Linear Position Sensors

Linear position sensors are used for precision measurement of linear displacement. Typical applications are: sequential gear drum position, throttle position for “drive by wire”, clutch paddle/position and suspension travel measurement.

McLaren Electronic Systems offers four types of linear position sensor using different technologies. These are:

- Linear Potentiometer
- Linear Hall Effect sensor
- Level Sensor
- Ride Height Sensor

Linear Potentiometers

Principle of Operation

The sensing element of a linear potentiometer is a conductive track. A wiper, attached to the operating shaft, contacts the track. As the shaft is moved, the resistance between one end of the track and the wiper changes in a linear manner. Typically, a constant voltage is supplied across the ends of the conductive track and the potentiometer is used as a voltage divider. When used in this way, the voltage at the wiper is proportional to the shaft position.

Sensor Design

The sensing element consists of a stable, precision wire base track with a high resistivity conductive plastic bonded to it. The wiper contacts the plastic part of the track. This arrangement gives stability over a wide range of temperature and humidity as most of the current flows through the precision wire base element. This reduces the effect of wear compared to an all plastic construction.

The bodies of the linear potentiometers are anodised aluminium and the shafts are stainless steel. The sensors are sealed to keep out dirt and dust but the seals are not intended to prevent the ingress of fluids under pressure. The shaft is captive and cannot be removed from the body.

Linear potentiometers are available in the following styles:

- Unsprung long stroke (27-252mm)
- Unsprung short stroke (12.5-150mm)
- Sprung

Unsprung Potentiometers

The shaft and body have spherical bearings (“Rose joints”) for mounting. Ideally, the sensors should be mounted using the spherical bearings and not supported anywhere else. The spherical bearings can accommodate a movement of ±12° (15mm square) and ±13° (9.5mm diameter). Unsprung potentiometers can be supplied with threaded studs instead of spherical bearings, if required. This type of mounting should only be used if the Installation can guarantee linear motion, otherwise there is a risk that the shaft will bind. The shaft, with the bearing attached, is free to rotate. The bearing on the body can be rotated so the relationship between the plane of the bearing and the cable outlet can be adjusted. Provision is made to adjust the length of the shaft by 4mm.

Sprung Potentiometer

The spring is installed so that the captive shaft is normally fully extended.

A dual, sprung version is available to give redundant outputs for critical applications. The dual version has two tracks, two shafts and two springs. A single cable and connector is used with a separate output signal wire for each track. The supply and ground connections are common. However, a version in which the electrical connections are totally independent can be supplied on request.

Sprung potentiometers are typically used to follow a contour on a moving component. The contour should be smooth and should not apply side loads to the potentiometer shaft.

The potentiometer body should be rigidly fixed. However, in high vibration environments, such as direct mounting on an engine or gearbox, a resilient or anti-vibration mounting should be used. Even with such a mounting, sprung potentiometers are susceptible to bouncing when there is excessive vibration.

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Linear Hall Effect Sensors

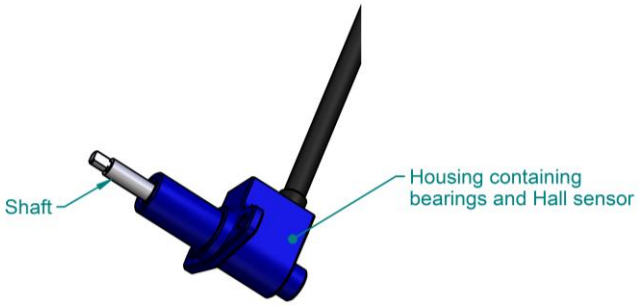
Principle of Operation

The linear Hall effect sensor consists partly of a Hall element and a magnet housed within the sensor shaft. The Hall element monitors the field magnitude along the magnet. With the element stationary, a linear movement of the shaft/magnet assembly causes a change in the magnitude of the magnetic field at the element face and hence generates an output voltage which can be seen at the signal wire of the sensor. By using the linear portion of the magnet, the sensors output voltage is proportional to the magnet (and shaft) position. The sensor is a 3 wire device and requires no signal conditioning.

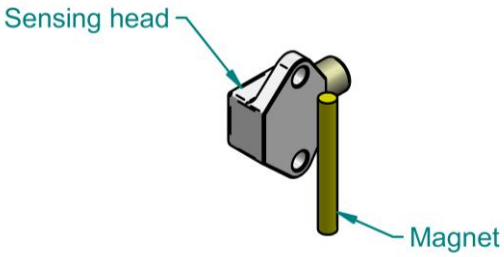
Sensor Design

The sensor can be supplied in three different formats:

- An all-in-one package to replicate a standard potentiometer. The shaft can be captive or non-captive within the housing. Lip seals are also available, depending on housing style and size.



- The sensing head can be supplied separately from the shaft to be remotely mounted inside the actuator assembly.
- The sensing element can be packaged into a small sensing head and fitted remotely to the side of a housing as shown below.



Housings and shafts can be designed to suit specific applications. The sensors can be supplied with flying leads or fitted with a connector if requested.

Installation

The linear Hall sensor is programmable and the stroke position and voltages can be adjusted according to customer requirements. Please contact our Technical Consultancy Department for further details. Typical programming parameters give an output from 0.5 to 4.5V over the full stroke length. A linear output is seen for stroke lengths up to 40mm.

A precision 5V supply is required.

Failure Modes

The operation of the sensor can be severely affected if the sensor is exposed to ferro-magnetic sources and permanent damage may be caused by large magnetic fields.

Shaft rotation during operation can cause repeatability errors of up to 4% max.

Level Sensor

Principle of Operation

The sensor is based on a capacitive principle, having an outer tube and inner core which act as electrodes. When the probe is empty the dielectric will be air which has a relative permittivity of 1. When the probe is filled with fluid, the relative permittivity can be anything between 2 to 3 depending of the type of fuel used. The capacitance is directly proportional to the height of the fluid which makes the relationship between capacitance and height linear.

Installation

The probe is supplied with a Graphical User Interface (GUI) which the user can use to calibrate the sensor in empty and full conditions with the actual fuel or oil to be measured.

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Laser Ride Height Sensors

Principle of Operation

The Laser ride height unit incorporates a photo diode which emits a pulsed light source. The response time of the reflected beam is used to calculate displacement.

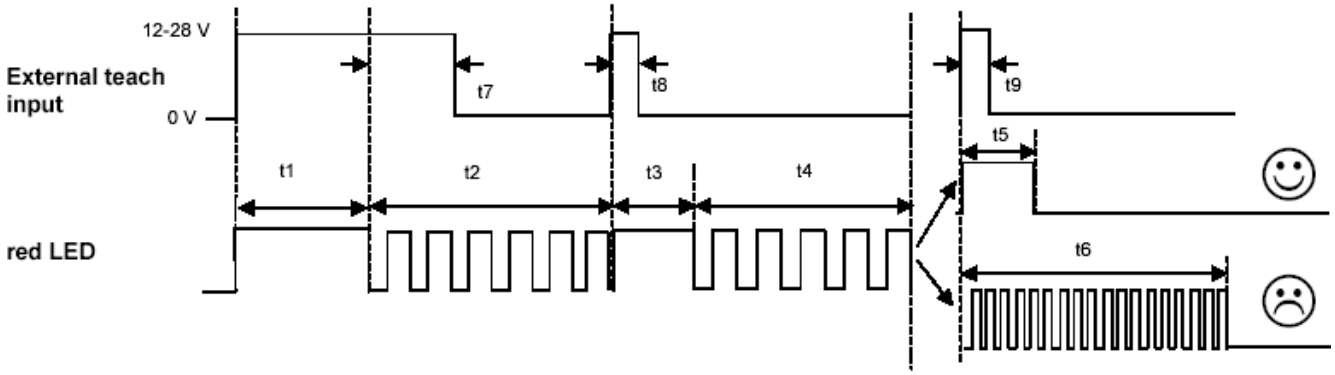
Sensor Design

The unit is housed in an anodised aluminium body which is sealed to prevent the ingress of dirt and fluids. The optical lens must be kept clean at all times to ensure correct functionality, any contamination or damage to the lens will result in a change in output.

Installation

The measurement range is configurable via an external teach function, this enables a range to be configured down to 10mm within the original measurement range (50 to 500mm). The procedure for the teach function is defined below.

Procedure for teaching a new measurement range:
Teaching the sensor via the external teach input. There is **no** time limit. The sensor may be taught at any time.



Time	Description of Timing Functions	Value	Comment
t1	Minimum hold time to enter teach mode	5s	Using the external teach input, it may be used at any time.
t2	Maximum waiting time after teaching the first position.	60s	If no “High signal at Teach input” during this interval, the sensor will leave the teach mode without any changes.
t3	LED on as response for the first position.	approx. 3s	
t4	Maximum waiting time after teaching the second position.	60s	If no “High signal at Teach input” during this interval, the sensor will leave the teach mode without any changes.
t5	LED on and “OK” response after the second position.	approx. 3s	
t6	LED Blinking for “NOT OK response” after teaching the second position	approx. 5s	
t7	Maximum hold time after LED starts blinking for teaching a new range.	8s	
t8	Minimum pulse lengths on external teach input for first position.	30ms	
t9	Minimum pulse lengths on external teach input for second position.	30ms	
t14	Minimum blinking time for the reset to factory settings with external teach input.	10s	
t15	Minimum high time of the external teach input after the LED stops blinking for reset to factory settings.	0.2s	

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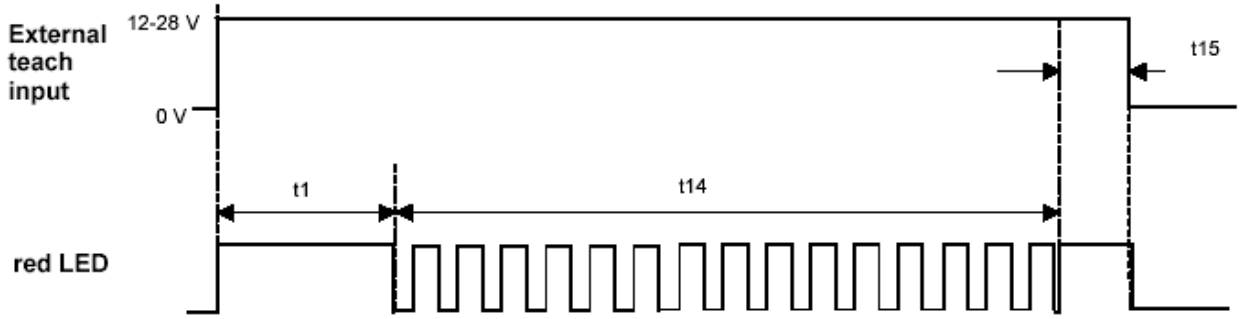
Procedure reset measurement range to factory default:
Teaching the sensor via the external teach input. There is **no** time limit. The sensor may be taught at any time.



Time	Description of Timing Functions	Value
t1	Minimum time (=High signal at input “Teach In”) to enter teach mode.	This value must be >= 5s
t14	Minimum blinking time for the reset to factory settings with external teach input.	This value must be >= 10s
t15	Minimum high time (=Low signal at input “Teach In”) of the external teach input after the LED stops blinking for reset to factory settings.	This value must be >=0.2s

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