a given number of degrees can be computed as follows:
Travel = 2 * Sin (0) * length of lever

The output motion of the workend of the cable is essentially the same as the input motion. For example, a 75mm pushing movement at the input end will result in a 75mm: pushing movement (less backlash) at the output end. If a differential between input/output and/or direction of movement is desired, it must be accommodated in the design of the lever and attaching point at the work end.

Layout

1. Control & Work End

Where cable ends are to be connected to objects requiring linear movement only (e.g., valve spools), maximum life and efficiency can be achieved by accurately aligning, in both planes, the cable hubs with the objects to be controlled.

Where cable ends are to be connected, the connection point will describe an arc as the cable moves through its travel. Standard cables with rod and sleeve type end fittings have a built-in swivel to accommodate this deflection.

For best operating life and efficiency, keep this deflection to a minimum. This can be accomplished by locating the cable centre line.

Anchor the cable securely, so that the anchor point will not move as load is applied. In most cases, the cable end must be anchored to the object to be controlled. This is especially important on engine and transmission controls, where power package "roll" could otherwise cause inadvertent operation of the control.

2. Cable Path

Although cables are flexible motion transfer devices, the best performance and life can be attained by keeping the number of bends to a minimum. Where bends are required, allow as generous a radius as is practical.

3. Protection

Kongsberg Automotive cables are sealed and resist abrasion and contamination. They should, however, be protected against pinching, shearing and crushing, and the effects of excess heat. The operating ends should be shielded against direct spray and excessive dust.

CABLE DEFINITION

Select the standard cable options that are suitable for your application.
For non-standard requirements, consult your Kongsberg Automotive Sales Manager.

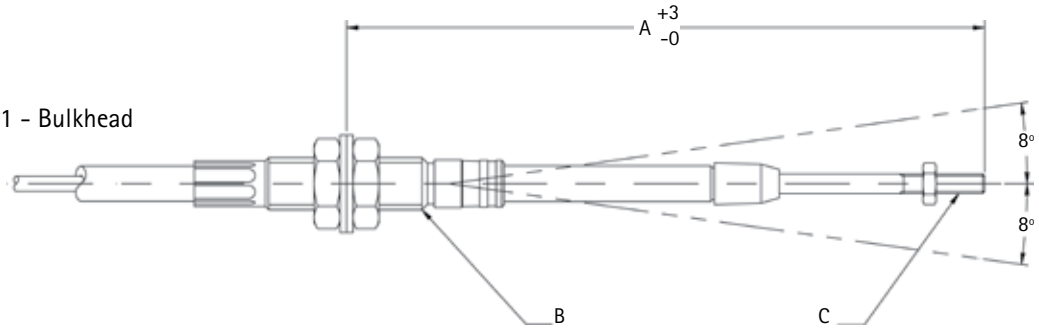
Stage 1:
Select cable series and travel based on application requirements

Cable Series	Pull Max Load	Push Max Load			Long Life Minimum Bend Radius
		50mm Travel	75mm Travel	100mm Travel	
30	222N	222N	178N		200mm
40	667N	578N	489N	400N	200mm
45*	667N	620N	580N	540N	200mm
60	889N		800N	667N	250mm
65*	889N		840N	780N	250mm

* Denotes flat wrap armoured core.

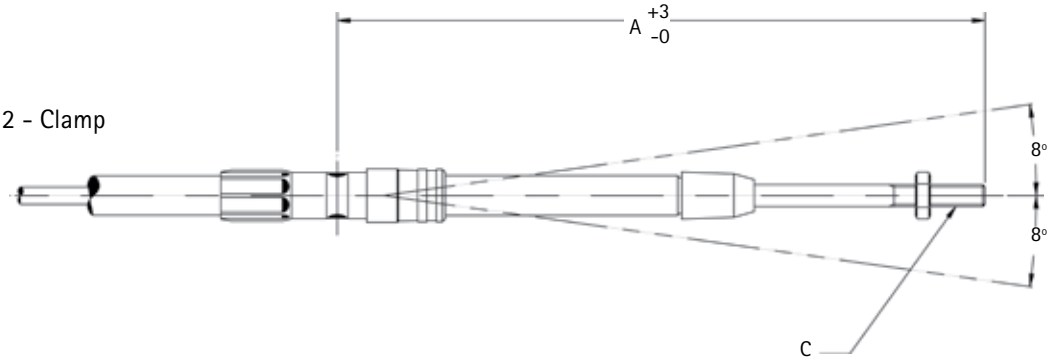
Stage 2:
Select required hub options for both ends of cable

1 - Bulkhead



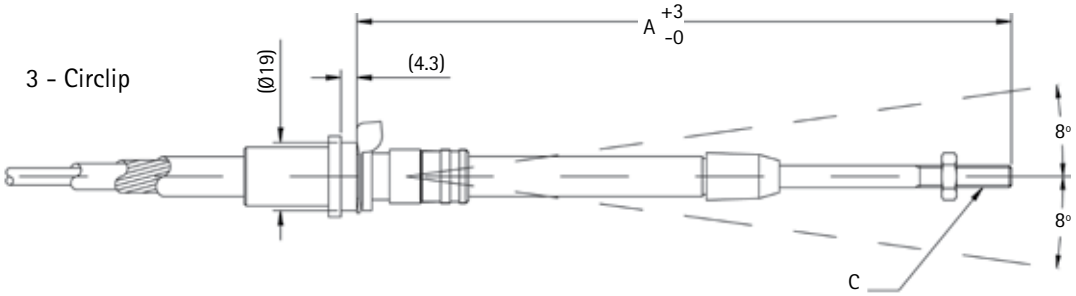
Cable Series	Thread B	Thread C	Dimension A		
			50mm	75mm	100mm
30	M12	M5	149	187	
40/45	M16	M6	159	197	234
60/65	M18	M8		205	234

2 - Clamp



Cable Series	Thread C	Dimension A		
		50mm	75mm	100mm
30	M5	132	170	
40/45	M6	140	178	215
60/65	M8		187	226

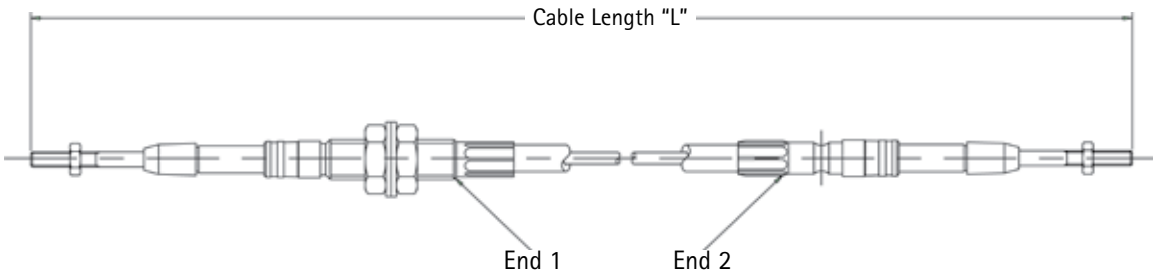
3 - Circlip



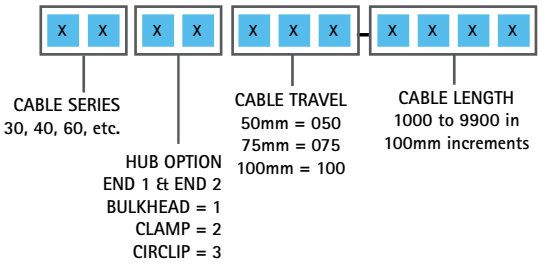
Cable Series	Thread C	Dimension A		
		50mm	75mm	100mm
40/45	M6	130	155	180

All sizes in mm, unless stated

Stage 3:
Choose the cable length (in 100mm increments) suitable for your application



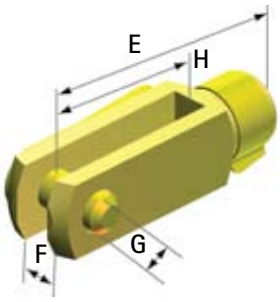
Stage 4:
Configure your Part Number with the information from Stages 1-3 as shown in this diagram.

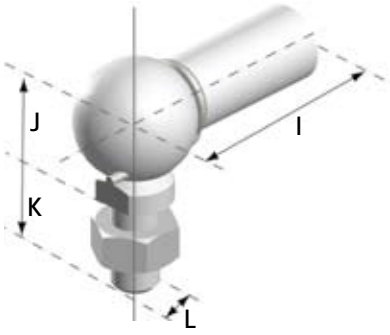


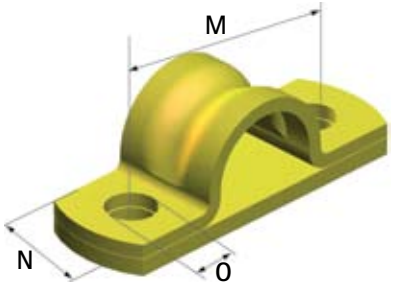
Example: Part Number 40 12 050-2400 represents a 40 Series cable with bulkhead and clamp hubs (1&2), 50mm travel (050), 2.4m long (2400)

ACCESSORY SELECTION

Stage 5:
Choose Cable Accessories to add to your standard cable. Nuts, washers and circlips are included as required. Dimensional information provided; part numbers supplied by Kongsberg Automotive Sales Manager.







Series		Clevis				Ball Joint				Clamp		
		E	F	G	H	I	J	K	L	M	N	O
30s	Std	20	5.2	5	10	22	9	10.2	M5	25.4	13	5.2
	Long	30	5.2	5	20							
40/45	Std	24	6.3	6	12	25	11	12.5	M6	25.4	13	5.5
	Long	36	6.3	6	24							
60/65	Std	32	8.3	8	16	30	13	16	M8	31.8	15.9	7.1
	Long	48	8.2	8	32							

For any additional assistance, other cable accessories, or any other enquiry please consult your Kongsberg Automotive Sales Manager.

All sizes in mm, unless stated

KONGSBERG AUTOMOTIVE

Kongsberg Automotive is a global provider of engineering, design, and manufacturing for seat comfort, driver and motion control systems, fluid assemblies, and industrial driver interface products. We are focused on automotive, commercial vehicle and industrial markets. Headquartered in Kongsberg, Norway, Kongsberg Automotive has nearly 50 facilities in 19 countries. With revenues of MEUR 623 (2009) and about 9,000 employees, Kongsberg Automotive provides system solutions to vehicle makers around the world.

DRIVELINE

Our vision is to be our customers' preferred choice for driver controls in the global light vehicle automotive market. A Tier 1 global supplier of custom-engineered cable controls and complete shift systems, we are world leaders in both control cables and shifter systems for our customers around the world. Our global resources ensure timely innovative product development and high quality manufacturing.

INTERIOR

Kongsberg Automotive is a global leader in the design, development and manufacture of mechanical and electromechanical light-duty motion comfort and seat comfort systems to Tier 1 and Tier 2 customers. Our product portfolio includes seat adjusters, seat recline, side bolsters and lumbar support (pneumatic/mechanical), cables, seat heating, ventilation and massage systems, arm rest and head restraints, as well as other interior actuation systems.

POWER PRODUCTS

Kongsberg Automotive Power Products is a global leader in the design, manufacture and supply of vehicle control systems, providing quality engineered pedal and steering systems, electronic displays, cable and hand controls that set the standard for the world's foremost manufacturers of commercial, industrial, agricultural and construction vehicles. We offer a product range that is unmatched in the market.

ACTUATION & CHASSIS

A global developer and manufacturer of operator control systems for industrial vehicle markets, Kongsberg Automotive offers a robust product portfolio with products that range from traditional mechanical linkages to servo-assisted hydraulic systems and manual and electronic cable shift systems. These modular systems enhance flexibility and ensure cost-effective adaptation to customers' needs.

FLUID TRANSFER

Kongsberg Automotive fluid handling systems serve a wide range of fluid assembly customers in the light duty, industrial and commercial vehicle markets. Products include pipe/hose assemblies for turbo chargers, brake and fuel systems, and air system couplings.

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