attocube
pioneers of precision

IDS3010

Displacement Sensing for Industry

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attoSENSORICS
Ultra Precision Sensors

IDS Sensors

Displacement Sensing for Industry

Some of the most important tasks in industrial metrology applications are contactless measurements of distances and displacements, the detection of vibration amplitudes of machine components and tools, and the ultra-precise survey of rotationally symmetric parts. The Fields of application are extremely versatile and range from ultra-precision machining to semiconductor technology.

The Requirements on accuracy, flexibility, and interconnectivity are constantly increasing and ask for ever more sophisticated solutions. These solutions should combine highest precision, speed, and reliability - while providing remote access and software maintenance from virtually anywhere on the planet. attocube's IDS3010 sensor has been specifically designed for challenging OEM and synchrotron applications and fulfills future requirements on precision and industry 4.0 connectivity already today.

Accurate

The built-in DFB laser of the IDS is locked to a molecular absorption frequency reference, making the detected displacement traceable to international length standards. All measurements are therefore truly accurate in a metrological sense.

Ultra fast

All IDS sensors measure the position of the target with a bandwidth of 10 MHz and a resolution of 1 pm. At the same time, the sensor is compatible with displacement velocities of up to 2 m/s.

Machine integrable

Due to its compact size (50mm x 55mm x 195mm) and its passively cooled housing, IDS sensors can be directly integrated into milling machines, coordinate measurement machines, and semicon equipment. Adapter plates enable the integration into electric control cabinets.

Industrial interfaces

IDS sensors are compatible with a multitude of interfaces. As standard interfacing, IDS sensors provide real-time digital (HSSL, AquadB) and analog (sin/cos) position data. In addition, IDS devices interface with field busses such as CANopen, Profibus, Profibus RT, and EtherCAT (optional).

Industry 4.0 compatible

All IDS sensors are equipped with an integrated webserver, enabling customers to setup, align, readback, and firmware-upgrade IDS devices remotely - from almost anywhere on the planet.

Multi axis operation up to 5m

The IDS offers three measurement axes which operate simultaneously, enabling tracking target displacements in three degrees of freedom over dynamic travel ranges of up to 5 m.

Environmental compensation

IDS sensors can be equipped with an optional environmental compensation unit (ECU). The ECU enables the operation of IDS sensors at ambient conditions while maintaining an accuracy of better than ± 1 ppm under a wide range of pressure, temperature, and humidity values.

VIS alignment laser

All IDS sensors are equipped with an integrated visible alignment laser (650 nm). The alignment laser can be software enabled during mechanical installation of the sensor, greatly reducing setup duration. An alignment software tool simplifies the process further.

IDS3010

integrated displacement sensing/OEM displacement sensing

The high-sensitivity displacement sensor IDS3010 far surpasses the performance of other commercial interferometry subsystems in terms of accuracy, speed, compactness, and cost. With its slim size, the IDS can be directly integrated into machines for free-beam operation and is the product of choice for challenging OEM & synchrothron applications. A passively cooled housing prevents contamination of optical and electrical components. For even more confined applications, sensor heads can be remotely operated and interconnected via glass fibers. Due to an integrated webserver, the sensor can be aligned, initialized and (re-) configured remotely at any time. A broad spectrum of digital and analog real-time interfaces and protocols enables the simple transmission of position data to the receiver such as CNC controllers or RTOS computers. The further support of the most common industrial networks such as CANopen, Profinet, Profinet RT, and EtherCAT enable the integration into broader industrial networks.

Environmental compensation unit – ECU

The environmental compensation unit enables sub-ppm accuracy in ambient environment.

Fields of Applications - Examples

Coordinate Measurement

Real-Time Vibration Detection

Semiconductor Technology

Synchrotron Applications

Drive Technology

Ultra-Precision Machining

IDS3010 – Displacement Measurements	
number of axes	3
working distance	0-5000mm
sensor resolution	1pm
sensor repeatability	2nm[1)]
max. target velocity	2m/s
measurement bandwidth	10MHz
Modes of Operation	
measurement modes	displacement, vibrometry
output signal: displacment measurement	laser light (IR)
output signal pilot laser sensor alignment	laser light (VIS) web interface
Interfaces	
analog interfaces	sin/cos (real-time)
digital interfaces	HSSL, AquadB (real-time)
field bus interfaces (optional)	EtherCAT, CANopen, Profibus , Profibus RT
interface bandwidth sin/cos	up to 25 MHz
interface bandwidth AquadB	up to 25 MHz
interface bandwidth HSSL	up to 25 MHz
interface bandwidth field bus systems	100 kHz
Controller Hardware	
dimensions	50 x 55 x 195 mm³
power supply	12 V DC
laser source	DFB laser
laser power	150 µW
laser wavelength	1530 nm
wavelength stability	50 ppb

1) at 10 mm working distance in vacuum conditions, +/-1ppm in ambient conditions with ECU.

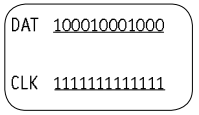
Interfaces

real-time digital and industrial interfaces

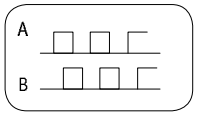
01 Main Power
02 Real-Time Interfaces
03 Ethernet (EtherCAT/Profinet)
04 CanOPEN
05 ECU
06 GPIO (General Purpose Input/Output)

Real-Time Digital Interfaces

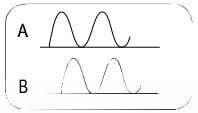
The IDS3010 is delivered with a standard set of high-speed interfaces for real-time data communication with FPGA-based or RTOS receivers. These interfaces consist of an incremental AquadB, a proprietary serial word (HSSL), and a synthetic analog sin/cos signal. All signals can be outputted as either single-ended (LVTTL) or differential (LVDS). Interface parameters can be configured in the web interface section of the IDS. All interfaces provide maximum bandwidth at highest resolution.



HSSL (digital): attocube's proprietary serial word protocol provides absolute position information - both in terms of the protocol and the measurement itself. The HSSL interface consists of one data and one clock signal (single ended or differential); position information is packed into one container of user-defineable bit-length, synchronization with the receiver is accomplished using the clock signal. The HSSL protocol is preferential if absolute displacement position data (i.e. sensor-target separation) is required or if incremental position counting is inacceptable.



AquadB (digital): The AquadB interface provides incremental displacement information on target displacement. Position resolution and (maximum) clock rate can be user defined using the IDS web interface.
For maximum data bandwidth, the AquadB interface is best used with differential signaling.



Sin/cos (analog): The sin/cos signal is a digitally synthesized analog signal which provides incremental position information. As with the digital AquadB signal, the increment (i.e. resolution) is user-definable in the system's web interface. For maximum data bandwidth, the sin/cos signal is best used with differential signaling.

Industrial Interfaces

In addition to the standard real-time interfaces, the IDS provides (optional) interconnectivity with industrial networks such as Ethernet (TCP/IP), EtherCAT, CanOPEN, Profinet, and Profinet RT.

EtherCAT (Ethernet for Control Automation Technology) is an open, real-time Ethernet-based fieldbus network originally developed by Beckhoff. The EtherCAT protocol is most typically used for machine control and regulation as well as for multi-channel, synchronous measurement devices.

Profinet is a protocol based on industrial Ethernet according to IEEE 802. It connects devices, systems, and cells, facilitating faster, safer, less costly and higher quality manufacturing.

Profinet RT is the real-time derivative of Profinet.

CANopen is a communication protocol based on CAN (Controller Area Network) which is most typically used for the interconnection of complex, embedded systems used in automation. Apart from communication, the CANopen protocol also provides device specification.

Integrated Web Server & Pilot Laser

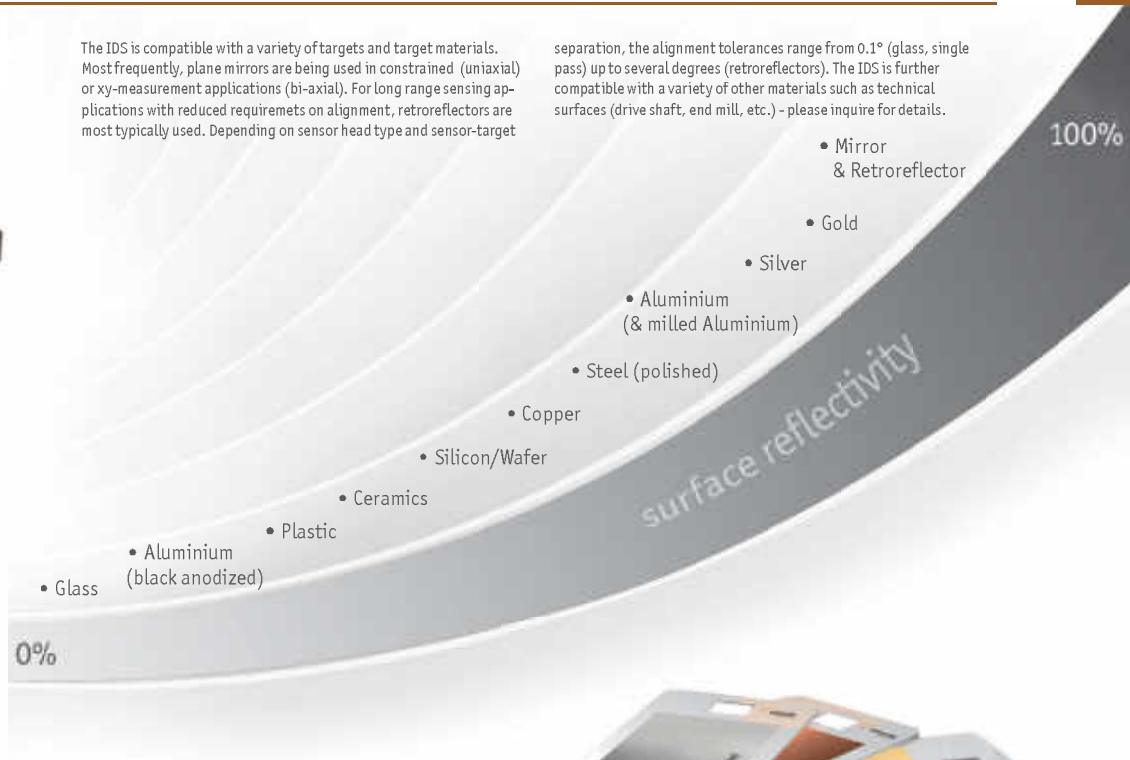
simple sensor alignment and remote configuration

All IDS sensors are delivered with an integrated webserver, allowing the end-user to configure and align the device at ease after physical connection with the local area network (LAN). An integrated, software-controllable visible pilot laser greatly simplifies the alignment process. In addition to the intial setup process, the web interface of the IDS further enables the remote upgrade of device specific software/ firmware and the readback of absolute position values (sensor-target separation).

Optical Targets and Materials

measurements down to 4% surface reflectivity

The IDS is compatible with a variety of targets and target materials. Most frequently, plane mirrors are being used in constrained (uniaxial) or xy-measurement applications (bi-axial). For long range sensing applications with reduced requiremets on alignment, retroreflectors are most typically used. Depending on sensor head type and sensor-target separation, the alignment tolerances range from 0.1° (glass, single pass) up to several degrees (retroreflectors). The IDS is further compatible with a variety of other materials such as technical surfaces (drive shaft, end mill, etc.) - please inquire for details.



FOR INFORMATION ON COMPATIBLE SENSOR HEADS PLEASE REFER TO THE NEXT PAGE.

Sensor Head Specifications

Alignment Tolerances and Working Ranges

attocube systems offers four different sensor head designs, compatible with a wide range of requirements such as physical dimension, alignment tolerance, and working distance. The xs, M12, and M15.5 sensor heads are fabricated from highest grade titanium and are further adapted to and tested in the specified environment.

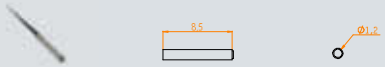
Each sensor head provides its own working range and angular tolerance specification. The angular working range of each sensor head is shown in the corresponding figure, along with the available working environments of the sensor heads and their alignment tolerances.

Compatible environments are:

/RT (ambient conditions): *0..100 °C, 1x10⁻⁴ mbar..10 bar*
/HV (high vacuum): *0..150 °C, 1x10⁻⁸ mbar..10 bar*
/UHV (ultra high vacuum): *0..150 °C, 1x10⁻¹⁰ mbar..10 bar*
/LT (low temperature): *mK..423 K (150 °C), cryogenic vacuum, 1x10⁻⁴ mbar..10 bar*
/RAD (radiation hard): *0..150 °C, up to 10 MGy radiation dose*

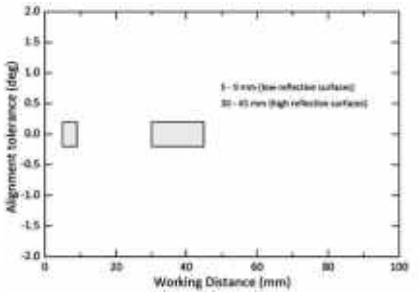
FOR DETAILED ARTICLE NUMBERS PLEASE REFER TO THE ACCESSORIES SECTION.

Miniature sensor "xxs"



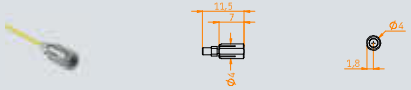
Dimensions: dia 1.2 mm, length 8.5 mm
Mounting: clamped
Connector: none (fiber glued)
Environment: /RT

angular working range



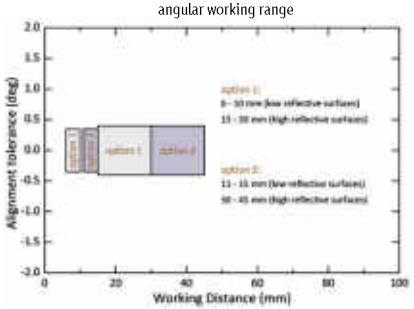
Working mode: single pass
Absolute accuracy: highest
Working range: 5 -9 mm (low reflective surfaces)
30 - 45 mm (high reflective surfaces)

Miniature sensor "xs"



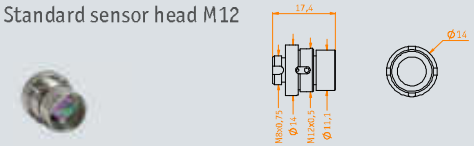
dia 4 mm, length 11.5 mm
clamped
none (fiber glued)
/RT, /HV, /LT, /UHV

angular working range



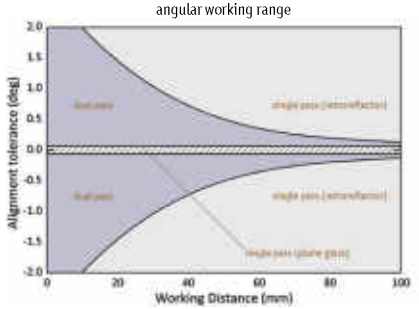
single pass
highest
option 1: 15-30 mm, option 2: 30-45 mm

Standard sensor head M12



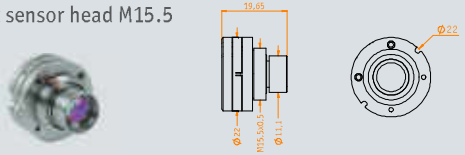
dia 14 mm, length 18 mm
metric M12 x 0.5
FC-PC
/RT, /HV, /LT, /UHV, /RAD

angular working range



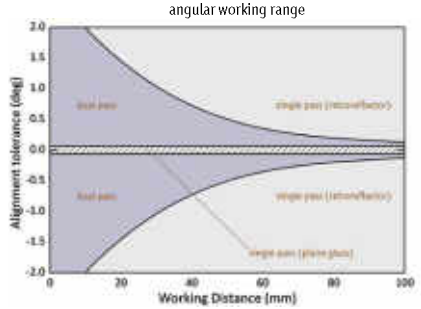
dual pass (single pass with retroreflector or plane glass)
medium (highest with retroreflector or plane glass)
0-100 mm (3000 mm with retroreflector or plane glass)

Flex sensor head M15.5



dia 22 mm, length 24 mm
metric M15.5 x 0.5
FC-PC
/RT, /HV, /LT, /UHV, /RAD

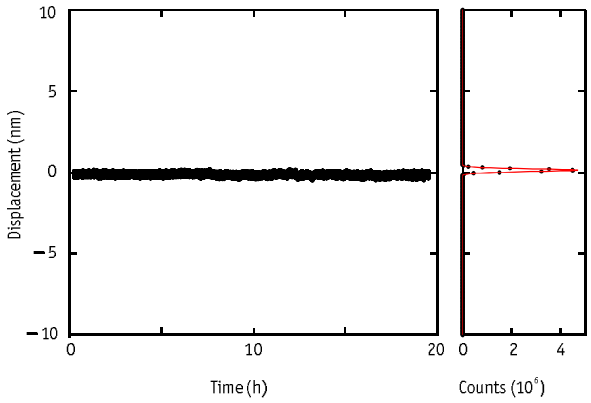
angular working range



dual pass (single pass with retroreflector or plane glass)
medium (highest with retroreflector or plane glass)
0-100 mm (3000 mm with retroreflector or plane glass)

Selected Measurements

superior position stability



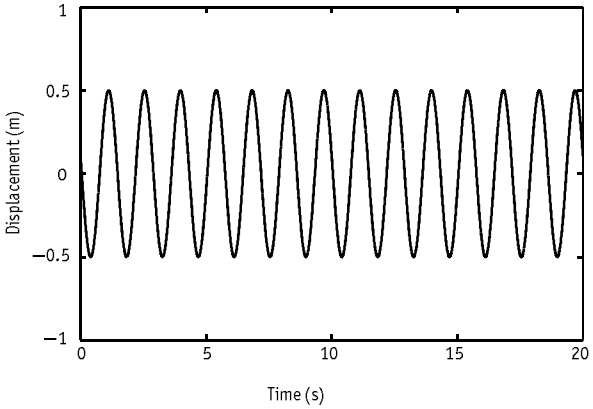
Proven sub-nanometer signal stability

The intrinsic signal stability of the IDS sensor – equivalent to its positional repeatabilty - is unheard of in industrial position sensing. While being specified to achieve a repeatability of 2 nm at 20 mm working distance and 100Hz measurement bandwidth (in vacuum), IDS sensors routinely achieve significantly better performance.

The actual measurement above shows positional stability as measured with an IDS3010 on a titanium cavity cooled to liquid helium temperature (-269 °C), temperature stabilized to few milli-degrees. The plot shows position sensing data recorded on a 20 mm long cavity during a 20 hour period of time, measured at 100 Hz bandwidth. The standard deviation of the above shown measurement is 55 picometer!

Selected Measurements

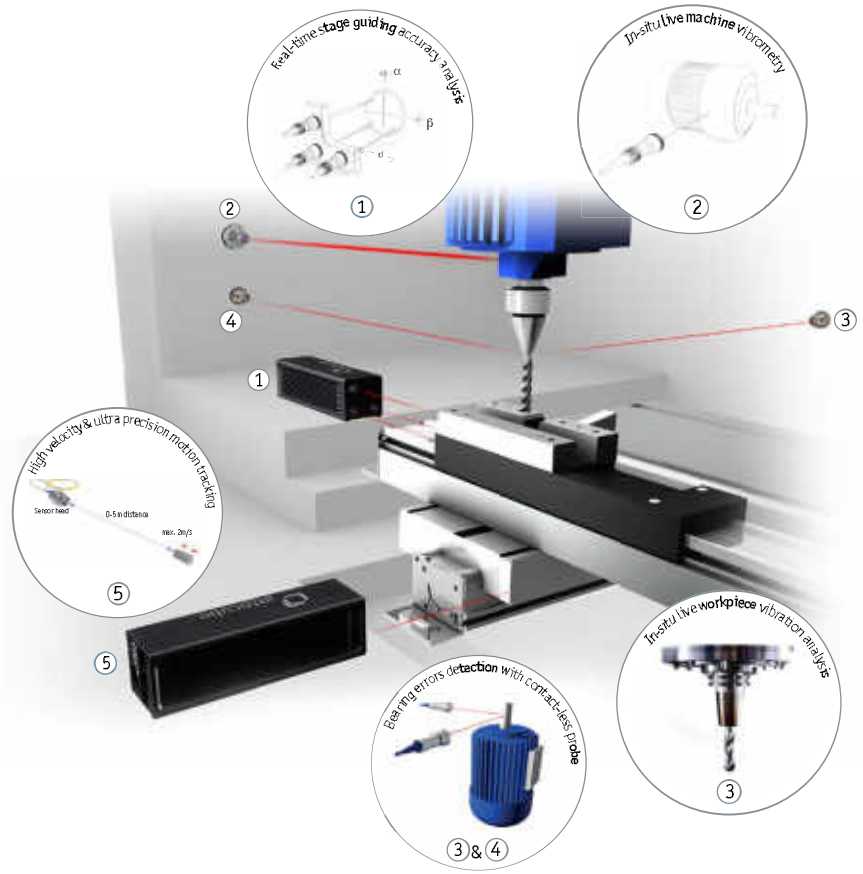
high speed position sensing



Compliant with high-bandwidth & high-velocity applications

Along with exceptional signal stability and picometer resolution, the IDS sensor family is designed to measure target position variations at very high pace. With a measurement bandwidth of 10 MHz, IDS sensors are able to master target displacement velocities of up to 2 m/s. This capability enables applications where objects are moved over macroscopic ranges at high speed while the target's final location needs to be recorded with nanometer resolution. A typical application is shown in the graph above where the target has been mounted onto a linear drive, providing travel velocities of up to 2 m/s over 1 m range.

Applications



① Real-time stage guiding accuracy analysis

Monitor your stage guiding accuracy in real time. With an angular tolerance exceeding several degrees, the IDS3010 can sense erratic pitch and yaw motions. A simple closed loop regulation may then control the carrier displacement within 6 degrees of freedom. The IDS3010 cost -effectiveness and compact design allow integration in industrial systems as a set-and-forget sensor. Indeed, interferometry intrinsically eliminates the need for time-consuming system recalibration.

② *In-situ* live machine vibrometry

Diagnose your parts' vibrations instantaneously. The IDS3010 electronics performs a live Fast Fourier Transform (FFT) of the part displacement. It enbales accurate, non-contact frequency analysis with a bandwidth from DC to 10 MHz. Its modular and portable design perfectly fits quality control applications and allow on-the-fly diagnosis of a machine directly in the production line. Moreover, its interface uses industry standards for easy integration.

③ *In-situ* live workpiece vibration analysis

Analyse directly your workpiece vibrations. The IDS3010 can recover in-plane motion of a rotating milling machine workpiece. For example, users can measure the difference in vibration spectra arising when the milling process takes place as compared to the idle state. This crucial information enables fine control of the machine tool in order to eliminatecontour errors or bad surface finish. This in turn improves part quality and higher production throughput.

④ Bearing errors detection with contact-less probe

Characterize the error motions of your bearings. Depending on the probe in use, the IDS3010 tolerates even curved and milled surfaces as target. Therefore, users can monitor the motion at the exact location of interest. For example, it can directly measure the actual runout of a rotating shaft and avoids any in between errors sources such as stage bearing imperfection (Abbe error) or slight angular encoder misalignment.

⑤ High velocity & ultra precision motion tracking

Track fast stage displacement with ultimate accuracy. In standard operation, the IDS3010 detects a target's relative displacement over range exceeding 5 m with sub-nanometer resolution. Its real-time electronics outputs linear stage motion with velocities up to 2 m/s. The sensor's compact and ergonomic design eases integration in OEM setups and grants use of this state of the art device even to non-specialists in interferometry.

Accessories

optional items for the attoSENSORICS product line

All sensor heads are delivered in conjunction with fiber packages, adapted to the individual work environments. All /HV, /UHV, and /LT fiber packages consist of 5 m long fibers for ambient conditions plus extra fibers for vacuum and/or low temperature operation (2 m Acrylate coated fibers in case of /HV and /LT, 2 m Polyimide coated fibers in case of /UHV). The xxs/RT and xs/RT sensor heads are equipped with a 3m long fiber. Metal coated fibers are available on request. Mirrors are included in the fiber package, while fiber feedthroughs are excluded.

14 days delivery

Single axis kit

Environment	Article
xxs/RT	1010654

	Option 1*	Option 2*
xs/RT	1010307	1010308
xs/HV	1010640	1010641
xs/UHV	1010644	1010645
xs/LT	1010640	1010641
xs/RAD	1010649	1010650

M12/RT	1010301
M12/HV	1010303
M12/UHV	1010305
M12/LT	1010303
M12/RAD	1010638

M15.5/RT	1010631
M15.5/HV	1010632
M15.5/UHV	1010634
M15.5/LT	1010632
M15.5/RAD	1010636

Three axes kit

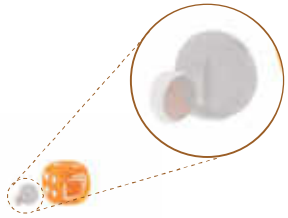
Environment	Article
xxs/RT	1010655

	Option 1*	Option 2*
xs/RT	1010309	1010310
xs/HV	1010642	1010643
xs/UHV	1010646	1010647
xs/LT	1010642	1010643
xs/RAD	1010651	1010652

M12/RT	1010302
M12/HV	1010304
M12/UHV	1010306
M12/LT	1010304
M12/RAD	1010639

M15.5/RT	1010583
M15.5/HV	1010633
M15.5/UHV	1010635
M15.5/LT	1010633
M15.5/RAD	1010637

Option 1: 15 - 30mm (focal length 8mm), Option 2*: 30 - 45mm (focal length 13mm)*



Plane mirrors

Plane mirrors are used in applications where miniature size matters and where vacuum/low temperature compatibility is key condition. Available in different sizes.

Recommended sensor heads: Miniature sensor "xs", Standard sensor head M12, Flex sensor head M15.5

14 days delivery

Article	
aluminum mirror Ø 5mm:	No: 1006631
aluminum mirror Ø 9mm:	No: 1004546

Retroreflectors

Retroreflectors are used for large dynamic working ranges, such as e.g. in industrial machining applications, or in coordinate measurement machines. Working range 0-3000mm.

Recommended sensor heads: Standard sensor head M12, Flex sensor head M15.5

14 days delivery

Article	
mounted retroreflector:	No: 1010022

Accessories

optional items for the attoSENSORICS product line

Accurate interferometrical measurements in ambient environment

In order to reduce position inaccuracy due to air-induced variations of the index refraction, attocube supplies an environmental compensation unit (ECU). By locally measuring environmental parameters, an accuracy of typically better ± 1 ppm can be achieved in air. The ECU is plug and-play compatible with all IDS models and can be screw- or magnet mounted.

Technical Specifications ECU	
integrated sensors	temperature (T), pressure (p), humidity (rH)
typ. accuracy (IDS)	better ± 1 ppm
sensor dimension	Ø 37 mm, 17.4 mm height
sensor mount	magnetic, screw mount
working environment	non-condensing
cable length	5 m
Meas. Accuracy (Sensors)	
T	±0.1 °C (0..50 °C)
p	±1 hPa (300 ..1100mbar)
rH	±2% (10..90%)
rH	±2% (10..90%)

Article	
ECU:	No: 1008536

KF40/3

CF40/3

Vacuum Fiber Feedthrough

KF flange: We supply KF vacuum flanges with FC/APC optical feedthrough in sizes KF16 to KF63, with one to three optical feedthroughs (depending on flange size). KF flanges are vacuum compatible down to 10-8 mbar (high vacuum) and bakeable to 150 °C.

CF flange: We supply CF vacuum flanges with FC/APC optical feedthrough in sizes CF16 to CF63, with one to three optical feedthroughs (depending on flange size). CF flanges are compatible down to 5x10-11 mbar and can be baked out at up to 180°C. These CF flange feedthroughs are designed for UHV operation.

Article	
KF40/1:	No: 1007201
KF40/3:	No: 1007203
CF40/1:	No: 1007192
CF40/3:	No: 1007196