

Technical Guide

Correct design and use of coloured PVC profiles for windows and front doors

Correct design and use of coloured PVC profiles for windows and front doors

A guide for architects, planners and window manufacturers
Bonn | Frankfurt, February 2018

1. Purpose of this guide

Coloured profiles heat up more than white ones. This can lead to temperature differences between the internal and external surfaces.

Coloured window and door profiles are a growing trend in modern architecture and are becoming ever more popular. When it comes to manufacture, there would be precious little difference between the coloured and white surfaces if it weren't for physics. That's because coloured surfaces can heat up more than white surfaces when exposed to the sun. Temperatures in excess of 70 °C are not unusual and, given the thermal insulation levels which are standard today, relatively large temperature differences can arise between the outer and inner surfaces as a result. This in turn is conducive to unwanted deformation. With regard to planning and fabrication coloured window profiles require special attention.

In a bid to prevent this deformation, we want to outline the special characteristics of coloured window profiles for planners, window manufacturers or professionals with an interest in the subject. This guide has been prepared by the pro-K Fachgruppen Haustürfüllungen und Kunststofffenstersysteme (pro-K team of specialists in PVC window systems) and the Gütegemeinschaft Kunststoff-Fensterprofilssysteme e.V. (quality association for PVC window profile systems) with a view to passing on the relevant information. It is intended as a useful addition to the installation manuals issued as standard in the industry and to the requirements provided by the system suppliers, and also as a ready reference to keep to hand all the way from planning to fitting windows and doors.

Please note that further literature sources are listed on page 7. There is also a guide there published by the Gütegemeinschaft Kunststoff-Fensterprofilssysteme with tips on cleaning windows.

2. Useful information for project planning

As already mentioned, this guide is mainly aimed at designers, builders and fitters of PVC windows and front doors. Our recommendations are particularly applicable to the use of the following PVC window profile systems:

- colour-coated and printed
- co-extruded with PMMA, PVC or other plastics
- fully dyed
- laminated with decorative films

The project manager takes account of all the parameters relevant to the construction product and the build.

The project manager in charge of the planning is responsible for selecting the right window to suit the structural and architectural conditions. The call for tenders issued by the project manager takes account of all the parameters relevant to the construction product and its integration in the build. This also applies in turn to the choice of colour and size of the (window) elements and their position and installation. Ultimately, the project manager must also be able to gauge how coloured surfaces will react when exposed to sunlight.

It should be noted, by the way, that the project manager is also required, under section 4 (3) of the German Construction Contract Procedures Part B (Vergabe- und Vertragsordnung für Bauleistungen Teil B - VOB/B), to inform the instructing party of any concerns which cast doubt on a favoured course of action or one which is actually already planned for the construction process.

3. Colour selection and place of installation

When designing coloured PVC windows, it is therefore necessary to take account of the properties of the material and the effect of the surface quality. Physically, the increased heat absorption of darker surfaces creates a larger thermal expansion of the window profile than in case of light surfaces. Referring to the system description, further recommendations can be listed as follows:

- Important parameters are window size, reinforcement, window openings (in critical installation positions we suggest to use tilt-and-turn) and finally the height/width ratio.
- We recommend to use paints suitable for both the place of installation and the window size.
- Counterbalance thermal stress points by suitable expansion joints.
- Ensure professional installation of the window.

Certain colours are more suitable for profiles than others depending on the fitting position and the thermal load at the installation site. Lighter colours are more favorable in terms of heat build up than darker ones and in addition to that are more suitable for difficult installation positions. In case of dark colours, it is advisable to choose products with heat-reducing properties. By reflecting the rays of the sun they reduce the build-up of heat in the profile.

Even in strong sunlight, the temperature on the coloured surfaces can remain relatively constant if a natural convection on the building facade provides a cooling effect (cf. Fig. 1). This convection is interrupted, however, by critical fitting positions, such as deep outside reveals and recesses in the wall, or in case of porches. This can cause an extreme build-up of heat in base mounting and sash frames and front door panels with a southerly or westerly aspect without any shade.

Due to their increased absorption of heat, dark profile surfaces are subject to greater expansion than white surfaces.

Profiles in light colours or with heat-reducing properties are suitable in south-facing positions.

Critical fitting positions, such as deep outside reveals and recesses, can interrupt the natural convection.

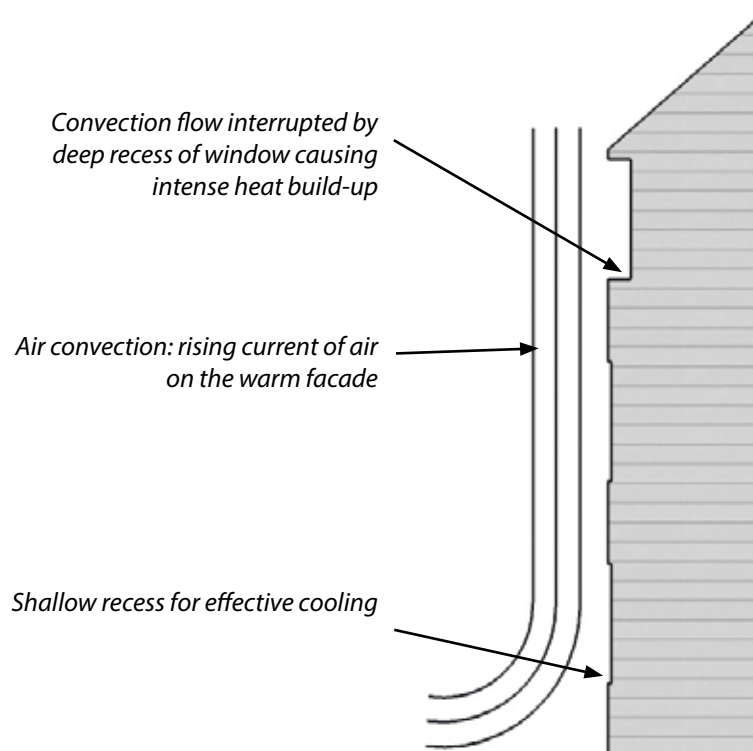


Fig. 1: Natural convection on the outside wall

Reflective windowsills or paving slabs intensify this effect further. Light windowsills made of natural stone are more suitable, for example.

If you are faced with one of the aforementioned critical fitting positions, it is advisable to draw up a separate plan tailored to the critical fitting position.

4. Special conditions for storage and transport

Once profiles have become warped, they will stay in this shape.

The surfaces of coloured PVC profiles are susceptible to mechanical damage. Damage can be impossible or, at best, difficult to rectify. Once PVC profiles and front door panels have become warped in storage or in transit, they will stay in this shape. It is therefore important to obey a few simple rules:

- Store and transport profiles and windows laid out with full support and front door panels vertically – out of direct sunlight.
- As far as possible, use light opaque packaging film rather than transparent or dark film.
- In order to avoid an accumulation of heat, provide adequate ventilation and allow sufficient clearance between windows and doors when stacking them on top of one another.

5. Basic principles in the manufacture of coloured window profiles

Some particular issues need to be factored in when selecting and then making coloured profiles, not least because of the thermal expansion. These are as follows:

- Profiles and panels must be suitable for the respective outside use.
- All the building connection joints must be expansion joints.
- There are differences in dimensions in contrast to white profiles depending on the thickness of the colouring layer. The lamination process will add a film layer of about 0.25 mm, for example.

5.1 Reinforcement and ventilation

PVC profiles are reinforced in order to transfer the load and to avoid deformation. In this respect, it is important not to detract from this reinforcement by the subsequent addition of fixtures and fittings. Make sure, for example, that the openings in the steel reinforcements on front door wings (e.g. for lock cases) are kept as small as possible.

During the installation process it is important to ensure both a proper ventilation of the chambers and that windows are not masked off completely.

The correct ventilation of the chambers is also very important when manufacturing the profiles. If the ventilation chamber in the profile is closed, for example, the air trapped inside can heat up and expand in the warmth of the sun, encouraging uncontrolled warping. It is also important to make sure during or after the installation process that the windows are not masked off completely in subsequent works, because the air between the cover sheeting and the windows can also become very hot.

5.2 Heat-sealing and finishing

The right cut of the profiles (angularity) is important for strong heat-sealed joints. If coloured profiles expand more lengthwise, they will put particular strain on the joint. If the bead is too clean or constricted, there is also an increased risk that the joint will come apart at the corners. You should therefore avoid sharp indentations when finishing the sensitive corner areas.

Important: the right cut.

Our tip for fabricators and installers: check the strength of corners regularly during the window production process. Additional information can be found in the RAL-GZ 716 Quality Assurance Guidelines and the corner strength tests required in this RAL publication. A guide to heat-sealing is also available online on the website of the quality association under: gkfp.de/en

5.3 Selecting the fittings

If you are provided with a choice of several fittings by the system supplier, we recommend choosing a fitting with as little distance as possible between locking points, thereby necessitating an increase in the number of locking points. As you know, the more locking points there are, the better the fixing of the casement.

The shorter the distance between locking points, the better the fixing of the casement.

You must also adhere strictly to the specified rebate dimensions so that the coloured profiles have enough space for the temperature-induced linear expansion. Another indication as to whether the profile has warped would be a temporary increase in the force required to operate the handle after a relatively long time in tilt position.

Expansions in length can be offset with expansion joints.

5.4 Fitting decorative bars

When adding decorative bars, it is important not to fit them flush in the window frame. Expansions in length can be effectively offset with expansion joints of at least 0.5 to 1.0 mm to the sash frame or main frame or to the transom or jamb. Decorative bars with side sealing lips should preferably be intersected at the joints and then the entire surface of the lips should be stuck down.

5.5 Front door panels

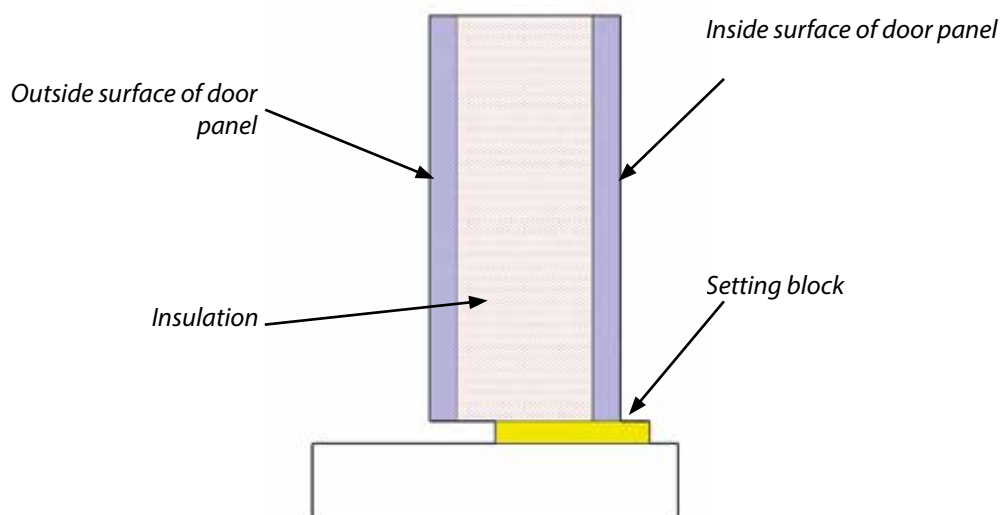


Fig. 2: Set-back spacer

PVC doors are subject to the same laws of thermal expansion as PVC windows so it is important to make sure of the necessary clearance during their installation. The air gap all around, i.e. the distance from the brickwork, should therefore be big enough to absorb the movement.

A set-back spacer can be used in case of extreme thermal loading (cf. Fig. 2).

If extreme thermal loads are expected, we recommend the use of a set-back spacer (cf. Fig. 2). This allows more freedom of movement in the outer carrier layer, thereby reducing the risk of deformation. Equally important in this connection is the firm bridging of grooves or ridges in the glazing rebate area. Finally, check the fitting position, paying particular attention to the guaranteed drainage of the wings.

6. Advice for the installation of coloured windows and doors

The following tips will help processes to run smoothly when installing coloured PVC windows:

To avoid deformation it is advisable to ensure a competent and certified installation, in particular using approved mounting devices like dowels, screws and anchors etc.

- Choose windowsills in white, or anodised in a light colour, or made of natural stone in order to avoid additional heat build-up, especially when fitting windows of a dark colour.
- Use an expansion joint in order to connect several elements.
- Allow a larger expansion joint when mounting laminated windows in brickwork.
- Avoid mounting additional profiles and accessories as far as possible.
- Fit inward opening doors rather than outward opening doors.
- Bear in mind that doors with round arches can be prone to specific deformation.

7. Acceptable and unacceptable deformation

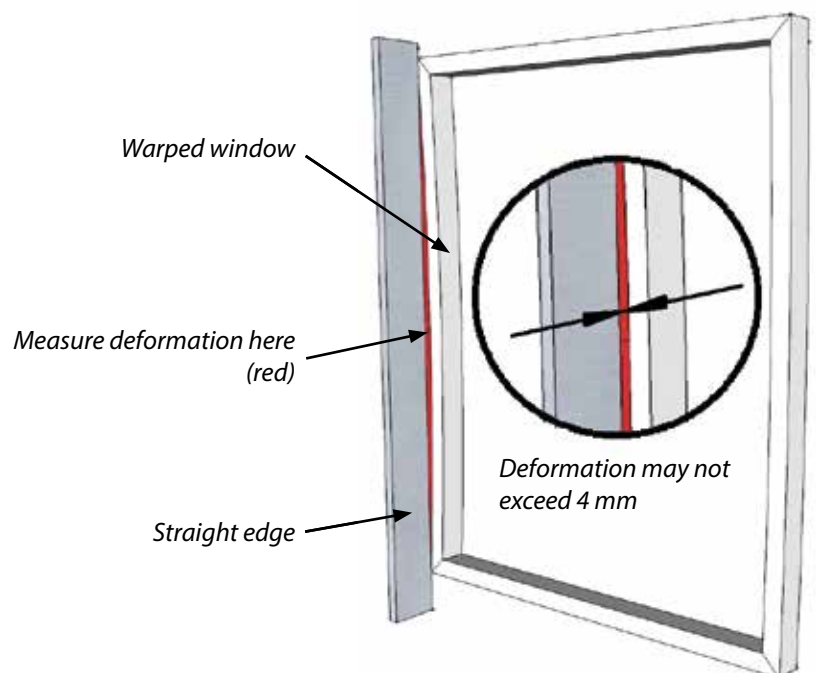


Fig. 3: A deformation is best measured on the concave profile

Coloured windows and doors can change their shape temporarily or permanently because of temperature differences between the internal and external surfaces. It may simply be a visual flaw but in more serious cases it may adversely affect the function.

Deformation is acceptable as long as the agreed standards are upheld in terms of airtight performance and resistance to heavy rain. Operability must also be guaranteed, represented by operating forces of ≤ 10 Nm with tilt & turn fittings. It is then possible to adjust the fittings and, where applicable, replace the locks. Practice has shown that windows and front doors work properly in practice if the deformation is ≤ 4 mm. In individual cases, the deformation may even be above 4 mm without amounting to a defect as long as the operability is guaranteed.

If you want to measure the deformation, place a straight edge at the outermost points of the profile on the concave side (cf. Fig. 3). In order to calculate the deflection, take the maximum deviation of the window from the straight line indicated by the straight edge as a basis.

In isolated cases, the deformation of windows and front doors may even exceed 4 mm if the performance standards are upheld.

8. Further information

- Production and installation instructions – list of system suppliers gkfp.de/en/about-us/members-ral-guetegemeinschaft/system-suppliers
- Technical guide to heat-sealing: gkfp.de/en/about-us/publications
- Fact sheets prepared by the pro-K Fachgruppen pro-kunststoff.de/info-service
- IVD-Merkblätter – Merkblatt Nr. 9: “Anschlussfuge für Fenster und Außentüren” [leaflet no. 9 on perimeter joints for windows and external doors published by the IVD sealant association]: abdichten.de/ivd-merkblaetter
- Merkblätter KU.01 – “Visuelle Berteilung von Oberflächen von Kunststofffenster- und Türelementen” and TBV.01 – “Thermisch- und feuchtebedingte Verformungen im Fenster-, Türen- und Fassadenbau” [leaflets KU.01 on the visual assessment of the surfaces of PVC windows and door elements and TBV.01 on the thermal and moisture-related deformations in window, door and façade construction] published by the Verband für Fenster- und Fassadenhersteller e.V., Frankfurt: window.de/Publikationen-Shop.224.0.html
- “Planung und Ausführung der Montage von Fenstern und Haustüren für Neubau und Renovierung” [guide to the design and installation of windows and front doors in newbuild and renovation projects] (last revised March 2014): window.de/Der-Leitfaden-zur-Montage.327.0.html
- TRLV – Technische Regeln für die Verwendung von linienförmig gelagerten Verglasungen vom Deutschen Institut für Bautechnik (DIBt) [technical rules for the use of glazing with linear supports published by the Deutsches Institut für Bautechnik (DIBt)]: dibt.de/en/service/data/eTRLV.pdf
- VOB/B – Deutscher Vergabe- und Vertragsausschuss für Bauleistungen; Vergabe- und Vertragsordnung für Bauleistungen; Teil B: Allgemeine Vertragsbedingungen für die Ausführung von Bauleistungen (Fassung 2016) [German Committee for Construction Contract Procedures; Construction Contract Procedures; Part B: General conditions of contract relating to the execution of construction work; 2016 issue]: bundesanzeiger.de



Published by:

RAL Gütegemeinschaft
Kunststoff-Fensterprofilsysteme e.V.
Am Hofgarten 1–2
53113 Bonn (Germany)

Phone: +49 (0)228 766 76 54
Fax: +49 (0)228 766 76 50
info@gkfp.de
gkfp.de/en

pro-K Industrieverband Halbzeuge und Konsum-
produkte aus Kunststoff e.V.
Städelstraße 10
60596 Frankfurt am Main (Germany)

Phone: +49 (0)69 27 105 31
Fax: +49 (0)69 23 98 37
info@pro-kunststoff.de
pro-kunststoff.de