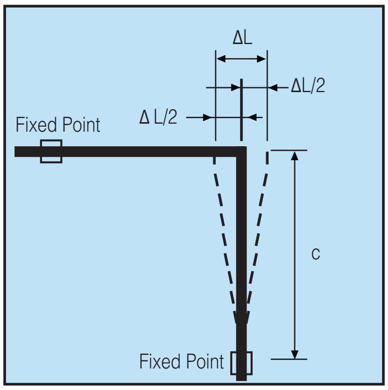
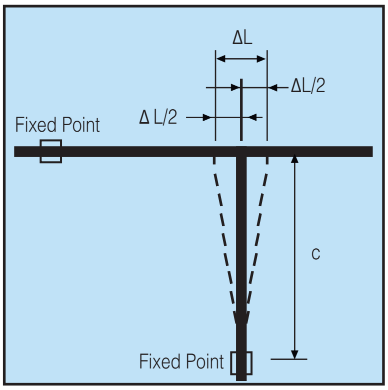
Compensating for expansion and constraction

Calculating the minimum straight length

Most commonly, the alteration of the pipe length due to expansion and contraction is accommodated by changes in pipe direction This takes advantage of the natural flexibility of the plastic material and the high resistance to stress Therefore in addition to a calculation to determine the minimum and maximum pipe length due to thermal expansion and contraction, the effect of this movement on the change in pipe direction needs to be considered In particular, the "minimum straight length", shown as the figure "c" in the diagrams below need to be calculated if undue stress on the pipe is to be avoided.





The following formula is used:

$C = k \sqrt{\Delta L \cdot d}$

Where

C = Minimum straight length (mm)
ΔL = Change in length due to thermal expansion (mm)
d = Pipe outside diameter (mm)
K = material specific constant (see table)

Material specific constant k	
PVC-U	= 34
PVC-C	= 34
ABS	= 33
PE	= 26
PP	= 30
PV0F	= 20

For example, a PVC-U pipe with an O.D. of 50mm is run for a straight length of 50 meters before a 90º change of direction The pipe is installed in ambient temperature conditions of 10°C. The maximum operating temperature is 20°C. The minimum operating temperature is 15°C. What is the minimum straight length?

First, calculate the change in length using the formula:

$\Delta L = L \cdot \Delta T \cdot \delta$

Where

ΔL = Change in length (mm)
L = Length of pipe being studied (m)
ΔL = Temperature change (°C)
δ = Material coefficient of linear expansion

Coefficient of linear expansion by material (δ)	
PVC-U	= 0.08 mm/m°C
PVC-C	= 0.07 mm/m°C
ABS	= 0.10 mm/m °C
PE	= 0.20 mm/m °C
PP	= 0.15 mm/m °C
PVDF	= 0.12 mm/m °C
ECTFE	= 0.10 mm/m °C

$\Delta L = 50 \cdot (20 - 10) \cdot 0.08$
ΔL = 40mm total change in length

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Next, insert the value into the formula to calculate the minimum straight length:

$$C = k \cdot \sqrt{\Delta L \cdot d}$$

where

- C = Minimum straight length (mm)
- Δ L = Change in length due to thermal expansion (mm)
- d = Pipe outside diameter (mm)
- k = Material specific constant (from table)

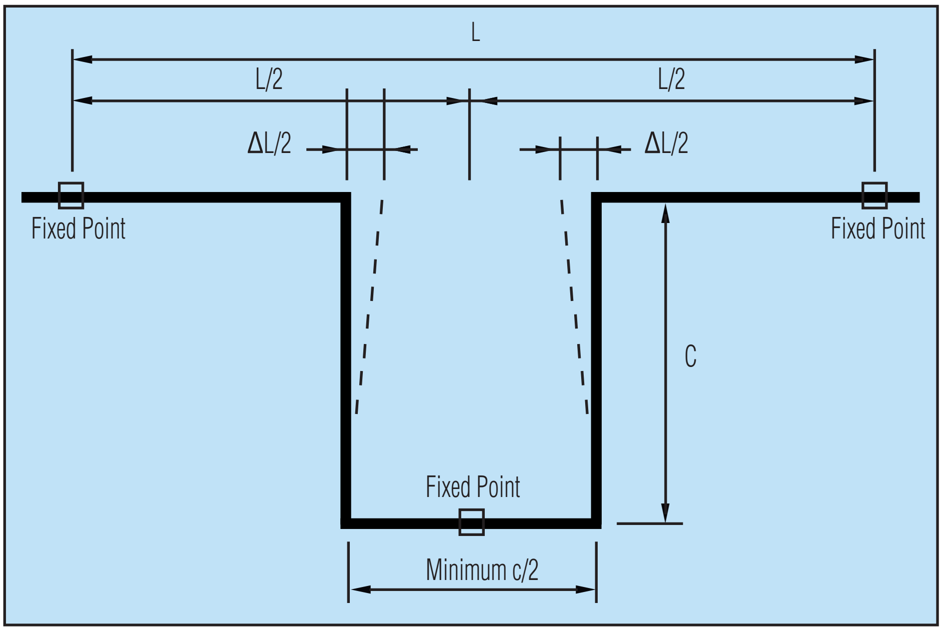
$$C = 33 \cdot \sqrt{40 \cdot 50}$$

$$C = 33 \cdot 45$$

C = 1485mm minimum straight length

Calculating the size of expansion loops

When changes of direction can not be used to accommodate expansion and contraction, it may be necessary to use an offset expansion loop. The expansion loop effectively distributes the thermal movement between two changes of direction. The size of the minimum straight length for the expansion loop is calculated using the same formula as described above.



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Mechnical expansion joints

Plastic piston-type expansion joints are available in PVC-U, PVC-C and Polypropylene in diameters up to 12" /3oomm (8"/200mm for Polypropylene). Travel distances vary from 150mm to 300mm.
The expansion joints are made from two pipes, one telescoping inside the other, with double O-ring seals preventing the ingress of contaminants and maintaining the line pressure. The outer part of the expansion joint must be anchored during installation, while the inner pipe is permitted to move freely as the pipe expands or contracts.
Alignment is critical with this type of joint, as any misalignment may result in binding or snagging as the pipe tries to move inside the expansion unit. Guides should be installed within approximately 3oomm from both ends of each expansion joint. Pipe runs must also be anchored at calculated distances so that pipe movement is directed towards the expansion joint. joints are usually installed with the piston partially extended, determined by the ambient temperature and the likely thermal movement.

Expansion bellows

Axial expansion bellows may be used with plastic piping, although they generally provide only a limited capacity for axial movement. However they may be useful when used to handle other movements in addition to axial, or when installation space is limited.
Expansion bellows should be installed with one end anchored securely, with the movement of the pipe directed toward the free end. If possible, a guide should be installed within approximately 300mm from the free end of the bellows.

Pipe anchors

There are a number of methods that may be used to anchor pipes, some of which are described here. However it should be noted that any method that creates stress through excessive compression (such as by tight fitting metal supports) is not recommended as damage to the pipe may occur.

"Fixed point fittings" are manufactured from Polypropylene, Polyethylene and PVDF. They are designed to accommodate a pipe bracket that can be securely fixed to a structural

support. It is also possible to fabricate this type of fitting in PVC-U and PVC-C using standard pipe sockets (see drawing).
Flanges may be also used to connect to an anchor point. wor fixed point fitting

PVDF fixed point fitting shown with clip

Some examples of anchor point construction methods: