

# Performing Reliably

Control Cable Technology



Outdoor Power Equipment

## 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 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.

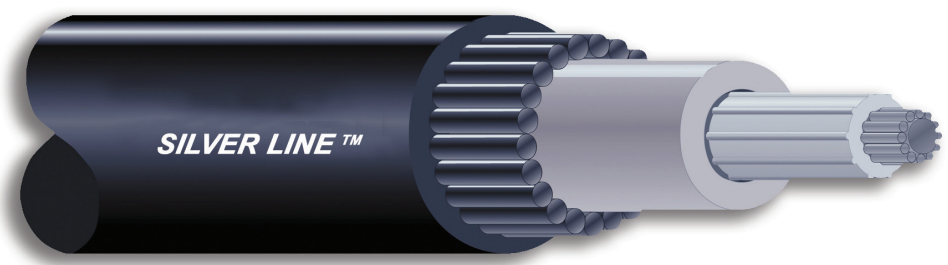


## SERVICE AND COMMITMENT

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.

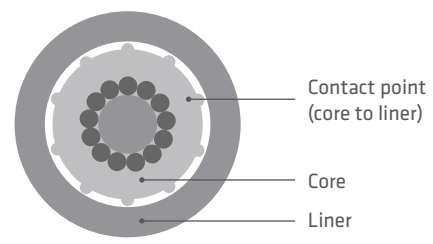


## SILVER LINE™ Cable

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.

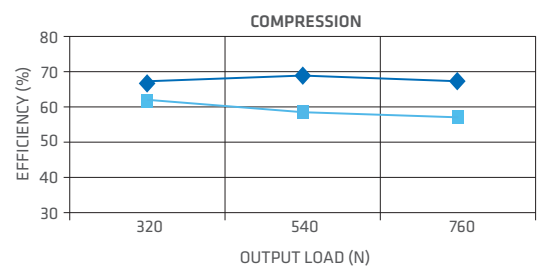
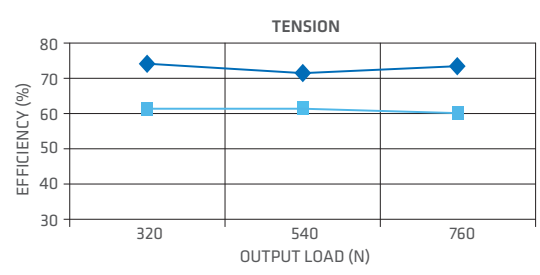
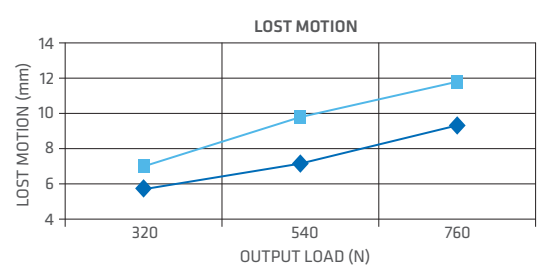
### CROSS SECTION VIEW



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™** outperforms other industry standard control cables for both lost motion and efficiency. Competitor samples were obtained through established after-market 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



## CABLE DESIGN AND APPLICATION

### 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:

$$\text{Input Force} = (\text{Output Load}) (\text{Bend Factor})$$

$$\text{Output Force} = \text{Input Force} / \text{Bend Factor}$$

Total Degrees of Bend in Cable	Bend Factors
90°	1.2
180°	1.4
270°	1.6
360°	1.8
450°	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	100 mm	-
30	200 mm	-
40	200 mm	125 mm
60	250 mm	150 mm
80	300 mm	150mm

## 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:  $\text{Travel} = 2 * \sin(\theta) * \text{length of lever}$

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.

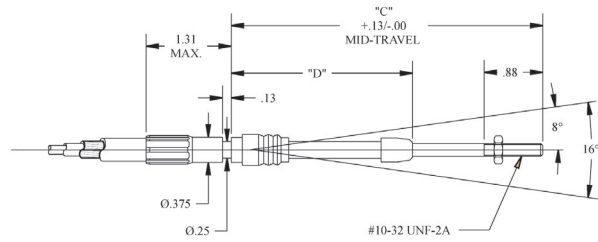
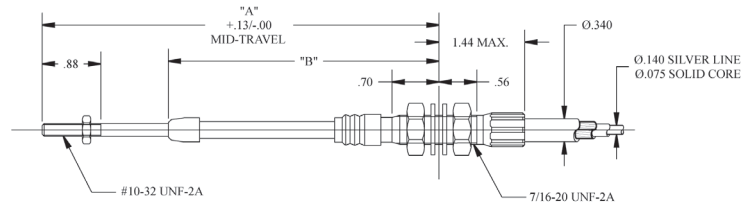
Anchor the cable securely, so that the anchor point will not move as load is applied. In most cases, the cable end must be anchored to the object to be controlled. This is especially important on engine and transmission controls, where power package "roll" could otherwise cause inadvertent operation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

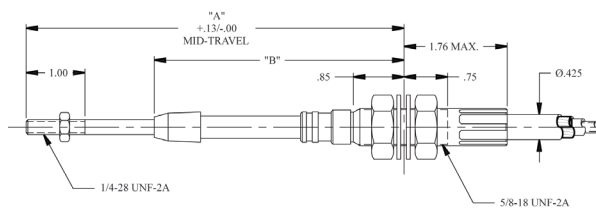
Kongsberg Automotive cables are sealed and resist abrasion and contamination. They should, however, be protected against pinching, shearing and crushing, and the effects of excess heat. The operating ends should be shielded against direct spray and excessive dust.



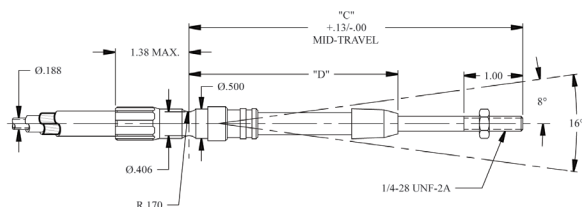
Travel	Bulkhead Type Fitting		Clamp Type Fitting		Input Load Pounds (N)
	"A"	"B"	"C"	"D"	Push/Pull
1"	4.38 (111.2)	3.00 (76.2)	3.69 (93.7)	2.31 (58.6)	50/50 (222/222)
2"	5.88 (149.3)	4.00 (101.6)	5.19 (131.8)	3.31 (84.0)	50/50 (222/222)
3"	7.38 (187.4)	5.00 (127.0)	6.69 (169.9)	4.31 (109.4)	40/50 (178/222)
4"	8.88 (225.5)	6.00 (152.4)	8.19 (208.0)	5.31 (134.8)	30/50 (133/222)
5"	10.38 (263.6)	7.00 (177.8)	9.69 (246.1)	6.31 (160.2)	20/50 (89/222)

All Dimensions are in inches (mm)

40 Series



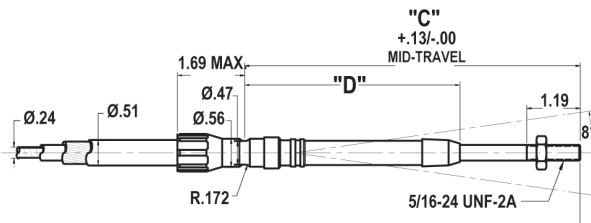
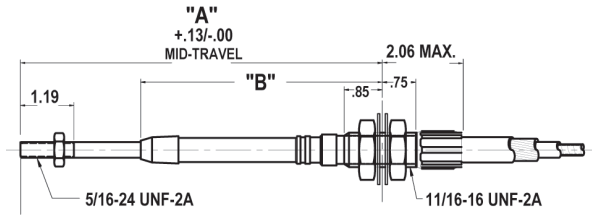
\*Metric Rod Ends are M6 x 1.



Travel	Bulkhead Type Fitting		Clamp Type Fitting		Input Load Pounds (N) Push/Pull
	"A"	"B"	"C"	"D"	
1"	4.63 (117.6)	3.13 (79.5)	4.00 (101.6)	2.50 (63.5)	150/170 (667/756)
2"	6.13 (155.7)	4.13 (104.9)	5.50 (139.7)	3.50 (88.9)	150/170 (667/756)
3"	7.63 (193.8)	5.13 (130.3)	7.00 (177.8)	4.50 (114.3)	130/170 (578/756)
4"	9.13 (231.9)	6.13 (155.7)	8.50 (215.9)	5.50 (139.7)	110/170 (489/756)
5"	10.63 (270.0)	7.13 (181.1)	10.00 (254.0)	6.50 (165.1)	90/150 (400/667)

All Dimensions are in inches (mm)

## 60 Series - Push Pull Cables

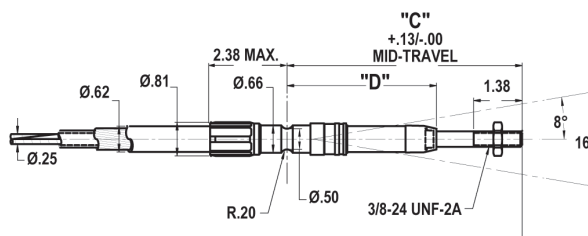
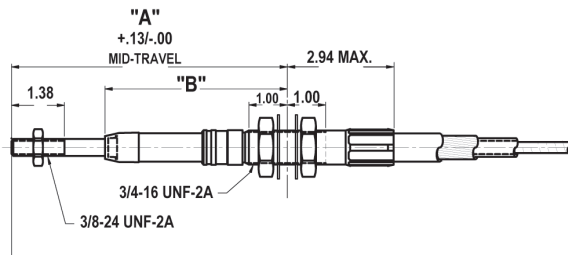


Travel	Bulkhead Type Fitting		Clamp Type Fitting		Input Load Pounds (N) STANDARD & SILVER LINE™
	"A"	"B"	"C"	"D"	
1"	5.06 (128.5)	3.38 (85.8)	4.38 (111.2)	2.69 (68.3)	200/200 (890/890)
2"	6.56 (166.6)	4.38 (111.2)	5.88 (149.3)	3.69 (93.7)	200/200 (890/890)
3"	8.06 (204.7)	5.38 (136.6)	7.38 (187.4)	4.69 (119.1)	180/200 (800/890)
4"	9.56 (242.8)	6.38 (162.0)	8.88 (225.5)	5.69 (144.5)	150/200 (668/890)
5"	11.06 (280.9)	7.38 (187.4)	10.38 (263.6)	6.69 (169.9)	120/200 (534/890)

All Dimensions are in inches (mm)



80 Series - Push Pull Cables



Travel	Bulkhead Type Fitting		Clamp Type Fitting		Input Load Pounds (N) Push/Pull
	"A"	"B"	"C"	"D"	
1"	5.69 (144.5)	3.75 (95.25)	5.19 (131.8)	3.25 (82.55)	700/700 (3113/3113)
2"	7.19 (182.6)	4.75 (120.6)	6.69 (169.9)	4.25 (107.9)	700/700 (3113/3113)
3"	8.69 (220.7)	5.75 (146.0)	8.19 (208.0)	5.25 (133.3)	600/700 (2669/3113)
4"	10.19 (258.8)	6.75 (171.4)	9.69 (246.1)	6.25 (158.7)	500/700 (2224/3113)
5"	11.69 (296.9)	7.75 (196.8)	11.19 (284.2)	7.25 (184.1)	400/700 (1779/3113)

All Dimensions are in inches (mm)

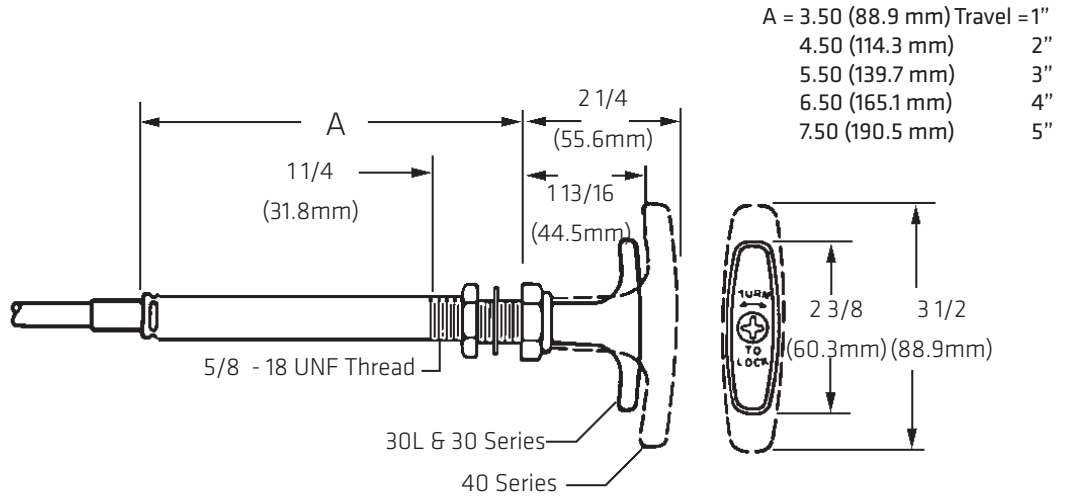
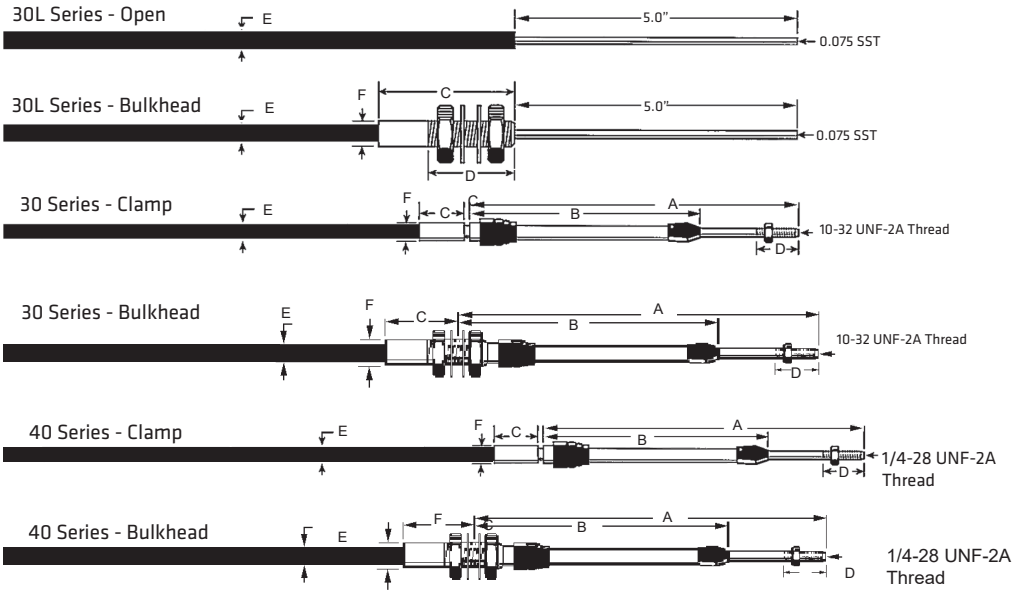
Features:

Positive Locks allow desired settings to be made and released by turning the T-handle less than 1/8 of a turn in either direction.

Positive Lock Cables



Cable End Types



## CABLE DEFINITION

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

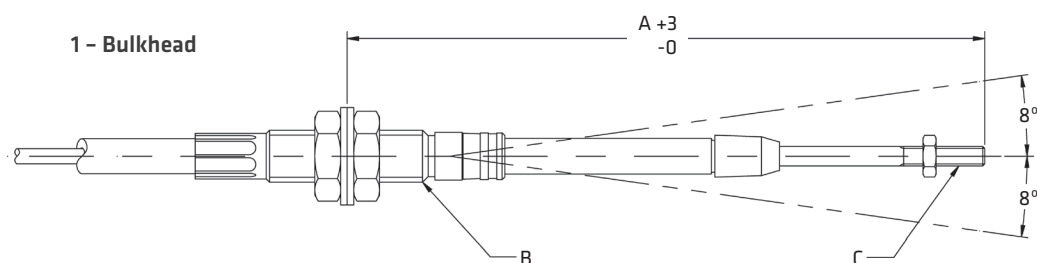
Cable Series	Pull Max Load	Push Max Load			Long Life Minimum Bend Radius
		50mm Travel	75mm Travel	100mm Travel	
30	222N	222N	178N	-	200mm
40	667N	578N	489N	400N	200mm
60	889N	-	800N	667N	250mm

### Stage 1:

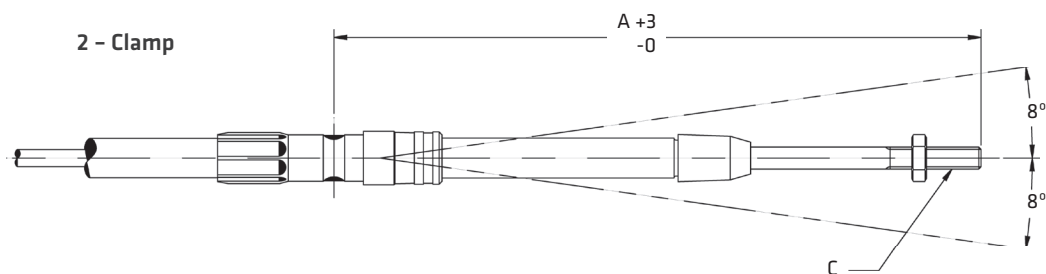
Select cable series and travel based on application requirements

### Stage 2:

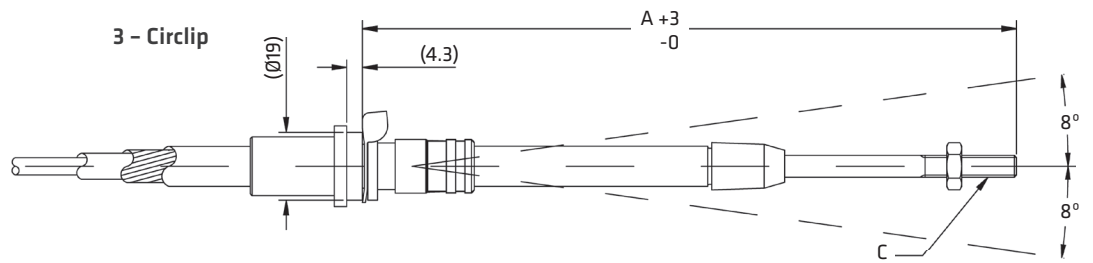
Select required hub options for both ends of cable



Cable Series	Thread B	Thread C	Dimension A		
			50mm	75mm	100mm
30	M12	M5	149	187	-
40	M16	M6	159	197	234
60	M18	M8	-	205	243



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

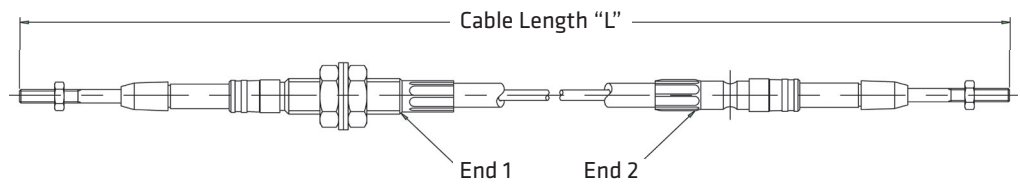


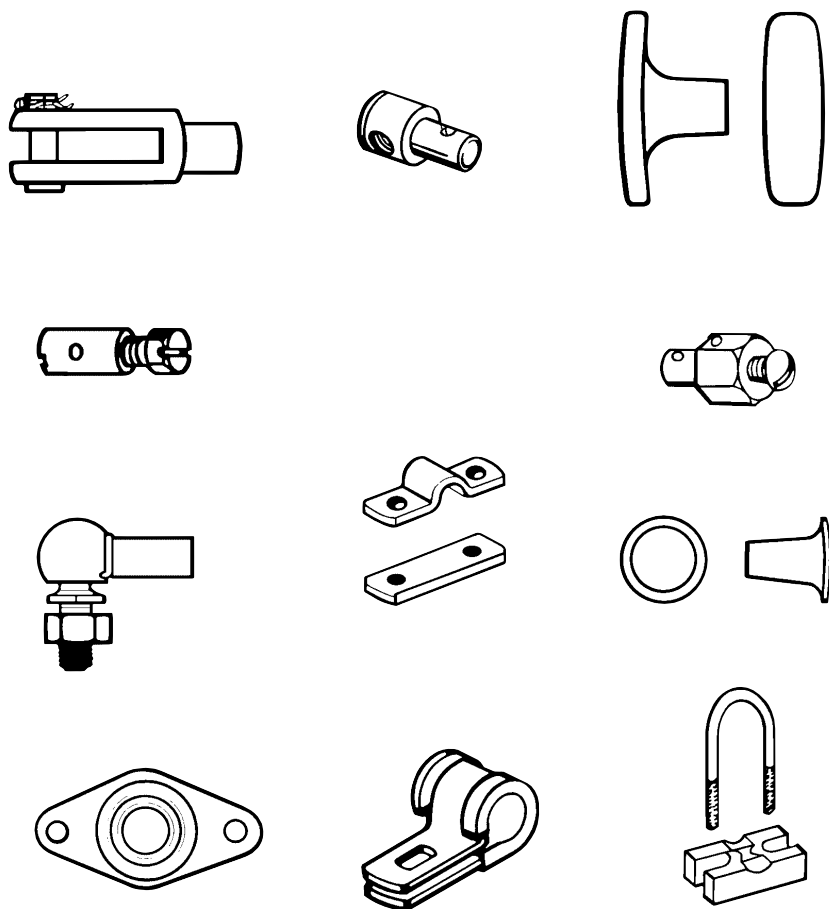
Cable Series	Thread C	Dimension A		
		50mm	75mm	100mm
40	M6	141	179	217

All sizes in mm, unless stated

### Stage 3:

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





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

**Stage 4:**  
Different types of cable accessories available to add to your standard cable.

## THE COMPANY

Kongsberg Automotive provides world-class products to the global vehicle industry. Our products enhance the driving experience, making it safer, more comfortable and sustainable. The Group has three business segments:

### Powertrain & Chassis

The P&C division of Kongsberg Automotive is a global leader in the design, manufacture and testing of custom powertrain and chassis solutions that enhance driver control. We engineer great products for world-leading commercial-vehicle makers.

### Interior

Kongsberg Automotive develops and supplies a world-class range of Interior Comfort Systems and Light Duty Cables & Actuators for the passenger-car, commercial-vehicle and off-highway markets. This business segment's innovations offer vehicle makers easy integration, customization and real cost advantage. Interior is the only supplier in the world that develops and delivers a complete range of seat comfort products.

### Specialty Products

Kongsberg Automotive's Specialty Products division comprises three segments: Off-Highway, Air Couplings and Fluid Transfer Systems. These niche-product business streams are driven by an entrepreneurial focus on innovation and fitment rates. Designing and delivering engineered solutions for the world's premier commercial and off-road vehicle makers helps keep KA atop the global automotive supply chain.



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