CONEX-LDS

Electronic Autocollimator for Metrology and Industrial Applications

For Motion, Think Newport™
The CONEX-LDS is a versatile electronic autocollimator traditionally used in non-contact alignment or measurement of angular variations. Using as much commercially available, but proven, optics and electronics technologies that simplified the design, the CONEX-LDS offers a high level of reliability for demanding metrology and industrial applications. With features like the integrated eyepiece and mounting accessories, the CONEX-LDS is easy to setup on site and on the production floor. The advantage of the CONEX-LDS is significant reduction in set-up time while still providing metrology-level features.

The light source is a visible red Laser diode, whose beam is perfectly collimated for use up to 5 m. The sensor is a dual axis analog silicon-based sensor chosen for its fast response time. With an RMS signal to noise ratio of 0.003 µrad/√Hz, the CONEX-LDS autocollimator is sensitive to even very small angular variations, enabling extremely accurate alignment procedures.

Sensor measurements are made at 5 kHz, which can be filtered (2nd order low pass filter) between 1 to 2000 Hz, for noise reduction.

The embedded controller supports RS-422 communication and can be connected to a computer through USB using the CONEX-USB-RS422 converter.

Analog outputs are included, with programmable gains and the instrument can be connected to a data logger, like the XPS Universal Motion controller which has data gathering capability.
DETAILS AND SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity (µrad)</td>
<td>0.01</td>
</tr>
<tr>
<td>Accuracy (µrad)</td>
<td>±5 ±(0.02 x measurement)</td>
</tr>
<tr>
<td>(±5 µrad around 0; [-250 µrad; +250 µrad])</td>
<td>(i.e. 2%)</td>
</tr>
<tr>
<td>Beam Diameter (mm)</td>
<td>22.5</td>
</tr>
<tr>
<td>Beam Divergence (µrad)</td>
<td>100</td>
</tr>
<tr>
<td>Beam Direction (µrad)</td>
<td>500</td>
</tr>
<tr>
<td>Equivalent Focal Length (mm)</td>
<td>250</td>
</tr>
<tr>
<td>Measuring Range (m)</td>
<td>5</td>
</tr>
<tr>
<td>Measurement Field (µrad)</td>
<td>±2000</td>
</tr>
<tr>
<td>Ocular Field - Eyepiece (mrad)</td>
<td>±15 (±0.85°)</td>
</tr>
<tr>
<td>Min. Reflectivity</td>
<td>2% reflectivity</td>
</tr>
<tr>
<td>Noise RMS (µrad/√Hz)</td>
<td>0.003 (at 100% reflectivity)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>1.1</td>
</tr>
<tr>
<td>Communication Interface</td>
<td>RS-422 accessible through a USB to RS-422 converter or Ethernet to RS-422 converter (available soon)</td>
</tr>
<tr>
<td>Protocol</td>
<td>ASCII</td>
</tr>
<tr>
<td>16-Bit Analog Outputs</td>
<td>±5 V, adjustable filter and gain</td>
</tr>
<tr>
<td>Data Acquisition Frequency (Hz)</td>
<td>2000</td>
</tr>
<tr>
<td>2nd Order Low Pass Frequency</td>
<td>Adjustable from 1 to 2000 Hz</td>
</tr>
<tr>
<td>Source</td>
<td>Visible laser diode modulated at 5 kHz; circular polarized</td>
</tr>
<tr>
<td>Wavelength (nm)</td>
<td>670</td>
</tr>
<tr>
<td>Peak Power (mW)</td>
<td>&lt;1 (Class II)</td>
</tr>
<tr>
<td>Operating Temperature Range (°C)</td>
<td>+15 to +25</td>
</tr>
<tr>
<td>Storage Temperature Range (°C)</td>
<td>-10 to +50</td>
</tr>
<tr>
<td>Power Supply</td>
<td>90/264 V, 50/60 Hz, 30 VA</td>
</tr>
</tbody>
</table>

**RoHS Compliant**

**Applications**

**SURFACE FLATNESS**

This is a classical application for autocollimators. To obtain flatness measurements, the autocollimator beam is reflected off a mirror. By indexing the mirror along the beam path at known distances, linear position vs. the pitch angle is obtained and is used to determine vertical displacement.

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**Flatness Measurement**

- **Reflector:** Mirror on a 150 mm granite stand
- **Filter setting:** 1 Hz
- **Acquisition:** point to point

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**Pitch Measurement**

**Calculated Flatness**
In manufacturing environments or metrology applications that utilize dividing heads or rotation stages with mechanical or air bearings, the CONEX-LDS is a very useful tool to verify the wobble of the bearings. In the manufacture of ball, thrust or air bearings, particularly those with large diameters, in-process or final verification of wobble specifications can be accomplished with the CONEX-LDS. In both cases, a simple mirror mounted perpendicular to the rotation axis with the CONEX-LDS beam coincident to it, will provide high precision measurements of wobble that will characterize the condition of the bearing. The results could indicate the need for maintenance, repair or rework. The graph on the right illustrates a typical result of a wobble test of a bearing. Using the same CONEX-LDS setup, but with a precision ball fixture rather than a mirror, it is possible to determine the axial eccentricity of a bearing.

**BEARING WOBBLE OR ECCENTRICITY MEASUREMENT**

**Wobble Measurement**

- **Reflector:** $\lambda/10$ flat mirror
- **Filter setting:** 10 Hz
- **Dynamic acquisition at 10 Hz for 2 turns of the stage**

**PITCH AND YAW OR YAW AND ROLL MEASUREMENT**

Pitch and Yaw deviations during motion increase positioning errors due to the Abbe effect, especially at a longer distance between the sample and the feedback encoder. With the CONEX-LDS autocollimator, this type of error can be accurately identified and used to calculate true position. Pitch and yaw can be measured concurrently using a simple flat mirror. In addition, these angular measurements can be used to derive the flatness and straightness deviations of the linear bearing.
SETTLING TIME AND STAGE DAMPING

The time required for settling into a position is an important parameter in high-accuracy, high-throughput applications like semiconductor inspection. Fast settling times result in processes to be performed very quickly, thus increasing productivity. In this case the CONEX-LDS autocollimator is used to measure the angular displacement at all stage positions, according to the control parameters. The dynamic measurements reflect the stage performance at the given situation. Using Fourier analysis of the same data enables understanding of the stage’s resonances.

ROTATION STAGE ACCURACY

Rotation stage accuracy can be measured using a precisely calibrated multifaceted mirror. The CONEX-LDS autocollimator measures the angular difference between the stage rotation and index of the calibrated standard. Absolute accuracy is measured directly, taking the index error and hysteresis into account. The measurement accuracy is better than 1 µrad.
**Principle of Operation**

### AUTOCOLLIMATION PRINCIPLES

A standard autocollimator uses a back illuminated cross light reticle A, located behind the focal plane of a collimating lens B.

The resulting image is projected to infinity and reflected back to the instrument from a plane reflecting mirror C.

The reflected image is focused on the back of the focal plane of the collimating lens (beamsplitter D). Most instruments use a measuring eyepiece E with a dark cross reticle to observe this autocollimated image.

If the reflected image becomes coincident with the incident beam, that the mirror is in autocollimating position.

For each angular movement of mirror C, a lateral displacement of the image is reflected on the back of the focal plane of the collimating lens.

If the value of the focal length of the collimating lens is “F”, then the lateral displacement will be:

\[ \Delta Y = F \times \tan(2\Delta\theta) \]

where \( \Delta\theta \) is the angular displacement of the mirror.

This displacement can be measured by using the measuring eyepiece.

Autocollimation is a common method to check and align optical elements, such as laser cavities, Fabry-Perot, and is used in optical workshops to measure prism characteristics and angular deviations.

All these operations are typically done manually.

### ELECTRONIC AUTOCOLLIMATOR

The advantage of the electronic autocollimator is the automation of angular measurements.

In the CONEX-LDS autocollimator, the basic principles are the same, but use different components:

- The source reticle is a Laser diode (1 mW; \( \lambda = 670 \text{ nm} \)).
- The measuring eyepiece is a position sensing device.

This position sensing device sends analog signals that are proportional to the position \( V_x \) and \( V_y \) of the reflected beam and are used to calculate the angular deviations \( \Delta\theta_x \) and \( \Delta\theta_y \).

A portion of the light from the diode is used for visual alignment, while a circle indicates the zone to start data recording.

Angular readings can be displayed using the supplied applet via USB. Alternatively, angular data can be obtained with a data logger. Note that the XPS Universal Motion Controller can be used to gather and store analog data.
Advantages

HIGH RESOLUTION

With an outstanding signal to noise ratio, the CONEX-LDS autocollimator is sensitive to extremely small angular variations, such as the angle produced by a 0.1 µm dust particle located beneath the end of a 1 m long bench.

FAST ACQUISITION

The CONEX-LDS autocollimator is equipped with an analog sensor which has been chosen for its fast response time. The architecture allows a sampling frequency of 2000 Hz. The advantage is not only the possibility of observing very rapid events, but also the ability to perform the maximum amount of acquisitions in a given period of time, less affected by noise.

The CONEX-LDS applet has an acquisition feature that is dedicated to Newport’s XPS Motion Controller. A 3rd party logger can also be connected to the analog outputs.

SIMPLE TO SET-UP, EASY TO USE

The intelligent design of the CONEX-LDS allows users to quickly set-up and obtain precise measurements. Alignment is easily performed by positioning the reflected visible beam in the integrated eyepiece of the CONEX-LDS. Precise measurements can be read immediately from the dedicated NStruct Applet or analog outputs. Compared to interferometers, the position sensing device provides absolute values, which are not lost if the beam is blocked during the measurement.

WITHIN EVERYONE’S REACH

You do not need to be an expert in instrumentation to obtain accurate measurements with the CONEX-LDS autocollimator, nor do you need to spend a fortune. Most operators can quickly learn how to use the CONEX-LDS to perform extremely accurate alignment operations, or simply to check the quality or movement of a structure, without wasting time and money.

LASER SAFETY

The CONEX-LDS autocollimator is a Class II device, producing a laser emission that is less than 1 mW at a wavelength of 670 nm. This means that safety goggles are not required when using this instrument.

CALIBRATION & CE MARKING

Each autocollimator is individually tested and comes with a detailed calibration certificate. It also complies with applicable European directives and is delivered with a CE Certificate of Conformity.


**ORDERING REFERENCES**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONEX-LDS</td>
<td>Electronic Autocollimator</td>
</tr>
<tr>
<td>CONEX-LDS-VER(1)</td>
<td>Verification Kit</td>
</tr>
<tr>
<td>CONEX-LDS-USB-422</td>
<td>USB/RS-422 Adapter</td>
</tr>
<tr>
<td>CONEX-LDS-CABLE20</td>
<td>20 m Cable</td>
</tr>
<tr>
<td>CONEX-LDS-PS</td>
<td>Power Supply</td>
</tr>
</tbody>
</table>

(1) The verification kit is a stand alone kit which includes a calibrated optical wedge fitted into a mechanical mount and all associated clamps and rod. The slide is delivered with a calibration certificate which provides the value of the angle of deviation which it produces on the autocollimator’s beam. This kit allows user to verify that the CONEX-LDS is still within its calibration limits set in the factory. The applet will guide you through the verification process.

To achieve optimum performance, use high quality Newport optics with the CONEX-LDS.

For metrology applications, we recommend using 50.8 mm (2") λ/10 mirrors. The SL51BD mirror mount provides the stability and adjustment sensitivity required for precise measurements.

For other high quality optics, optical mounts and assembly hardware visit www.newport.com

**VERIFICATION KIT**

The CONEX-LDS-VER verification kit includes a calibrated optical wedge fitted into a mechanical mount and all associated clamps and rods. The slide is delivered with a calibration certificate which provides the value of the angle of deviation which it produces on the autocollimator’s beam.

This kit enables the user to periodically verify the calibration verification of the CONEX-LDS autocollimator.

The measurement is performed in the middle of the range with a 0.5% level of uncertainty.

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**SET-UP**

Various mounts are available to facilitate setting up the CONEX-LDS autocollimator. With two angular and two linear axes, the CONEX-LDS-SLXY is the most flexible mount. The CONEX-LDS-SL mount provides only two angular adjustments.

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**ORDERING REFERENCES**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Axis Height (mm)</th>
<th>Angular Range (°)</th>
<th>Centering Travel (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONEX-LDS-SLXY</td>
<td>Precision Adjustable Four Axis Mount, XYθxy</td>
<td>100</td>
<td>±2</td>
<td>±12.5</td>
</tr>
<tr>
<td>CONEX-LDS-SL</td>
<td>Precision Adjustable Two Axis Mount, θxy</td>
<td>75</td>
<td>±2</td>
<td>–</td>
</tr>
</tbody>
</table>

Email: sales@newport.com • Web: newport.com/motion
Dimensions

CONEX-LDS

CONEX-LDS-SLXY

DIMENSIONS IN INCHES (AND MILLIMETERS)

BM17.25

SL51 BODY

BM17.04N

M-UMR8.25XYZ

RANGE: ±2°
Complete listings for all global office locations are available online at www.newport.com/contact.

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