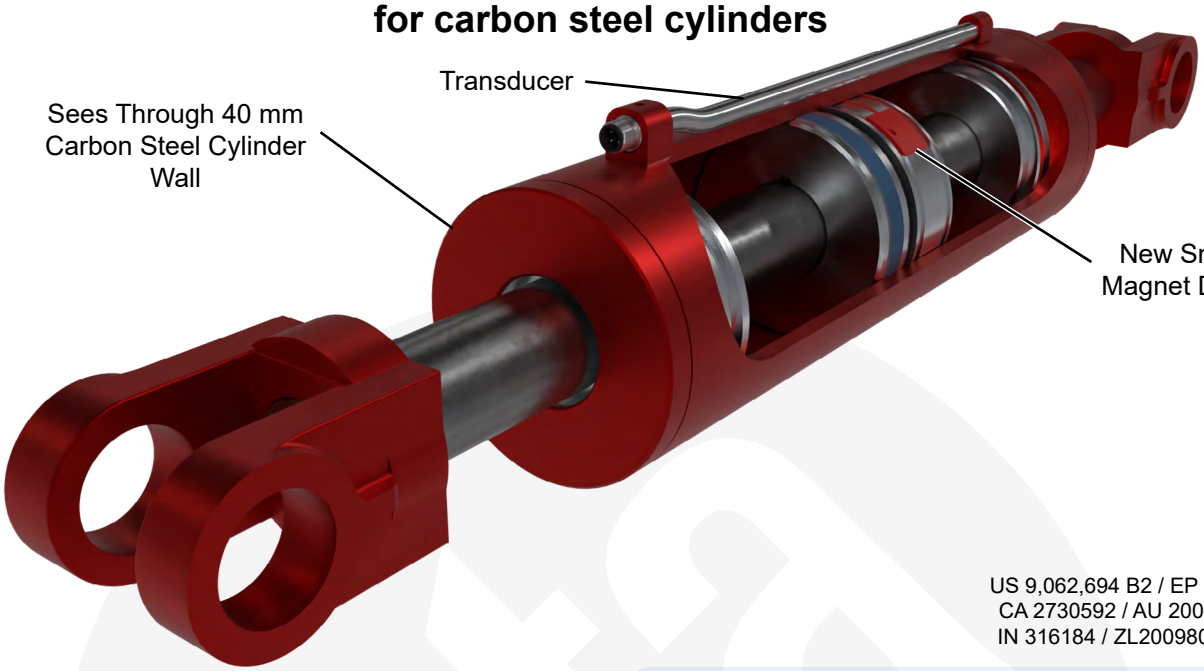
ELU AND MLU SERIES
LINEAR TRANSDUCER CATALOGUE

New externally-mounted linear transducers for carbon steel cylinders



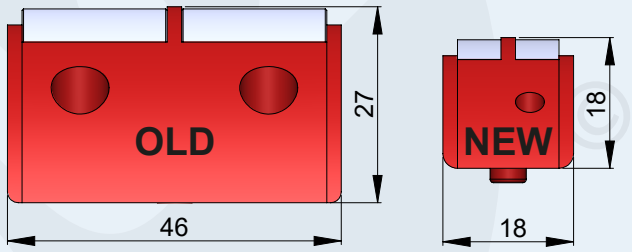
Patented:
US 9,062,694 B2 / EP 2300722 /
CA 2730592 / AU 2009272461 /
IN 316184 / ZL200980127536.3

Rota Limited's patented EL Series linear transducers are perhaps the easiest, lowest-cost solution for achieving a robust smart cylinder with electrical position feedback.

The externally-mounted EL Series transducer detects the position of cylinder's piston by sensing a magnetic field from a permanent magnet embedded in the piston itself.

This method of transducer installation eliminates the need to deep drill the piston rod, providing a cost saving, while retaining the piston rod's strength.

This is of particular use for long-length cylinders, where drilling the piston rod is usually very expensive, and for double-rod steering cylinders that cannot be drilled for internally-mounted linear transducers.

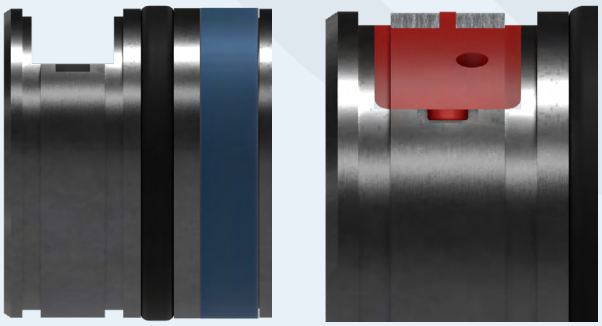


Example ELC Magnet Assembly

Example ELU Magnet Assembly

Example magnet assemblies shown are for a 100 mm bore E355 SR cylinder with 7.5 mm wall, with a max. speed of 250 mm/s.

Larger magnet assemblies are available for higher speeds.



A typical ELU magnet installation involves milling a simple slot in the piston head for the magnet, and a slot or hole for the orientation pin. The magnet assembly is then installed in the slot, with the North pole facing the transducer head/cable end.

The cylinder is then assembled as normal.

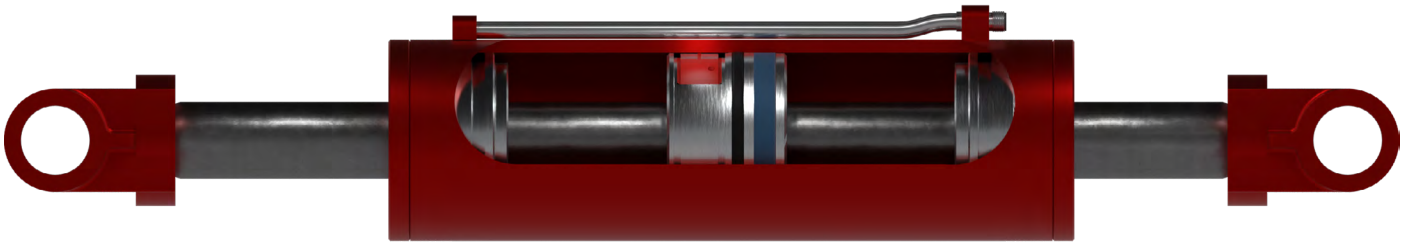
Rota's new ELU Series uses an even smaller magnet assembly, with improved resolution, now up to 0.3 mm!

ELU magnet assemblies are up to 78% smaller volume than ELC magnet assemblies, allowing installation in even smaller cylinders/pistons, with reduced machining cost and time (typical machining cost of 1 €/£/$).

The reduced cross-sectional area of the new ELU magnet assembly also means that 45% less of the piston's cross-sectional area needs to be removed, maintaining even more piston strength.

The new ELU Series magnets have been tested with cylinder walls ≤40 mm thick!

ELU SERIES LINEAR TRANSDUCER CATALOGUE

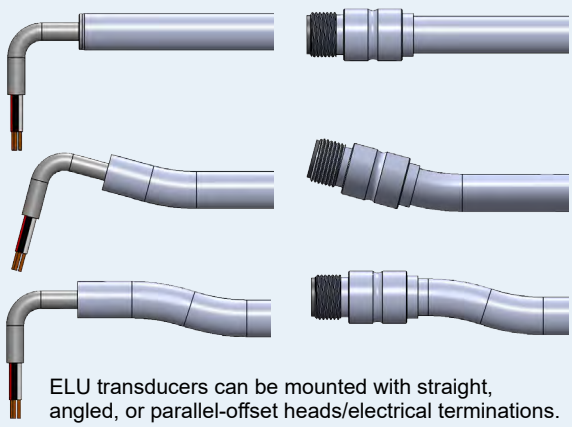


BENEFITS FOR CYLINDER MANUFACTURERS

- New magnet design; up to 78% less volume than ELC magnet assemblies, 45% smaller cross-sectional area
- Very simple low-cost cylinder machining (typical machining cost of 1 €/£/$)
- No gun-drilling of piston rod required
- Maintains piston and piston rod strength
- Cylinder is easier to assemble and service
- No additional hydraulic port required - less oil leakage
- Eliminates need for complicated hydraulic cushions; cylinder can be electronically cushioned, reducing machining costs and reducing the risk of unwanted temperature increases, or oil cavitation

BENEFITS FOR END USERS

- Easily field-replaceable for maximum machine uptime
- Service call-out costs minimised
- Robust, solid-state design
- Ideal for double-rodded steering cylinders where internal sensors cannot be fitted
- Can mount two sensors with one magnet to achieve redundancy
- Magnet can be installed in every cylinder and end users can add transducers only where required



ELU transducers can be mounted with straight, angled, or parallel-offset heads/electrical terminations.

PERFORMANCE

- Absolute signal output
- Up to 0.3 mm signal resolution
- Very robust, high vibration/shock ratings
- UN ECE R10 Automotive EMC specification
- Operating oil temperature -40 to +115°C
- Magnet peak temperature 150°C for cylinder painting

OUTPUTS

- Analogue Voltage/Current/PWM options
- CANbus SAE J1939 and CANopen

See page 8 for more details.

TERMINATION

- Deutsch DT & DTM with Rota IP69K un-mated pins
- Integrated or cable-mounted IP69K rated M12
- PVC or PUR cable with flying leads

See page 4 for more details.

Patented:
US 9,062,694 B2 / EP 2300722 /
CA 2730592 / AU 2009272461 /
IN 316184 / ZL200980127536.3

SENSOR ENCLOSURE

The sensor has a 10 mm diameter Aluminium 6082 enclosure as standard, with Stainless Steel 304L available as an option.

Modular Aluminium 6082 enclosure available for >2.3 m stroke. See MLU option on page 6.

MAGNET HOUSING

The magnet assembly is an extremely robust item, the housing is made of cylinder wear ring material and should never require servicing. The magnet assembly itself has a maximum operating temperature of +115˚C (240˚F), and a maximum storage temperature of +150°C (300°F).

VIBRATION TESTS - INCLUDING RESONANT FREQUENCIES

To assure an extended life for our products, Rota is one of only a few companies that exceed standard requirements during vibration testing. Rota sensors are tested at 20g (RMS) from 10-2000Hz (including resonant frequencies) and held at 1g for one hour at resonant frequencies.

The ELU series electronics have been tested to and exceed the following standards:

IEC 60068-2-64 Random Vibration (including resonant frequencies!) - 10-2000Hz @ 20g (all 3 axes)
Resonant Frequency Search and Dwell Test - 10-2000Hz up to 7 found and each held @ 1g for 1 Hour

SHOCK TESTS

IEC 60068-2-27 (Shock) Total of 3000 shocks (11ms) at 50g (all 3 axes)
Total of 10 shocks (5.5ms) at 100g (all 3 axes)

EMC RATINGS

The ELU series electronics have been tested to and exceed[1] the following standards:

UN ECE Reg. 10.05: October 2014 (AUTOMOTIVE)
EN ISO 14982:2009 (AGRICULTURAL AND FORESTRY MACHINERY)
ISO 13766:2018 (EARTH-MOVING AND BUILDING CONSTRUCTION MACHINERY)

1. ELU series electronics exceed the above requirements with the following performance:
   100 mA - Conducted Immunity (ISO 11452-4)
   200 V/m - Radiated Immunity (ISO 11452-2)

QUALITY

Rota's quality systems were originally approved to British Standard 5750 back in 1986, and are now assessed by B.S.I to ISO 9001:2015. The QA system is also Audited by B.S.I and CSA for Ex certified transducers and connectors.

Rota's environmental management system has achieved ISO 14001:2015 certification.

IMPORTANT INFORMATION

The piston/rod must not rotate in the cylinder (limited rotation such as rod-eye movement can be easily catered for). If the piston must rotate, Rota have an AC or AL design for carbon steel accumulators that can be used on cylinders with moderate end cap load.

The cylinder wall must be consistent thickness throughout the entire stroke-sensing zone.

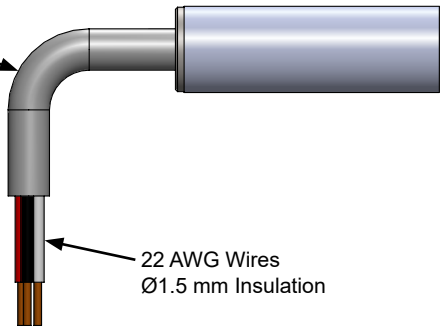
Two-wire 4 to 20 mA output is not available for the ELU series.

CABLE AND CONNECTOR OPTIONS

N - Unscreened PVC Cable

-55°C to +105°C (-67°F to +221°F)

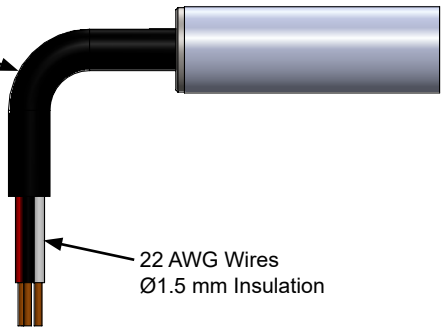
2 & 3 Wires Ø4.8 mm
- for Analogue Outputs
4 Wires Ø4.8 mm
- for Digital Outputs
Min fixed bending radius
25.4 mm at -40°C



U - Unscreened PUR Cable

-40°C to +90°C (-40°F to +194°F)

2 & 3 Wires Ø4.8 mm
- for Analogue Outputs
4 Wires Ø4.8 mm
- for Digital Outputs
Min fixed bending radius
25.4 mm at -40°C



ELU and MLU transducers are available with unscreened PVC or PUR cables, which can both be fitted with any of these connectors:

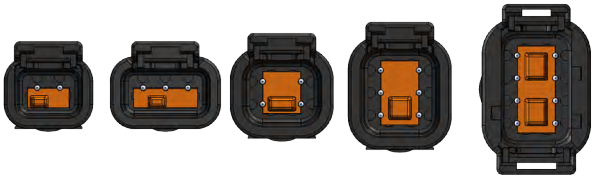
Connector Model Rota pins for DT	Rota Order Code	Connector Model Rota pins for DTM	Rota Order Code	Connector Model AMP Superseal	Rota Order Code	Connector Model M12	Rota Order Code
DT04 2 pin	2RT	DTM04 2 pin	2RM	282104-1	2UP	M12 4 pin	4BH
DT04 3 pin	3RT	DTM04 3 pin	3RM	282105-1	3UP	M12 5 pin	5BH
DT04 4 pin	4RT	DTM04 4 pin	4RM	282106-1	4UP	M12 90° 4 pin	4B9
DT04 6 pin	6RT	DTM04 6 pin	6RM	282107-1	5UP	M12 90° 5 pin	5B9
DT04 8 pin	8RT	DTM04 8 pin	8RM	282108-1	6UP		

Rota/Deutsch DT - Superior Sealing

Deutsch connector with Rota machined male pins
IP69k un-mated (Steam Jet Clean 99°C at 150 bar)
Enables transducer's Deutsch connector to be left safely un-mated

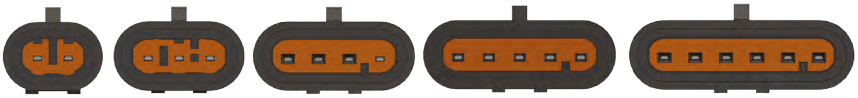
Rota/Deutsch DTM - Superior Sealing

Miniature Rota pins for smaller wire gauge applications
Operating Temperature:
-55°C to +125°C
IP68 rated un-mated



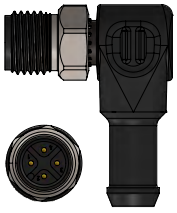
AMP Superseal 1.5 - Series

Operating Temperature:
-40°C to +125°C
IP67 rated when mated



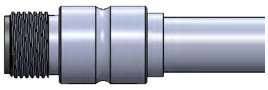
M12 Connector - Straight or 90 Degree

M12 A connector male pins
Operating Temperature:
-25°C to +90°C
IP67 & IP69K rated when mated

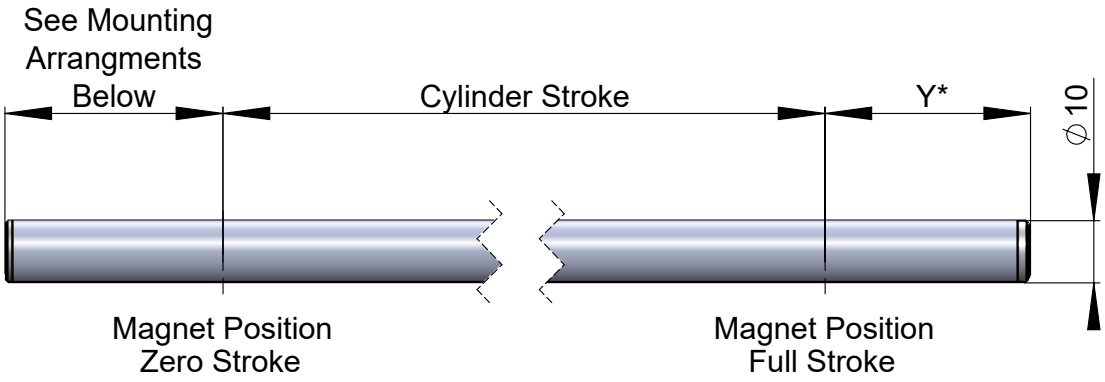


Integrated M12 Connector

IP69k un-mated
(Steam Jet Clean
up to 150 bar [2180 psi]
at 85°C [185°F])
M12 A connector male pins

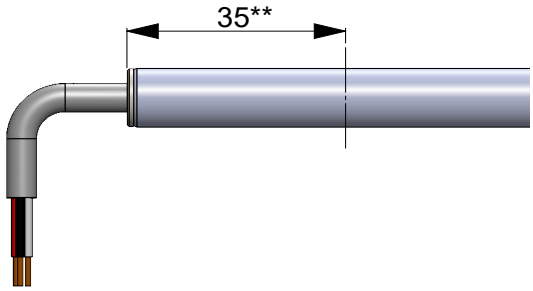


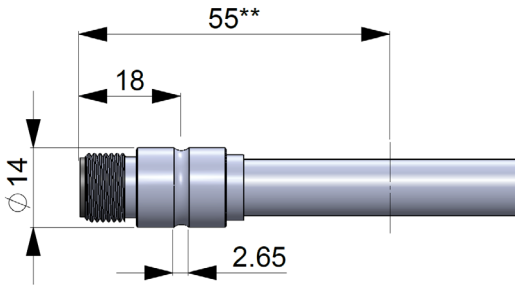
MOUNTING ARRANGEMENTS



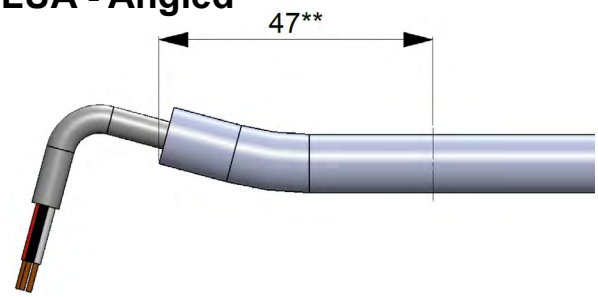
ELU transducers are available with Flat, Angled, or Parallel mounting types. Each mounting type is available with either a cable termination (with a range of connectors if required - see Page 4), or an integrated M12 connector rated at IP69K for steam jet cleaning - up to 150 bar (2180 psi) at 85°C (185°F).
The zero stroke magnet position is affected by the mounting style as shown below.

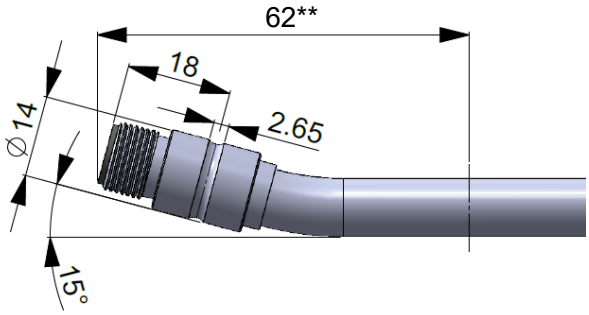
ELUF - Flat



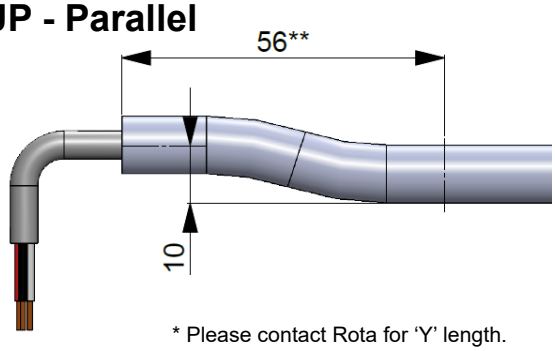


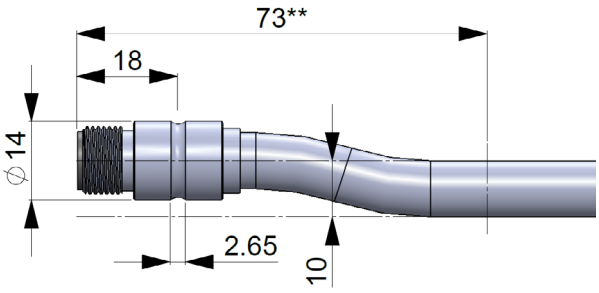
ELUA - Angled





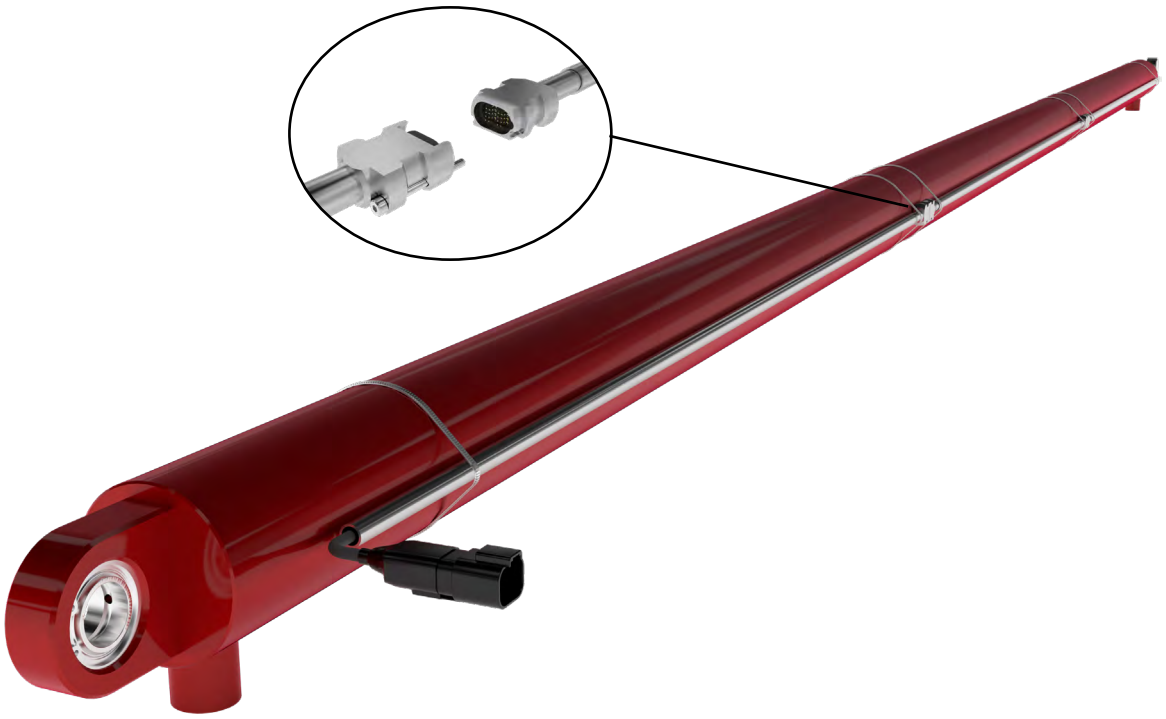
ELUP - Parallel





* Please contact Rota for 'Y' length.
** Minimum Length, can be increased if required. Please contact Rota to confirm this dimension.

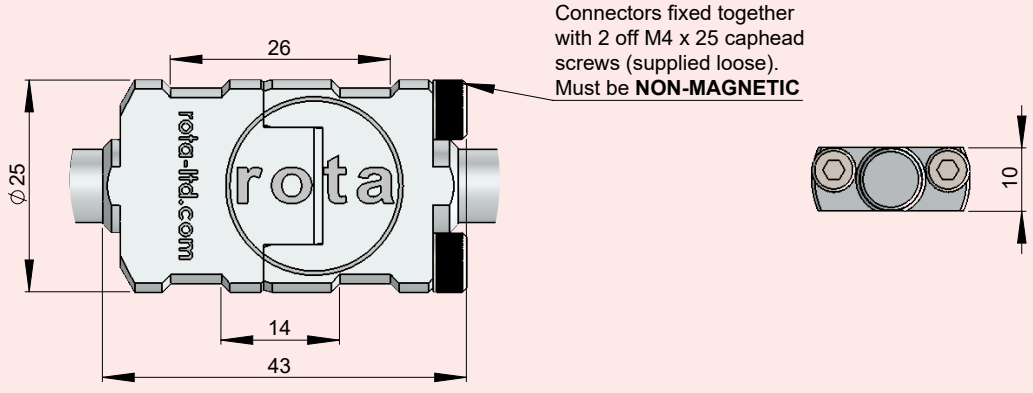
MLU - COMPACT MODULAR VERSION



For long stroke lengths, the MLU's modular sensor enclosure allows the transducer to be shipped and fitted in manageable lengths that simply connect and screw together.

BENEFITS OF THE MLU SERIES

- Ideal for long boom cylinders (up to 40 metre stroke)
- Reduced shipping costs
- Very compact connection joint
- No problems with icing up or dirt contamination, as there are no external moving parts like string pull designs
- No wires to stretch requiring recalibration
- No bird nesting



MLU connection dimensions

INFORMATION ABOUT YOUR CYLINDER PRODUCT BRIEF

Dear Client, to calculate the magnet size for your transducer, please fill in this form with your hydraulic cylinder details, thank you.
For an Excel version of this form, please contact Rota.

Originator:		Date:	
Customer Information:		Contact:	
Company:		Title: Eng.	
Country/State:		Tel No:	
End Customer if known:		Email:	

CYLINDER AND PISTON INFORMATION

Cylinder Number	Cylinder Tube Material	Cylinder Bore Diameter (mm)	Cylinder Wall Thickness
1			
2			
3			
4			
5			

Note: Preferred cylinder tube materials, and thinner cylinder walls will utilise smaller magnet assemblies.

Cylinder Number	Stroke Length (mm)	Max. Piston Speed	Max. Angle of Rod Rotation (±)	Max. Oil Temperature (°C) (up to 113°C [235°F])	Rod Type
1					
2					
3					
4					
5					

Note: Lower speed, angle of rod rotation below ±5°, and lower operating temperature will utilise smaller magnet

Cylinder Number	Initial Prototype Quantity	Estimated Annual Quantity	UTCN (to be completed by Rota)
1			
2			
3			
4			
5			

Any Certification/Documentation Required:	
Other information you feel may help:	

STANDARD PERFORMANCE DATA

Stroke	Up to 5.8 m [228"] for ELU, up to 40 m [1600 "] for modular version (MLU)									
Resolution including ripple	0.3 mm, 0.4 mm, and 0.5 mm available dependent on cylinder properties. Please contact Rota for details.									
Repeatability Hysteresis Non-linearity	Dependent on cylinder properties. Please contact Rota for details.									
Operating and Storage Temperature	Sensor rod: -40°C to + 105°C (Max. operating oil temperature +115°C) Magnet assembly: -40°C to +150°C									
Surge Protection	Tranzorb Protection Diode (BS EN 61000-4-5 Compliant)					ISO 7637-2 & ISO 7637-3				
Short Circuit Protection	All types protected to maximum input voltage									
Electrical Protection	All types fully protected against incorrect connection (all wires) to maximum input voltage Supply Reverse polarity protection up to -36V DC									
Analogue Outputs										
Update Frequency	Update Frequency 550Hz - any length									
Update Period	1.8 ms; any length - gives 1.8 mm [0.071 "] resolution at 1 metre/second magnet speed. 1.8 ms; any length - gives 0.9 mm [0.035 "] resolution at 0.5 metre/second magnet speed.									
Start-up Time	< 120 ms									
Analogue Outputs *(custom output on request)*	0.5 - 3.5V	0.25 - 4.75V	0.5 - 4.5V	0.5 - 10V	0.5 - 4.5V	0.5 - 4.75V	0.5 - 5.0V	4 - 20mA		4 - 20mA 1.0 - 5.0V
Order Code	C	F	G	H	L	R	V	A[1]	B[2]	BU[3]
Input Voltage	4 - 10V	9 - 32V	9 -32V	13 - 32V	5 - 10V	9 - 32V	9 - 32V	13 - 32V	10 - 18V	10 - 30V
Current Consumption (~)	10mA	11.5mA	11.5mA	11.5mA	10mA	11.5mA	11.5mA	12mA + Signal	12mA + Signal	12mA + Signal
Power Consumption	0.04W (5V)	0.2W (24V)	0.2W (24V)	0.2W (24V)	0.04W (5V)	0.2W (24V)	0.2W (24V)	0.7W (24V)	0.35W (12V)	0.35W (12V)
Magnet Off-Stroke Output	~0.2V	~0.2V	~0.2V	~0.2V	~0.2V	~0.2V	~0.2V	0.7mA	0.7mA	0.7mA & 0.2V

1. Three wire current output signal type "A" designed for a 24V Input, 500Ohm load. For other input voltages and load resistances please inform Rota
2. Three wire current output signal type "B" designed for a 12V Input, 250Ohm load. For other input voltages and load resistances please inform Rota
3. Three wire current output signal type "BU" designed for a 12V Input, 250Ohm load. For other input voltages and load resistances please inform Rota

Digital Outputs[4, 5]				
Position Resolution	CAN	0.1 mm per bit - any length (Standard)		Higher bit resolution available on request to Rota
Update Frequency	CAN	J1939 and CANopen - 1100 Hz - any length		
Update Period	J1939	0.9 ms; any length - gives 0.9 mm [0.035 "] resolution at 1 metre/second magnet speed		
	CANopen	0.6 ms; any length - gives 0.45 mm [0.018 "] resolution at 0.5 metre/second magnet speed		
Start-up Time	J1939	< 10 ms		
	CANopen	< 250 ms		
Digital Output	**CANopen (CiA 301)**		**SAE J1939**	**P.W.M**
Order Code	O		J	P
PWM Frequency	-			500Hz
Duty Cycle	-			1 - 99%
Magnet Off-Stroke Output	Magnet Error Byte			0.5% Duty Cycle
Input Voltage	9 - 32V			
Temperature Co-Efficient (~)	±15ppm/°C [±0.0008%/°F] +0.002mm/°C			
Current Consumption (~)	20 mA			8mA
Power Consumption (~)	0.48W (24V) or 0.24W (12V)			0.2W (24V)

4. Canbus test kit 'LJ 2914' available, please contact Rota
5. You will be asked to complete a CAN order form with your desired parameters

Environmental Performance

Sensor Enclosure	Aluminium 6082 T6 as standard, Stainless Steel 304L optional
Vibration Tests	IEC 60068-2-64 Random Vibration (including resonant frequencies) - 10-2000Hz @ 20g (all 3 axes) Resonant Frequency Search and Dwell Test - 10-2000Hz up to 7 found and each held @ 1g for 1 Hour
Shock Tests	IEC 60068-2-27 (Shock) Total of 3000 shocks (11ms) at 50g (all 3 axes) Total of 10 shocks (5.5ms) at 100g (all 3 axes)
EMC	UN ECE Reg. 10.05: October 2014 (AUTOMOTIVE) EN ISO 14982:2009 (AGRICULTURAL AND FORESTRY MACHINERY) ISO 13766:2018 (EARTH-MOVING AND BUILDING CONSTRUCTION MACHINERY) 100 mA - Conducted Immunity (ISO 11452-4) 200 V/m - Radiated Immunity (ISO 11452-2)
Ingress Protection	IP69K Sensor enclosure available (dependent on mounting configuration - see page 5) IP69K Connector options available (see page 4)

CE

HOW TO ORDER

ELU	-	F	0500	A	0.3	A	R	-	J	-	1234

Transducer Type
ELU = Single-part enclosure
MLU = Modular enclosure

Optional
B = Stainless Steel 304L sensor enclosure

Mounting Configuration
A = Angled
F = Flat
P = Parallel Offset

Stroke (mm)

Magnet Length (Designated by Rota)
A, B, C, etc.

Signal Resolution (Determined by cylinder characteristics)
0.3 mm, 0.4 mm, or 0.5 mm

Output Signal

A	= Current 4 to 20 mA (3 Wire)	(13 to 32 V Input)
B	= Current 4 to 20 mA (3 Wire)	(10 to 18 V Input)
C	= Voltage 0.5 to 3.5 V	(4 to 10 V Input)
F	= Voltage 0.25 to 4.75 V	(9 to 32 V Input)
G	= Voltage 0.5 to 4.5 V	(9 to 32 V Input)
H	= Voltage 0.5 to 10.0 V	(13 to 32 V Input)
J	= CANbus SAE J1939	(9 to 32 V Input)
L	= Voltage 0.5 to 4.5 V	(5 to 10 V Input)
O	= CANopen	(9 to 32 V Input)
P	= P.W.M 500 Hz	(9 to 32 V Input)
R	= Voltage 0.5 to 4.75 V	(9 to 32 V Input)
V	= Voltage 0.5 to 5.0 V	(9 to 32 V Input)

Optional
R = Reversible signal

Optional
2RT = Deutsch DT04-2P with Rota contacts
3RT = Deutsch DT04-3P with Rota contacts
4RT = Deutsch DT04-4P with Rota contacts
6RT = Deutsch DT04-6P with Rota contacts
2RM = Deutsch DTM04-2P with Rota contacts
3RM = Deutsch DTM04-3P with Rota contacts
4RM = Deutsch DTM04-4P with Rota contacts
6RM = Deutsch DTM04-6P with Rota contacts
4BH = M12 connector (Moulded) - 4 pin [PUR cable only]
5BH = M12 connector (Moulded) - 5 pin [PUR cable only]
4B9 = 90° M12 connector (Moulded) - 4 pin [PUR cable only]
5B9 = 90° M12 connector (Moulded) - 5 pin [PUR cable only]

Electrical Termination
J = Integrated M12 Connector
N = PVC Cable
U = PUR Cable

Cable Length (m)
Standard lengths:
0.15, 0.3, 0.5, 1.0, 1.5, 2.0

Unique Transducer Calibration Number