

Instruction Manual

High Precision Extensometer (Strain Gauge Transducers)



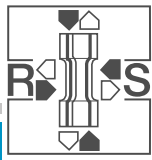
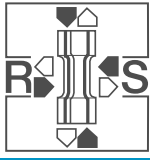
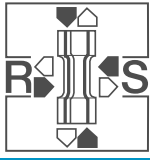


Table of contents

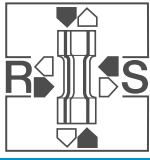
EXTENSOMETER-kits and basic units	5
Application and construction	5
Further characteristics	5
Axial extensometer EXA	5
High-temperature extensometer EXH	6
Crack opening transducer EXR	6
Diametral strain transducer EXD	6
Design and function	6
Electrical data	7
Temperature range	7
Ambient conditions	7
Test frequency	7
Errors of measurement	8
Signal conditioner and connection cable	8
Calibration	8
Calibration units KEE KED KEM	9
Axial extensometer EXA (Fig. 4...9 and charts 1...3)	10
Design and function	10
Extensometer equipped with locking pin	10
Extent of delivery (clearly arranged in a box).....	10
Extensometers equipped with gauge block	11
Attachment to the specimen by means of standard clamping springs (Fig. 5, 7, 8 and 9)	11
Fastening by means of special elements	12
Accessory mounting kits (see charts 2 and 3)	13
Measuring range extension unit	14
Conversion procedures	14
Gauge length extension unit	14
Extent of delivery (in the box)	14



Conversion procedures	15
Axial extensometer EXH**A for high temperature tests up to 1200°C and optional up to 1800°C (Fig. 10 and charts 4..6)	16
Design and function	16
Extent of delivery	16
Mounting	18
Re-calibration	18
Accessory mounting kits (see charts 5 and 6)	19
Extent of delivery	19
Conversion procedures	19
Note:	19
Crack opening displacement transducer EXR (Fig. 12 and 13 and charts 7...9)	20
Design and function	20
Attachment to the specimen	20
Accessory mounting kits (see charts 8 and 9)	21
Extent of delivery (in the box).....	21
Conversion procedures	22
Accessory mounting kit – gauge length extension unit	22
Extent of delivery (in the box).....	22
Conversion procedures	23
Diametrical strain transducer EXD (Fig. 14 and charts 10...12)	24
Design and function	24
Extent of delivery (in the box).....	24
Attachment to the specimen	25
Accessory mounting kits	26
Extent of delivery (in the box).....	26
Conversion procedures	26
Diametrical strain transducer EXH**D for high temperature test up to 1200°C (Fig. 15, charts 13 and 14)	27
Design and function	27
Extent of delivery	27
Chart 13: Diametrical extensometer up to 1200°C, technical data	27



Attachment to the specimen	28
Accessory mounting kits (see chart 14)	28
Conversion procedures	29
Extent of delivery	29
Calibration unit KE* (Fig. 16 and 17)	30
Design and function	30
Extent of delivery (in the box)	30
Fig.16: Calibration unit KEE for axial extensometer EXA and crack opening displacement transducer EXR	30
Accessory mounting kits	31
Extend of delivery	31
Conversion procedures	31



EXTENSOMETER-kits and basic units

Technical data: see charts 2, 3, 5, 6, 8, 9, 11, 12 and 14

All basic devices in Design x are available for temperatures up to 120°C.

All basic devices in Design o are available for temperatures up to 220°C.

All basic devices in Design u are available for temperatures up to 300°C.

Special design extensometers are available upon request.

Application and construction

Measurement of deformation due to strain and deformations due to compression (standard specimen and components) under static, quasi-static and dynamic load.

Each transducer consists of a basic unit (Fig. 1) and accessories to suit the application. The basic units are identified by their nominal gauge length and by their nominal strain. As standard designs, basic units with 10 mm (Fig.4) and 25 mm (Fig. 6) lengths and with nominal strains according charts 2 and 3 are available.

These basic units have the option of being extended with interchangeable accessory kits:

- Axial extensometer, design EXA (see Fig. 4...9) or
- Extensometer, for high-temperature tests, design EXH (see Fig. 10 and 15) or
- Crack opening transducer, design EXR (see Fig. 12 and 13) or
- Diametral strain transducer, design EXD (see Fig. 14).

In addition special design strain transducers are available, with gauge lengths of 15 mm, 20 mm and 30 mm, which normally can not be combined with the accessory mounting kits.

Characteristics

Compact and light construction, minimum deflection spring forces, so that only minor cohesions and inertia forces which insignificant as interference factors, have an effect on the specimen. High natural frequency, thus disturbance-free strain measurement, even at high frequencies.

Flexible connection cable with fixed wiring.

Temperature compensation over a wide range.

May be used in nonconductive fluids, like e.g. alcohol, acetone, silicone.

Modular system: Basic units with mounting kit and extension possibility by means of accessory kits.

Limit stops are a protection against overload.

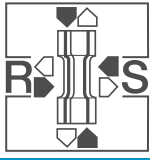
Possible extension of the gauge length ranges, beyond the modular programme, by means of complete special design mounting kits.

Further characteristics

Axial extensometer EXA

Special distance gauge for quick and precise fixing of the gauge length.

Easy-to-apply clamping springs ensure reliable fitting even to specimens with rough and uneven surfaces. Expansion of the measuring range and the nominal strain for the same gauge length using a mounting kit with measuring range extension. Wide range of gauge lengths and measuring ranges with constant nominal strain, using a mounting kit with gauge length extension.



High-temperature extensometer EXH

Large temperature range from room temperature up to 1800 °C. High accuracy of measurement even in the upper temperature range high-temperature resistance and easily exchangeable ceramic rods. Ceramic rods usable at both sides; contact probes may be refinished on normal grinding machines.

Crack opening transducer EXR

The clamping force is generated by a separate spring, i.e. a measuring signal independent of the clamping force. The clamping force may be adapted to the requirements by changing the spring force. Extension of measuring range and nominal strain are available by means of accessory kits.

Diametral strain transducer EXD

Transducer without separate support which may be clamped directly onto the specimen, i.e. no errors of measurement caused by the relative movement of the support. Self-centering of the transducer in the case of round specimens. Fixing elements for round specimens and flat specimens. Stepless adaptation to the specimens dimensions.

Design and function

The strain transducers EX.. operate on the " transverse beam measuring principle ". Strain gauges are applied to the cross member of a U-shaped, precision-manufactured measuring spring, and connected into a Wheatstone bridge. The two legs of the measuring spring are elastically deformable in such a way that despite the very small overall dimensions, long measuring distances may be obtained. To the end of the legs of the measuring spring, various connecting parts may be bolted, so that depending upon the requirements, this results in transducer models EXA, EXD or EXR.

Increase or reduction of the distance between the ends of the legs causes bending of the cross member of the measuring spring, which results in a proportional electrical change of resistance in the strain gauges. This is output in the form of an electrical signal by a **SANDNER-universal signal conditioner**. The connection cable carries a mini-connector, which is connected to the strain gauges as shown (Fig. 1). The supply voltage 5 V to (max. 10 V) is to be between 2 and 3, the measuring signal is between 1 and 4. Correct polarization of the supply voltage will result in a negative measuring signal (not in the case of EXH**A and EXD), when the two legs of the spring of the transducer are compressed.

Damage to the strain gauges is prevented by a protective cover.

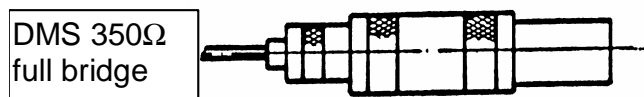
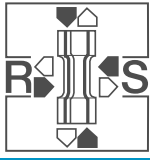


Fig.1: Connections of Lemosaplug
FFA.OS.304.CLAL27

Supply voltage+:	Pin3	green
Supply voltage-:	Pin2	red
Measuring signal+:	Pin 1	white
Measuring signal-:	Pin 4	black



Electrical data

Application in strain gauge practice	full bridge circuit
Nominal resistance (input and output)	350 Ω
Supply voltage	5 V (max.10 V)
Nominal sensitivity: output signal related to supply voltage (V) ("nominal sensitivity")	1,6 mV/V \pm 25% tolerance
Warming-up time (of extensometer and signal conditioner before running the test)	10 min.

Temperature range

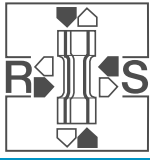
The strain transducers are available in several designs for measurement in various temperature ranges. The transducer EX**x are suited for measurements at -80°C... +120°C (normal temperature stability) . The transducer EX**o are suited for measurements at -270°C...+220°C (extended temperature stability) . The transducer EX**u are suited for measurements at -270°C...+300°C (short term increased temperature stability at 300°C) . The high -temperature transducer EXH are suited for measurements of room temperatures up to 1200°C, optional sapphire rods up to 1800°C are available.

Ambient conditions

The application of the strain transducers is covered with a special protective coating, such that effects caused by the environment, like humidity, sea water spray or contaminated atmosphere have no impact on the result of the measurement. It is also possible to use fluids, e.g. alcohol, acetone, liquid nitrogen, in the case of special conditions we should be consulted.

Test frequency

The strain transducers have been developed particularly for application with dynamic testing machines. Small design and low weight result in a high natural frequency, and thus, in a high test frequency. For natural frequency, please refer to charts 1, 4, 7,10 and 13 "technical data" . Natural frequencies cause interfering signals which depend upon the accelerating forces acting on the transducer. Normally, test frequencies from 0.2 to 0.3 natural frequency, may be obtained without noticeable disturbance of signals. In critical individual cases, e.g. in the case of strain control, the disturbance of signals may be eliminated by means of an electric filter. For this purpose, a filter module should be connected having a corner frequency of one half of the natural frequency of the strain transducer.



Errors of measurement

The errors of measurement of the strain transducers are shown in the charts of the different extensometer types. They contain linearity errors and hysteresis errors and are related to the respective calibrated full scale value in the measuring ranges 1:1 and 1:5 in tension and in compression. In the case of alternating loading, the values indicated are doubled, and contain in addition the sensitivity error tension - compression. Accuracy classes according to ASTM-E83, B1... C depending upon transducer type and calibration.

Signal conditioner and connection cable

The strain transducer of series EX.. may be connected to any DC voltage or carrier frequency signal conditioner, which is suitable in view of signal amplification and accuracy of measurement. The bridge supply voltage of 10V should not be exceeded.

SANDNER-universal signal conditioner are particularly suitable for operation of the strain transducers. They are equipped with a potentiometer enabling the zero-point to be trimmed to +/-1V over the measuring range. This is useful for transducers which have been "biased" during assembly allowing compensation of the bias.

The input amplification of the signal amplification of the signal conditioners should be adjustable.

Thus, the accuracy of measurement of the transducers may be increased in the case of tests with low strain. The connection cable between the signal conditioner and the strain transducer, is a normal, 4-code shielded measuring cable. One cable end is equipped with a Lemosa plug size 0F0 304, and the other end carries a plug matching the signal conditioner used.

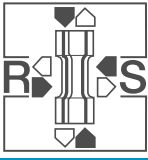
The cable length depends on customers requirements. The standard cable length is 10 m.

Calibration

All strain transducers are calibrated in the factory. The data is recorded on a data sheet in the cover of the storage case. For calibration of the strain transducer to a signal conditioner, the data sheet contains two details:

Sensitivity in	mV/ V
Calibration factor U_{cal} in	V

When using the **SANDNER signal conditioners** the strain transducer may easily be calibrated to the signal conditioner by means of the value U_{cal} . For this purpose, the strain transducer is connected and brought to its mechanical zero position. The signal conditioners is set to 0.000 V. After depressing the calibration pushbutton on the signal conditioner, voltage indication appears on a connected measuring unit. This indication is changed by turning the potentiometer at the front panel of the signal conditioner, until the value indicated in the data sheet appears. After this has been done, a measured signal at the output of the signal conditioner of +/-10 V corresponds to the nominal sensitivity of the strain transducer. When supplementary accessories are delivered for a strain transducer, the strain transducer is to be re-calibrated by the customer after the conversion. Where there are other signal conditioners present, the strain transducer is to be calibrated by means of sensitivity value or a calibration unit.



Calibration units KEE KED KEM

A calibration unit KE* is useful to check calibration data, transducers and for recalibration to the strain values given by a test. It serves to increase the measuring accuracy (signal conditioner change over) and enables measurement of the linearity, hysteresis and sensitivity errors.

The calibration units KE* made by **SANDNER** are recommended for this purpose.

Calibration units can be used for:

Axial extensometer EXA

High-temperature extensometer EXH

Crack opening displacement transducer EXR

Diametral strain transducer EXD

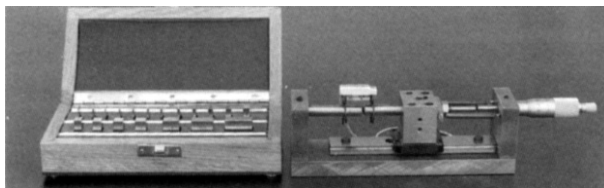


Fig. 2: Calibration unit KEE with axial extensometer EXA put on

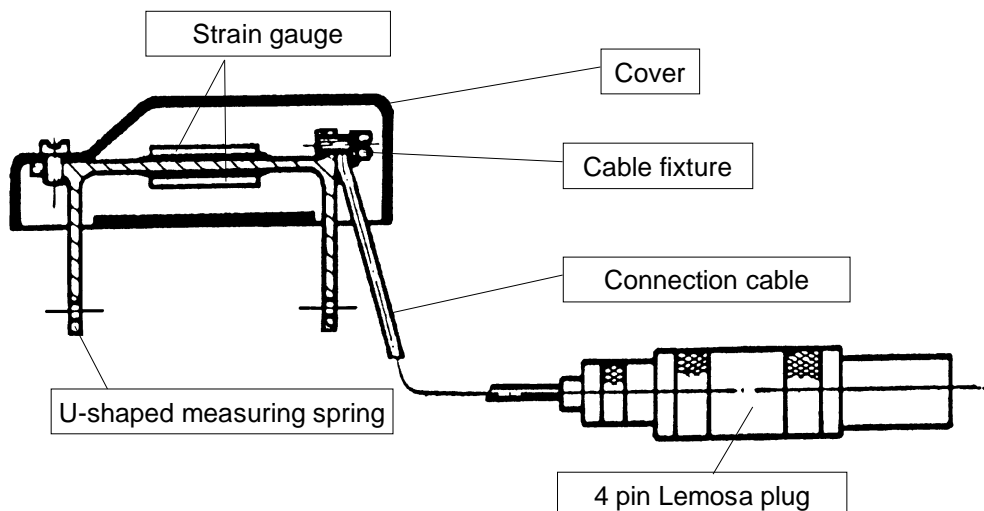
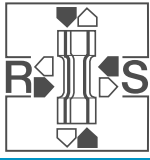


Fig. 3: Schematic setup of an extensometer



Axial extensometer EXA (Fig. 4...9 and charts 1...3)

Design and function

Axial extensometers are used for the measurement of deformations in the case of axial strain (tension, compression), acting on specimens and components. The axial extensometer consists of a basic unit, two edges, two stroke limiting blocks, a set of clamping springs and a gauge block or a locking pin.

The 60° edges, hardened and precision-ground, are used for round and flat specimens. They are suitable for most materials. Special edges are available for specific testing problems. All edges have longitudinal bores for accommodation of a clamping spring. In addition, there are flats at the edges, for attaching the stroke limiting block and the guides for the gauge block.

Together with stroke limiting blocks, which are to restrict the stroke in both directions, and thus to avoid a mechanical overload of the transducer, the edges are screwed onto the legs of the measuring spring. For attachment of the transducer onto the specimen, clamping springs are moved onto the longitudinal bores of the edges, and around the specimen, this is considered to be a very easy and safe method of fastening.

The following set of clamping springs is included in the standard delivery:

	diameter or thickness of specimen in mm			
round specimens	1 -3	3 -6	6 -10	10 -18
flat specimens				

Extensometer equipped with locking pin

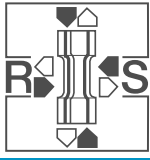
This is a new easier method but more precise and can be used with some extensometers instead of a gauge block.

Pretensioned application

In addition to the "normal" gauge blocks (width = nominal gauges length, e.g. 10 or 25 mm) gauge blocks are available with a width larger or smaller than "normal", differing up to the nominal displacement.

Extent of delivery (clearly arranged in a box)

- 1 Basic unit with 0.5 m long connection cable
- 1 Pair of edges for round and flat specimens
- 2 Stroke limiting blocks
- 1 Slip gauge or locking pin
- 1 Screw driver
- 4 Pairs of clamping springs for round specimens 1...18 mm \varnothing
- 4 Pairs of clamping springs for flat specimens 1..18 mm thickness
- 1 Perlon string with snap link



Extensometers equipped with gauge block

The gauge block is used to ensure accurate fixing of the gauge length by clamping the transducer until it is on the specimen. It is equipped with a spring clip which firmly presses both edges against the gauge block. When the transducer is fixed to the specimen the gauge block is removed. For this purpose, the spring clip is used as a grip. The gauge is indicated in the diagram (in the cover of the box).

Attachment to the specimen by means of standard clamping springs (Fig. 5, 7, 8 and 9)

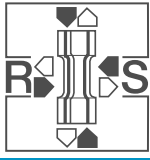
When fixing the transducer to the specimen, the following procedures are to be carried out:

- a) Select clamps, according to specimen type (round or flat) and thickness.
- b) Place the slip gauge between the knife edges. Care is to be taken that the spring clip is secured firmly in the guides and that the contact area is clean.
- c) Connect transducer with the connection cable to the signal conditioner.
- d) Fix strain transducers against the specimen, by gently pushing the cover, on the side where the screws are.
- e) Move clamp into the longitudinal bore of the edges, and around the specimen. Keeping the clamp laterally supported with 2 fingers makes this easier.
- f) Align clamp on the centre line of the edges, if necessary reposition the the transducer on the specimen.
- g) Make second clamp slide in and align it.
- h) Check position of strain transducer on specimen, and correct if required. Check for secure fit of the transducer on specimen by slightly moving the cover.
- i) Withdraw slip gauge or locking pin carefully, whilst holding transducer in position with your finger tips.
- j) Adjust electrical zero on signal conditioner.

When a transducer is to be mounted in pre-tension or pre-compression, it is advisable to use a gauge block with a width corresponding to the bias value.

Such a gauge block may be manufactured by the customer after the zero gauge has been delivered, or it may be ordered from **SANDNER** as a special design.

In the case of a specimen fracture, it is to be expected that the transducer comes loose from the specimen and falls down. It is protected from damage by means of the Perlon string. The string is knotted into a bore on the bolts of the cover. The other end of the string is equipped with a clipper, which is to be attached to a suitable point (e.g. specimen grips, crosshead) such that the transducer will be caught by the string, when falling down, and swing out of the way.



Fastening by means of special elements

1. Fastening by means of specially designed clamping springs, up to approx. 80 mm thickness of specimen: The fastening is carried out as described for the standard clamping spring.

2. Fastening to round specimens $> 80 \text{ mm } \varnothing$

- a) Screw special screws and nuts into the longitudinal bores of the edges.
- b) Select helical springs according to the diameter of the specimen.
- c) Suspend one side of the helical springs into the bores of the special screws.
- d) Strain transducer is then applied to the specimen, tensioning the spring and attaching to the nut.

For the further steps, see items h...j for fastening with standard clamping springs.

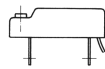


Fig. 4: Extensometer basic unit EXA10-1 without knife edges

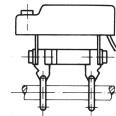


Fig. 5: Axial extensometer EXA10-1 put on a round specimen

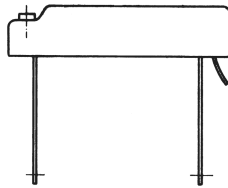


Fig. 6: Extensometer basic unit EXA25-10 without knife edges

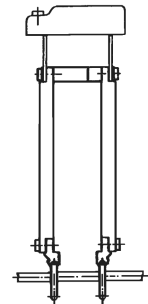
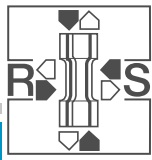


Fig. 7: Axial extensometer EXA10-5 also put on a round specimen



Model Type x/o/u Version	Gauge Length [mm]	Measuring Displacement [mm]	Measuring Error of Full Scale [± %]	Natural Frequency [Hz]	Activation Force [N]	Weight [g]	Dimensions		
							L [mm]	B [mm]	H [mm]
EXA 10-0,25	10	± 0,25	0,1	500	3	5	20	10	15
EXA 10-0,5	10	± 0,5	0,3	500	3	5	20	10	15
EXA 10-1	10	± 1	0,25	250	3	6	20	10	21
EXA 10-2	10	± 2	0,25	100	3	7	20	10	29
EXA 10-5	10	± 5	0,3	40	0,7	12	20	10	65
EXA 15-0,5	15	± 0,5	0,25	500	3	5	20	10	20
EXA 15-1	15	± 1	0,3	250	3	5	20	10	20
EXA 15-2	15	± 2	0,3	100	3	6	20	10	32
EXA 15-4	15	± 4	0,3	40	0,7	12	20	10	65
EXA 20-0,625	20	± 0,625	0,2	500	3	7	34	10	25
EXA 20-1,25	20	± 1,25	0,35	500	3	7	34	10	25
EXA 20-1,250	20	± 1,25	0,2	500	3	8	34	10	31
EXA 20-2,5	20	± 2,5	0,35	250	3	8	34	10	31
EXA 20-5	20	± 5	0,35	100	3	9	34	10	45
EXA 20-10	20	± 10	0,35	40	0,7	14	34	10	68
EXA 25-0,625	25	± 0,625	0,1	500	3	7	34	10	25
EXA 25-1,25	25	± 1,25	0,2	500	3	7	34	10	25
EXA 25-1,250	25	± 1,25	0,1	500	3	8	34	10	31
EXA 25-2,5	25	± 2,5	0,2	250	3	8	34	10	31
EXA 25-5	25	± 5	0,2	100	3	9	34	10	45
EXA 25-10	25	± 10	0,3	40	0,7	14	34	10	65
EXA 30-0,625	30	± 0,625	0,2	500	3	7	34	10	25
EXA 30-1,25	30	± 1,25	0,35	500	3	7	34	10	25
EXA 30-1,250	30	± 1,25	0,2	500	3	8	34	10	31
EXA 30-2,5	30	± 2,5	0,35	250	3	8	34	10	31
EXA 30-5	30	± 5	0,35	100	3	9	34	10	45
EXA 30-10	30	± 10	0,35	40	0,7	14	34	10	65
EXA 40-4	40	± 4	0,2	250	2,5	22	44	10	40
EXA 50-5	50	± 5	0,2	250	2,5	24	54	10	46
EXA 60-6	60	± 6	0,2	250	2,5	28	64	10	53
EXA 70-7	70	± 7	0,2	250	2,5	31	74	10	60
EXA 80-8	80	± 8	0,2	250	2,5	33	84	10	68
EXA 90-9	90	± 9	0,2	250	2,5	36	94	10	76
EXA 100-10	100	± 10	0,2	250	2,5	38	105	10	82

Chart 1: Axial extensometer EXA, technical data

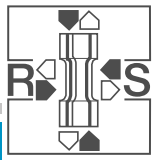
We manufacture extensometers upon request, technical specifications and applications of strain gauges can be supplied.

Accessory mounting kits (see charts 2 and 3)

As the strain transducers are constructed according to modular systems, the range of applications of various transducers can be extended by means of accessory mounting kits.

These mounting kits are designed as basic units, using axial extensometers EXA, but a combination of suitable units is also possible.

In the following, the operating procedures required for fixing accessory mounting kits to axial extensometers, are described. After the conversion, the transducer is to be calibrated.



Measuring range extension unit

The measuring range extension unit is used for extending the measuring range. The unit consists of levers fixed between the legs of the transducer and the edges. For axial extensometers, the measuring range extension units according to charts 2 and 3 are available.

Extent of delivery

- 2 Extension legs

Conversion procedures

In the case of the axial extensometers, the extension legs are fixed between knife edges and the arms of the measuring springs
The limit stops are attached to the upper ends of the extension legs.

Gauge length extension unit

To increase the gauge length of axial extensometers, accessories are available, e.g. for the transducer EXA25-2.5. By means of these accessories, transducers with a gauge length up to 100 mm may be obtained. Charts 2 and 3 show the gauge length extension units available and the axial extensometers which may be obtained from them.

Basic Model x/o/u		EX 10-0,25	EX 10-0,5	* EX 10-1	EX 10-2	* EX 10-5
Accessory Kit	A10	±0,25	±0,5	±1	±2	±5
	A15	±0,5	±1	±2	±4	

Chart 2: Axial extensometer EXA10-X with gauge length extension unit

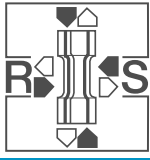
Basic Model x/o/u		EX 25-0,625	EX 25-1,25	* EX 25-2,5	EX 25-5	* EX 25-10
Accessory Kit	A20	±0,625	±1,25	±2,5	±5	±10
	A25	±0,625	±1,25	±2,5	±5	±10
	A30	±0,625	±1,25	±2,5	±5	±10
	A40			±4		
	A50			±5		
	A60			±6		
	A70			±7		
	A80			±8		
	A90			±9		
	A100			±10		

Chart 3: Axial extensometer EXA25-X with gauge length extension unit

Extensometers marked by * can be equipped with measuring range extension units.

Extent of delivery (in the box)

- 2 Transmission levers with spring link
- 2 Stroke limiting blocks
- 2 Edges
- 1 Set of clamping springs
- 1 gauge block or locking pin



Conversion procedures

- Remove all the limit stops on the axial extensometer.
- Clamp the axial extensometer into the grooves on the transmission lever, by means of clamping springs.
- Fasten at the specimen, as described for standard design.

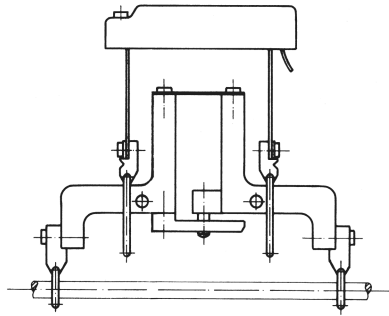


Fig. 8: Axial extensometer EXA50-5, as example for the use of gauge length extension units. Basic extensometer EXA25-2,5.

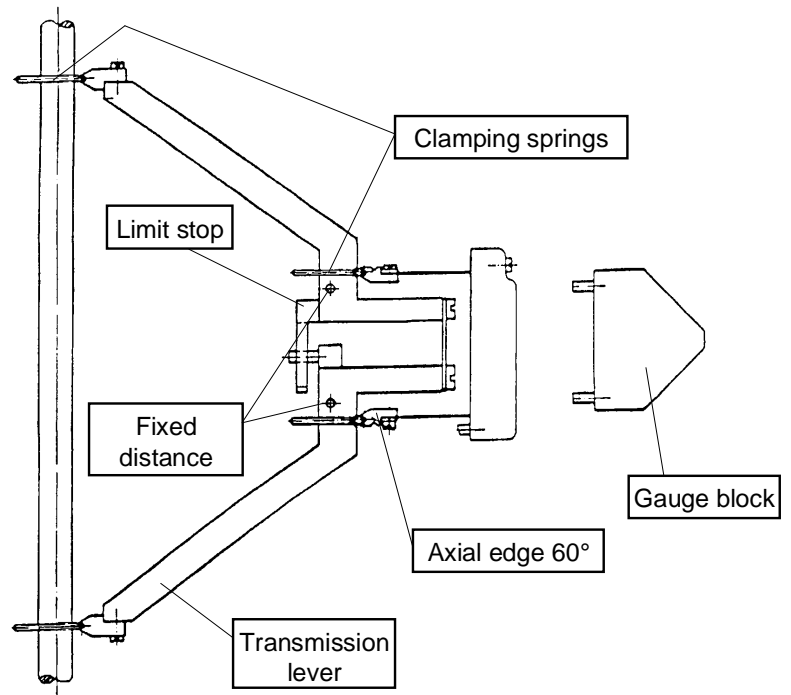
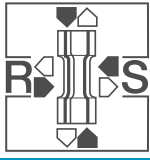


Fig. 9: Axial extensometer EXA100-10 existing of basic unit EXA25-2,5 and accessory kit A100



Axial extensometer EXH**A for high temperature tests up to 1200°C and optional up to 1800°C (Fig. 10 and charts 4...6)

Design and function

Together with a high-temperature furnace, this extensometer is used for the determination of axial deformation during high-temperature tests.

The transducer consists of an axial extensometer EXH and transmission rods. The transmission rods consist of a heat shield with setting screws, a spring element, two ceramic measuring rods, two measuring rod supports with limit stops, 4 knurled nuts and 2 clamping springs. When the transmission rods are delivered as an accessory mounting kit, 2 edges are additionally supplied, depending upon the transducer type.

The heat shield is attached to the high-temperature furnace. The strain transducer is moved over the setting screws, and pressed against the specimen by means of the knurled nuts via the spring element. The ceramic measuring rods transfer the deformation of the specimen onto the measuring rod support, via the joints of the spring element, which are free from backlash.

The axial extensometer attached to the end of the measuring rod support converts the deformation of the specimen between the measuring rod probes into electric signals. The limit stops prevent an overload of the strain transducer.

SANDNER supplies the EXH axial extensometer and the EXH accessory kits with a bigger heat shield especially for inductive furnaces and long period tests.

For a very high temperature stability a temperature chamber is available which will keep the extensometer at constant temperature. The cooling is done by a cooling coil that completely surrounds the extensometer and part of the transmission rods.

As cooling liquids water or a other medium can be used.

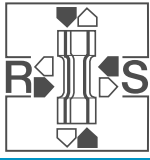
With the adjustable movement system the axial extensometer can be put gently on the specimen.

Extent of delivery

- Axial extensometer EXH**A with connection cable of 0.5 m length
- Transmission rods with heat shield

According to model:

- Larger heat shield or temperature chamber
- Manual adjustable movement system



Model Type	Gauge Length [mm]	Measuring Displacement [mm]	Measuring Error of Full Scale [± %]	Natural Frequency [Hz]	Activation Force [N]	Weight [g]	Temperature Range [°C]	Dimensions		
								L [mm]	B [mm]	H [mm]
EXH 15-0,75A	15	± 0,75	0,3	150	2		1200/1800	110	60	240
EXH 15-1,5A	15	± 1,5	0,3	150	2		1200/1800	110	60	240
EXH 15-3A	15	± 3	0,3	150	2		1200/1800	110	60	210
EXH 15-6A	15	± 6	0,3	150	2		1200/1800	110	60	210
EXH 20-1A	20	± 1	0,25	150	2	≈100	1200/1800	110	60	210
EXH 20-2A	20	± 2	0,25	150	2		1200/1800	110	60	210
EXH 20-4A	20	± 4	0,25	150	2		1200/1800	110	60	240
EXH 25-1,25A	25	± 1,25	0,25	150	2		1200/1800	110	60	210
EXH 25-2,5A	25	± 2,5	0,25	150	2		1200/1800	110	60	210
EXH 25-5A	25	± 5	0,25	150	2		1200/1800	110	60	240
EXH 30-1,5A	30	± 1,5	0,25	150	2		1200/1800	110	60	210
EXH 30-3A	30	± 3	0,25	150	2		1200/1800	110	60	210
EXH 30-6A	30	± 6	0,25	150	2		1200/1800	110	60	240
EXH 50-10A	50	± 10	0,25	150	3		1200/1800	110	60	256

Chart 4: Axial extensometer up to 1200°C/1800°C, technical data

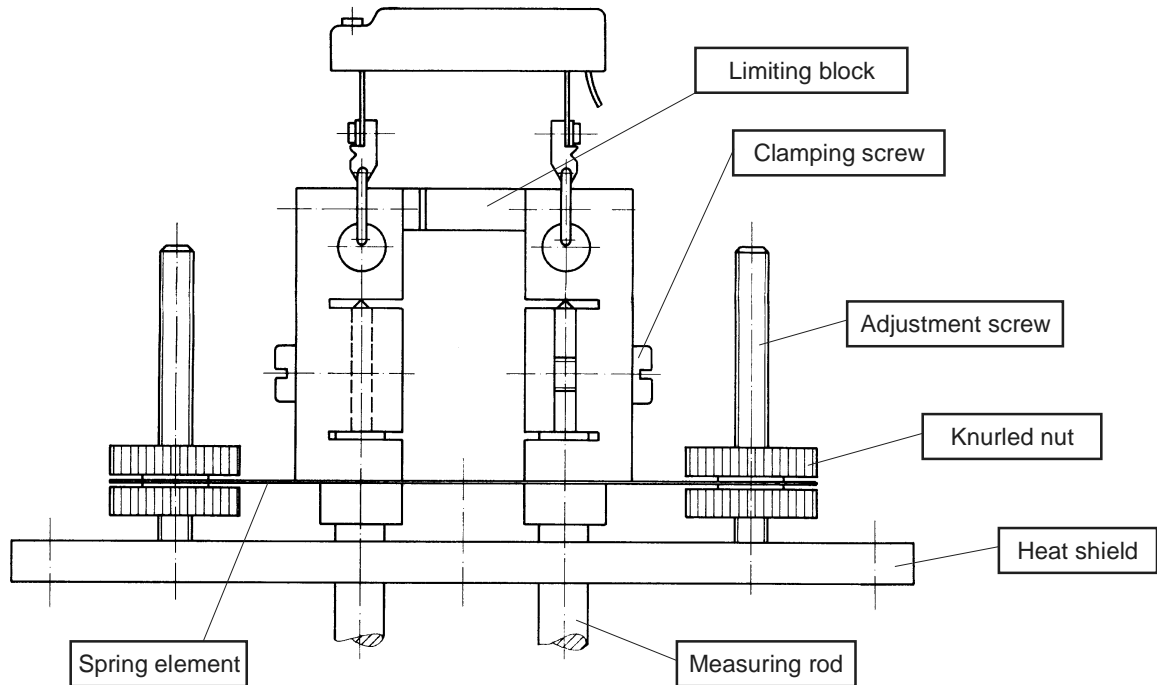
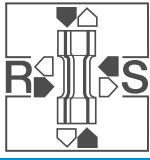


Fig. 11: High-temperature axial extensometer EXH25-2,5A



Mounting

Prior to mounting attach the heat shield to the furnace and align the centre of the furnace on the centre line of the specimen.

- a) The axial extensometer is mounted on the transmission rods by means of the clamping springs, such that the edges are positioned in the grooves of the measuring rod support.
- b) Connect the strain transducer to the signal conditioner.
- c) Insert the bottom knurled nuts to the end of the setting screw. The screwed on collar must point towards the top.
- d) Move the transducer onto the setting screws of the heat shield, until the probes of the ceramic rods touch the specimen.
- e) Rest the transducer against the specimen, to do this pretension the spring element by means of the top knurled nuts. The screwed on collar of the nut must point towards the spring. By means of a spring pre-tension corresponding to a spring excursion of approx. 5 mm, a sufficient contact pressure is obtained.
- f) Align the measuring rods in a rectangular position to the longitudinal axis of the specimen, and centric to the centre of the specimen. Adjust to the required gauge length by positioning a suitable slip gauge between the measuring rods. When displacing the measuring rods they have to be lifted against the force of the spring element, in order not to damage the probes. It is possible to centre the specimen (centering angle 120°) to accommodate the contact probes, but normally, direct application to the specimen is sufficient.
- g) Fix the spring element onto the setting screws by tightening the bottom knurled nuts.
- h) Zero balance of the signal conditioner.

After termination of the test, the transducer should be disassembled, in order to avoid damage to the ceramic rods. The contact probes are to be checked for possible damage because they have been subject to a heavy load. When damage is detected the other end of the measuring rods may be used. For this purpose, the rods are to be removed from their support, after releasing the clamping screws, and they are to be turned around. During the re-installation care is to be taken that the distance of 144 mm between the spring element and the contact probe is strictly adhered to, in order maintain the accuracy of calibration.

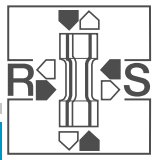
When both contact probes are damaged, the rods may be reground on a circular grinding machine with a diamond grinding wheel; point angle 90°.

Re-calibration

The transducers have been calibrated in the factory at room temperature, (see section "calibration"). In the case of high temperatures, the calibration may be changed slightly as the calibration values depends on temperature.

In the case of 1200°C this deviation can be 0.2.... 1.5%. This error can be corrected by recalibration at the required temperature as follows:-

- a) Install a separated specimen into the clamping unit.
- b) Position the piston rod by placing slip gauges underneath the bottom clamping head. The adjustment of the piston rod is, for practical reasons, pressure legs and carried out by a threaded spindle, attached to the bottom clamping head.
- c) Adjust to the required measuring range by adjusting the threaded spindle, and placing the corresponding slip gauges underneath. Then, the threaded spindle is to be turned back, until the weight of the piston rod and clamping head is applied to the slip gauges.
- d) To determine the correction values, change the amplification setting of the signal conditioner.



Accessory mounting kits (see charts 5 and 6)

Various axial extensometers may be extended to high-temperature axial extensometers by using accessory mounting kits.

Basic Model x/o/u		EX 10-0,25	EX 10-0,5	EX 10-1	EX 10-2	EX 10-5
Accessory Kit	H15A	±0,75	±1,5	±3 +6		

Chart 5: Conversion kit high-temperature axial extensometer EXH for basic unit EXA10-X

Basic Model x/o/u		EX 25-0,625	EX 25-1,25	EX 25-2,5	EX 25-5	EX 25-10
Accessory Kit	H20A	±1,25	±2,5			
	H25A	±1,25	±2,5 +5			
	H30A	±1,25	±2,5 +5			
	H50A			±10		

Chart 6: Conversion kit high-temperature axial extensometer EXH for basic unit EXA25-X

Extent of delivery

Transmission rods (in the box) consisting of :

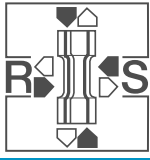
- 1 Heat shield with setting screws
- 2 Ceramic rods
- 2 Measuring rod supports with stops
- 1 Spring element
- 4 Knurled nuts
- 2 Clamping springs
- (2 Knife edges)

Conversion procedures

The existing axial extensometer is clamped onto the transmission rods (see mounting).

Note:

The polarity of the extensometer is changed when the transmission rods are attached to the axial extensometer. In the case of strain control, an inversion of polarity by exchanging the supply voltage connections needs to be performed. To do this resolder the connection cable to the signal conditioner at the connector. In case frequent conversions are required it is useful to have a second cable with the exchanged connections.



Crack opening displacement transducer EXR (Fig. 12 and 13 and charts 7...9)

Design and function

Crack opening displacement transducers are used for measuring crack openings during fracture mechanics tests. They consist of a basic unit, 2 edges designed in accordance with ASTM E-399 requirements, 2 mating edges which are attached to the specimen, 2 stroke limiting blocks and a clip spring.

For contacting the mating edges, the hardened edges are provided with a transverse groove which is dimensioned according to ASTM requirements. In addition the knife edges have flats for attachment of the stroke limiting blocks which prevent mechanical overload of the transducer. The spring clip pushes the knife edges into the mating edges on the specimen, thus fixing the transducer to the specimen.

The gauge length is preset by the mating edges, aligned and fixed by means of a slip gauge. The crack opening displacement transducers are also suitable for specimens which have integral contact edges machined into them. Due to the small dimensions and the light weight of the measuring elements, special knife edges can be made for a multitude of testing problems, measuring under conditions close to the actual operation. These special edges are designed according to the same principle as the ASTM knife edges.

Extent of delivery (in the box)

- 1 Basic unit with 0.5 m long connection cable
- 1 Pair of edges according to ASTM E-399
- 1 Pair of mating edges
- 2 Stroke limiting blocks and 1 spring clip
- 1 Perlon string with clipper

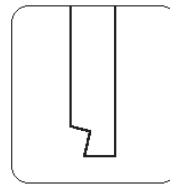


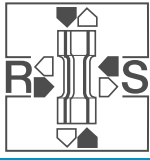
Fig. 11: ASTM-knife edge

Attachment to the specimen

When fixing the transducer to the specimen, proceed as follows:

- a) When using mating edges, bolt them to the specimen and set the gauge length by means of a slip gauge or an auxiliary device.
- b) Connect transducer to signal conditioner cord.
- c) Fix transducer into mating edges or measuring edges of specimen by compressing the legs of the transducer.
- d) Adjust signal conditioner to the given conditions.

In the case of the specimen fracture, the transducer may come loose from the specimen and fall down. The transducer will be protected from any damage by the Perlon string. It is attached into a bore in the bolts of the cover. It has a clipper at its other end which should be fitted to a suitable point (e.g. clamping unit, crosshead) such that, when falling, the transducer will be caught by the string and swing out of the way.



Model Type x/u Version	Gauge Length [mm]	Measuring Displacement [mm]	Measuring Error of Full Scale [± %]	Natural Frequency [Hz]	Weight [g]	Dimensions		
						L [mm]	B [mm]	H [mm]
EXR 10-0,25	10	± 0,25	0,15	500	3 - 8	20	10	17
EXR 10-0,5	10	± 0,5	0,25	500	3 - 8	20	10	17
EXR 10-1	10	± 1	0,25	250	3 - 8	20	10	23
EXR 10-2	10	± 2	0,25	100	3 - 8	20	10	31
EXR 10-5	10	± 5	0,35	40	3 - 8	0	10	67
EXR 20-0,625	20	± 0,625	0,25	500	3 - 8	34	10	25
EXR 20-1,25	20	± 1,25	0,25	500	3 - 8	34	10	25
EXR 20-2,5	20	± 2,5	0,25	250	3 - 8	34	10	31
EXR 20-5	20	± 5	0,25	100	3 - 8	34	10	45
EXR 20-10	20	± 10	0,35	40	3 - 8	34	10	65
EXR 25-0,625	25	± 0,625	0,15	500	3 - 8	34	10	25
EXR 25-1,25	25	± 1,25	0,25	500	3 - 8	34	10	25
EXR 25-2,5	25	± 2,5	0,25	250	3 - 8	34	10	31
EXR 25-5	25	± 5	0,25	100	3 - 8	34	10	45
EXR 25-10	25	± 10	0,35	40	3 - 8	34	10	65
EXR 30-0,625	30	± 0,625	0,3	500	3 - 8	34	10	25
EXR 30-1,25	30	± 1,25	0,3	500	3 - 8	34	10	25
EXR 30-2,5	30	± 2,5	0,3	250	3 - 8	34	10	31
EXR 30-5	30	± 5	0,3	100	3 - 8	34	10	45
EXR 30-10	30	± 10	0,35	40	3 - 8	34	10	65
Clip-on								
		alternatively						
EXRC 2	2	+ 3, +4, +5, +6	0,1	80	8	20	10	67
EXRC 3	3	+ 3, +4, +5, +6	0,1	80	8	20	10	67
EXRC 4	4	- 3, ±3, +4, +5, +6	0,1	80	8	20	10	67
EXRC 5	5	- 3,5, ±3, +4, +5, +6	0,1	80	8	20	10	67

Chart 7: Crack opening displacement transducer EXR/C, technical data

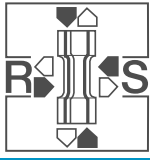
Accessory mounting kits (see charts 8 and 9)

By using accessory mounting kits, axial extensometers can be converted into crack opening displacement transducers.

A conversion kit is assigned to each axial extensometer.

Extent of delivery (in the box)

- 2 Edges
- 2 Mating edges
- 1 Spring clip
- 2 Stroke limiting blocks



Conversion procedures

The knife edges with the stroke limiting blocks are removed from the extensometer and replaced by the edges with attached stroke limiting blocks from the accessory mounting kit. Then the spring clip is attached.

Accessory mounting kit – gauge length extension unit

For crack opening displacement transducers the gauge length extension units R10, R20, R25, R30 are available. Thus, the axial extensometer EXA 10-1 may be converted into crack opening displacement transducer EXR 10-1 and transducer EXA 25-2.5 may be converted into a transducer EXR25-2.5 (for technical data, see chart 7)

Basic Model x/o/u		EX 10-0,25	EX 10-0,5	EX 10-1	EX 10-2	EX 10-5
Accessory Kit	R10	±0,25	±0,5	±1	±2	±5

Chart 8: Conversion kit crack opening transducer EXR for basic unit EXA10-X

Basic Modell x/o/u		EX 25-0,625	EX 25-,125	EX 25-2,5	EX 25-5	EX 25-10
Accessory Kit	R20	±0,625	±1,25	±2,5	±5	±10
	R25	±0,625	±1,25	±2,5	±5	±10
	R30	±0,625	±1,25	±2,5	±5	±10

Chart 9: Conversion kit crack opening transducer EXR for basic unit EXA25-X

Extent of delivery (in the box)

- 2 Extension legs
- 1 Spring clip
- 2 Knife edges
- 2 Mating edges
- 2 Stroke limiting blocks
- Various small parts

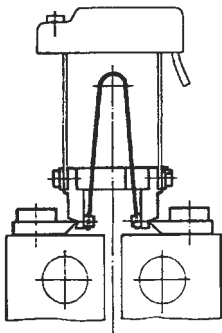
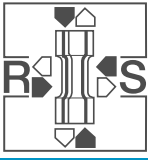


Fig. 12: Crack opening transducer EXR10-2 with mating edges bolt to a CT specimen



Conversion procedures

The edges of the axial extensometer are removed. The top end of the extensometer leg is attached to the legs of the strain transducer, when the limiting blocks are mounted to the bottom end of the knife edges of the crack opening displacement transducer, the spring clip is attached.

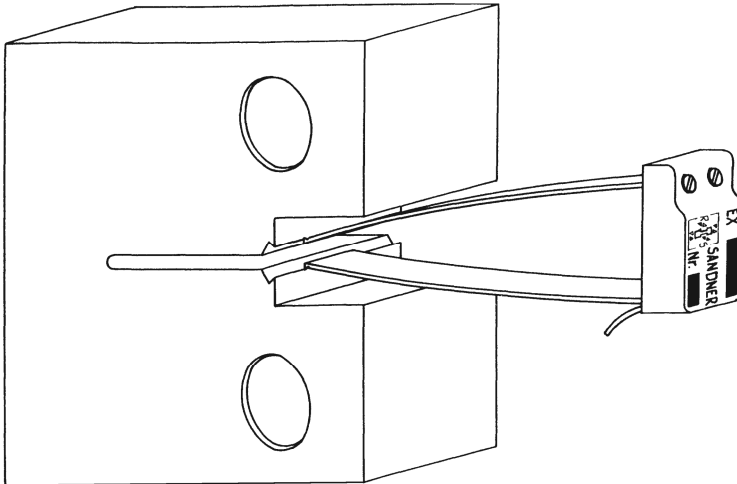
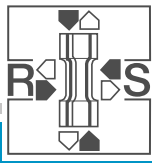


Fig. 13: Clip-on crack opening displacement transducer EXRC 4+6 with integral contact edges machined into a CT specimen



Diametrical strain transducer EXD (Fig. 14 and charts 10...12)

Design and function

Diametral strain transducers are used to measure the diametral or lateral deformations of round and flat specimens. They are self clamping and therefore require no special support. The basic unit is mounted in transverse direction to the test axis.

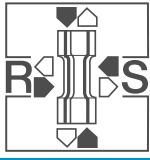
The size of transducer is related to the specimen thickness. The support for the basic unit is equipped with stroke limiting blocks. The spring clips arranged at both sides, with the contact probes, are adapted to the specimen thickness by means of setting nuts. When the clamping spring is applied it presses the transducer against the specimen free from any backlash.

Extent of delivery (in the box)

- 1 Basic unit with 0.5 m long connecting cable
- 1 Two-piece support with limiting blocks and setting nuts
- 2 Pairs of spring clips with adjustable spindle and measuring pin for round specimens and flat specimens
- 1 Clamping spring for fixing the transducer
- 1 Perlon string with clipper

Model Type x/o/u Version	Specimen Thickness Adjustment Range [mm]	Measuring Displacement [mm]	Measuring Error of Full Scale [± %]	Natural Frequency [Hz]	Weight [g]	Dimensions		
						L [mm]	B [mm]	H [mm]
EXD 8-0,25	1 - 8	± 0,25	± 0,35	90	14	40	32	28
EXD 8-0,5	1 - 8	± 0,5	± 0,35	90	14	40	32	28
EXD 8-1	1 - 8	± 1	± 0,35	80	16	40	32	32
EXD 15-0,5	5 - 15	± 0,5	± 0,35	90	20	51	39	36
EXD 15-1	5 - 15	± 1	± 0,35	90	20	51	39	36
EXD 15-1,5	5 - 15	± 1,5	± 0,35	80	22	51	39	39
EXD 30-1,25	15 - 30	± 1,25	± 0,35	90	26	73	47	45
EXD 30-2,5	15 - 30	± 2,5	± 0,35	90	26	73	47	45
EXD 30-4	15 - 30	± 4	± 0,35	80	29	73	47	49
EXD 45-2	30 - 45	± 2	± 0,35	70	41	95	53	65
EXD 45-4	30 - 45	± 4	± 0,35	70	41	95	53	65

Chart 10: Diametral strain transducer EXD, technical data



Attachment to the specimen

- a) Select the transducer according to specimen thickness and measuring range.
- b) Select the spring clips with contact probes according to specimen type.
- c) Installation of the spring clips into the support for the basic unit. For this, the guide spindles are to be moved from the inside of the transducer through the square guiding device, to the setting nuts. When spring clips are used for round specimens, the entry sloping edge of the spring plates must point towards the outside. By turning the nut, the spring clips are moved further to the outside. With regard to the small transducers, the connecting screws between basic unit and support might have to be unscrewed. When these screws are tightened afterwards, care is to be taken that the support is aligned exactly on the centre axis.
- d) Connect the transducer to the signal conditioner and zero balance.
- e) Insert the clamping spring into the guide spindles. For this, the guide spindles are to be adjusted in such a way, that their ends project over the setting nuts by 1 mm. The clamping spring on the side of the transducer cable should be inserted into the slot of the guide spindle and clamped after the transducer, so that the other end can be inserted in the opposite spindle.
- f) Adjust the spring clips to the specimen thickness by adjusting the setting nuts. During this procedure, care is to be taken that the spring clips are adjusted symmetrical to the centre axis. The thickness of the specimen is measured between the probes.
- g) Fixing the transducer to the specimen. In the case of round specimens, the transducer is moved onto the specimen and aligned. In the case of flat specimens, the transducer is to be extended against the spring force of the spring clip, moved onto the specimen, and aligned.
- h) Adjust to the desired electric signal by turning the setting nuts.
- i) Fix the guide spindles by tightening the clamping screws.
- j) Check the transducer's position on the specimen and correct, if required.
- k) Use the signal conditioner to make fine adjustment of the electric signal.

When several specimens of the same dimensions are tested, only the steps g, j and k are to be carried out during all subsequent tests.

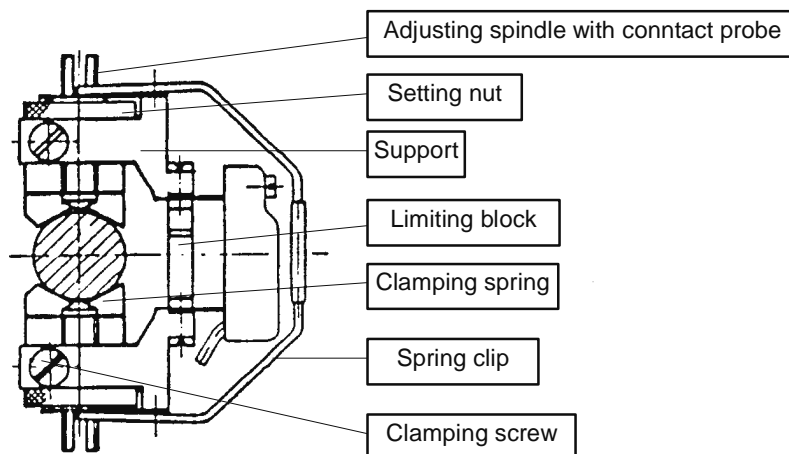
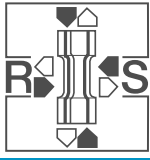


Fig. 14: Setup diametral strain transducer EXD15-1,5



Accessory mounting kits

Basic Model x/o/u		EX 10-0,25	EX 10-0,5	EX 10-1	EX 10-2	EX 10-5
Accessory Kit	D8	±0,25	±0,5	±1		
	D15	±0,5	±1	±1,5		

Chart 11: Conversion kit diametral strain transducer for basic unit EXA10-X

Basic Model x/o/u		EX 25-0,625	EX 25-1,25	EX 25-2,5	EX 25-5	EX 25-10
Accessory Kit	D30	±1,25	±2,5			
	D45	±2	±4			

Chart 12: Conversion kit diametral strain transducer for basic unit EXA25-X

By using the accessory mounting kit, axial extensometers can be converted into diametral strain transducers. A conversion kit is assigned to every axial extensometer.

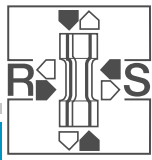
Extent of delivery (in the box)

- 2 Supports with setting nuts
- 2 Stroke limiting blocks
- 2 Spring clips with adjusting spindle and contact probe for round specimens
- 2 Spring clips with adjusting spindle and contact probe for flat specimens
- 1 Clamping spring

Conversion procedures

Remove the edges with the stop blocks from the existing extensometer, then the supports with the screwed-on stop blocks are mounted such that the setting nuts point towards the top.

For further mounting procedures, refer to section "attachment to the specimen".



Diametrical strain transducer EXH**D for high temperature test up to 1200°C (Fig. 15, charts 13 and 14)

Design and function

Together with a high temperature furnace this extensometer is used for the determination of the diametrical deformation at high temperature tests.

The high temperature extensometer consists of a quartz hoop support as well as of a ceramic measuring rod. These are connected by two supports via spring joints (free from backlash). The contact pressure of the hoop support, respectively measuring rod takes place through a spiral spring with variable pretension setting. The extensometer basic unit will be fixed to the two supports. In this way the diametrical deformation of the specimen will be transformed into an electrical signal.

The design of the extensometer allows a parallel displacement between specimen and the fixing of the extensometer two the machine frame or to the clamping table.

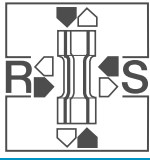
Furthermore exists the possibility of a combined design with another high temperature axial extensometer, so that axial and diametrical deformation can be recorded simultaneously.

Extent of delivery

- Diametrical extensometer EXH**D with connecting cable of 0,5 m length
- Transmission rods

Model Type	Specimen Thickness Adjustment Range [mm]	Measuring Displacement [mm]	Measuring Error of Full Scale [± %]	Natural Frequency [Hz]	Preload max [N]	Weight [g]	Temperature Range [°C]	Dimensions		
								L [mm]	B [mm]	H [mm]
EXH 8-0,625D	1 - 8	± 0,625	0,1		20	280	1200	110	60	250
EXH 8-1,25D	1 - 8	± 1,25	0,35		20	280	1200	110	60	250
EXH 8-2,5D	1 - 8	± 2,5	0,2		20	280	1200	110	60	250
EXH 15-0,625D	5 - 15	± 0,625	0,1		20	280	1200	110	60	250
EXH 15-1,25D	5 - 15	± 1,25	0,35		20	280	1200	110	60	250
EXH 15-2,5D	5 - 15	± 2,5	0,2		20	280	1200	110	60	250
EXH 30-0,625D	15 - 30	± 0,625	0,1		20	280	1200	110	60	250
EXH 30-1,25D	15 - 30	± 1,25	0,35		20	280	1200	110	60	250
EXH 30-2,5D	15 - 30	± 2,5	0,2		20	280	1200	110	60	250

Chart 13: Diametrical extensometer up to 1200°C, technical data



Attachment to the specimen

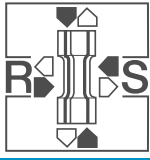
- a) Choice the extensometer according to the specimen thickness and measuring displacement.
- b) Put the existing adjustment plate in one of both lateral slots and clamp the transmission rods.
- c) After releasing the clamping screws on the upper and lower side, the measuring rods can be adjusted to the specimen diameter. During this operation take care that the ceramic edge has to be adjusted parallel to the quartz hoop support and rectangular to the axis of the specimen.
- d) Fixing of the basic support plate to the prepared position in the machine frame or temperature chamber.
- e) After removing the adjustment plate the transmission rod with spring element can be placed into the spring plates, which are fixed on the external spiral springs.
- f) Place the internal spiral springs and spring plates pretension with both knurled nuts. During this operation take care that the mechanized bundle is used for centering of the spiral springs.
- g) Place both measuring rods rectangular to the specimen.
- h) Pretension of the spring elements via the knurled nuts, so that you reach a spring pretension of the hoop support to the specimen. The spring displacement should not exceed 4mm depending on the specimen diameter and the measuring displacement.
- i) After checking the correct seat of the transmission and measuring rods, fit the extensometer on the transmission rods via clamping springs, so that the measuring edges are seated in the grooves of the measuring rods support.
- j) Adjust signal conditioner zero balance and amplification.

In case you test different specimen with the same dimensions, for each test you have only to proceed steps i and j.

To avoid damages of the hoop support and of the ceramic rod the extensometer should be removed after finishing the test. Check both measuring rods if they are damaged because they are exposed to an extrem termical load. If you find out that a hoop support is damaged, change it. Both ends of the ceramic rod are provided with 90°point angles, so that after removing the clamping screw the other end can be used. If both ends are damaged you can regrind them using a round grinding machine provided with a diamond disc.

Accessory mounting kits (see chart 14)

Different axial extensometers can be extended, using accessory mounting kits, to diametrical high temperature extensometers.



Conversion procedures

The existing axial extensometer is clamped to the transmission rods (see mounting).

Basic Model x/o/u		EX 25-0,625	EX 25-1,25	EX 25-2,5	EX 25-5	EX 25-10
Accessory Kit	H8D	±0,625	±1,25	±2,5		
	H15D	±0,625	±1,25	±2,5		
	H30D	±0,625	±1,25	±2,5		

Chart 14: Conversion kit high temperature diamatrical extensometer EXH for basic unit EXA25-X

Extent of delivery

Transmission rods (in the box) consisting of:

- 1 Ceramic rod
- 1 Hoop support (quartz)
- Clamping plate
- Adjustment plate
- 4 Knurled nuts
- 4 spring plates
- 4 Spiral springs
- 4 Clamping springs

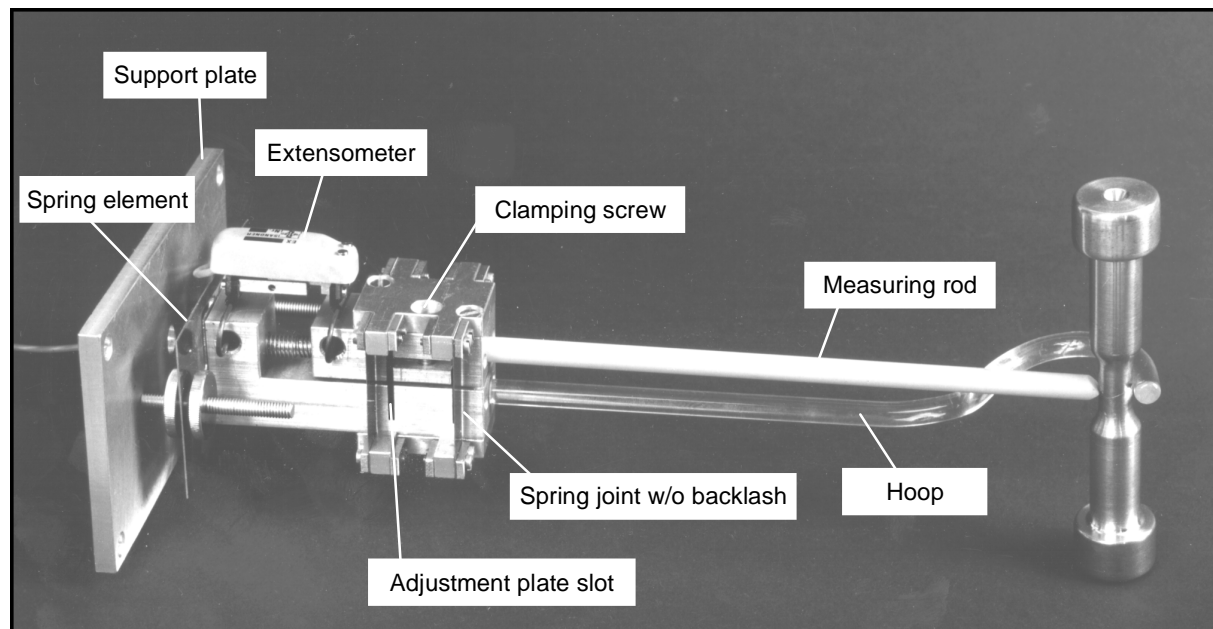
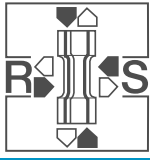


Fig.15: EXH15-0,625D for diametrical high temperature tests up to 1200°C



Calibration unit KE* (Fig. 16 and 17)

Design and function

The calibration units KE* are provided with a linear guiding device (free from backlash). The displacement will be performed via a precision spindle. It is possible to compensate the backlash through a drill-hole in the sled construction. After compensating the measuring bolts to the corresponding displacement, the sled will be positioned in the middle place via the spindle and by the model KEE via gauge blocks. Afterwards the extensometer will be positioned, for more data see under chapter „Fixing to the specimen (here measuring bolts)“. After that the error protocol for the corresponding extensometer can be measured. Determination of the hysteresis as well as the linearity can be done in ten steps, whereby the extensometer will be run in a cycle from -10V to +10V. The values determined herewith gives the error of hysteresis and measurement between the actual and the nominal values.

Extent of delivery (in the box)

Calibration unit KE*

According to model:

- KEM manual displacement spindle
- KEM digital displacement spindle
- KEE box with gauge blocks, quality grade 0
- Support for axial extensometer EXA
- " " high temperature extensometer EXH
- " " crack opening extensometer EXR
- " " diametrical extensometer EXD

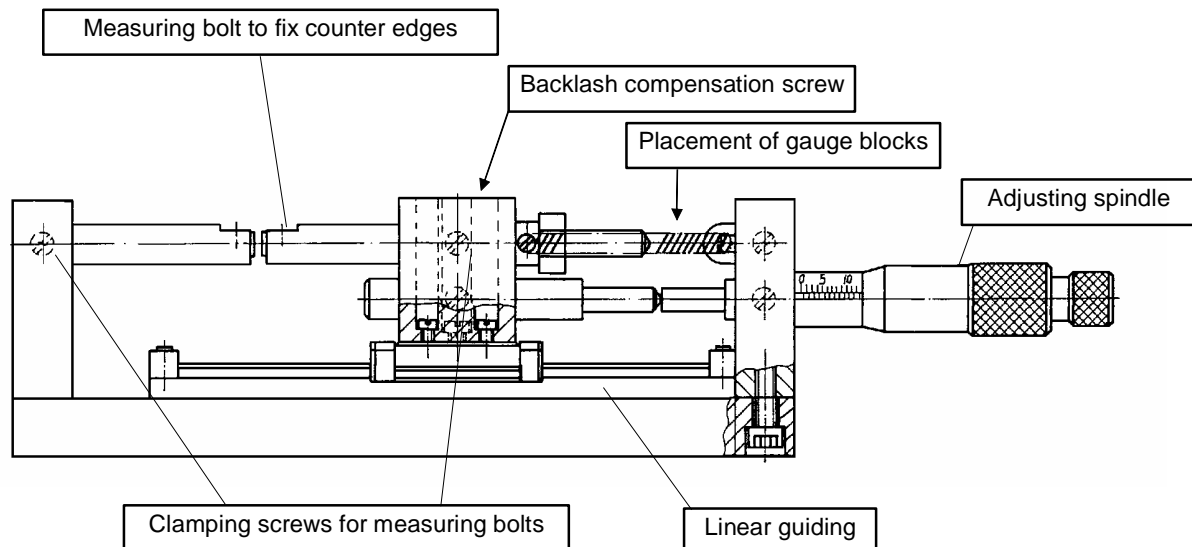
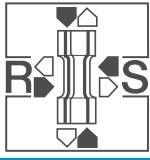


Fig.16: Calibration unit KEE for axial extensometer EXA and crack opening displacement transducer EXR



Accessory mounting kits

To check different types of extensometers the calibration unit model KE* can be extended.

Extend of delivery

Conversion kit	EXD	EXH**A	EXR	EXH**D
Contents	- 2 diametrical measuring bolts	- 4 supports	- 2 measuring bolts with counter-edges	- 2 diametrical-measuring bolts - 1 support

Conversion procedures

According to the conversion kit the measuring bolts will be changed removing the clamping screws and the delivered support will be mounted to the calibration unit.

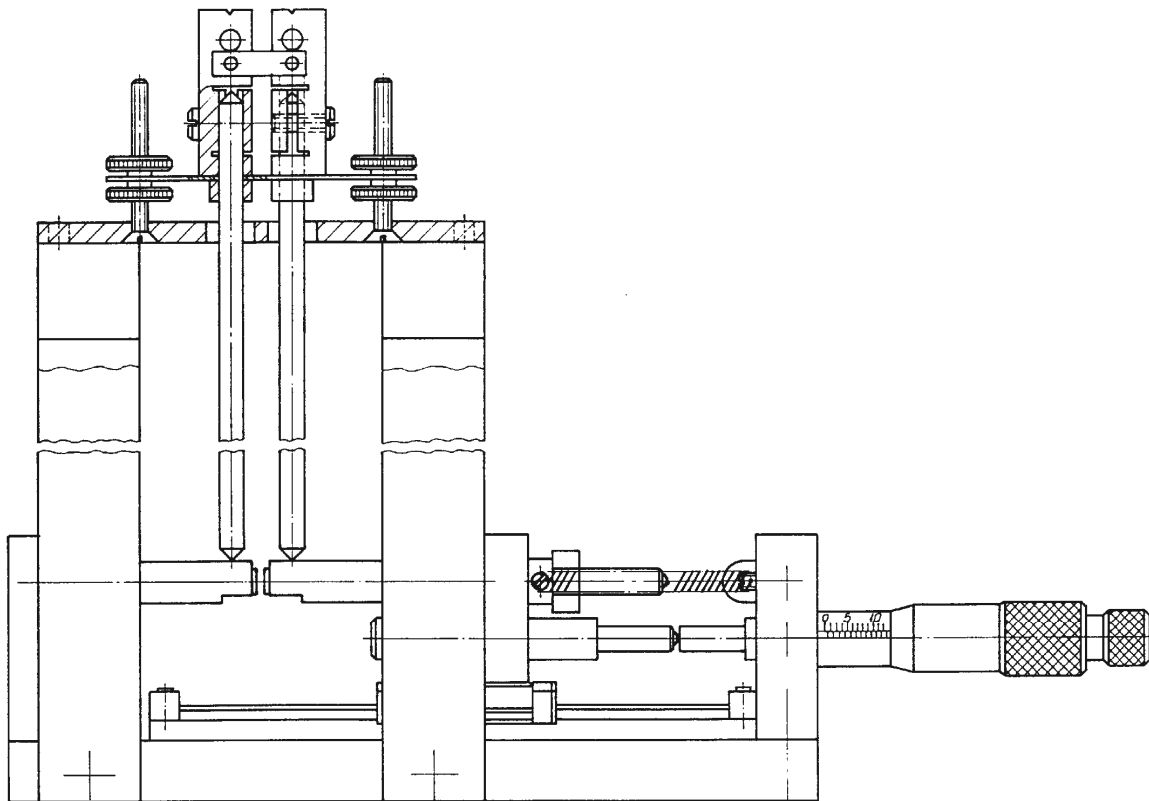


Fig.17: Calibration unit KEE with conversion kit for high temperature EXH**A mounted