



Instruction Manual

RSL51

Hall-effect Cylinder Sensor

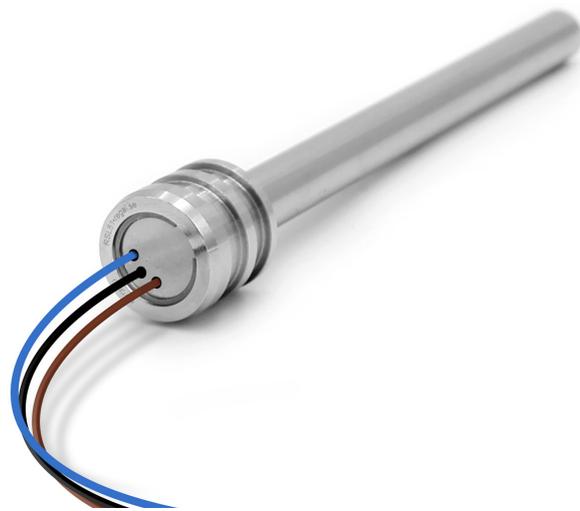


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1. Introduction

1.1. Document description

This document contains technical data, instructions for installation and commissioning of the product.

1.2. Target group

This document is intended for installation and commissioning technicians, design engineers and machine operators.

1.3. Referred documents

- RSL51 Cylinder Sensor Datasheet
- 6160 Connector Solder Free Datasheet

1.4. Intended use

The RSL51 linear position sensor together with an application control system constitutes a positioning measurement system. The sensor is intended to, but not limited to, be installed in hydraulic cylinders used in mobile off highway applications. For other applications, verify compatibility with applicable specifications before use.

The specifications of the sensor are valid only when adhering to the installation requirements outlined in this manual.

The sensor is not intended to be installed in a non-ferromagnetic construction without adhering to the specified ferromagnetic zone in the piston, see chapter "4.8. Magnet assembly installation" on page 11.

1.5. Product liability

Regal is not liable for damages in case:

- The product is incorrectly installed, operated or maintained.
- The sensor wire lead seal is disassembled.
- The product is used together with accessories that are not original accessories from Regal.

1.6. Transportation

- Transport the sensor in its original packaging or in an equivalent container.
- When transporting a cylinder equipped with the RSL51 sensor and 6160 M12 connector, use a protective cap on the connector. The connectors ingress protection is not valid when not equipped with its mating connector.

1.7. Storage

Correct storage prior to installation is necessary to ensure proper function. Obey the storage instructions below.

Part	Storage instruction
O-rings	The sensor includes O-rings made of NBR. Improper storage can lead to the aging of the O-rings, which may compromise the performance of the sensor. Take necessary precautions to prevent the aging of the O-rings supplied with the sensor.
Chassis	Handle the sensor with care to avoid physical damage. Do not place heavy objects on top of the sensor or subject it to mechanical stress.
Connector (6160)	Use a ≥IP54 sealing cap to protect connectors when not connected to the sensor.
Packaging	Store the sensor in its original packaging or in an equivalent container.

1.8. Disposal

The RSL51 sensor is an EEE (Electrical and Electronic Equipment) and shall be handled as such. Consult national and regional regulations for disposal.

2. Safety

2.1. Introduction

This chapter gives safety information about the product.

2.2. Safety definitions

Warnings and notes are used to point out specially important parts of the manual.

Warning

If you do not obey these instructions, there is a risk of personal damage, damage to the product, other materials, or the adjacent area.

Note

Information that is necessary in a given situation.

2.3. General safety instructions

- Installation and commissioning of the product should only be carried out by qualified personnel with fundamental electrical knowledge.
- Qualified personnel are those who, through their experience, can identify potential hazards and implement necessary safety measures related to the tasks at hand.
- The operator is responsible for ensuring compliance with applicable safety regulations and must take precautions to prevent hazardous events in case of sensor malfunction.

2.4. Safety instructions for dismantling

Warning

- Ensure that the sensor is disconnected from power before it is dismantled. Otherwise there is risk of personal damage and damage to the sensor.
- Ensure that the hydraulic system is not pressurized when the sensor is dismantled to avoid risk of personal injury.
- Use safety glasses and keep a finger on the retaining ring when it is dismantled. It can flick away and be lost.

2.5. Symbols on the product

- A QR code is attached to the product. The scannable code contains a text string that includes the product type and the serial number of the sensor.
- The sensor header is laser-marked with the product family identifier and web address to Regal official website.

- The packaging label has product information such as the configuration code, part number, and serial number. The CE and WEEE marks are affixed to the label. A scannable QR code provides access to this manual.

Symbol	Description
	QR-code, on the sensor and on the packaging
	CE-mark
	WEEE-symbol (Waste of Electrical and Electronic Equipment)

3. Product overview

3.1. Introduction

This chapter describes the product.

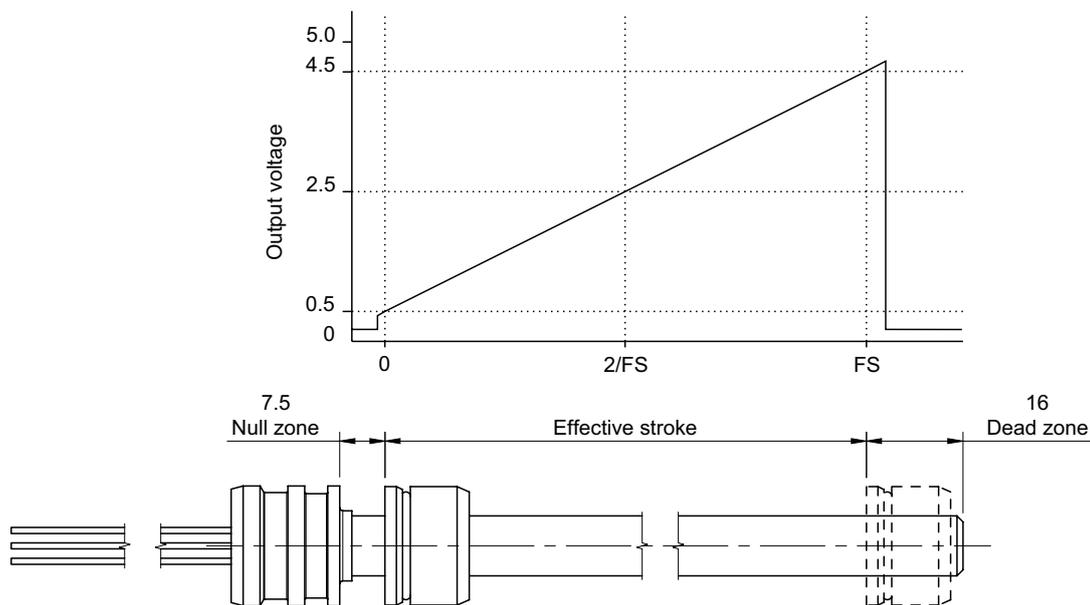
3.2. Product description

The RSL51 sensor is a linear position sensor intended to be installed in hydraulic cylinders where accurate feedback of the piston position is needed for the control of various functions. The sensor provides an analog signal ranging from 0.5 to 4.5 V. With its small installation dimension, it is especially well suited for applications with small hydraulic cylinders where space is at a premium.

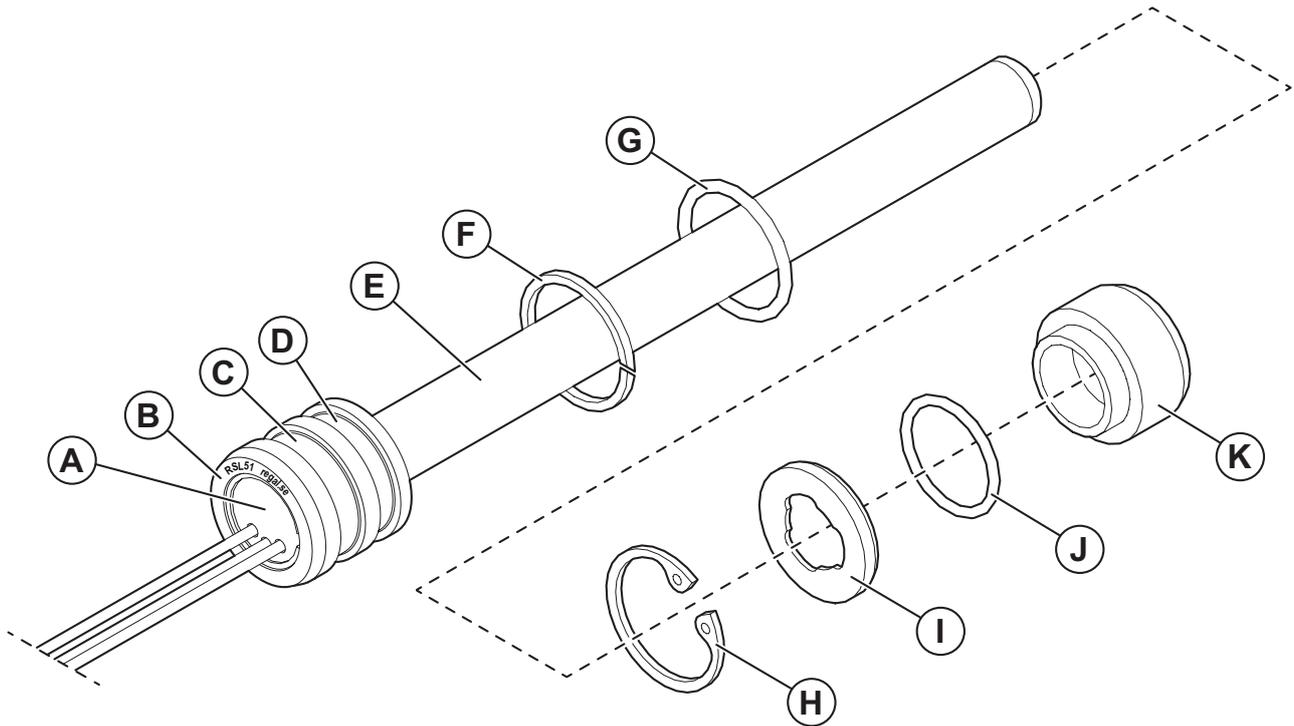
The RSL51 sensor contains an array of hall-effect sensors housed in a stainless steel chassis. A surrounding ring magnet, mounted in a sliding ferromagnetic piston, influences the output of the hall-effect sensors. Data from the hall-effect sensors are then processed by an algorithm which determines the position of the piston.

3.3. Signal output

The sensor provides a linear proportional output signal between 0.5–4.5 V over the effective stroke. Error signaling is defined as < 0.3 V.



3.4. Product overview



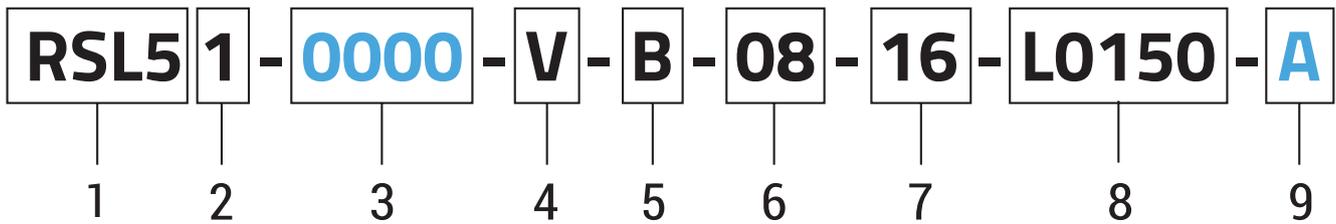
Position	Part name
A.	QR-code
B.	Sensor header
C.	Set screw groove
D.	O-ring groove
E.	Sensor rod
F.	Back-up ring
G.	O-ring (17.17x1.78 NBR shore 70)
H.	Retaining ring
I.	Magnet cover
J.	Manget O-ring (NBR shore 70)
K.	Magnet shell with magnet

3.5. Scope of delivery

Upon delivery and before you install the product, check that the integrity of the RSL51 sensor is not compromised. Check the following:

- Inspect the sensor header and O-ring groove for any damage.
- Verify that the sensor rod is not bent or otherwise compromised.
- Check the sensor wire leads for any damage.
- Ensure that the magnet is free from scratches, cracks, and foreign ferromagnetic objects.
- Confirm that the supplied O-rings are in good condition.

3.6. Configuration code



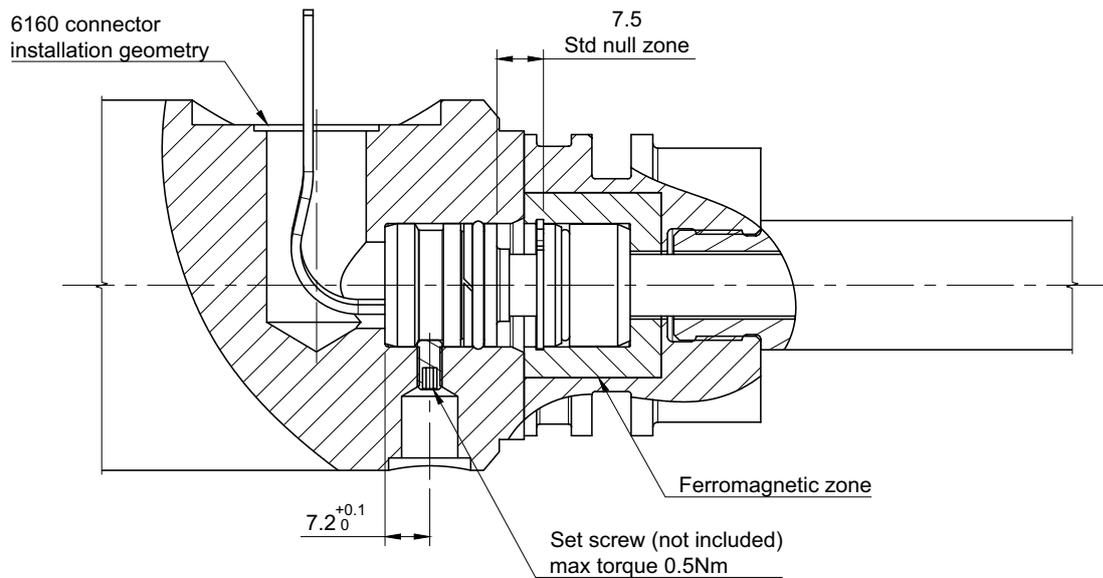
Pos	Description	Configurations	Function
1	Product family identifier	RSL5	
2	Header type	1	
3	Effective stroke	50...400	50 mm increments
4	Output	V	0.5 - 4.5 V
5	Operating voltage	B	9 - 32 VDC
6	Null zone	08	8 mm null zone (std)
7	Dead zone	16	16 mm dead zone (std)
8	Wire lenght	L0150	150 mm flying leads (std)
9	Contact option	Blank	No connector (std)
		A	Flying leads equiped with 6160 crimp contacts

4. Installation

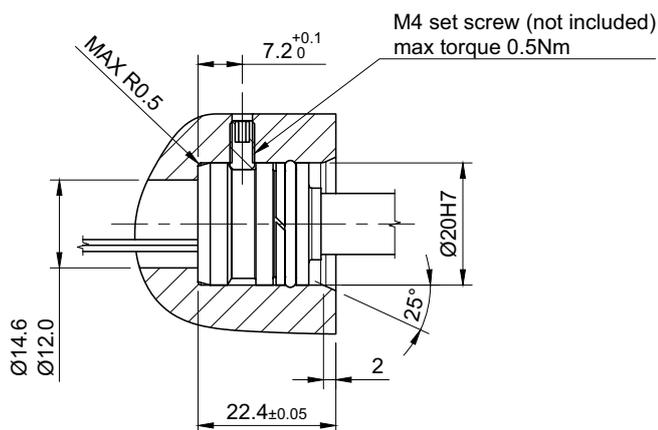
4.1. Introduction

This chapter describes how to mechanically install the parts in the scope of delivery in a hydraulic cylinder.

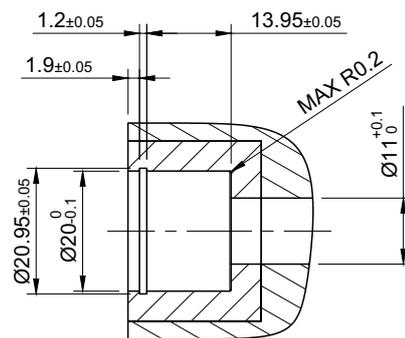
4.2. Overview of installation



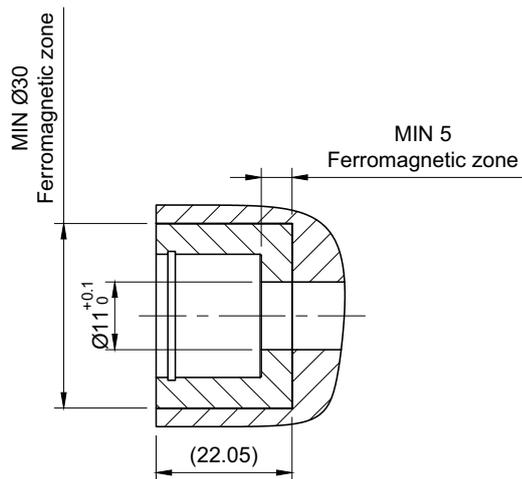
4.3. Header installation cylinder interface



4.4. Magnet assembly installation piston interface



4.5. Minimum ferromagnetic zone requirements



Warning

- Ensure that the piston material is ferromagnetic steel. The sensor will not function if the piston is solely made out of non-ferromagnetic materials such as stainless steel or aluminium.
- Ensure that the piston geometry surrounding the magnet assembly cavity adheres to the requirement.
- Ensure that the specified ferromagnetic material zone is used. Otherwise, the performance of the sensor will be compromised

4.6. Tools and materials needed

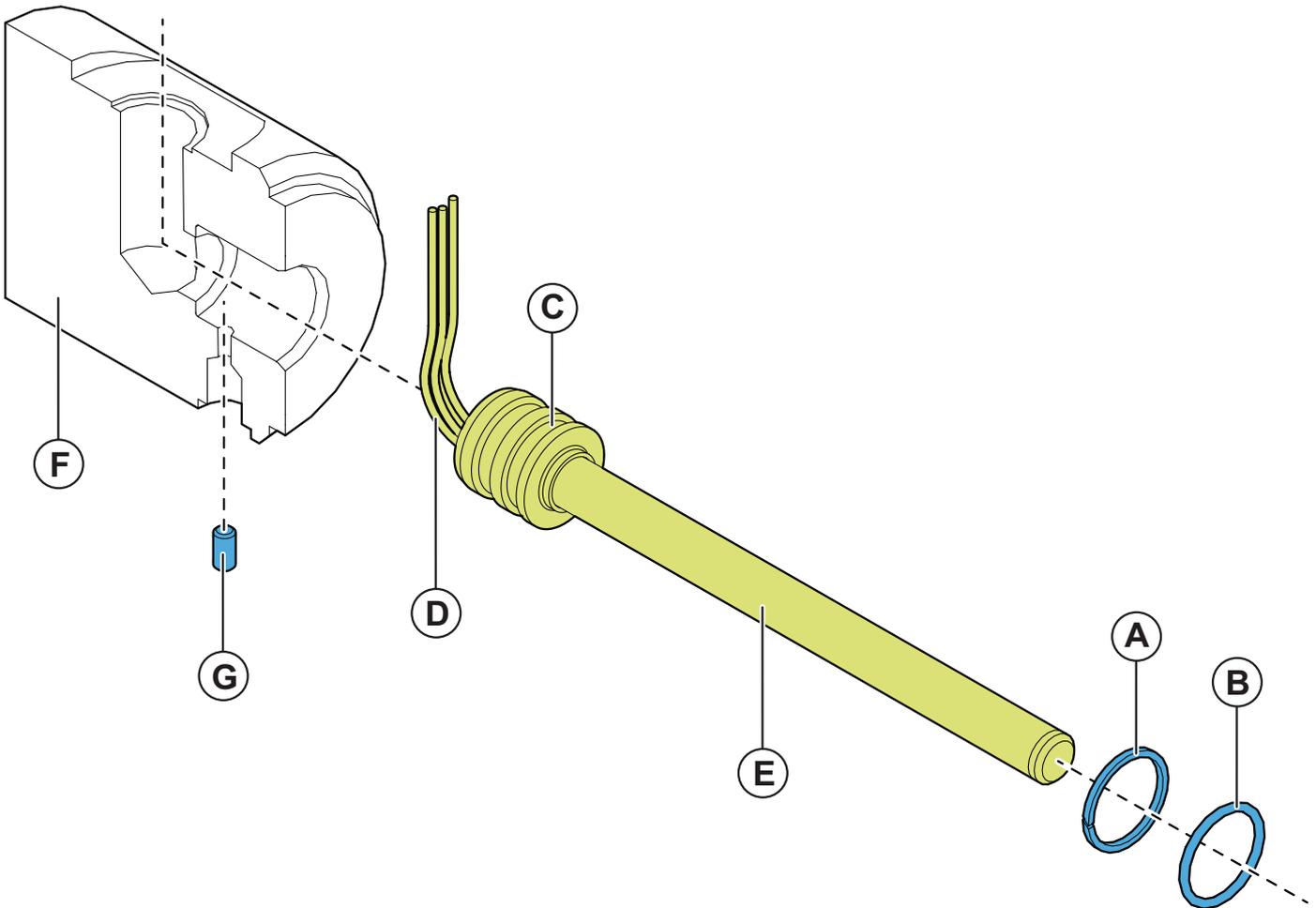
The following tools and materials are required for the installation:

- Internal circlip pliers
- Torque screwdriver
- Flat point set screw (M4)
- Hydraulic oil
- Locking/sealing compound (optional)

Warning

Ensure that the set screw has a flat point. A sharp point can damage the sensor header and compromise the pressure seal.

4.7. Sensor installation



1. Mount the back-up ring (A) and O-ring (B) in the O-ring groove (C) in the header as the illustration shows. Lubricate the O-ring with hydraulic oil to ease the installation.

2. Feed the sensor wire leads (D) through the bore hole ($\varnothing 14$) up to the connector mount.

3. Gently push the sensor rod (E) in a straight motion, into its fitting bore in the cylinder (F).

4. When the sensor head is properly seated in its cavity, fasten the sensor with the flat point set screw (G) using a torque screwdriver. The maximum allowed tightening torque is 0.5 Nm.

Note

Make sure the parts are installed in the order described in the text.

Warning

Do not pull on the sensor wire leads, as this can damage the sensor.

Warning

- Be careful to not damage the O-ring and back-up ring in the process.
- Ensure that the wire leads are not pinched against the back wall of the chassis.

Warning

- The force from the hydraulic pressure should be applied to the back of the sensor head against the cylinder body, not on the set screw.
- Do not tighten the set screw more than 0.5 Nm. Over-tightening the set screw may cause damage to the sensor head and compromise the pressure seal.

Note

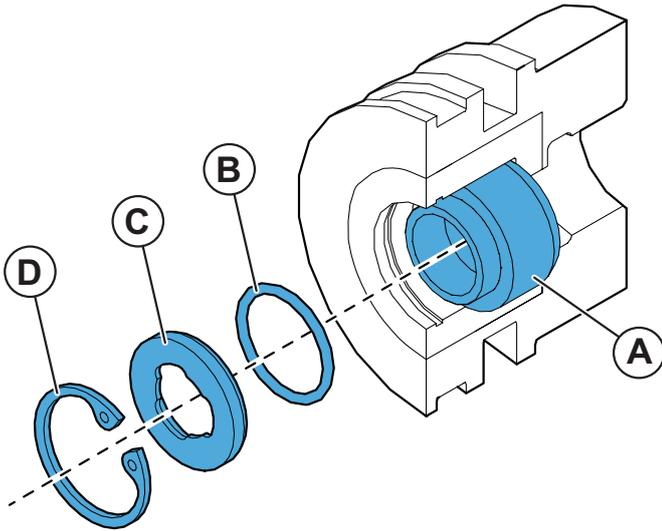
It is good practice to use a suitable locking/sealing compound for the set screw.

4.8. Magnet assembly installation

1. Insert the magnet shell (A) with the magnet into its cavity in the piston.

Warning

- Use the magnet provided with the sensor, they are calibrated together. Mixing of magnets reduce sensor signal performance.
- Ensure that the magnet is installed in the correct orientation.



2. Place the magnet O-ring (B) around the protruding circumference of the magnet and towards the magnet shell.
3. Place the magnet cover (C) over the magnet O-ring.
4. Using internal circlip pliers, secure the magnet assembly in place with the retaining ring (D).

5. Electrical connection

5.1. Introduction

This chapter describes how to do the electrical connections of the sensor.

5.2. Sensor wire leads connection

Color	M12 pinning	Function
Brown	1	Operating voltage
Blue	3	GND
Black	4	Output signal

5.3. Connector

In its standard configuration, the RSL51 sensor is equipped with wire leads without crimp contacts, allowing the freedom to choose a connector suitable for the intended application.

The sensor wire leads is also available with crimp contacts for installation with an M12 connector, model 6160.

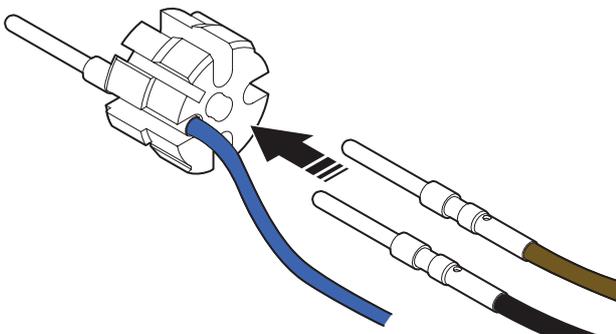
The 6160 connector consists of:

- Crimp contacts (x3)
- Contact carrier (x1 red)
- Insulating body (x1 black)
- Housing (Zinc die-cast, nickel-plated)
- O-ring (NBR)

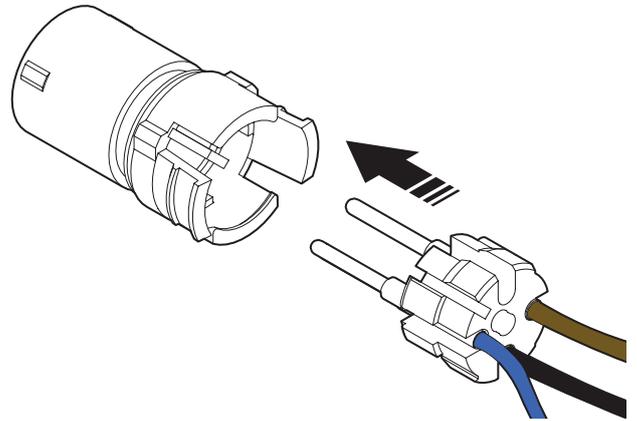
See chapter "5.4. Installing the 6160 connector" on page 12 for installation instructions.

5.4. Installing the 6160 connector

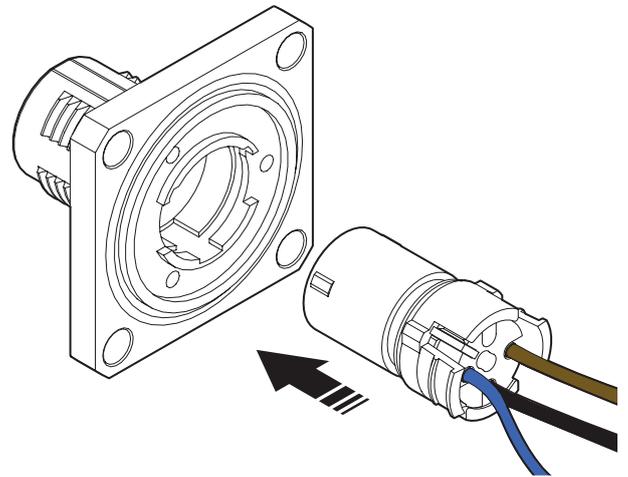
1. Insert the crimp contacts on the sensor wire leads into the red contact carrier.



2. Observe the coding when inserting the contact carrier into the black insulating body.



3. Place the O-ring in its groove in the housing.
4. Insert the insulation body with contact carrier and sensor wire leads into the housing. The insulation body shall click into place. To remove the insulation body, press the two locking clips.



5. Mount the assembled contact to the cylinder. Use a tightening torque of 1.0-1.2 Nm.

Note

Please note that the required 4xM3 screws are not in the scope of delivery.

5.8. Connecting mating connector

Permissible mating connectors: M12 field connectors in accordance with IEC 61076-2-101.

- Axially screw the M12 field connector onto the 6160 M12 connector and tighten to specified torque. Recommended torque 0.4 Nm.

5.9. Cable routing and shielding

1. Do not route the sensor cable near high voltage cables, it could degrade sensor performance. If high voltage cables cannot be avoided use a shielded sensor cable or a twisted triple.
2. In applications where aggressive EMI is present, use a shielded M12 cable grounded to the cylinder via the connector.

5.10. Filtering

The sensor has internal filtering. The signal quality measured at the ECU can benefit from a simple RC-filter to reduce noise introduced on the signal line in between.

5.11. Grounding

- Use a common ground for GND and signal reference ground.

6. Commissioning

6.1. Introduction

This chapter describes what to do before the product can be operated and during power up.

6.2. Before you start the product

Before you power up the system, make sure that:

- the electrical installation has been executed according to chapter "4. Using internal circlip pliers, secure the magnet assembly in place with the retaining ring (D)." on page 11.
- there is sufficient grounding of the hydraulic cylinder to prevent it from charging up to high voltage over time.
- the sensor is not exposed to strong magnetic fields.
- the hydraulic cylinder is not exposed to direct contact with strong industrial magnets.

Warning

Strong external magnetic fields cause the sensor to go into error state and can permanently alter the ferromagnetic properties of the cylinder.

6.3. When you integrate the product

- Before the sensor is integrated into a machine, test the sensor and the cylinder to validate the signal.
- When the sensor is integrated into a machine, ensure that it is not possible for the sensor to be positioned outside of the intended stroke area.

6.4. Power up

Warning

If the sensor is installed in an application that executes functions that could damage property or human life at startup, isolate the measuring system before its function has been verified.

1. Start the system by applying power within specified voltage supply range. The startup time of the sensor is 75 ms, before that the signal will be low (<0.3 V).
2. Check that the measured value is proportional to the piston position within the effective stroke.

The sensors active electrical stroke is calibrated from factory, no further calibration is necessary.

7. Troubleshooting

7.1. Introduction

This chapter describes what to do if there is an error when operating the product.

7.2. Troubleshooting schedule

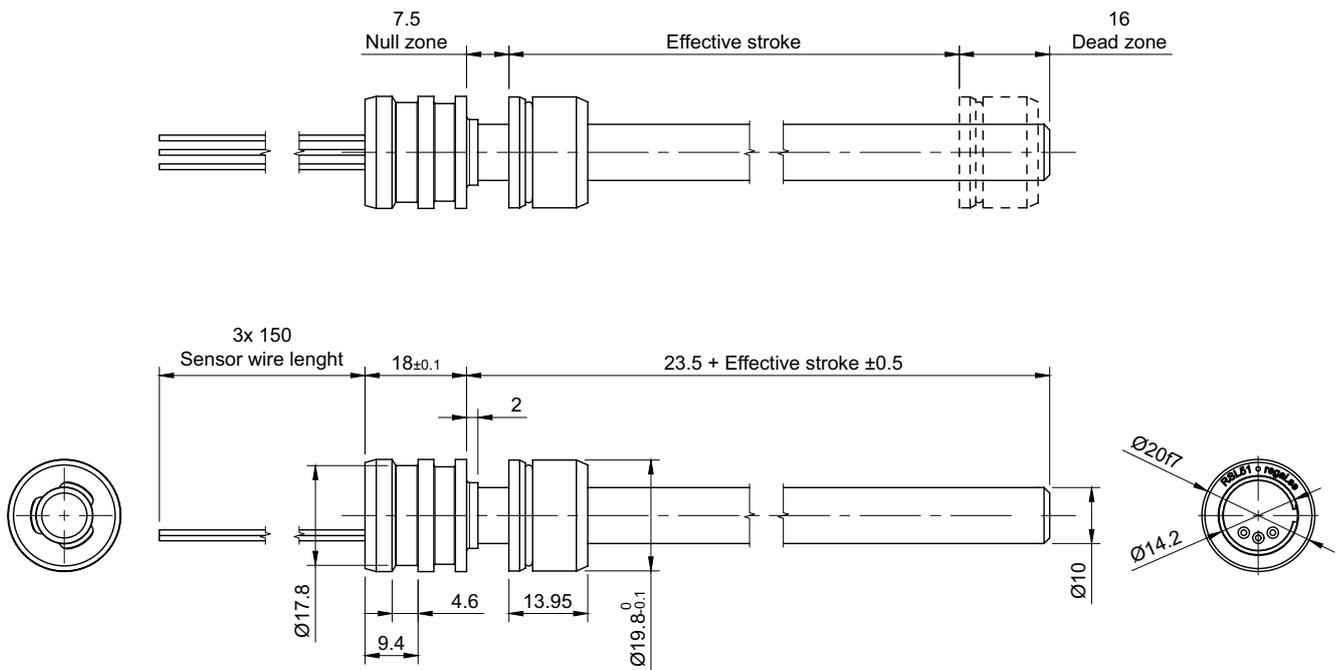
Error	Cause	Solution
No sensor signal	Damaged or faulty connected sensor leads.	Check wiring, replace sensor if the wires are damaged.
	Blown sensor internal fuse due to: <ul style="list-style-type: none"> • out of scope transients. • sensor used out of voltage range. 	Replace sensor.
	Faulty external power supply fuse.	Check external power supply fuse.
High signal (> 4.7 V)	Loss of GND sensor wire lead.	Check wiring.
Low signal (< 0.3 V)	Loss of magnet.	
	Magnetic field out of range.	<ul style="list-style-type: none"> • Check for strong magnetic fields near the sensor. • Reboot system
	Magnet has moved outside of the specified stroke length.	<ul style="list-style-type: none"> • Return within specified stroke length. • Reboot system.
The sensor goes into error state upon start up	Ferromagnetic zone is not according to specification.	Redesign piston according to requirements..
Hydraulic oil in the compartment behind the sensor	Broken O-ring seal.	Dismantle the cylinder and reinstall the sensor with a new O-ring and back-up ring. Check the condition of the sensor (e.g. signal).
	Blown sensor chassis caused by over pressure	

8. Technical data

8.1. Introduction

This chapter gives technical data about the product. For more technical data than presented in this chapter, refer to the datasheet included in the scope of delivery.

8.2. Product dimensions



8.3. Technical specification

Electrical connection		
Operating voltage	10 - 32 VDC (ISO 16750-2)	
Over voltage	36 VDC at +85 °C for 60 min (ISO 16750-2)	
Transient overvoltage	U _{trans} 36 VDC (ISO 16750-2)	
Voltage drop tolerance	1 ms (ISO 16750-2)	
Voltage increase/decrease	U _A 32V (ISO 16750-2)	
Voltage interrupts	100 ms (ISO 16750-2)	
Reverse polarity protection	Up to 32 VDC	
Current consumption	< 30 mA at 24 VDC	
Startup time	75 ms	
Load resistance	> 10 kohm	
Connection type	M12 or flying leads	
Signal characteristics		
Effective stroke	50 to 400 mm (50 mm increments)	
Signal output	0.5 to 4.5 V	
Alarm output	< 0.3 V	
Repetability error	< 0.6 mm	
Linearity error	< 0.5 mm	
Resolution	14 bit	
Output update frequency	RSL51-0050	1672 Hz
	RSL51-0100	1250 Hz
	RSL51-0150	TBD
	RSL51-0200	1250 Hz
	RSL51-0250	TBD
	RSL51-0300	1220 Hz
	RSL51-0350	TBD
	RSL51-0400	950 Hz
Cut of frequency	RSL51-0050	279 Hz
	RSL51-0100	208 Hz
	RSL51-0150	TBD
	RSL51-0200	208 Hz
	RSL51-0250	TBD
	RSL51-0300	203 Hz
	RSL51-0350	TBD
	RSL51-0400	158 Hz
Temperature coefficient	0.005%/°C	

Operating condition	
Operating temperature	-40... +105 °C (ISO 16750-4)
Storage temperature	-40...+85 °C (ISO 16750-4)
Operating pressure	35 MPa
Proof pressure (static)	46 MPa
Max pressure (static)	60 MPa
Vibration	Random 36 m/s ² 10-1000 Hz EN 60068-2-64"
Shock	25g 11ms 500 pulses x,y,z direction 50g 11ms 500 pulses x,y,z direction 100g 6ms 8 pulses x,y,z direction EN 60068-2-27"
EMC	ISO 13766-1:2018 Earth-moving and building construction machinery ISO 13766-2:2018 Earth-moving and building construction machinery. ISO 14982:2009 Agricultural and forestry machinery.
Material	
Sensor housing	Stainless steel (EN 1.4301 & EN 1.4404)
Magnet shell	POM
Magnet cover	POM
Retaining ring	Beryllium copper
O-rings	NBR Sh70
Back-up ring	PTFE
Sensor wires	LiH-T 0.25 mm ² , 32 x 0.1 thinned copper wire, TPE insulation

8.4. Product weights

Sensor	Weight (kg)
RSL51-0050	0.130
RSL51-0100	0.142
RSL51-0150	0.156
RSL51-0200	0.168
RSL51-0250	0.182
RSL51-0300	0.196
RSL51-0350	0.208
RSL51-0400	0.219

8.5. Directives and standards

The product complies with the following directives, standards, and part of standards.

Directive or Standard	
2014/30/EU	Electromagnetic compatibility (EMC)
2011/65/EU	Restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS)
ISO 16750-3:2023	Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 3: Mechanical loads
IEC 60068-2-64: 2008+A1:2019	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance
IEC 60068-2-27:2008	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock
SS-EN ISO 19879:2021	Metallic tube connections for fluid power and general use - Test methods for hydraulic fluid power connections
IEC 60068-2-1:2007, 5.2 Test Ab	Storage test low temperature
IEC 60068-2-1:2007,5.3 Test Ad	Operating test low temperature
IEC 60068-2-2:2007, 5.2, Test Bb	Storage test high temperature
IEC 60068-2-2:2007, 5.3 Test Bd	Operating test high temperature
IEC 60068-2-14, Test Nb	Cyclic temperature test
ISO 16750-2:2023	Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads
ISO 13766-1:2018	Earth-moving and building construction machinery – Electromagnetic compatibility / EMC) of machines with internal electrical power supply
ISO 13766-2:2018	Earth-moving and building construction machinery – Electromagnetic compatibility /EMC) of machines with internal electrical power supply – Additional EMC requirements for functional safety
ISO 14982:2009	Agricultural and forestry machinery – Electromagnetic compatibility
CISPR 25:2021	Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers
ISO 11452-2:2019	Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Absorber-lined shielded enclosure
ISO 11452-4:2020	Road vehicles – Component test method for electrical disturbances from narrowband radiated electromagnetic energy – Harness excitation methods
ISO 10605:2008	Road vehicles – Test methods for electrical disturbances from electrostatic discharge
ISO 7637-1:2015	Road vehicles – Electrical disturbances from conduction and coupling – Definitions and general considerations
ISO 7637-2:2011	Road vehicles – Electrical disturbance from conduction and coupling – Electrical transient conduction along supply lines only
ISO 16750-2:2012	Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Electrical loads
ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances
ISO 3601-2	Fluid power systems - O-rings - Part 2: Housing dimensions for general applications

9. Service and warranty

9.1. Introduction

This chapter gives information about the service and warranty of the product.

9.2. Service

The sensor is not serviceable.

9.3. Warranty

Regal Components AB grants warranty according to Nordiska leveransbestämmelser (NL09) in applicable areas or Orgalime S2012. Warranty is not provided for defects due to improper use, storage or excessive stress on the product.

Warranty is not provided if the product has been modified. No repairs are allowed, in event of sensor malfunction contact Regal Components AB.

9.4. Contact information

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www.regal.se



EU DECLARATION OF CONFORMITY

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www.regal.se

Declare that this declaration of conformity is issued under our sole responsibility as a manufacturer.

Object(s) of the declaration: Linear position sensor for installation inside hydraulic cylinders
Model: RSL51 series sensors
Example product code: RSL51-0100-V-B-08-15-L0150
Affixed marking: RSL51 ● regal.se

The object(s) of the declaration described above is in conformity with the relevant Union harmonisation legislation:
EMC directive 2014/30/EU
ROHS directive 2011/65/EU

The following harmonised standard(s) and standardized test methods have been applied/used:
EN IEC 63000:2018
Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances
EN ISO 13766-1:2018
Earth-moving and building construction machinery - Electromagnetic compatibility (EMC) of machines with internal electrical power supply - Part 1: General EMC requirements under typical electromagnetic environmental conditions
EN ISO 13766-2:2018
Earth-moving and building construction machinery - Electromagnetic compatibility (EMC) of machines with internal electrical power supply - Part 2: Additional EMC requirements for functional safety

Place and date of issue: Uppsala, 2024-04-08

Signature:

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