SHEET MATERIALS

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FOAMALUX

PRODUCT GUIDE

FOAMALUX & FOAMALUX ULTRA
RIGID FOAM PVC SHEETS

PERFORMANCE
& SPECIFICATION

DESIGN

PROCESSING

BRETT MARTIN

BRETT MARTIN

Brett Martin is a multi-site international organisation producing comprehensive ranges of semi-finished plastic products, rooflight sheeting materials and plastic drainage products.

Our reputation for excellence in product quality and technical service is built on over 40 years manufacturing experience.

BRETT MARTIN
PRODUCT MANUALS

foamalux®

FOAMALUX ULTRA

PRODUCT GUIDE

Brett Martin is a leading European producer of plastic sheet products and manufactures Europe's largest range of rooflight sheeting and glazing products.

Brett Martin has many years of experience in the production of GRP, PVC and Polycarbonate sheet products, on the basis of which Foamalux and Foamalux Ultra extruded rigid foam PVC sheets are a natural product development.

Foamalux, rigid foam PVC sheet, exhibits an excellent range of properties - a satin smooth surface finish, a range of vibrant colours, superior fire performance and easy workability. Foamalux has the most comprehensive colour and thickness range manufactured in the UK. Foamalux Ultra, gloss foam PVC sheet, combines the same excellent combination of properties with a superb gloss surface.

Foamalux and Foamalux Ultra, in common with all Brett Martin products, are manufactured to standards of excellence which have earned Brett Martin BSI Registered status under BS EN ISO 9002.

CONTENTS

IMPORTANT NOTE ON SEMI FINISHED MATERIALS

Since the end uses of semi finished materials are so diverse it is the responsibilty of each user of Brett Martin's Foam PVC Sheets to make his own tests to determine the material's suitability for his own particular use.

All the information is given in good faith but without commitment and warranty given or implied. Brett Martin accepts no liability for defects, loss or damage resulting from misuse, improper installation, inappropriate specification or any other factor beyond its control.

In accordance with our company's policy of continual product development, you are advised to check with your local Brett Martin representative to ensure that you have obtained the most up to date information.

INDEX
PRODUCT GUIDE

PRODUCT GUIDE

BRETT MARTIN

Brett Martin is an international multi-site manufacturing company, specialising in plastic sheet products including PVC, GRP and Polycarbonate.

The Brett Martin range is one of the largest in Europe and is available from specialist distributors throughout the UK and in an increasing number of countries around the world.

Brett Martin Ltd is listed on the BSI Register of Firms of Assessed Capability under BS EN ISO 9002.

FOAMALUX

Foamalux, rigid foam PVC sheet, is ideal for use in a wide variety of indoor and short term outdoor applications. It is an extruded, unplasticised PVC foam sheet with a smooth semi-matt surface finish.

FOAMALUX ULTRA

Foamalux Ultra, rigid gloss foam PVC sheet, combines the cost and weight advantages of foam PVC with a superb gloss top surface. It is an extruded, closed cell, unplasticised PVC foam sheet with a co-extruded surface layer of UV stabilised PVC which forms an integral part of the sheet. Foamalux Ultra has better UV stability than standard foam PVC.

FOAMALUX & FOAMALUX ULTRA

Foamalux and Foamalux Ultra have very similar product characteristics and are therefore dealt with together throughout this product guide, with any differences being highlighted within the relevant section. These two materials possess an impressive range of properties and advantages:

- **The optimum surfaces** - Foamalux has a uniform closed cell structure with a satin finish. Foamalux Ultra has a smooth, hard, high gloss surface layer, co-extruded on the Foamalux substrate. Their uniformity in surface finish and colouring is of superior quality for all types of processing, giving outstanding results where substrate surface quality is critical, eg. in screen printing, application of vinyl graphics and photographic print mounting.

- **Design versatility** - Foamalux and Foamalux Ultra offer extensive choices to the designer, who can exploit many original ways of using white and coloured materials in gloss or satin finishes to produce stimulating signs, displays, in-store graphics and merchandising.

- **Lightweight** - Foamalux and Foamalux Ultra are approximately half the weight of solid PVC sheet, so are ideal for constructing displays and exhibitions where portability is important. They are more cost effective than solid rigid materials.

- **Consistency** - Production controls ensure uniformity of surface finish, thickness, colour, cell structure and density across the Foamalux ranges. Tolerances on all these parameters are set within strict limits.

- **Strength and durability** - The size and uniformity of the closed cell structure is designed to give an ideal combination of strength and durability. The surfaces of both Foamalux and Foamalux Ultra have excellent resistance to knocks and scratches. The closed cell structure minimises water absorption, ensuring that the structure of the sheet will not deteriorate when used in exterior applications.

- **Workability** - Basic wood and metal working tools are suitable for cutting, shaping and drilling Foamalux and Foamalux Ultra. They can be curved and bent, thermoformed, bonded, glued and mechanically fixed very successfully when appropriate procedures are followed.

- **Product Range**

Foamalux

WIDTH	WHITE	COLOURS
1220mm x 2440mm	1, 2, 3, 4, 5, 6, 8,10 &13mm	3 & 5mm
1220mm x 3050mm	3 & 5mm	-
1560mm x 3050mm	2, 3, 4, 5, 6, 8 & 10mm	-
2050mm x 3050mm	2, 3, 4, 5, 6, 8 & 10mm	*3 & 5mm

*Please contact Brett Martin for details of colours available.

Foamalux Ultra

WIDTH	WHITE	COLOURS
1220mm x 2440mm	3, 5, &10mm	3 & 5mm

The range is expanding to meet market demands and alternative options may be available subject to minimum order quantities. Please consult Brett Martin for up to date range information.

- **Fire rating** - Foamalux and Foamalux Ultra have been tested in accordance with BS 476: Part 7: 1987 and have achieved Class 1 Surface Spread of Flame designations. Testing in accordance with other European standards has also produced high classifications.

- **Chemical and environmental resistance** - Foamalux and Foamalux Ultra are resistant to dilute acids and alkalis, do not corrode or rot and are not prone to attack by pests.

APPLICATIONS

Uses of Foamalux and Foamalux Ultra derive from their visual qualities combined with consistency, lightness, easy workability, excellent fire performance and chemical resistance. They include:

- SCREEN PRINTING
- VINYL GRAPHICS SUBSTRATES
- PHOTOGRAPHIC MOUNTING
- SIGNS & SIGN LETTERING
- CEILING TILES
- DECORATIVE PANELS
- DISPLAYS
- POINT OF SALE, DISPLAY & MERCHANDISING EQUIPMENT
- EXHIBITION SYSTEMS
- CONTAINERS
- MODELS
- CHEMICAL RESISTING SURFACES
- INSULATION SANDWICH PANELS
- ENCLOSURES
- EQUIPMENT COVERS
- FURNITURE COMPONENTS
- ETC.

PRODUCT GUIDE

The Foamalux Product Guide contains information on product specifications and performance, uses, design criteria, machining, fabricating and installation instructions to ensure successful use of Foamalux and Foamalux Ultra in almost every application.

INDEX
SPECIFICATION & PERFORMANCE

SPECIFICATION

PERFORMANCE

SPECIFICATION & PERFORMANCE

MATERIAL PROPERTIES

The properties listed are typical values obtained by testing large numbers of specimens under specified conditions and procedures. As additional processing of the sheet can influence the material properties, the information given should be treated with caution when applied to finished products. Unless otherwise specified the properties apply to both Foamalux and Foamalux Ultra.

PHYSICAL CHARACTERISTICS

Characteristic	Foamalux	Foamalux Ultra
Base polymer:	Polyvinyl Chloride (PVC)	Polyvinyl Chloride (PVC)
Form:	Semi-finished sheet product.	Semi-finished sheet product.
Thickness:	White available in 1, 2, 3, 4, 5, 6, 8, 10 & 13mm.	White available in 3, 5 & 10mm
	Colours available in 3 & 5mm.	Colours available in 3 & 5mm.
Smell:	Odourless	Odourless
Moisture absorption after	<0.25% by weight	<0.25% by weight
24hrs @ 23°C:		
Water solubility:	Insoluble	Insoluble
Tensile strength at yield:	16MPa	16MPa
Modulus of elasticity:	0.9MPa	0.9MPa
Elongation at break:	27%	27%
Flexural strength:	27MPa	27MPa
Impact resistance:	15kJ/m²	15kJ/m²
(Charpy test, un-notched specimen)		
Shore hardness:	45-65 (3mm)	70-75 (3mm)
Oxygen index:	48%	48%

* NB The shades of colours are different in the two material ranges.

THERMAL PROPERTIES

Property		Value
Vicat softening temperature:		76°C
Thermal conductivity K:		0.085 W/m°C
Thermal decomposition temperature:		>200°C
Thermal resistance R:	1mm	0.18 m²°K/W
	2mm	0.19 m²°K/W
	3mm	0.20 m²°K/W
	4mm	0.22 m²°K/W
	5mm	0.23 m²°K/W
	6mm	0.24 m²°K/W
	8mm	0.26 m²°K/W
	10mm	0.29 m²°K/W
Thermal expansion coefficient:		0.076 mm/m°C
Service temperature range:		-20 to +60°C

ELECTRICAL PROPERTIES

Property	Value
Dielectric Strength	≈100 kV/cm
Surface Resistance	$>10^{12}\Omega$
Volume Resistivity	$4 \times 10^{15}\Omega$cm
Dielectric Constant	2.4 (for 1kHz)
Dielectric Dissipation Factor	0.013 (for 1kHz)
Tracking Resistance	600 CPI

ACOUSTIC PROPERTIES

Sound attenuation - frequency range 100-3500Hz

Thickness	Attenuation
1mm	12dB
2mm	18dB
3mm	19dB
4mm	20dB
5mm	22dB
6mm	23dB
8mm	24dB
10mm	27dB

SHEET SIZES & TOLERANCES

Dimension	Value
Standard sheet sizes: Foamalux	2440 x 1220mm
	3050 x 1220mm
	3050 x 1560mm
	3050 x 2050mm
Foamalux Ultra	2440 x 1220mm
Other sizes are available to order subject to minimum quantities.	
Tolerances:	
Length:	-0, +10mm
Width:	-0, +3mm
Thicknessess:	± 5%

FIRE PERFORMANCE

Foamalux and Foamalux Ultra achieve excellent results when tested using several national standard test methods. Test certificates relating to the results summarised below are available on request.

FOAMALUX

Country	Test Method	Result
Belgium	NBN S21-203	A1
France	NF P 92-507	M1
Germany	DIN 4102	B1
Italy	CSE RF2/75/A, RF3/77	Class 1
Spain	UNE 93.727-90	Class 1
UK	BS 476 Part 7	Class 1
USA	UL-94	94V-0

Foamalux Ultra has achieved Class 1 Surface Spread of Flame designation when tested under BS 476: Part 7: 1987 in the UK.

SURFACE PROTECTION & PACKAGING

Normally all sizes and colours have an easily removed protective polyethylene surface film, branded with the Foamalux or Foamalux Ultra logo, applied to one side.

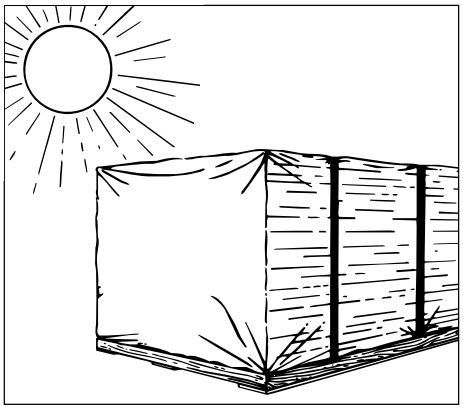
All Foamalux and Foamalux Ultra sheets are factory packaged to ensure they are received by the user in pristine condition. The sheets should be similarly protected or packaged at all stages of processing to ensure the quality of finished items.

STORAGE

Foamalux and Foamalux Ultra, in common with all other PVC sheet materials, are best stored indoors, away from direct sunlight, in a cool dry store. The temperature of uncovered stacked sheets in direct sunlight can rise to levels which will be detrimental to the material: the presence of moisture between sheets can add to damage.

Sheets, whether stored indoors or outdoors, should be laid horizontally on a flat clean surface, for example, a solid topped pallet or wooden sheet raised from the floor or ground. Under the total weight of sheet loaded on to it, this support must not distort, or distortion of the sheet could occur during longer storage periods.

Standing sheets on ends or sides, even for short periods, should be avoided. Coloured sheets should be stored in their protective cardboard sleeves. Do not store indoors close to heat sources, for example, radiant heaters or boilers. Where storage outdoors cannot be avoided, at all times the stack of sheets should be completely enclosed within a reflective waterproof cover, placed over wooden battens on top of the stack to avoid contact with the sheet surface. The cover should be secured to protect the stack against sun, wind and rain and the stack should be ventilated to avoid heat build-up.



HANDLING

Foamalux and Foamalux Ultra are relatively flexible materials but, if lifted or carried incorrectly, they can be stressed beyond their flexible limits and cracked.

Sheets and cut panels should not be dragged off a stack but lifted up directly and set down directly. Surfaces on which sheets are set must be clean to avoid damage. When carrying, sheets should be turned on edge and held top and bottom. It will require more than one person to carry a large sheet or panel. Particular care should be taken with panels which have been processed, for example, screen printed.

SAFETY

Foamalux and Foamalux Ultra are rigid foam PVC sheets extruded from polyvinyl chloride. They are not subject to the laws governing the use of dangerous materials or chemicals.

No special protective measures are needed when transporting or handling the material. When working with the material care must be taken to protect eyes and avoid inhalation of dust.

Foamalux and Foamalux Ultra sheets do not constitute fire, explosion or toxic hazard material.

In case of a fire involving Foamalux, Foamalux Ultra or any other PVC material, water, foam and carbon dioxide extinguishers may be used. Burning causes noxious fumes to be released eg. hydrochloric acid, carbon monoxide. Do not breathe decomposition products. When decomposition products have been accidentally inhaled, medical assistance is required.

WASTE DISPOSAL

Do not dispose of Foamalux or Foamalux Ultra by burning. They form an inert waste and can be used as landfill, with no harmful environmental effects. High temperature incineration may be used. Disposal through local plastics recyclers is possible.

INDEX
DESIGN FACTORS

DESIGN FACTORS

DESIGN FACTORS

Every material has its unique advantages and specific restrictions in use. A satisfactory finished product in any material is achieved through due consideration at design of its properties, means of processing and fabrication and also of the environmental conditions to which it will be subject in use.

SUNLIGHT

Sunlight affects all materials, to varying degrees, by the action of the UV radiation component of sunlight and by raising surface temperatures.

FOAMALUX

Ultraviolet light attacks many materials, as is evident by the fact that, for example, painted surfaces fade. Foamalux, like all other plastic materials, is affected by UV light: a colour will change according to its colourfastness and the quantity of radiation absorbed.

In practical terms, all coloured foam PVC sheets will fade, but this may be immaterial in short term outdoor applications and is irrelevant where the panel is completely coated with, for example, ink, paint or varnish.

Brett Martin does not recommend the use of Foamalux colours for exterior uses where extended life is expected. Exterior uses which demand colour retention of Foamalux for an extended period can be satisfied by applying a transparent vinyl or acrylic film, or varnish.

FOAMALUX ULTRA

The key constituent of Foamalux Ultra is the co-extruded surface layer, derived from a PVC formulation and offering enhanced exterior performance. The UV protection afforded by this high gloss layer means that Foamalux Ultra, as well as being suitable for internal use, is also ideal for external applications without the need for additional protection. While it is impossible to completely eliminate change, Foamalux Ultra will retain its colouring with minimal change over an extended period of weathering. The rate of change is dependent on a number of factors including orientation and air quality.

SURFACE TEMPERATURE EFFECTS

At moderate ambient air temperatures, 25°C to 35°C, material surfaces can, depending on colour and duration of exposure to direct sunlight, reach temperatures which would adversely affect any PVC sheet materal causing, for example, permanent buckling.

SURFACE TEMPERATURES IN DIRECT SUNLIGHT

Surface Colour	Typical Temperature (°C)
Black	80
Dark Blue	68
Grey	67
Red	68
Green	70
Yellow	57
White	40

The maximum surface temperature for Foamalux and Foamalux Ultra in service is 60°C. For exterior use, lighter colours, or darker panels predominantly covered with light coloured laminates, paints or inks, are best suited.

Applications using extensive darker coloured panels, or panels with dark coloured laminates, paints or inks, when exposed to sunlight may achieve undesirably high temperatures.
Small darker coloured panels or components are less liable to damage.

Use behind glass requires adequate spacing from the glass and ventilation as, in a relatively enclosed space, temperatures may get high enough to cause distortion.

Internal applications require careful positioning in relation to heat sources, for example, radiant heaters or artificial lighting, which could produce panel distortion.

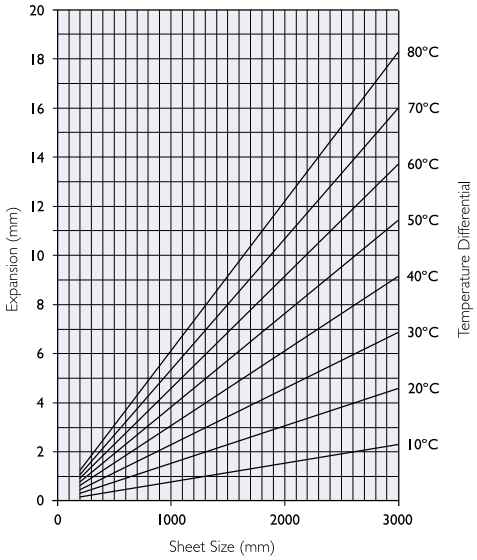
THERMAL MOVEMENT

Changes in temperature produce thermal movement in Foamalux and Foamalux Ultra panels. The amount of movement is a product of the sheet dimensions, temperature change and the coefficient of linear expansion, 0.068mm/m°C.

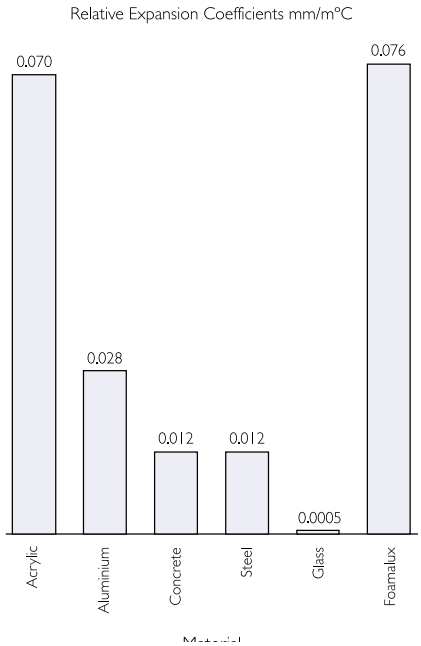
A 2440mm long panel will expand by 3.71mm as the temperature rises from 7°C to 27°C, a temperature differential of twenty degrees.

Significant temperature changes will occur in all exterior applications; there may also be internal applications where variation in temperature is considerable. Thermal movement must therefore always be accomodated in whatever means of fixing is used. In Appendix 1 examples are given of how to calculate changes in sheet dimensions with temperature change. Adequate fixing hole and slot sizes which will accomodate thermal movement are given in Appendix 4.

The service temperature range limits, -20°C and + 60°C, form the basis for the overall temperature differential range of eighty degrees.



In practice, Foamalux and Foamalux Ultra will be used in conjunction with many common building and accessory materials, the thermal expansion properties of which must also be taken into consideration. The graph below illustrates the relative coefficients for various materials. Foamalux clearly expands much more than timber, concrete, brickwork and metals when their temperature is changed by the same amount.



LOW TEMPERATURES

As temperatures fall to freezing point and below, all PVC sheet materials become less pliable and more brittle, therefore more susceptible to damage through rough handling and impact.

Foamalux and Foamalux Ultra should be handled with care in cold weather; all knocks and excessive twisting and bending should be avoided.
When cutting, drilling or performing any other operations, care must be taken in colder conditions.

WIND LOADING

Any panel mounted outside a building will be subject to wind loading. Panels mounted on walls will not be critically affected by positive wind pressures which force the sheet against the wall: however, negative or suction pressures will tend to pull the sheet away from the wall.

In many external applications eg. where panels are edge mounted in frames, they will be subject to wind pressures from both sides.

When designing an external application, wind loads should be estimated and provision made for secure means of fixing. For example, the fixing spacing should be as recommended on page 27 and the diameter of the washer on the fixing should be at least two times that of the hole drilled for the fixing shank.

Wind loads can be estimated using BS CP3: Chapter V: Part 2.

PRECIPITATION

All panels in external situations will be subject to precipitation in the form of rain, sleet, snow and hail. Foamalux and Foamalux Ultra do not absorb moisture from precipitation: they will not therefore degrade or deteriorate in the presence of moisture.

Hail storms may cause damage through impact of large hail stones on cold panels.

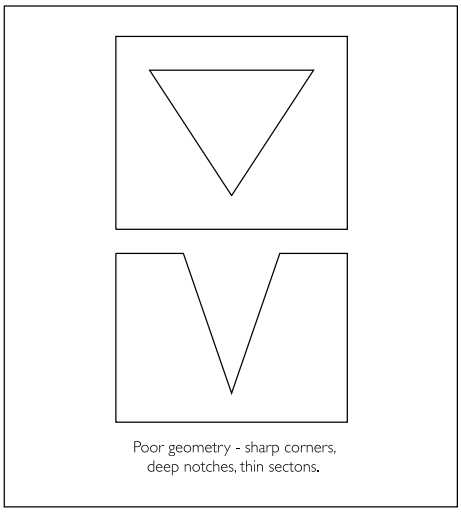
CHEMICAL & ENVIRONMENTAL ATTACK

The base material for Foamalux and Foamalux Ultra, PVC, is highly resistant to attack from chemicals and from pollutants in the atmosphere.
Contact with solvents and wet wood preservatives must be avoided. A listing of resistance to a range of chemicals at 23°C is given in Appendix 2.

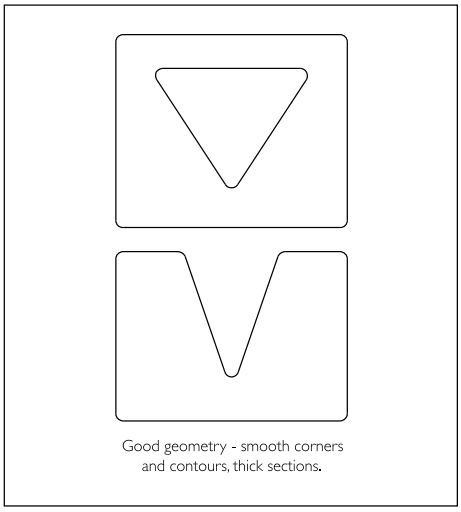
COMPONENT GEOMETRY

Sharp corners and notches in thermoplastic components assist in the initiation and propagation of cracks, particularly if a component is under stress. Creases, grooves and sharp bends also form potential weaknesses. Component shapes should exclude such features; all internal and external corners or changes in direction should follow a smooth radiused profile.

Where designs involve hot bending of sheets, radii should ideally be not less than two and a half times the sheet thickness.



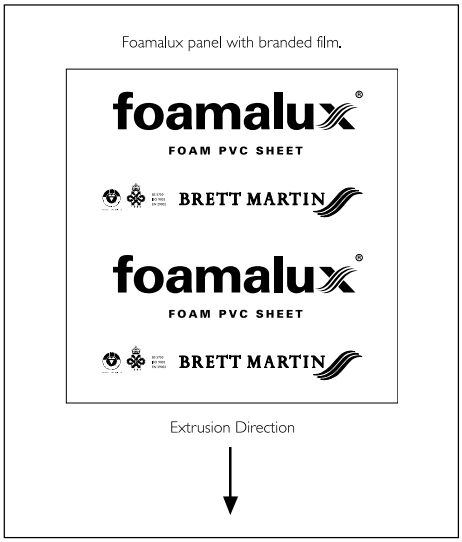
Poor geometry - sharp corners, deep notches, thin sectons.

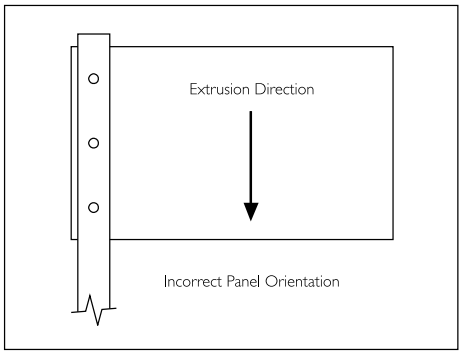


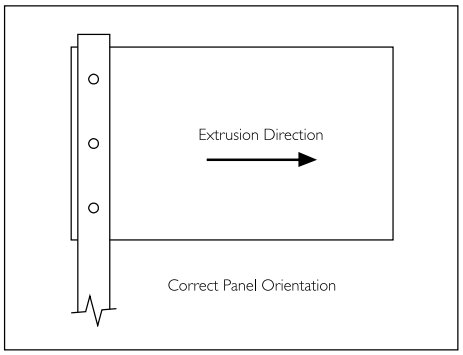
Good geometry - smooth corners and contours, thick sections.

PANEL ORIENTATION

Panel orientation should be considered when mounting, for example, rectangular panels by only one short edge in external applications. Extruded materials generally have fractionally greater flexural strength, and therefore resistance to bending, in the direction of extrusion. The protective film has the brand running across the direction of extrusion, providing ease of identification for correct cutting of panels for such applications.







INDEX
MACHINING OPERATIONS

MACHINING

OPERATIONS

MACHINING OPERATIONS

Foamalux and Foamalux Ultra are easy materials to work with, using basic wood and metal working tools.

When working with any power tool, the sheet temperatures must be kept below the material softening point of 70°C. Compressed air is a suitable and easy to apply coolant. Efficient removal of dust and swarf from the cutting tool helps to lower temperatures. These measures assist in obtaining a good quality cut finish.

In general, machining operations require a combination of low feed speed and depth of cut together with a high cutting speed. Correct tool geometry is also important. The recommendations given for tool geometries and speeds should be used as a guide: some experimenting may be required to obtain best results.

It is necessary to have an effective means of removing dust produced by machining operations from the operator's environment.

CUTTING, SHAPING & FINISHING

Different means of cutting are appropriate for various thicknesses, ranging from hand tools to power saws.

CUTTING

Sheets 1mm and 2mm thick can be cut with shears: sheets 1-3mm thick can be cut with a craft knife: preheated sheets are easiest to cut. Sheet exceeding 3mm in thickness should be sawn.

GUILLOTINING

Guillotines can be used for rough cutting but are not usually employed to finish-cut as their action compresses the sheet and can give a poor edge finish eg. permanent edge distortion: cracks can also be initiated in cold sheets.

Guillotines with blades heated to around 160°C give a good quality cut edge with less possibility of compressing or otherwise damaging the sheet edge.

DIE CUTTING

Flat shapes with complex outlines can be die cut from thinner sheets - up to 4mm thick - using sharp, accurately set, steel rule dies: best results are obtainable by preheating sheets to a maximum of 35°C; however, cut shapes should be placed between flat metal plates to cool, avoiding distortion.

When designing components to be die cut, narrow sections and radii less than 3mm should be avoided.

Sheets thicker than 4mm can be die cut provided they are preheated and component radii are at least equal to sheet thickness. Edge finishing may be required.

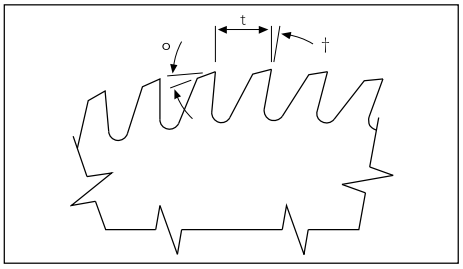
SAWING

Blades designed for cutting plastics are ideal for cutting Foamalux and Foamalux Ultra, as are most types of wood saws - band, bench, circular, hand, jig and wall saws.

Blades must be sharp, with a slight side set. Hold and support sheets to avoid stress and vibration, particularly in cold conditions. Blunt blades and very fine tooth metal cutting blades, or incorrectly held material, produce an unsatisfactory finish.

Blades should always cut down into the gloss surface of Foamalux Ultra.

When using power saws, clear swarf and avoid heat build up at the cut to produce clean cuts.

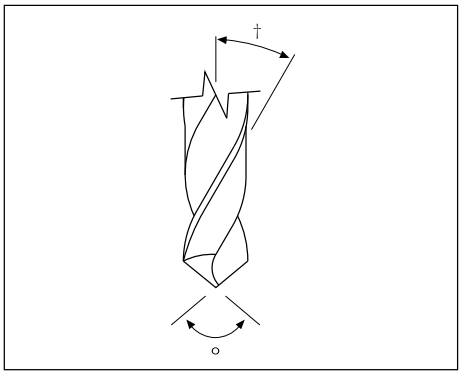


Angle	10°-15° circular saw 30°-40° band saw
Rake angle †	0-8°
Tooth pitch t	5-15mm circular saw 2-8mm band saw
Circumference speed	1000-3000m/min.
Feed speed	6-30m/min.

DRILLING

Sheet thickness and hole diameter required determine the appropriate drill type. It is more difficult to drill large holes in thinner sheets than small holes in thicker sheets. Thin sheets require a high drill speed and low feed speed. Slower feed speeds are used in deeper holes to minimise heat build up.

Standard twist bits for metal are suitable for holes up to 12mm diameter in all thicknesses. Holes over 12mm in diameter can be drilled with flat bits, normally used for drilling wood. Above 25mm diameter it is necessary to use hole saws or circular cutters.



Tip angle o	100° - 110°
Helix angle †	30°
Drill speed	1000 - 3000 rpm
Feed speed	0.2 - 0.5mm /rev.

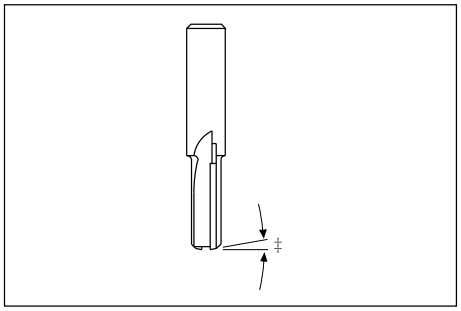
MILLING & ROUTING

All types of milling machines and routers can be used to machine Foamalux and Foamalux Ultra if suitable tool geometry and cutting conditions are used.

Vacuum clamping machines are ideal as they are less likely to mark the surface than mechanical clamping. Where sheets are mechanically clamped, load spreading pads should be used to avoid surface marks.

Cutting tools must be capable of clearing large quantities of chips and cut depths and feed speeds must not be too high to avoid heat build up and poor edge finish.

Cutters with single or twin cutting edges are most suitable.



Relief angle ‡	0-15°
Cutting speed	up to 18000 rpm
Feed speed	0.3-0.5mm /rev.

FINISHING

Sheet edges can be finished by filing, sanding, grinding, planing or using a deburring tool, for example, a flat steel edge scraper. Such finishing operations on the sheet surfaces will expose the inner cell structure which will be undesirable in most applications. Glossy surface finishes can be obtained using soft buffing wheels and applying polishing compound, but avoid abrading the surface.

INDEX
FORMING, FABRICATION & BONDING

FORMING, FABRICATION

BONDING

FORMING, FABRICATION & BONDING

Many processing operations involve heating. Foamalux and Foamalux Ultra are thermoplastic materials which attain an elastic state and are therefore formable at material temperatures in the range 115-135°C. The panel to be shaped or formed requires even heating throughout its area and thickness. The component formed in the elastic state, when cooled slowly to a rigid state in the forming device, retains the formed shape.

Heat sources can be hot air blowers, hot gas welders, hot air circulating ovens and infra-red panel heaters: all must have controls which enable good regulation of their temperature and that of the Foamalux.

Heating of one side will usually be enough for sheets up to 3mm thick: above this thickness heat should be applied to both sides, reducing heating times and the possibility of surface damage. Using radiant heat, a heating time of 20 seconds for each 1mm of sheet thickness and using an oven, a heating time of 40 seconds for each 1mm thickness of sheet are reasonable starting points from which to develop.

Some experimentation will always be required to obtain optimum temperatures for forming, these being a function of sheet thickness and the specific forming operation: sheet colour and atmospheric conditions also have some influence.

It is essential to ensure that all panels are free from dust, oil and any other contaminants prior to any forming operation, as these will detract from the quality of the finished product.

As Foamalux and Foamalux Ultra are cellular materials they are not suitable for forming operations which involve excessive stretching in the elastic state. This will cause rupture of the cells and blemishing of the external surface.

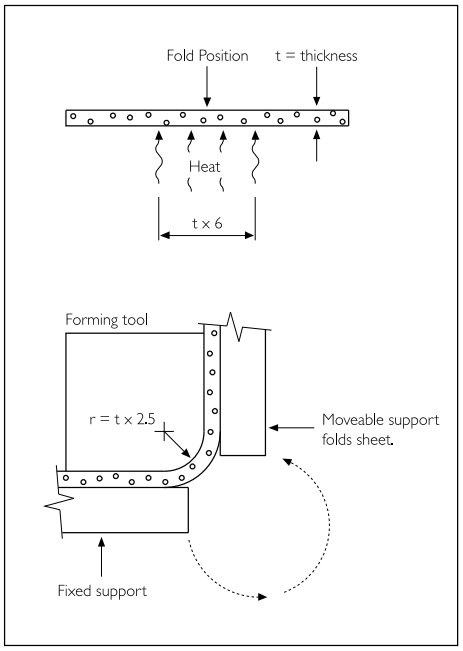
FOLDING

Cold folding is not practical as the materials will stress and crack.

Prior to folding, localised strip heating to about 130°C is required. Heat the material for a distance equivalent to three times the sheet thickness on each side of the fold centre line.

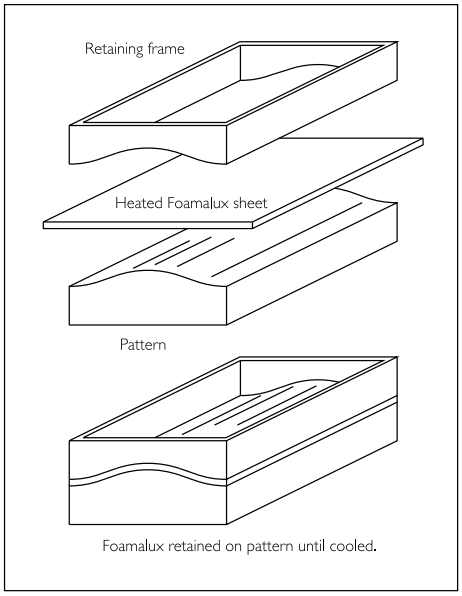
When heating is complete and the required shape produced, it must be allowed to cool on the forming equipment before handling or further processing, to avoid warping.

Foamalux and Foamalux Ultra can be folded on a simple jig fitted with a forming tool having a radius of about two and a half times the sheet thickness.



DRAPE FORMING

Where a specific thickness of Foamalux or Foamalux Ultra is to be curved to a smaller diameter than is possible by cold bending, or it is required to form a simple curved skin, it is possible to do this by softening a panel to an elastic state, draping over an appropriately shaped pattern and retaining it until cooled and rigid.



Foamalux retained on pattern until cooled.

THERMOFORMING

Components which are relatively simple and shallow in form are thermoformable from Foamalux and Foamalux Ultra heated to an elastic state.

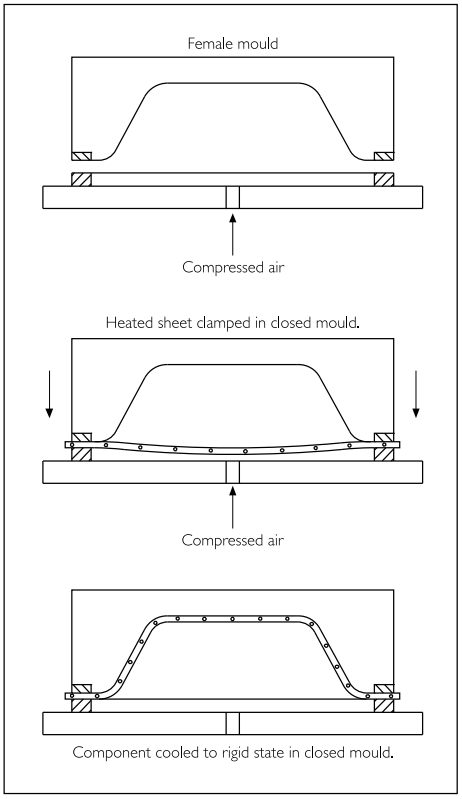
Air-pressure forming is possible at about 130°C and pressures of about 2 bar and vacuum forming at about 170°C. As the material has relatively low density, heating and cooling cycles are faster than with solid thermoplastics. Higher temperatures enhance definition but at the expense of surface finish.

Most industrial press and vacuum formers for thermoplastics are suitable. Best results are achievable from machines which controllably heat both sides of the sheet. Large area panels and thick panels need some air pressure support during heating to avoid sag. Prior conditioning, by suspending in an air circulating oven at about 130°C, removes inherent stresses.

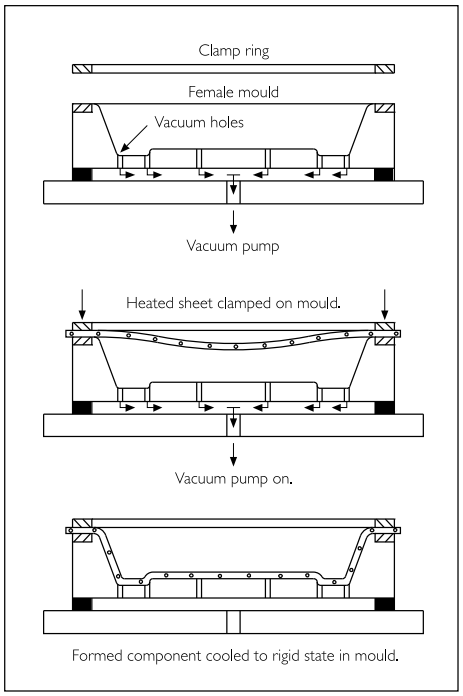
Male moulds are suitable for vacuum forming, female moulds for vacuum and pressure forming. Secure clamping of the sheet during forming is essential to avoid shrinking: components must be completely rigid before removing from the mould.

When an item involves screen printing and thermoforming for its production, the thermoforming processess should always precede the printing.

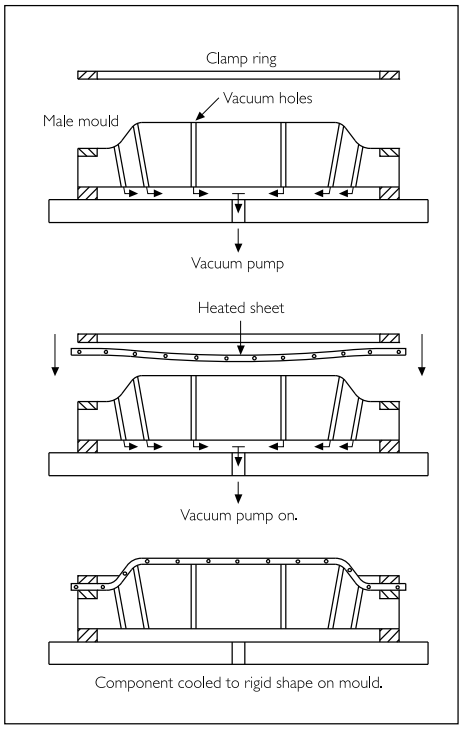
PRESSURE FORMING IN A FEMALE TOOL



VACUUM FORMING IN A FEMALE TOOL



VACUUM FORMING IN A MALE TOOL



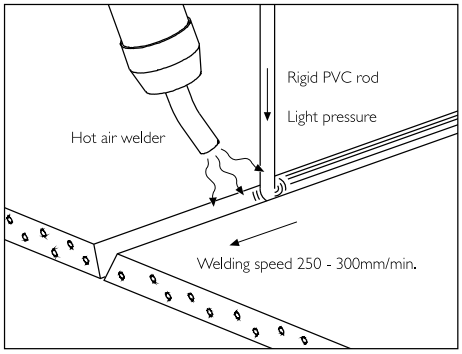
WELDING

Hot air welding and butt welding are most commonly used in fabrication. The equipment, welding rods and skills employed for welding solid thermoplastic sheets are suitable.

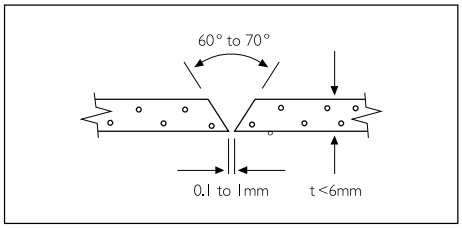
HOT AIR WELDING

Typical joints and the necessary panel preparations are illustrated in the diagrams.

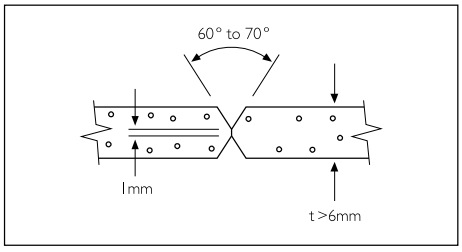
WELDING TECHNIQUE



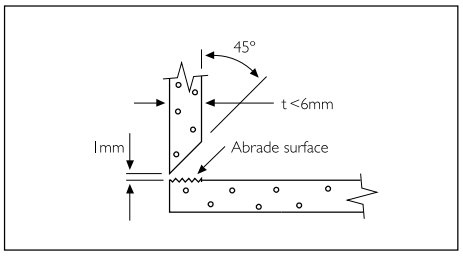
SINGLE V BUTT WELD



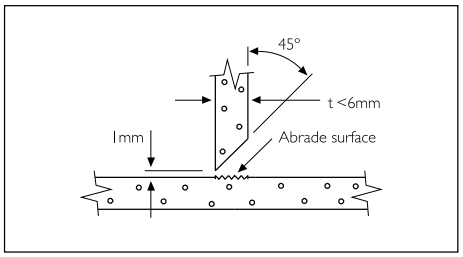
DOUBLE V BUTT WELD



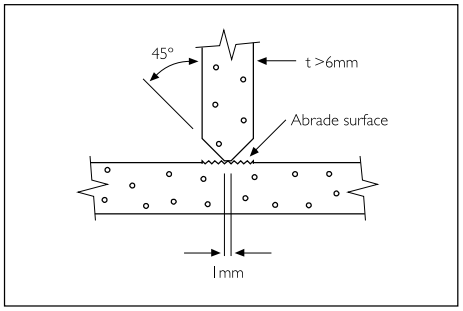
SINGLE BEVEL CORNER WELD



SINGLE BEVEL BUTT WELD



DOUBLE BEVEL BUTT WELD

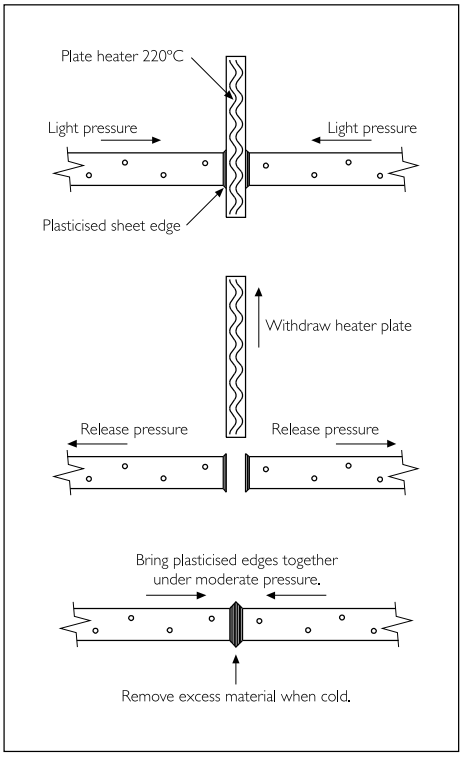


Air temperatures should be about 250°C to plasticise the sheet and welding rod sufficiently for effective bonding. Welding speeds of 250-300mm/minute should avoid excessive heating which will damage the sheet cell structure. Greater speed can be achieved with high speed welding nozzles. Where multiple welds of a joint are necessary, the joint and surrounding area should be allowed to cool between welds: cooling between stages in fabrication is necessary to avoid distortion when the component is moved.

HOT PLATE WELDING

Butt welding of edges of sheets thicker than 3mm is possible using hot plate welding techniques.

Sheet edges are plasticised through contact, under slight pressure, 0.05 - 0.07N/mm², with a flat plate heater at a temperature of about 220° C.
A welded join is formed by withdrawing the tool, pressing the plasticised edges together under controlled pressure, 0.2- 0.27N/mm², and cooling.



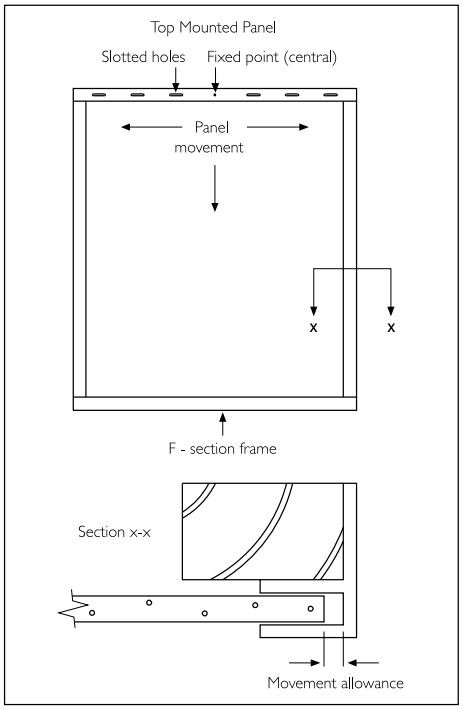
STRUCTURES & FRAMES

In practice Foamalux and Foamalux Ultra are fixed to structures and frames made from many materials, most commonly wood and metals. In the design of these, the differences in thermal expansions must be accomodated, for example, when calculating sizes for fixing holes. An illustration of a typical calculation is given in Appendix 1.

Fixings should be placed at centres not exceeding those recommended on page 27.

Where large and relatively heavy panels are being fixed, the panels should be suspended from a row of fixings located near to the panel top, allowing it to expand down and to each side with temperature change. A large and relatively heavy panel mounted with most of its weight bearing on fixings near the bottom edge could distort at elevated temperatures.

Large panels mounted on external walls should be spaced from the wall surface using battens to maintain a ventilating air gap of about 20mm behind the panel. Direct mounting of the panels to the walls could result in distortion due to heat build up.



MECHANICAL FASTENING

Panels can be fixed to supporting structures using screws, rivets or nails. Screws are most suitable as they are most controllable: tightening a screw and then backing it off slightly allows the panel to move with temperature changes without deformation.

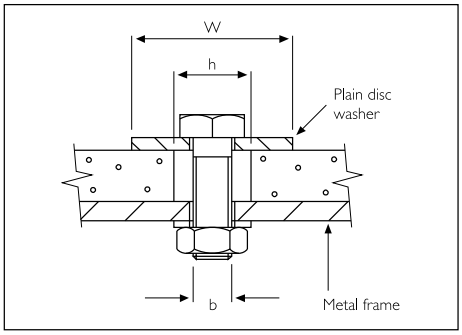
Nails and rivets can be used with small panels or in internal applications where there is little thermal movement since temperature differentials are small.

In all cases holes must be predrilled oversize through the panel to accommodate thermal movement. This in turn necessitates the use of an oversize washer on the fastener to provide adequate retention of the sheet and spread the load. Countersunk screws must never be used without a recessed washer.

Appendix 4 gives details of appropriate hole, or slot and washer size for given sheet dimensions and fixing shank diameters.

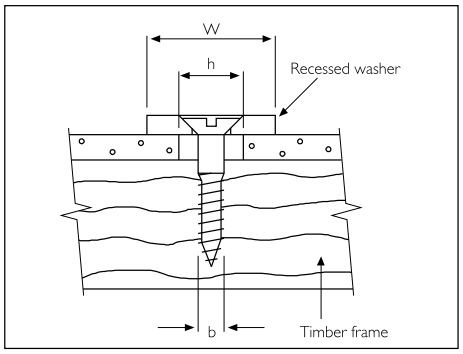
Self tapping screws can be used to mount lightweight items to panels thicker than 6mm.

BOLT FIXING

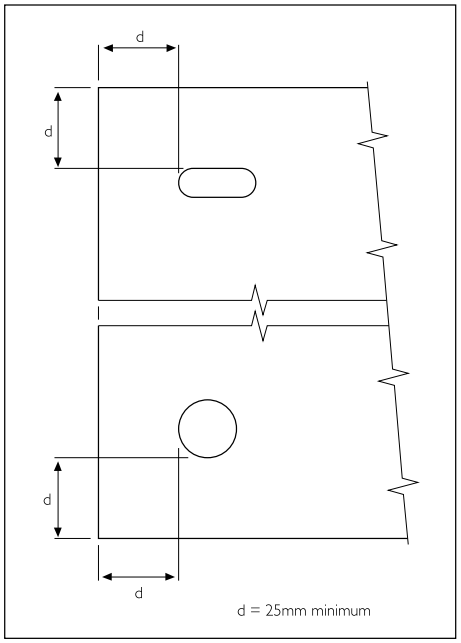


W = Washer Diameter
h = Hole Diameter
b = Fixing Shank Diameter

WOOD SCREW FIXING



Holes or slots in a panel to accomodate fasteners should always be at least 25mm from the panel edge.



Fasteners should be spaced at the separations given for each thickness of panel.

Thickness	Fastener Spacing (mm)
1mm	100 - 150
2mm	150 - 250
3mm	250 - 350
4mm	350 - 500
5mm	500
6mm	500
8mm	500
10mm	500

ADHESIVES

Recommendations on adhesives are made on the basis of tests, following each manufacturer's recommendations on surface preparation, bonding conditions, application of primers and adhesives.

The user should also satisfy himself, preferably by testing, that any adhesive or bonding material will be suitable for his specific application. The user should at all times follow the adhesive manufacturer's recommendations as to suitability, surface preparation, use of primers, application methods, curing times and conditions to be satisfied for effective bonding.

Manufacturers' health and safety precautions should also be observed.

BONDING FOAMALUX AND FOAMALUX ULTRA TOGETHER

Solvent Adhesives - Based on methyl ethyl ketone (MEK), tetrahydrofuran (THF) and cyclohexanone.

Adhesives set as solvents evaporate; successful bonding requires application of pressure and components fitted together accurately as solvent based adhesives will not fill gaps.

BONDING FOAMALUX & FOAMALUX ULTRA TO OTHER MATERIALS

1. Reaction Adhesives - There are two basic types: 1-part adhesives set by reacting with moisture; 2-part adhesives set by the reaction between a chemical base and a catalyst.

- 1-part adhesives - polyurethane or cyanoacrylate based - set very quickly and are ideal when small components, particularly of wood, metals and plastics, are bonded to Foamalux and Foamalux Ultra.

- 2-part adhesives - polyester, polyurethane, polymethacrylate or epoxy based - are slower to cure, but ideal for bonding Foamalux and Foamalux Ultra to metals, wood and masonry.

2. Contact Adhesives - These are used when bonding sheets of Foamalux and Foamalux Ultra to flat surfaces and are based on solvent solutions of synthetic rubbers - eg. polychlorophene or nitrile rubber. Both surfaces to be joined should have adhesive applied: after solvent evaporation bring the two surfaces together under pressure.

Double sided pressure sensitive adhesive tapes are a very efficient and effective means of attaching flat panels to each other and to support structures and of attaching other flat materials to Foamalux.

Please refer to the Brett Martin web site or contact the Technical Department for further information.

INDEX
SUBSTRATE APPLICATIONS

SUBSTRATE APPLICATIONS

SUBSTRATE APPLICATIONS

Foamalux and Foamalux Ultra surface finish and consistency of thickness make them ideal substrate materials for silk screen printing, photographic mounting and laminating in the production of signs, displays and point of sale equipment. As they do not crease or bend easily they are superior substrates to card and board materials in many instances.

PREPARATION

A perfectly clean surface is an essential prerequisite to any substrate use. Film protection at manufacture maintains surface cleanliness and should be retained until the latest possible stage in processing.

Prior to processing, eg. adhesive bonding or printing, the user must satisfy himself by trial that the qualities of Foamalux and Foamalux Ultra are appropriate for the intended use and whether any additional surface cleaning or preparation may be required.

Cleaning by wiping with a soapy water solution will remove dust from cutting or prolonged storage. Residual soapy film may affect keying of inks or vinyls and should be removed using a lint free wipe moistened with aliphatic solvent - heptane or octane. These solvents will remove greasy deposits and dust or dirt adhering to the surface, as will methyl alcohol or methylated spirits. Wipe in one direction only; wiping with a circular motion can create additional static charge.

Abrasive and alkali cleaners will harm the surface finish and must not be used. Cleaners must not contain silicone compounds, as residues of these prevent vinyl inks adhering.

STATIC ELECTRICITY

Static electricity is produced when the protective film is stripped off and during processing and handling. It is necessary to remove it from panels which are to be screen printed. Static charges can be neutralised temporarily in several ways.

Isopropyl alcohol solution applied to the sheet surface by wipe or spray evaporates quickly in air, leaving an antistatic film which is effective for a considerable period of time. Wiping with soapy water solution has a charge neutralising effect.

The static charge can also be neutralised by blowing ionised air on to the panel or component.

Foamalux AS uses a special formulation to resist the build up of static charge. Please contact our technical department for full details.

TOLERANCES

When processing eg. screen printing and tighter tolerances are required, the user, when ordering, must make allowances for truing panels to the accuracy required for processing.

PAINTING & VARNISHING

Sheet surfaces are excellent for painting and varnishing. All paint application techniques - brush, roller, spray - can be used. Surface preparation instructions should again be followed. Vinyl, acrylic and two part polyurethane based paints are ideal - manufacturers' application and safety directions should be followed.

VINYL GRAPHICS

Decorative and lettering / script graphics can be applied to Foamalux and Foamalux Ultra as both materials form very rigid and stable substrates. Their surface quality ensures excellent results free from visual distortion.

All materials used in the application process must be dust and moisture free to avoid surface bumps and blisters. Application pressure must be even and strong enough to expel air from the vinyl but excessive pressure can lead to distortion of the graphic and may cause wrinkles.

LAMINATION

All material used in the laminating process must be dust and moisture free while pressure must be even and strong enough to expel air across the sheet width.

Roller laminating machines are essential for larger sizes and volumes of panels as ideal roll temperatures, pressures and laminating speed can be determined and accurately controlled to suit the sheet thickness and the material being applied. Hand laminating is suitable only for small sizes and runs of panels.

Laminating on a clear film protects the print or graphic surface while matt finishes can reduce glare.

Application of films which require high temperatures should be avoided as this could lead to buckling of the sheet.

Photomounting to Foamalux and Foamalux Ultra gives very high quality results due to the excellent surface finishes and stability of the materials

PRINTING

The surface quality on both materials is ideal for screen printing in particular: vinyl or vinyl/acrylic based inks, with their own thinners, should be used. Surface preparation instructions should be thorough, as dust, dirt, static electricity, or undesirable residues can affect the finished print quality. A list of ink manufacturers is given in Appendix 3.

Foamalux and Foamalux Ultra are semi-finished materials, manufactured in a continuous process subject to the manufacturing tolerances appropriate for semi-finished products. When tight tolerances are required, allowances must be made, when ordering, for truing panels to the accuracy required for processing.

APPENDICES

APPENDIX 1
THERMAL MOVEMENT CALCULATIONS

EXAMPLE 1

A Foamalux sheet is to be used to form a sign panel on the outside of a building. It is expected that the panel temperature will be as low as -12°C in winter and as high as 31°C in summer. The panel measures 1.2m wide and 1.5m high in a workshop at a temperature of 18°C. The panel is to be hung from its top edge with a fixed point at the centre, so that thermal movement takes place from the top down and from the centre horizontally to each side. Estimate the clearance required in retaining channels which will frame the bottom and sides of the sheet.

1. Width

Dimension change in cooling from 18°C to -12°C
Temperature change = 30°C
Initial width = 1.2m
Expansion coefficient = 0.068mm/m°C
Reduction in width = 1.2 x 30 x 0.068 = 2.45mm

Dimension change in heating from 18°C to 31°C
Temperature change = 13°C
Initial width = 1.2m
Expansion coefficient = 0.068mm/m°C
Increase in width = 1.2 x 13 x 0.068 = 1.06mm

Total width change = $\delta w = 2.45 + 1.06 = 3.51$mm, say 4mm when rounded up to the nearest mm.

As the sheet is fixed at its centre it will move half of this distance each side of the fixed point, ie. 2mm clearance is required in each side channel.

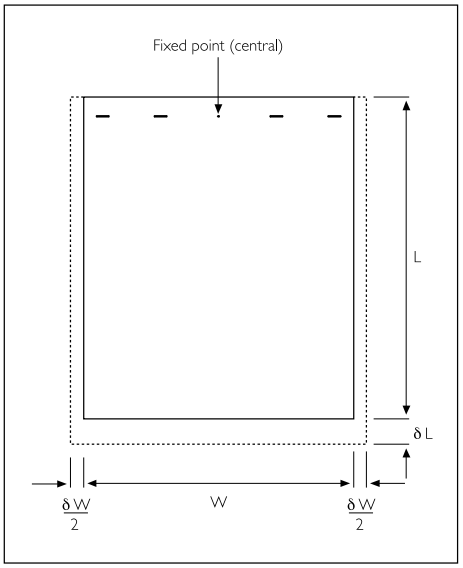
2. Length

Dimension change in cooling from 18°C to -12°C
Temperature change = 30°C
Initial length = 1.5m
Expansion coefficient = 0.068mm/m°C
Reduction in length = 1.5 x 30 x 0.068 = 3.06mm

Dimension change in heating from 18°C to 31°C
Temperature change = 13°C
Initial length = 1.5m
Expansion coefficient = 0.068mm/m°C
Increase in length = 1.5 x 13 x 0.068 = 1.33mm

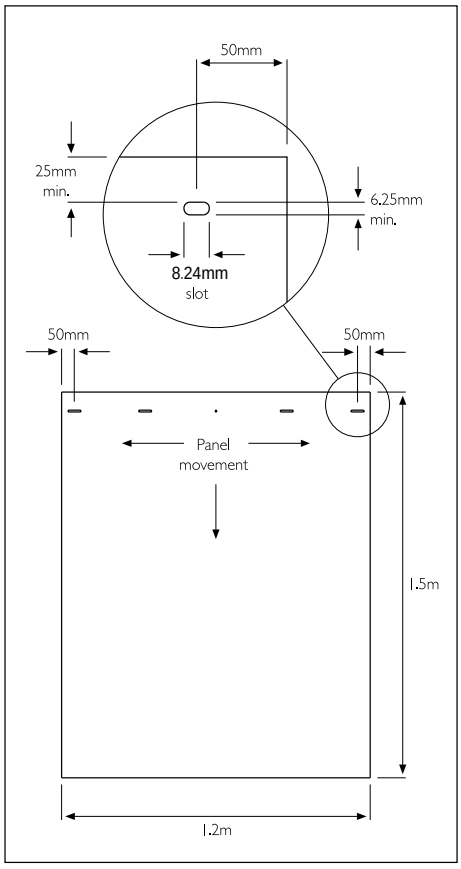
Total length change = $\delta L = 3.06 + 1.33 = 4.39$mm, say 5mm when rounded up to the nearest mm.

As the sheet is fixed at the top it will move vertically 5mm, ie. 5mm clearance is required in bottom channel.



EXAMPLE 2

The Foamalux sheet in the previous example is to be fixed with a row of screws along its top edge, with outer screws 50mm in from sheet sides. Estimate the size of slot required to accommodate thermal movement. The screws have a shank diameter of 6mm.



Sheet width 1.2m
Outer slot separaration =1.2 - (2 x 0.05) = 1.1m
Distance from fixed point to slot centre = 0.55m
This distance contracts as sheet cools from 18°C to -12°C by an amount 0.55 x 30 x 0.068 = 1.12mm
This distance expands as sheet heats up from 18°C to 31°C by an amount 0.55 x 13 x 0.068 = 0.49mm

The fixing must be centred in a slot with a length which can accommodate, at least, the greater amount of thermal movement. In this case, the greater movement is 1.12mm from cooling.

Minimum slot length = fixing shank diameter + (2 x greater thermal movement)
= 6 + (2 x 1.12) = 8.24mm

CHEMICAL RESISTANCE OF FOAMALUX & FOAMALUX ULTRA

KEY:
+ good resistance
- poor resistance

Chemical name	Resistance at 23°C
Acetaldehyde 40%	+
Acetaldehyde 100 %	-
Acetic acid 10%	+
Acetic acid 20%	+
Acetic acid 80%	+
Acetic acid, glacial	+
Acetic anhydride	-
Acetone	-
Adipic acid	+
Allyl alcohol 96%	+
Allyl chloride	-
Alum	+
Aluminium alum	+
Aluminium chloride	+
Aluminium fluoride	+
Aluminium hydroxide	+
Aluminium oxychloride	+
Aluminium nitrate	+
Aluminium sulphate	+
Ammonia gas (dry)	+
Ammonia, liquid	-
Ammonium acetate	+
Ammonium alum	+
Ammonium bifluoride	+
Ammonium carbonate	+
Ammonium chloride	+
Ammonium fluoride 25%	+
Ammonium hydroxide	+
Ammonium metaphosphate	+
Ammonium nitrate	+
Ammonium persulphate	+
Ammonium phosphate	+
Ammonium sulphate	+
Ammonium sulphide	+
Ammonium thiocyanate	+
Amyl acetate	-
Amyl alcohol	+
Amyl chloride	-
Aniline	-
Aniline chlorohydrate	-
Aniline hydrochloride	-
Anthraquinone sulphonic acid	+
Antimony trichloride	+
Aqua regia	+
Aromatic hydrocarbons	-
Arsenic acid 80%	+
Arylsulphonic acid	+
Barium carbonate	+
Barium chloride	+
Barium hydroxide	+
Barium sulphate	+
Barium sulphide	+
Beer	+
Beer sugar liquors	+
Benzaldehyde 10%	+
Benzaldehyde, above 10%	-
Benzene	-
Benzine	+
Benzoic acid	+
Bismuth carbonate	+
Bleach 12% Cl	+
Borax	+
Boric acid	+
Bromic acid	+
Bromine liquid	-
Bromine water	+
Butadiene	+
Butane	+
Butanol normal	+
Butanol iso	+
Butyl acetate	-
Butyl phenol	+
Butyric acid	+
Cadmium cyanide	+
Calcium bisulphite	+
Calcium carbonate	+
Calcium chlorate	+
Calcium chloride	+
Calcium hydroxide	+
Calcium hypochlorite	+
Calcium nitrate	+
Calcium oxide	+
Calcium sulphate	+
Carbon disulphide	-

APPENDIX 2
CHEMICAL RESISTANCE

Carbon dioxide	+	Ethyl acetate	-
Carbon monoxide	+	Ethyl acrylate	-
Carbon tetrachloride	+	Ethyl alcohol	+
Carbonic acid	+	Ethyl chloride	-
Castor oil	+	Ethyl ether	-
Caustic potash	+	Ethylene bromide	-
Caustic soda	+	Ethylene chlorohydrin	-
Chloroacetic acid	+	Ethylene dichloride	-
Chloral hydrate	+	Ethylene glycol	+
Choric acid 20%	+	Ethylene oxide	-
Chlorine (dry)	-	Fatty acids	+
Chlorine (wet)	-	Ferric chloride	+
Chlorine water	+	Ferric hydroxide	+
Chlorobenzene	-	Ferric nitrate	+
Chloroform	-	Ferric sulphate	+
Chlorosulphonic acid	+	Ferrous chloride	+
Chrome alum	+	Fluoboric acid	+
Chromic acid 10%	+	Fluorine gas (wet)	+
Chromic acid 50%	-	Fluorine gas (dry)	+
Citric acid	+	Fluorosillicic acid 25%	+
Copper carbonate	+	Formaldehyde	+
Copper chloride	+	Formic acid	+
Copper cyanide	+	Fructose	+
Copper fluoride	+	Fruit juices and pulp	+
Copper nitrate	+	Furfural	-
Copper sulphate	+	Gallic acid	+
Cottonseed oil	+	Glucose	+
Cresol	+	Glycerine	+
Cresylic acid	-	Glycol	+
Crotonaldehyde	-	Glycolic acid	+
Crude oil	+	Heptane	+
Cupric fluoride	+	Hexane	+
Cupric sulphate	+	Hexanol, tertiary	+
Cuprous chloride	+	Hydrobromic acid 20%	+
Cyclohexanol	-	Hydrochloric acid 10%	+
Cyclohexanone	-	Hydrochloric acid 35%	+
Detergents	+	Hydrocyanide acid	+
Dextrin	+	Hydrofluoric acid 50%	+
Dextrose	+	Hydrogen	+
Diazo salts	+	Hydrogen peroxide 30%	+
Diglycolic acid	+	Hydrogen peroxide 90%	+
Dimethylamine	+	Hydrogen phosphide	+
Dioctyl phthalate	-	Hydrogen sulphide	+
Disodium phosphate	+	Hydroquinone	+
Distilled water	+	Hydroxylamine sulphate	+
Esters	-	Hypochlorous acid	+
Ethers	-	Iodine	-

APPENDIX 2
CHEMICAL RESISTANCE

Kerosene	+	Nicotine acid	+
Ketones	-	Nitric acid, anhydrous	-
Lactic acid 25%	+	Nitric acid 10%	+
Lauric acid	+	Nitric acid 60%	+
Lauryl chloride	+	Nitric acid 68%	+
Lead acetate	+	Nitrobenzene	-
Lead chloride	+	Nitrous oxide	+
Lead sulphate	+	Oils and fats, vegetable	+
Lead tetraethyl	+	Oleic acid	+
Linoleic acid	+	Oleum	-
Linseed oil	+	Oxalic acid	+
Lithium bromide	+	Oxygen	+
Lubricating oil	+	Ozone	+
Machine oil	+	Palmitic acid	+
Magnesium carbonate	+	Paraffin	+
Magnesium chloride	+	Perchloric acid 10%	+
Magnesium citrate	+	Perchloric acid 15%	+
Magnesium hydroxide	+	Perchloric acid 70%	+
Magnesium nitrate	+	Petrol	+
Magnesium sulphate	+	Petrol high octane	+
Maleic acid	+	Phenol	+
Malic acid	+	Phenylhydrazine	-
Mercuric chloride	+	Phenylhydrazine hydrochloride	+
Mercuric cyanide	+	Phosgene gas	+
Mercurous nitrate	+	Phosgene liquid	-
Mercury	+	Phosphoric acid 10%	+
Methyl alcohol	+	Phosphoric acid 85%	+
Methyl bromide	-	Phosphoric acid (yellow)	+
Methyl chloride	-	Phosphorus pentachloride	+
Methyl methacrylate	-	Phosphorus trichloride	-
Methylene chloride	-	Photographic solutions	+
Methyl ethyl ketone	-	Pictic acid	-
Methyl iso butyl ketone	-	Potassium alum	+
Methyl sulphate	+	Potassium bicarbonate	+
Methyl sulphuric acid	+	Potassium bichromate	+
Milk	+	Potassium borate	+
Mineral oils	+	Potassium bromate	+
Molasses	+	Potassium bromide	+
Monochloracetic acid	+	Potassium carbonate	+
Muriatic acid	+	Potassium chromate	+
Naphtha	+	Potassium chlorate	+
Napthalene	-	Potassium chloride	+
Natural gas	+	Potassium cyanide	+
Nickel chloride	+	Potassium dichromate	+
Nickel nitrate	+	Potassium ferricyanide	+
Nickel sulphate	+	Potassium ferrocyanide	+
Nicotine	+	Potassium fluoride	+

APPENDIX 2
CHEMICAL RESISTANCE

Potassium hydroxide	+	Stannous chloride	+
Potassium nitrate	+	Starch	+
Potassium perborate	+	Stearic acid	+
Potassium perchlorate	+	Sulphur	+
Potassium permanganate 10%	+	Sulphur dioxide (dry)	+
Potassium permanganate 25%	+	Sulphur dioxide (wet)	+
Potassium sulphate	+	Sulphur trioxide	+
Propane liquid	+	Sulphuric acid 3%	+
Propane gas	+	Sulphuric acid 70%	+
Propargyl alcohol	+	Sulphuric acid 80%	+
Propyl alcohol	+	Sulphuric acid 85%	-
Propylene dichloride	-	Sulphurous acid	+
Plating solutions	+	Tallow	+
Rochelle salts	+	Tall oil	+
Sea water	+	Tannic acid	+
Selenic acid	+	Tartaric acid	+
Sewage	+	Tetraethyl lead	+
Sillicic acid	+	Tetrahydrofurane	-
Silver cyanide	+	Thionyl chloride	-
Silver nitrate	+	Terpineol	+
Silver plating solution	+	Titanium tetrachloride	-
Silver sulphate	+	Tanning liquors	+
Soaps	+	Toluene	-
Sodium acetate	+	Transformer oil	+
Sodium alum	+	Tributyl phosphate	-
Sodium benzoate	+	Trichlorethylene	-
Sodium bicarbonate	+	Triethanolamine	+
Sodium bisulphate	+	Trimethyl propane	+
Sodium bisulphite	+	Trisodium phosphate	+
Sodium bromide	+	Turpentine	+
Sodium carbonate	+	Urea	+
Sodium chlorate	+	Urine	+
Sodium chloride	+	Water - deionized	+
Sodium cyanide	+	Water - distilled	+
Sodium dichromate	+	Water - demineralized	+
Sodium ferricyanide	+	Water - salt	+
Sodium ferrocyanide	+	Whiskey	+
Sodium fluoride	+	Wines	+
Sodium hydroxide 10%	+	Xylene	-
Sodium hydroxide 50%	+	Yeast	+
Sodium hypochlorite	+	Zinc chloride	+
Sodium nitrate	+	Zinc nitrate	+
Sodium peroxide	+	Zinc sulphate	+
Sodium sulphate	+		
Sodium sulphide	+		
Sodium sulphite	+		
Stannic chloride	+		

ADHESIVES MANUFACTURERS

Loctite (UK) Ltd

Watchmead, Welwyn Garden City
Herts, AL7 1JB

Tel: 01707 358800 Fax: 01707 358900

3M United Kingdom plc

3M House
PO Box 1, Market Place
Bracknell, Berkshire, RG12 1JU

Tel: 01344 858000 Fax: 01344 858278

Stelmax Ltd

21/23 Gloster Road,

Martlesham Heath Industrial Estate
Nr. Ipswich, Suffolk, IP5 7RD

Tel: 01473 622265 Fax: 01473 610651

Dunlop Adhesives Ltd

Chester Road, Birmingham, B35 7AL

Tel: 0121 373 8101 Fax: 0121 384 2826

Bostik Ltd

Ulverscroft Road, Leicester, LE4 6BW

Tel: 0116 2510015 Fax: 0116 2531943

Dow Corning Hansil

Meridian Business Park, Copsi Drive
Coventry, CV5 9RG

Tel: 01676 528000 Fax: 01676 528101

Evode Ltd

Common Road, Stafford, ST16 3EH

Tel: 01785 257755 Fax: 01785 241615

Henkel Chemicals Ltd

Road 5, Winsford Industrial Estate
Winsford, CW7 3QY

Tel: 020 8804 3343 Fax: 020 8443 2777

INK MANUFACTURERS

Gibbons Inks & Coatings

Screen Division, 25 Deer Park Road, Wimbledon

London, SW19 3UE

Tel: 020 8540 8531 Fax: 020 8542 5256

Sericol Ltd

Patricia Way, Pysons Road Industrial Estate
Broadstairs, Kent, CT10 2LE

Tel: 01843 866668 Fax: 01843 872074

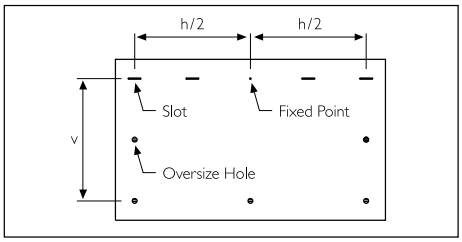
Apollo Colours Ltd

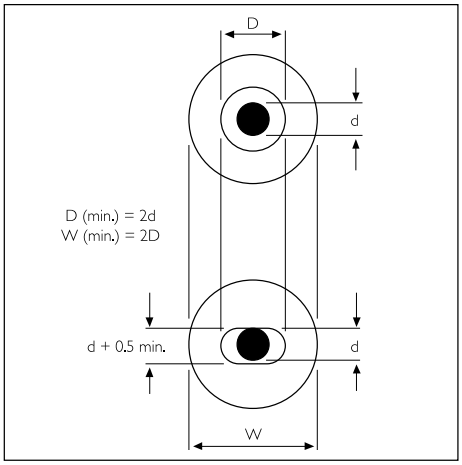
127 Nathan Way, West Tensmead Business Park
London, SE28 0AB

Tel: 020 8854 0017 Fax: 020 8316 6956

HOLE, SLOT & WASHER SIZES

The following table gives minimum hole diameters or slot lengths, 'D' and corresponding washer diameters, 'W', to be used for panel dimension 'v' or 'h', assuming screw diameter 'd' and using a maximum temperature differential of 60° C.





v,h	d = 4 D	W	d = 5 D	W	d = 6 D	W	d = 8 D	W	d = 10 D	W
200	5	10	6	12	7	14	9	18	11	22
400	6	12	7	14	8	16	10	20	12	24
600	7	14	8	16	9	18	11	22	13	26
800	8	16	9	18	10	20	12	24	14	28
1000	9	18	10	20	11	22	13	26	15	30
1200	10	20	11	22	12	24	14	28	16	32
1400	11	22	12	24	13	26	15	30	17	34
1600	12	24	13	26	14	28	16	32	18	36
1800	12	24	13	26	14	28	16	32	18	36
2000	13	26	14	28	15	30	17	34	19	38
2200	14	28	15	30	16	32	18	36	20	40
2400	15	30	16	32	17	34	19	38	21	42
2600	16	32	17	34	18	36	20	40	22	44
2800	17	34	18	36	19	38	21	42	23	46
3000	18	36	19	38	20	40	22	44	24	48

d = fixing shank diameter
D = minimum hole diameter or slot width
W = minimum washer diameter
v = vertical panel dimension
h = horizontal panel dimension

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