



Features

- Single axis angle measuring
- Output fully conditioned offering a complete stand alone measurement system
- Ranges $\pm 1^\circ$ to $\pm 90^\circ$
- Extremely rugged (withstands 1500g shock)
- Measurement resolution down to 0.2 arc seconds
- Analogue voltage ($\pm 5V$) output.
- Solder pin outputs
- Stackable for X and Y dual axis measurements
- 100% Over-range ability
- 2 Year Warranty



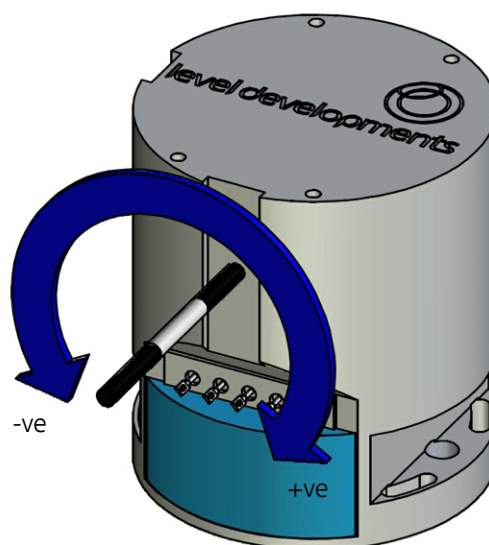
Description

The LSR series is a high precision closed loop gravity referenced servo inclinometer, it is designed for use where overall space is limited. The device incorporates a closed loop mechanism suspended in an oil damped chamber. The unit can be stacked to provide dual axis x and y measurements. Models are available in a wide variety of angle ranges and solder pin terminations are standard.

Applications

- Robotics position sensing
- Radar levelling and monitoring
- High Accuracy, robust levelling systems
- Oil platform levelling
- Satellite antenna platform levelling
- Semiconductor wafer handling systems
- Borehole mapping devices

Axis Direction and Mounting Orientation





Environmental Characteristics

Operating Temperature Range	°C	-18 to 71
Survival Temperature Range	°C	-60 to 90
Vibration	grms	20
Shock Survival		1500g, 0.5msec, 1/2 sine
Weight	g	115
Environmental Sealing		IP65

Specifications by Range @ 20°C

Range		$\pm 1^\circ$	$\pm 3^\circ$	$\pm 14.5^\circ$	$\pm 30^\circ$	$\pm 90^\circ$
Excitation Voltage	Volts dc			± 12 to ± 18		
Current Consumption	mA (nom)	± 15	± 15	± 15	± 15	± 15
Full Range Output (FRO) (see note 1)	Volts dc			± 5		
Output Impedance	Ohm	15k	$\pm 5k$	16k	8k	4k
Output Noise	V rms (max)			0.002		
Non-Linearity (see note 2)	% FRO (max)	0.05	0.05	0.02	0.02	0.05
Scale Factor	V/g	286.5	95.5	20	10	5
Non-Repeatability	% FRO (max)	0.02	0.01	0.002	0.001	0.0005
Resolution	arc seconds	0.2	0.4	1.0	2.0	4.0
-3 dB Frequency	Hz	1	2	15	20	40
Sensitive Axis-to-Case Misalignment	deg (max)	± 0.1	± 0.15	± 0.25	± 0.5	± 1.0
Cross-axis sensitivity (see note 3)	% FRO (max)			0.1		
Zero Offset (see note 4)	Volts dc (max)	± 0.1	± 0.04	± 0.02	± 0.02	± 0.02
Thermal Zero Shift	Volts/°C (max)	0.005	0.003	0.001	0.0005	0.0003
Thermal Sensitivity	% Reading/°C (max)	± 0.04	± 0.03	± 0.01	± 0.006	± 0.006

Notes

1. Full Range Output is defined as the full angular excursion from positive to negative, i.e. $\pm 90^\circ = 180^\circ$
2. Non-linearity is determined by the method of least squares
3. Cross-axis Sensitivity is the output of unit when tilted to full range output angle in cross axis
4. Zero offset is specified under static conditions with no vibration inputs

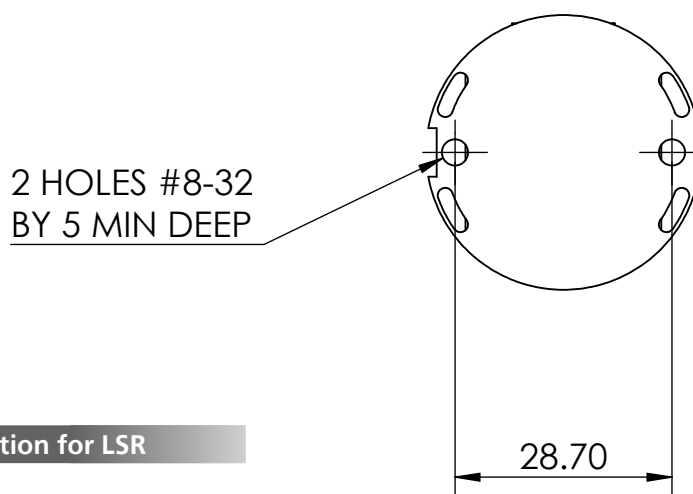
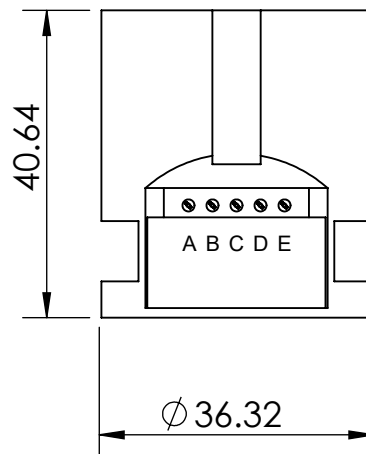
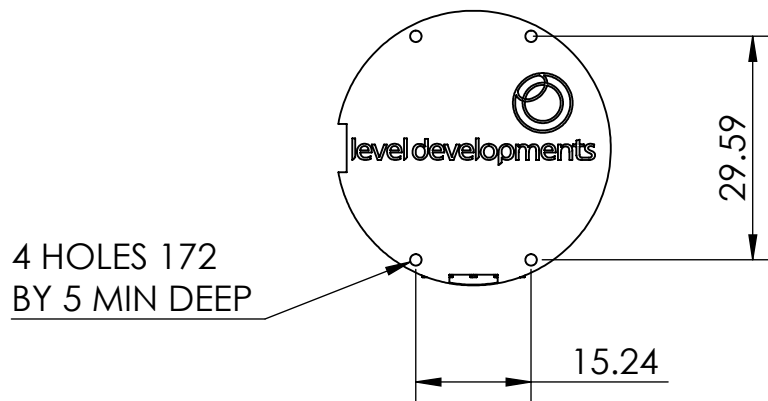
Ordering Information

Specify model type with appropriate range e.g. LSRP-30-A denotes an LSR type inclinometer with solder pin connections, a range of $\pm 30^\circ$, and a $\pm 5V$ analogue output. Please specify when ordering if cable assembly is required.

LSRP - Inclinometer Type Angular Range



Dimension Drawing

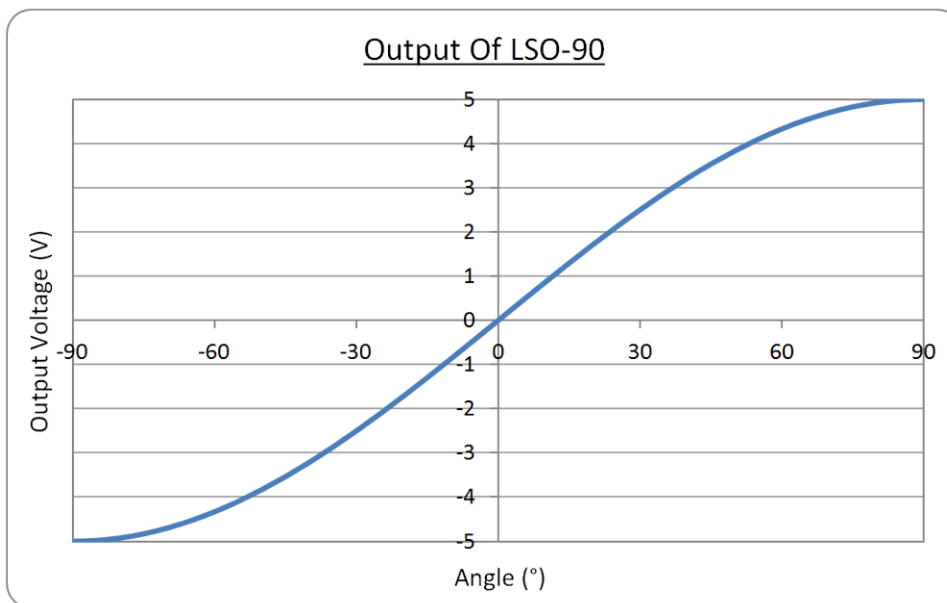


Pin Connection for LSR

Pin Ref	Function
A	+12 to +18Vdc
B	GND
C	-12 to -18Vdc
D	Output
E	Do Not Connect

**Voltage Output Change With Angle**

As the LSR sensor is tilted the sensing element is subject to gravitational acceleration which exerts force on the proof mass. The proof mass is attached to a torquer mechanism in a closed loop configuration. A feedback current is applied to the torquer mechanism to maintain the mass in a positional equilibrium. The amount of feedback current is proportional to the acceleration (due to gravity) acting on the mass, and this current is converted to a voltage at the output stage. As such the voltage output from the sensor is linear with the change in acceleration (g), which means that the output is a sine function of the change in angle ($^{\circ}$). Please see the graph below for the output of an LSR with a $\pm 90^{\circ}$ full scale range.



Because of the shape of the sine curve, the output is very linear around the zero position, for example at $\pm 3^{\circ}$ the sine non linearity would only introduce an error of 0.0005° , so for small angular ranges it is reasonable to consider the output as linear. For larger angles it is necessary to use an arcsine function to derive the angle (see below). As the angle approaches 90° the sensitivity of the sensor drops significantly making measurements up to the full 90 degree range much less accurate.

$$Angle = \sin^{-1}\left(\frac{V_{out}}{ScaleFactor}\right)$$

Where:

Angle is the angle of tilt of the sensor

V_{out} is the measured voltage from the output

Scale Factor depends on the full scale measurement range of the sensor, see table below:

Full Scale Range	Scale Factor
$\pm 1^{\circ}$	286.4934
$\pm 3^{\circ}$	95.53661
$\pm 14.5^{\circ}$	19.96965
$\pm 30^{\circ}$	10
$\pm 90^{\circ}$	5