



## Window and Glazing Topics – Thermal expansion of PVC-U

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## 1. Introduction

All materials expand and contract with increasing or decreasing temperature and with windows this requires an allowance between the window and the building aperture. The thermal expansion of materials is one of the most powerful forces known to man. If allowance is not made for the expansion, then either the window or the building will be damaged.

## 2. Linear coefficient of thermal expansion

The linear coefficient of thermal expansion for a material is a measure of how much that material will expand for each change in temperature of 1 °C.

Typical values are:

<b>PVC-U</b>	<b>0.0000600/°C</b>
<b>Mild Steel (0.06 % Carbon)</b>	<b>0.0000126/°C</b>
<b>Aluminium (99 % Pure)</b>	<b>0.0000240/°C</b>

This does not have any length units given as it is cm/cm or ft/ft or m/m and they effectively cancel out. The thermal expansion of PVC-U is therefore about 5 times that of steel and 2.5 times that of aluminium under the same conditions.

A sample calculation best shows this:

Assume that you have a 1000mm length of PVC-U at 20°C and you increase the temperature to 40°C. The change in temperature is 20°C and the original length is 1000mm. The change in length is given by:

$$1000\text{mm} \times 0.00006/\text{°C} \times 20\text{°C} = 1.2\text{mm}$$

i.e., Total length after expansion = 1001.2mm

If you decrease the temperature to 0°C then the calculation is the same but the change in temperature is -20°C and the length changes by -1.2mm i.e., a decrease in length to 998.8mm.

For the same length and change in temperature steel will expand or decrease by:

$$1000\text{mm} \times 0.0000126/\text{°C} \times 20\text{°C} = 0.252\text{mm}$$

i.e., 1000.252mm or 999.748mm depending on whether the temperature increases or decreases.

For the same length and change in temperature aluminium will expand or decrease by

$$1000\text{mm} \times 0.0000240/\text{°C} \times 20\text{°C} = 0.480\text{mm}$$

i.e., 1000.48mm or 999.52mm depending on whether the temperature increases or decreases.

For PVC-U over a 20°C change in temperature the change in length is thus 0.12% of the original length and is effectively negligible when the recommended expansion gaps are used between the window and building structure.

## 3. Other factors

The values given above are for an unrestrained product. When PVC-U profiles are reinforced with steel or aluminium then naturally the overall expansion will be slightly reduced because of the restraining effect of the steel or aluminium. The reinforcing will not stop the expansion of the PVC-U but simply reduce it slightly.

The value of the coefficient of linear thermal expansion can be regarded as constant for the normal temperatures experienced in the UK.

The temperature difference between the inside and outside surfaces of the PVC-U can lead to differential thermal expansion but this is not a concern provided reinforcement is used as recommended.

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The temperature used for the general calculation is the bulk temperature of the material. This is not always the same as the surface temperature of the outside air temperature. For white profiles the values are approximately the same but for dark profiles the bulk temperature can be higher than the air temperature due to the increased solar heat gain of dark profiles. The expansion gaps are higher for dark profiles to take account of this.

### **4. Conclusions / summary**

The expansion of PVC-U windows under UK environmental conditions does not present any concern provided the manufacturers recommendations for reinforcement and expansion gap allowances are followed.