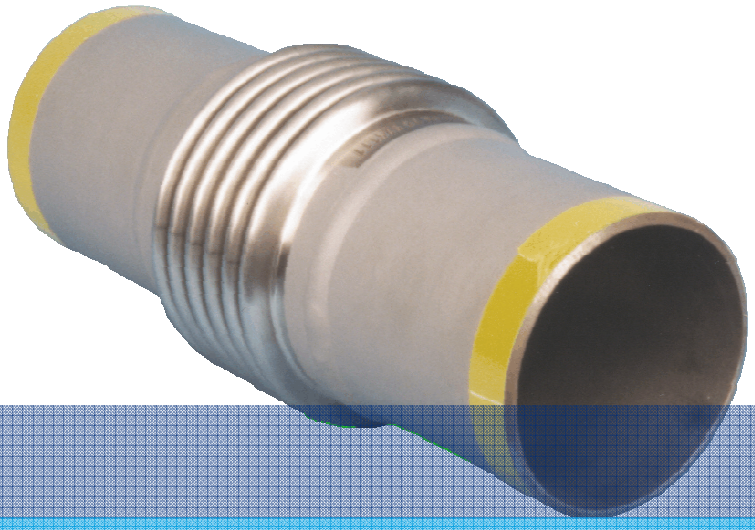
BOA® Group

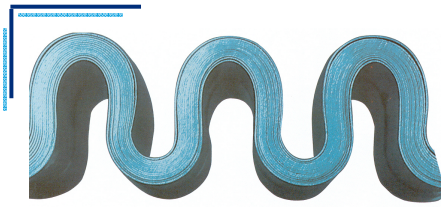


Expansion Joints Guide Module 2a

- Axial Expansion Joints General
- Standard Program (EFB)
- Installation Instructions

Expansion Joints Guide

Summary Module 2a



Elastomer Formed Bellows (EFB):
- several to multi-ply (2 to 16 layers)
- high flexibility
- short construction length
- low displacement forces
- big movement capacity
- small corrugation height
- vibration absorbing

1 Axial Expansion Joints General

Axial expansion joints are intended to take up pipe expansion, particularly in the longitudinal direction of a straight pipe section. Even if an axial expansion joint - depending on length and diameter of the bellows - can absorb small lateral deflections of only a few millimetres or can slightly rotate angularly without parallelism at its end, such an effect should not be allowed and should never be the main function of the axial expansion joint. The basic element of the axial expansion joint is the multi-ply bellows made of austenitic steel. To connect axial expansion joints to the piping, they are provided with either weld ends or flanges, wherein the flanges are either of welded or collared type. Whilst collared flanges have a raised face and can rotate, welded flanges are plane and firm. The standardization for certain types of expansion joints is also due to constructional reasons. The piping designer can not achieve a higher movement capacity by installing two or more axial expansion joints in series to get a double expansion joint or a unit of them. This approach would lead to lateral buckling of the bellows as the stability of the axially very flexible bellows is separately calculated for each expansion joint type. The stability is depending on diameter and nominal pressure which affects primarily the sum of wall thickness of the individual layers. In their standard version, axial expansion joints may be supplied provided with inner sleeve made of austenitic steel.

Calculations

Anchor point load
The task of anchor points in pipelines is to safely absorb the forces occurring in the pipeline, and to assign the thermal expansion to the individual sections of the line. The essential loads to be taken up by the anchor points using unrestrained expansion joints are:

- pressure thrust F_P
- spring rate of the bellows F_B
- sum of friction forces ΣF_R

Pressure thrust F_P
The pressure thrust tends to expand the bellows of the expansion joint. Since the pressure thrust is in almost all cases substantially bigger than the bellow's spring force, no equilibrium condition can be established between both forces. Without anchor points, this would lead to overstretching and thus the destruction of the bellows. The pressure thrust is calculated from the product of the bellow's cross section area and the pressure. The effective cross section area A_B [cm^2] is given in the technical data tables.

$$F_P = 10 \cdot A_B \cdot p$$

F_P = axial pressure thrust [N]
A_B = effective cross section area [cm^2]
p = pressure (operating and test pressure) [bar]

Spring rate of the bellows F_B
The bellows' spring rate is the force the bellows opposes to its extension or contraction. The specific bellows spring rate per ± 1mm expansion is given in the technical data tables as spring rate C_{ax} [N/mm].

$$F_B = C_{ax} \cdot \Delta_X$$

F_B = spring rate of the bellows [N]
C_{ax} = spring rate taken from the table [N/mm]
Δ_X = occurring pipe expansion [mm]

Friction forces ΣF_R
The pipe friction forces depend on the weight of the piping, including flow medium, insulation and the friction force coefficient of the pipe guide. Some empirical values for pipe guide friction force values μ:

steel / steel	0.15 - 0.5
steel / PTFE	0.1 - 0.25
roller bearing	0.03 - 0.1

$$F_R = 9.81 \cdot m_L \cdot \mu$$

F_R = pipe friction force [N]
m_L = weight of piping including medium and insulation weight [kg]
μ = pipe guide friction force value [-]

For axial expansion joints, the major portion of the force to the anchor point results from the pressure thrust. Axial expansion joints are an elastic interruption of the pipeline. As a result of the operating pressure in the line, the pressure thrust is set free and must be taken up by appropriate anchor points (see fig. 1).

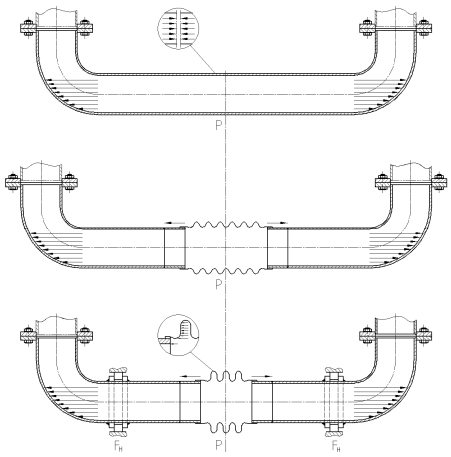


Fig. 1

Basically, we distinguish between main anchors and intermediate anchors.

Main anchors are always positioned at the beginning and at the end of a pipeline, at points of direction changes and also at branching points, thus where full reaction forces occur (fig. 2).

$$F_H = F_P + F_B + \Sigma F_R$$

F_H = anchor point force [N]

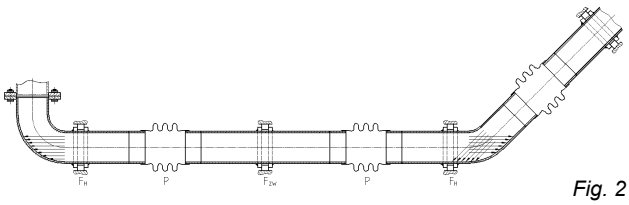


Fig. 2

Intermediate anchor points are practically released from pressure thrust and take up only axially the spring rate of the expansion joint and the friction forces of the pipe guides.

$$F_{ZW} = F_B + \Sigma F_R$$

F_{ZW} = intermediate anchor point force [N]

If local conditions do not allow the positioning of anchor points, restrained expansion joints must be installed.

Details for the pipe layout, the design of pipe guides and prerestraint are described in detail in Module 1, starting from section 2.8.

2 Standard Program BOA Axial Expansion Joints (EFB)

2.1 General

Expansion joints manufactured by BOA AG Switzerland are formed in the elastomer process (EFB). The core element is the multi-ply metal bellows (2 to 16 layers) made of austenitic steel. Expansion joints produced by this method have a large expansion capacity and are very flexible. They are especially appropriate to compensate for thermal expansion and minor misalignment during installation. Their advantages are:

- BOA AG has over 70 years experience in manufacturing expansion joints
- multi-ply construction of the bellows, made of high-grade stainless steel (1.4571 and 1.4541), which means high resistance against ageing, temperature, UV-rays and most of aggressive media.
- very low spring rate due to the multi-ply construction of the bellows.
- large movements at short construction lengths
- due to reasonable stocks, various types in different sizes and pressure ranges are usually available at short time.

Inner sleeve
Inner sleeves protect the bellows and prevent it from being stimulated to oscillate by the fluid. The installation of an inner sleeve is recommended in the following cases:

- abrasive media
- large temperature variations
- flow rates **higher than approx. 8m/s for gaseous media**
- flow rates **higher than approx. 3m/s for liquid media**

When installing, the flow direction must be observed!

The designation for the design with/without inner sleeve for **axial expansion joints** (Types W, FS, FB) is the following:
Expansion joint **types marked with*** are available **either with or without inner sleeve** (extra charge for inner sleeve).
Expansion joint **types marked "B"** do **not need an inner sleeve** because of their short length.
Expansion joint **types marked "L"** have **always an inner sleeve**.

Example:
Type FS16-3**B** = Basic version **without inner sleeve**
Type FS16-3**L** = Basic version **with** inner sleeve
Type FS16-2* = Basic version **without inner sleeve, but may be equipped with inner sleeve**.

2.2 Reduction

2.2.1 Expansion capacity

NOTE (Hereinafter the term **load cycle** is used for full load change cycle.)
The maximum permissible expansion capacity is indicated on the expansion joint. It refers to 1000 load cycles (for expansion joints conforming to EC standards: 500 load cycles with safety factor 2). At higher load cycles, the expansion capacity must be reduced by the load cycle factor K_L according to table 1. For the accurate determination of the load factor K_L the following formula can be applied:

$$K_L = (1000 / N_{adm})^{0.29}$$

Load cycles N_{adm}	Load cycle factor K_L
1'000	1.00
2'000	0.82
3'000	0.73
5'000	0.63
10'000	0.51
30'000	0.37
50'000	0.32
100'000	0.26
200'000	0.22
1'000'000	0.14
25'000'000	0.05

Table 1

2.2.2 Temperature related movement and pressure reduction

NOTE
The admissible operating pressure is determined by the nominal pressure considering the reduction factor K_P according to tab. 2. At higher temperatures, the expansion capacity K_Δ has to be reduced according to the reduction factors.

Reduction factors [1] for pressure [K_P] and expansion capacity [K_Δ]		
Temperature °C	K_P	K_Δ
-10...20	1.00	1.00
50	0.92	0.97
100	0.87	0.94
150	0.83	0.92
200	0.79	0.90
250	0.74	0.88
300	0.67	0.86
350	0.60	0.85
400	0.53	0.84

Table 2

[1] linear interpolation for intermediate values

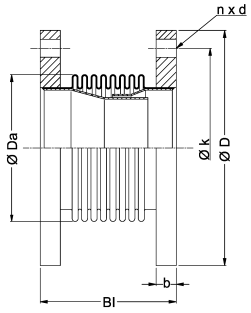
2.3 Axial expansion joints with flanges

2.3.1 Type FS

- expansion joints of type FS are equipped with **flanges firmly welded onto the bellows;**
- as a standard, flanges are made of carbon steel and are primer coated;
- as a standard, expansion joints of type FS are manufactured in nominal diameters from DN 40 to 1000 and in pressure ranges of PN 6, 10, 16, 25 and 40 (for DN 15 – 32 see type FS-Za „Technical Data“);
- the design type I or II is indicated in the last column of the standard tables (see fig.).

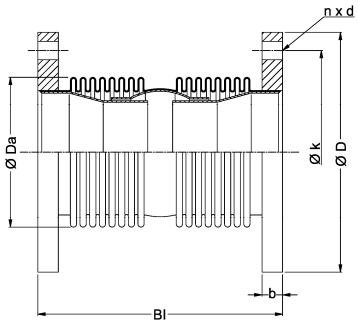
Design I (single bellows)

All types marked * and B are manufactured accordingly.



Design II (double bellows to avoid buckling)

Available only with inner sleeve.



2.3.2 Type FB

- expansion joints of type FB are equipped **with collared, movable flanges**. The fluid is only in contact with the austenitic bellows material;
- as a standard, flanges are made of carbon steel and galvanized or primer coated (larger diameters).
- as a standard, expansion joints of type FB are manufactured in nominal diameters from DN 40 to 1000 and in pressure ranges of PN 6, 10, and 16;
- the basic version of type FB is manufactured without inner sleeve. Yet it can be equipped with one (extra charge).

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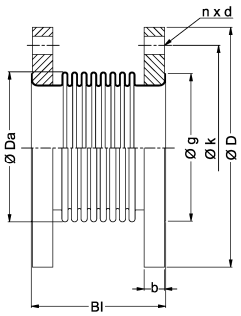
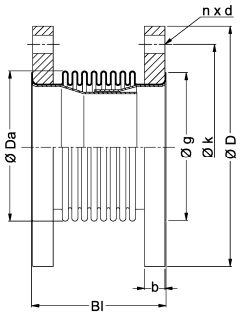
Basic version
additional designation **B**
(without inner sleeve)



additional designation **L**
(with inner sleeve)



2.4 Axial expansion joints with weld ends

2.4.1 Type W

- expansion joints of type W are equipped with **weld ends, firmly welded onto the bellows**;
- as a standard, the weld ends are made of carbon steel and are primer coated; part of the weld connection area is colourless;
- as a standard, expansion joints of type W are manufactured in nominal diameters from DN 40 to 1000 and in pressure ranges of PN 6, 10, 16, 25 and 40 (for DN 15 – 32 see type Za).
- the design type I or II is indicated in the last column of the standard tables (see fig.).

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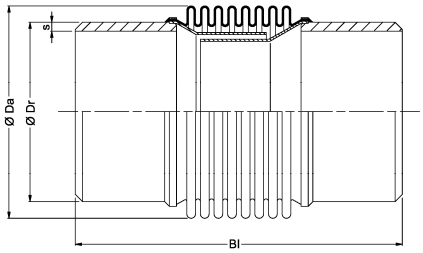
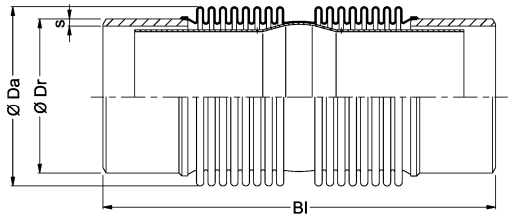
Design I

All types with * and B are manufactured accordingly.



Design II (double bellows to avoid buckling)

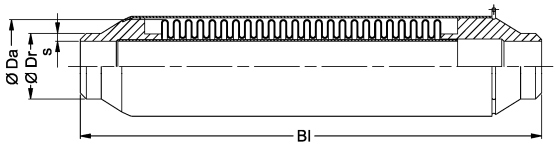
Available only with inner sleeve.



2.5 Small expansion joints

2.5.1 Small expansion joint Type Za (for welding into steel pipe)

Design with weld ends, supplied in prerestrained condition. The main element of this small expansion joint is the multi-ply bellows made of austenitic steel. The two weld ends for welding in are made of carbon steel St 52-3. The inner protection sleeve is reinforced and therefore also acting as a guiding tube. The outside sleeve protects the bellows from mechanical impacts. All connections are welded.



Materials:

bellows:	stainless steel 1.4571 (similar to AISI 316 Ti)
weld ends:	carbon steel St 52-3
inner protective sleeve:	carbon steel St 35
outside guiding tube:	EN AW-6063 T6

Application area:
Absorption of axial movements in the supply network of heating and industrial lines.

Nominal sizes: ½" – 2"
For larger dimensions, expansion joints of **type W** are used.

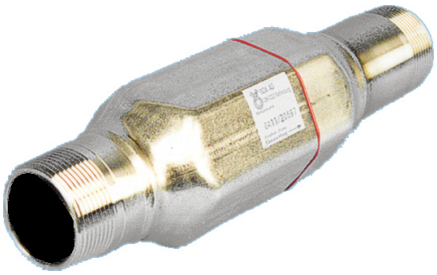
Pressure:
Size ½" – 1 ¼": PN 16
Size 1 ½" – 2": PN 10
For higher pressures, expansion joints of **type W** are used.

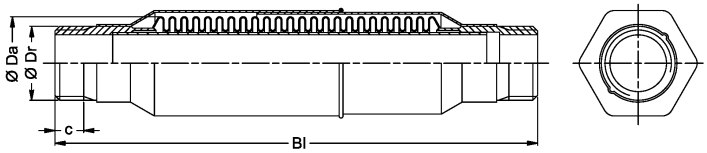
Endurance: 5000 full load cycles at 25 mm movement
(1000 full load cycles at 45 mm movement)

Temperature resistance: up to 450°C

2.5.2 Small expansion joint Type Ga (with thread for screwing in)

Drinking water resistant, torsion-proof design, supplied in prerestrained condition, all connections are welded. The basic element of the small expansion joint is a BOA multi-ply bellows made of stainless steel. Both ends are equipped with male threads. The inner sleeve is reinforced and therefore also acting as a guiding tube. During installation, the outside hexagonal sleeve helps gripping the wrench. By screwing in sockets, screw fittings or flanges, Type Ga covers all installation needs.





Materials:
bellows: stainless steel 1.4571 (AISI 316 Ti)
connecting ends with male thread: stainless steel 1.4301 (AISI 304)
inner protective sleeve: stainless steel 1.4301 (AISI 304)
outside guiding tube, hexagonal: stainless steel 1.4301 (AISI 304)

Application area:
Absorption of axial movements in the service water network of sanitary installations.

Nominal sizes: ½" – 2"
For larger dimensions, expansion joints of **type FB** are used.

Maximum temperature: PN 10 bar
For higher pressures, expansion joints of **type FB** are used.

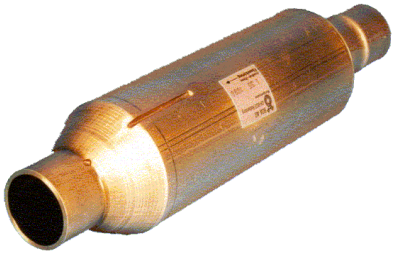
Endurance: 5'000 full load cycles at 25 mm movement

Temperature resistance: up to 450°C

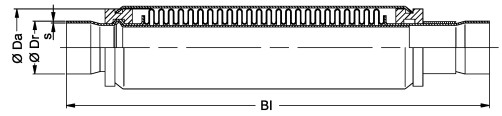
2.5.3 Small expansion joint Type I (for copper piping)

Drinking water resistant design, supplied in prerestrained condition, all connections are welded. The basic element of the small expansion joint is a BOA bellows made of bronze. Both connections are equipped with inner brazed ends. The inner sleeve is reinforced and therefore also acting as a guiding tube. The outside sleeve protects the bellows from mechanical impacts. By soldering in sockets, screw fittings or flanges, Type I covers all installation needs.

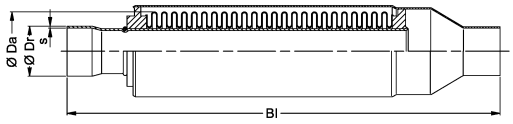
Certified by SVGW (Swiss Gas and Water Association, Certificate # 8002-820)



DN 15-28



DN 35-42



Materials:
bellows: bronze (CuSN6)
connecting ends: copper (Cu-DHP)
inner protective sleeve: copper (Cu-DHP)
outside guiding tube: copper (Cu-DHP)

Application area:
For taking up axial movements in copper piping used in sanitary and heating water systems.

Nominal sizes: 15-42 mm
For larger dimensions, expansion joints of **type FB** are used.
.

Maximum pressure: PN 10 bar
For higher pressures, expansion joints of **type FB** are used.

Endurance: DN 15 - 28: 1'000 full load cycles (at 18 mm movement)
DN 35 - 42: 5'000 full load cycles (at 25 mm movement)

Temperature resistance: up to 180°C

3 Installation Instructions Axial Expansion Joints

3.1 General safety recommendations

Prior to installation and start-up, installation and start-up instructions must be read and observed. Installation, start-up and maintenance work shall only be performed by **qualified and authorized staff.**

Maintenance
Axial expansion joints and disassembly joints are maintenance free.

CAUTION
Prior to disassembly and maintenance, the system must be
- depressurized,
- cooled down,
- emptied.

Otherwise there is a risk of accident!

Transport, packaging and storage
- The consignment must be checked for completeness upon receipt.
- Any transport damage must be reported to the carrier and the manufacturer.
- At an intermediate storage we recommend to use the original packaging.

Admissible ambient conditions for storage and transport:
- ambient temperature - 4°C to +70 °C
- relative humidity up to 95%.

Axial expansion joints or disassembly joints must be protected against wetness, humidity, dirt, shocks and damage.

Warranty
A warranty claim requires professional installation and start-up in accordance with installation and start-up instructions. The necessary installation, start-up and maintenance work must be performed by qualified and authorized staff.

Operating pressure
NOTE
- The permissible operating pressure results in the nominal pressure considering the reduction factors given in section 2.2 "Reduction".
- At higher temperatures, the expansion capacity has to be reduced according to the reduction factors (see section 2.2).

Start-up and check
Before starting-up check if
- the pipeline is installed with sufficient inclination to avoid water pockets
- there is sufficient drainage
- pipe anchors and pipe supports/ guides are firmly installed prior to filling and pressure testing the system
- the expansion joint is not stressed by torsion, especially not expansion joints with socket attachment
- the flow direction has been observed for expansion joints with inner sleeves
- the steel bellows is free of dirt, welding, plaster or mortar splatters or any other soiling; clean if necessary
- all screwed connections are tightened properly
- the general due diligence requirements to avoid corrosion damage are observed, such as water treatment, or prevention of galvanic corrosion in copper and galvanized pipes.

Insulation
Expansion joints may be insulated exactly as the pipeline.
- If no coating is provided, protect the bellows by means of a slidable metal sleeve to avoid insulation material dropping into the convolutions.
- If the expansion joint is to be placed under plaster, a protective cover is essential. This ensures the bellows' function, protects against soiling and avoids contact with structure materials.

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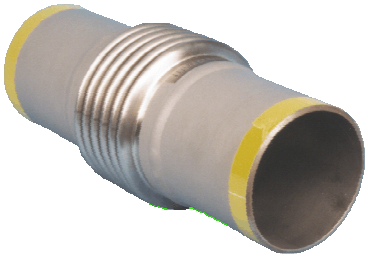
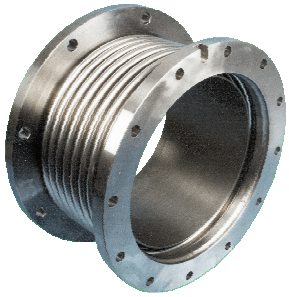
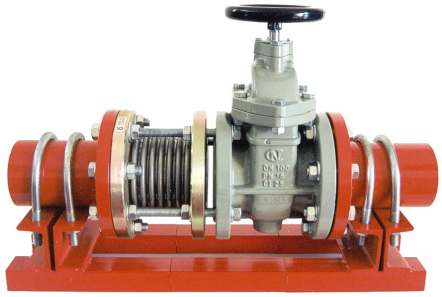
Improper operation
- The limits given in the technical data of the standard range must not be exceeded.
- Swinging suspensions adjacent to expansion joints are not permitted.
- Do not clean the newly installed pipeline by blowing it with steam to avoid water hammers and unacceptable vibration stimulating of the bellows.

System start-up
CAUTION
- During pressure testing and operation, the allowable test pressure or operating pressure defined for the expansion joint must not be exceeded.
- Excessive pressure peaks as a consequence of valves closing too abruptly, water hammers etc. are not permitted.
- Avoid contact with aggressive media.
- The start-up of steam lines must be performed such that the condensate has time to drain off.

3.2 Axial expansion joints / Disassembly joints







Description and application fields of axial expansion joints
Axial expansion joints are intended to compensate for axial expansion movements in straight pipeline sections. In addition, they are used:

- for vibration absorption and reduction of structure born noise on pumps and compressors
- as flexible seals at the end of jacketed pipes in district heating systems
- to compensate for thermal expansion and vibrations in exhaust gas lines of boilers and engines
- as disassembly joints for pumps, valves and plate heat exchangers
- as gas-tight wall penetration of pipelines in reactor construction and shipbuilding
- to take up occurring differential expansion in vessel and apparatus construction

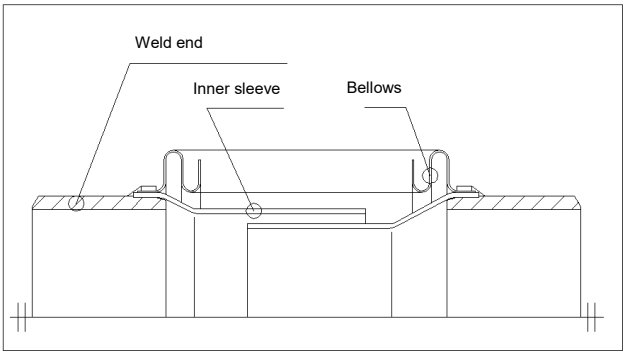


Fig. 3

Prerequisite for the application of axial expansions is the presence of appropriate anchor points and axial guide bearings. The technical data given on the rating plate are decisive for use.

These installation and start-up instructions apply to the types listed in table 3.

On site the general due diligence requirements to avoid corrosion damage must be observed, such as water treatment, or prevention of galvanic corrosion in copper and galvanized pipes.

Description and application fields for disassembly joints
During assembly of piping and any subsequent dismantling and replacement of individual components (valves, shut-off gates, pumps, etc.) for maintenance reasons, an axial gap is essential to comfortably set and exit the components. Often there is inaccuracy and misalignment due to laterally displaced flanges. During operation of such systems also occur thermally induced expansions of pipe sections.

Therefore, so-called disassembly joints are installed between pipes and components.

Type overview

BOA Axial expansion joints			
not prerestrained	connection type	50% prerestrained	connection type
FS	2	Za	1
FB	5	Ga	11
W	1	I	10
EXF	5		
EXW	1		

Connection type:
1 weld end
2 flange, welded
5 flange, collared
10 brazing fitting LF
11 threaded nipple, welded

Table 3

3.3 Installation advice

Assembly

- Anchor points and pipe guides must be firmly installed before filling and pressure testing the system.
- Expansion joints must be installed without being subject to torsion. This applies particularly to expansion joints with socket connection.
- The steel bellows must be protected against damage and dirt (e.g. welding, plaster or mortar splatter).
- Steam pipelines should be installed in such a way that water hammers are avoided. This can be achieved by adequate drainage, insulation, by preventing water pockets and by sufficient inclination of the line.
- Observe the flow direction while installing expansion joints with inner sleeves.
- Avoid the installation of expansion joints in the immediate vicinity of pressure reducers, hot steam coolers and shut-down valves, if high-frequency oscillations are expected due to turbulence. Otherwise special measures must be installed (e.g. thick-walled sleeves, perforated disks, calming sections etc.).
- If high frequency vibrations or turbulence or high flow speed are expected, we recommend the installation of expansion joints with inner sleeve.
- Inner sleeves are also recommended for expansion joints with DN ≥ 150, if the flow speed of air, gas or steam media exceeds 8 m/s, or 3 m/s in case of liquid media.

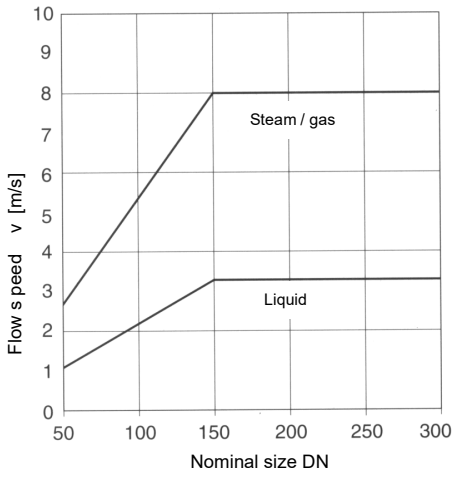


Diagram 1

Pipe guides, pipe supports

- Provide inclination for drainage
- Align the pipeline, distance between pipe guides according to fig. 4, table 4 and diagram 2

NOTE
Sliding or roller supports are the safest measures to avoid buckling and lifting of the pipeline.

CAUTION
Swing suspensions are not permitted adjacent to expansion joints!

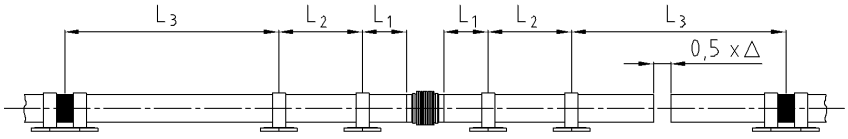


Fig. 4

Δ = expansion capacity of the expansion joint [mm]
L_1 = max. 2 x DN + Δ/2 [mm]
L_2 = 0.7 x L_3 [mm]
L_3 = 400 x $\sqrt{}$DN [mm] valid only for steel pipelines
L_3 is the distance between the pipe supports according to the formula above. If buckling must be expected, L_3 must be reduced according to diagram 2.

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DN	L_1 [mm]	L_2 [mm]	L_3 [mm]
15	30 +Δ	1050	1550
20	40 +Δ	1200	1750
25	50 +Δ	1400	2000
32	64 +Δ	1550	2250
40	80 +Δ	1750	2500
50	100 +Δ	1950	2800
65	130 +Δ	2250	3200
80	160 +Δ	2500	3550
100	200 +Δ	2800	4000
125	250 +Δ	3100	4450
150	300 +Δ	3450	4900
200	400 +Δ	3950	5650
250	500 +Δ	4400	6300
300	600 +Δ	4850	6900
350	700 +Δ	5200	7450
400	800 +Δ	5600	8000
450	900 +Δ	5900	8450
500	1000 +Δ	6250	8900
600	1200 +Δ	6850	9800
700	1400 +Δ	7450	10600
800	1600 +Δ	7900	11300

Table 4 (only valid for steel pipelines)

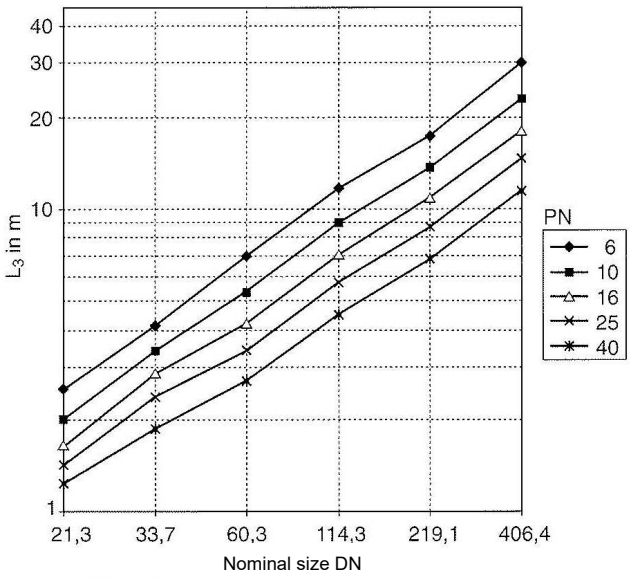

Diagram 2

Anchor points

- Install main anchors at locations where the pipeline changes direction.
- Limit by anchors each pipe section to be compensated for.
  - Only one expansion joint is allowed between two anchors.
  - Main anchors must be installed at locations where the pipeline changes direction. They must take up the pressure thrusts of the expansion joints as well as the frictional forces of the pipe supports/ guides.
  - Intermediate anchors must be installed if the movement capacity of one axial expansion joint is not sufficient to compensate for the entire expansion of a long pipeline. In that case, several axial expansion joints are required.
  - In vacuum mode, the anchor points must be capable to take up tensile and pressure forces.

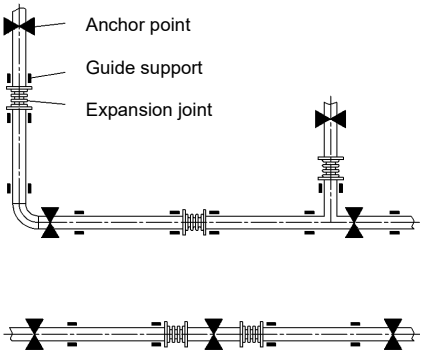

Fig. 5

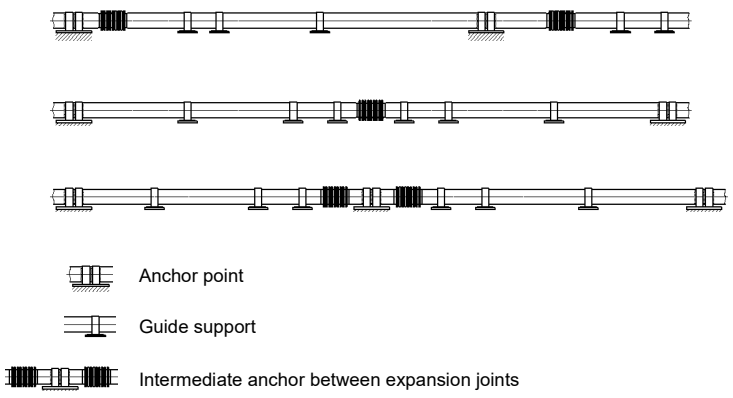

Fig. 6

Vibration compensation

- The expansion joint should be installed as close as possible to the vibrating unit to make use of its entire absorption capacity.
- The vibration absorber must be installed as close as possible to the vibration source so as to avoid resonance of the other parts.
- Primarily it must be ensured that the vibration amplitude acts laterally, i.e. perpendicular to the vibration absorber axis.
- Install an anchor directly behind the expansion joint. Installation is made without prerestraint.

CAUTION
If unrestrained vibration absorbers are installed, the reaction force must be taken into account.

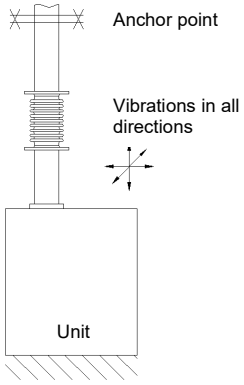

Fig. 7

Prerestraint
All common expansion joints must be installed prerestrained by 50% of their movement capacity (for heating systems: overall length of expansion joint plus 50%, whereas for cooling systems: overall length of expansion joint minus 50% of the movement). If an expansion joint is not installed at the lowest operating temperature of a heating system or at the highest operating temperature of a cooling system (e.g. repair of a still-warm pipe), an individual prerestraint mode must be chosen (see diagram 3).

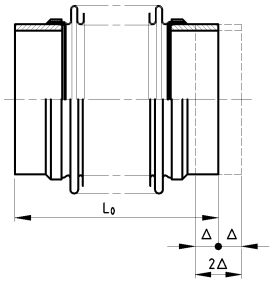

Fig. 8

Prerestraint diagram

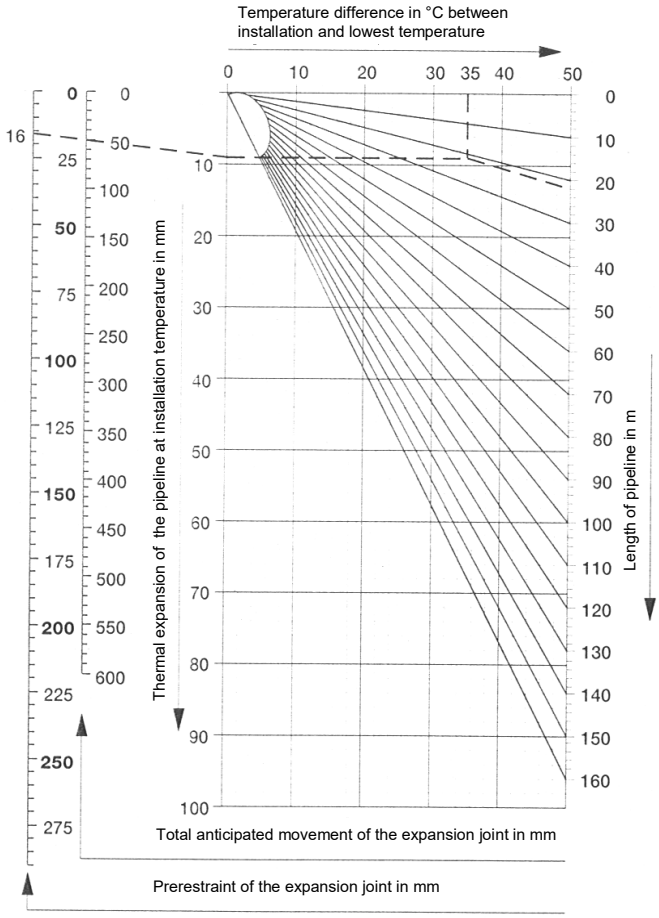

Diagram 3

Example for Diagram 3
Order is placed for an axial expansion joint to be installed in a pipeline of 22 m length.
Lowest temperature: –15°C.
Highest temperature: +165°C.
Max. expansion corresponding to 180°C heating = 50 mm.
The expansion joint shall be restrained by 50% of this expansion = prerestrained by 25 mm, i.e. pulled apart.
The remaining 50% = 25 mm will be compressed in operation mode.
Special attention must be given to the restraint during installation. The temperature shall not be –15°C, but +20°C.
This results in a corresponding expansion of the pipeline of 9 mm (see diagram 3), by which the expansion joint must be less prerestrained:
25-9 = 16 mm.

The prerestraint diagram (3) allows to determine the correct prerestraint value without intermediate calculation:

1. Temperature difference between installation and lowest temperature: –15°C to +20°C = 35°C.
2. Length of the pipe section to be compensated for: = 22 m.
3. Draw a straight line from point "22 m pipe length“ to the "0°C" point.
4. Draw a vertical line from the "35°C" point towards the beam coming from "22 m".
5. Draw a horizontal line from this intersection to the line "Thermal expansion of pipeline in mm"; the result is, as stated above, 9 mm.
6. Draw a straight line from the "9 mm" point to "Total anticipated movement" = 50 mm, and lengthen the connecting straight line to "Prerestraint of the expansion joint in mm".

This results in a prerestraint value of 16 mm, which is the value by which the axial expansion joint must be pulled apart during installation.

Installation of an expansion joint with flanges

- Align pipe axes and flange bolt holes.
  - ensure flanges are parallel
  - ensure gaskets are centred
  - tighten bolts crosswise.
- Make sure the expansion joint is not exposed to torsion during installation.
- After installation, check if the bellows convolutions are free of dirt.

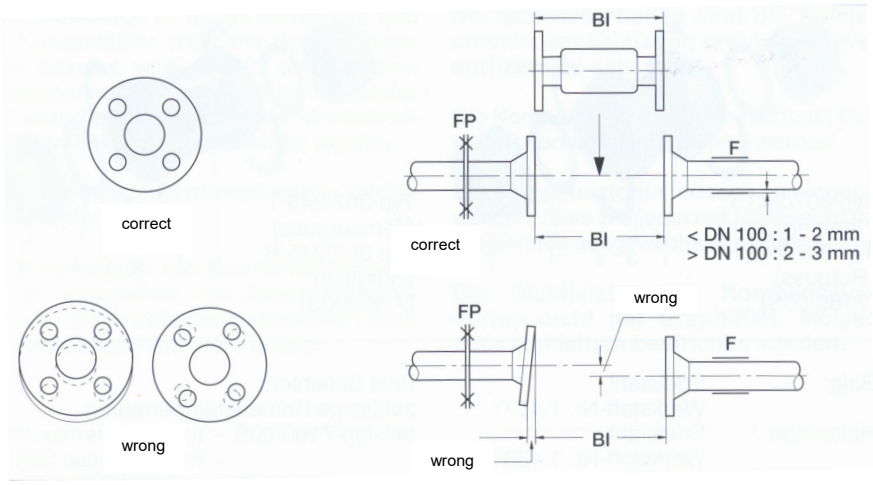

Fig. 9

Disassembly joints

NOTE
Depending on the nominal diameter, the installation length EL of the disassembly joint shall be max. 50 mm longer than the unrestrained total length TL.

- Install anchor points on each side: With unrestrained expansion joints the reaction force must be absorbed by the anchors.

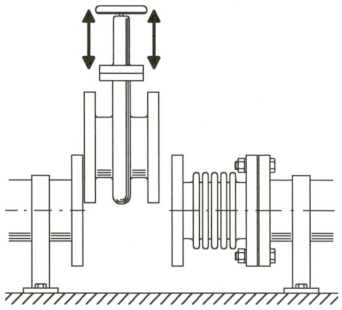

Fig. 10

Installation

- Flange the disassembly joint to one pipe end (fig. 10). On the other side, pull the disassembly joint towards the components (valve, shut-off gate, pumps, etc.) either using long screws (unrestrained) or with the supplied threaded rods (restrained) (fig.11). When installed correctly, the disassembly joint is restrained (fig. 12).

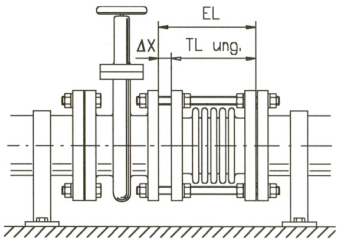

Fig. 11

Disassembly

- Loosen the extended screws or the threaded rods. - The disassembly joint swings back, creating a gap, which is necessary for comfortable subsequent assembly and disassembly of the components.

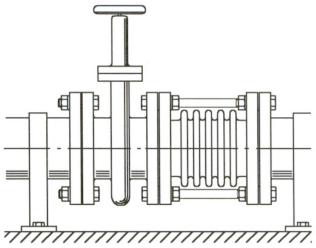

Fig. 12