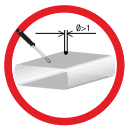
Technical information I Protection classes

Important: We assume no liability for cited standards!
The degree of protection offered by an enclosure is shown by the letters IP (Ingress Protection) and two indexes. The first index indicates two factors (protection for persons and equipment), the second index indicates only one factor (protection against water).

Example: IP 54
- 5 = protection against dust and wire contact with dangerous parts
- 4 = protection against splashing water

acc. to DIN EN 60529; VDE 0470–1 : 2014-09

First index: Protection against contact and foreign objects

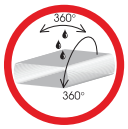
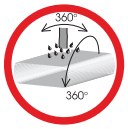
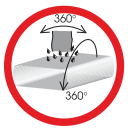
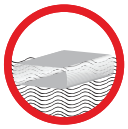
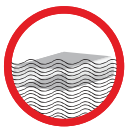
		Protection against contact		Protection against foreign objects	
Symbol	**Index**	**Brief description**	Definition	**Brief description**	Definition
	**0**	Not protected	–	Not protected	–
	**1**	Protection against the back of the hand touching dangerous parts	The object probe, a >50 mm diameter sphere, must be at a sufficient distance from dangerous parts	Protection against a solid foreign object of 50 mm or more in diameter	The object probe, a >50 mm diameter sphere, must not fully penetrate
	**2**	Protection against a finger touching dangerous parts	The test finger, jointsed, >12 mm in diameter and 80 mm long, must be at a sufficient distance from dangerous parts	Protection against a solid foreign object of 12.5 mm or more in diameter	The object probe, a >12.5 mm diameter sphere, must not fully penetrate
	**3**	Protection against a tool touching dangerous parts	The object probe, >2.5 mm in diameter, must not be able to penetrate	Protection against a solid foreign body of 2.5 mm or more in diameter	The object probe, a >2.5 mm diameter sphere, must not penetrate at all
	**4**	Protection against a wire touching dangerous parts	The object probe, >1.0 mm in diameter, must not be able to penetrate	Protection against a solid foreign object of 1.0 mm or more in diameter	The object probe, a >1.0 mm diameter sphere, must not penetrate at all
	**5**	Protection against a wire touching dangerous parts	The object probe, 1.0 mm in diameter, must not be able to penetrate	Protection against dust	Dust penetration is not completely prevented [1]
	**6**	Protection against a wire touching dangerous parts	The object probe, 1.0 mm in diameter, must not be able to penetrate	Dust-tight	No ingress of dust

An enclosure must only be designated with the **first index** (protection against penetration) for a degree of protection when it also meets all lower degrees of protection.
1) Dust must not penetrate in sufficient quantities to prevent the equipment from operating satisfactorily, or to impair safety.

Up to index 6, the **second index** (protection against water) must only be used for a degree of protection for an enclosure if it also meets all lower degrees of protection. However, an enclosure which is only designated with the second index 7, 8 (protection against immersion) or 9K (protection against a jet of steam) is considered to be unsuitable for use with a jet of water (index 5 or 6). This means that it does not need to meet the requirements indicated by indexes 5 or 6. Only an enclosure with a double designation meets the requirements regarding resistance to a jet of water and to immersion/jet of steam.

Important note:
The degrees of protection given for the enclosures refer to unmachined enclosures as supplied. In the case of protection against water in particular (second index), the test conditions will be met if during the given time for the experiment no water has penetrated, or not in harmful quantities.
The protection classifications do not take into account the effects of ageing and thus cannot be guaranteed throughout the lifetime of the enclosure. Additionally, changes in temperature and atmospheric conditions can create loss of pressure in the enclosure, and moisture may be absorbed through the seal area. BOPLA can fit the enclosure with a pressure compensation element for enclosures to be deployed in these environments.

Second index: Protection against water

Symbol	Index	Brief description		Definition
	0	Not protected		–
	1	Protection against falling water drops		Drops of water falling vertically onto the enclosure must not have any harmful effects.
	2	Protection against falling drops of water when the enclosure is tilted at any angle of up to 15°		Drops of water falling vertically onto the enclosure must not have any harmful effects if the enclosure is tilted at any angle of up to 15° on both sides of the vertical.
	3	Protection against spraying water, spray nozzle: 10 l/min; 5 min		Water sprayed onto the enclosure at an angle of up to 60° on both sides of the vertical must not have any harmful effects.
	4	Protection against splashing water, spray nozzle: 10 l/min; 5 min		Water splashed onto the enclosure from any direction must not have any harmful effects.
	5	Protection against water jets, jet nozzle: 12.5 l/min; 3 min		Water projected in jets against the enclosure from any direction must not have any harmful effects.
	6	Protection against powerful water jets, jet nozzle: 100 l/min; 3 min		Water projected in powerful jets against the enclosure from any direction must not have any harmful effects.
	7	Protection against the effects of temporary immersion in water 1 m; 30 min	Test procedures acc. to code numbers 7 and 8 may **NOT** meet the requirements of code numbers 5 and 6.	Water must not enter in a quantity that could have harmful effects if the enclosure is temporarily immersed in water under standardised conditions of pressure and time.
	8	Protection against the effects of continuous immersion in water > IPx7; definition acc. to agreement		Water must not enter in a quantity that could have harmful effects if the enclosure is kept under water.
	9	Protection against high water jet temperatures and high water pressure from a flat jet nozzle		Water directed at high pressure and at high temperatures onto the enclosure from any direction must not have any harmful effects.

Technical Information I Plastics

General information on plastics

The standard material is chosen during the design process, taking into account the data available to us on the usage and pricing. The injection tools are made to suit the material.

Many of our customers use the enclosures under quite different conditions from those we have considered in selecting the material. For this reason, it is frequently necessary to use a special material or a special colour to suit these conditions.

We will willingly meet customers' special requirements, if the technical means are available. In the case of materials that we cannot use for technical reasons, we propose viable alternatives on the basis of your material requirements

Special colours / material for plastic enclosures

In principle, all plastic enclosures can be produced in special colours to meet customers' wishes. However, the following factors need to be taken into consideration:

1) The colour required can only be approximately achieved for production reasons.
2) In choosing the colour, wherever possible only the standard palette published by the raw materials manufacturer should be used, as this will enable subsequent orders to be as close as possible to the original colour. The delivery time and the quantity of the raw material required are ensured within specific limits.
3) Our series production has to be interrupted to set up the necessary mould. The plant has to be thoroughly cleaned of the previous material to ensure that no impurities enter the special colour.
4) The cleaning required before the special colour can be used causes additional material loss.

When we make our products in special colours and/or special materials, the following deviations from our standard products are possible for material and production reasons:

- Standard products are subject to the tolerances according to DIN 16901.
- In the case of special materials, the nominal dimensions change in accordance with the shrinkage difference from the standard material, as do the tolerance groups.
- Deviations in dimensions and shapes from the standard versions are due to differences in shrinkage and shrinkage behaviour.
- Deviations in colour from standard or RAL colour charts occur.
- Other surface properties, such as
  - gloss
  - structures
  - lines of flow or streaks on dark colours
- Increased formation of ridges is possible.
- Colour additives can affect the material properties (combustibility, UV resistance).
- Or others.

General advice for machining plastic enclosures

Milling, drilling
When machining plastic enclosures, the tools must only be cooled with oil-free air. Drilling coolants and separators can cause splitting and tearing.
When using separators containing silicone, subsequent imprinting and lacquering is not possible as the lacquer would not adhere properly.
In case of doubt, please ask us for information.
Our machining service protects you against these risks.

Punching
When plastic parts are punched, corners can tear or break.

Gluing
The quality of a glued joint depends on the materials to be glued, the size of the glued area, and the adhesive used.

The following should be taken into consideration:

1) Only glue the same materials.
2) Glue as large an area as possible.
3) Use suitable glues and follow the technical instructions.
4) Before starting series production, test the adhesion under conditions of use, for example temperature, strain, etc.

Tolerances on plastics according (DIN 16901)

Deviations from the nominal dimensions are unavoidable in the manufacture of plastic mouldings.

There are various reasons for these deviations:

a) Processing parameters. These depend on
- the evenness of the moulding compounds
- the setting of the machine
- the temperature of the tools
- the distortion of the tool under pressure.

The tolerances for this standard have been laid down taking into account these factors and numerous measurements in practice.

The plastics in this standard are divided into tolerance rows. All the plastics used by BOPLA for standard enclosures are in row 130, for which the tolerances given below apply.
The tolerances apply on the basis of the machining shrinkage worked into the tool only for the appropriate enclosure with the standard material stated.

b) The condition of the tool:
- manufacturing tolerances for tool dimensions
- wear on tools
- deviations in the position of movable tool parts.

Nominal measuring range

over	0	1	3	6	10	15	22	30	40	53	70
up to	1	3	6	10	15	22	30	40	53	70	90
A	±0.18	±0.19	±0.20	±0.21	±0.23	±0.25	±0.27	±0.30	±0.34	±0.38	±0.44
B	±0.08	±0.09	±0.10	±0.11	±0.13	±0.15	±0.17	±0.20	±0.24	±0.28	±0.34

over	90	120	160	200	250	315	400	500	630	800	
up to	120	160	200	250	315	400	500	630	800	1000	
A	±0.51	±0.60	±0.70	±0.90	±1.10	±1.30	±1.60	±2.00	±2.50	±3.00	
B	±0.41	±0.50	±0.60	±0.80	±1.00	±1.20	±1.50	±1.90	±2.40	±2.90	

A = Dimensions which are not tool-specific are those formed by the interaction of movable tool parts, e.g. wall thickness, floor thickness or dimensions which are affected by additives or slide bars.

B = Tool-specific dimensions are those in the same part of the tool.

Information on membrane keypad tolerances:
The installation areas for membrane keypads are dimensioned in the catalogue illustrations (Internet) with the tolerances which are present during manufacture. These tolerances are already restricted in comparison with DIN 16901.
As the membrane dimensions are also furnished with manufacturing tolerances, this may result in undesirable crack dimensions (greatest dimension of enclosure and the smallest dimension of membrane). In the case of membrane keypads developed by BOPLA, this is reduced to a minimum.

Technical Information I Plastics

The material properties of plastics

Material properties	Unit	Test specification	PS	ABS	PC	SE1 GFN1	PC/ABS-blend	PA6.6 FR	PA6 FR (NV12)	PA6 GF 15	UP-GF
Impact strength + 20 °C Impact strength - 30 °C	KJ/m^2	ISO 179 DIN 53453	- -	60 40	without breaking	30 30	- -	- -	without breaking	36 -	49 -
Notched impact str. (Charpy) + 20 °C Notched impact str. (Charpy) - 30 °C	KJ/m^2	ISO 179 DIN 53453	7 4	10 4	25 10	- -	- -	- -	3,5 -	55 -	- -
Max. bending stress	N/nm^2	ISO 178 DIN 53452	-	64	> 70	110	-	-	-	-	> 100
Round body pressure stress	°C	ISO 335-1 DIN 0471/2-5	-	75	125	125	125	-	125	-	-
Retention of shape under heat [1] A Retention of shape under heat [1] B	°C	ISO 75 DIN 53461	75 -	80 85	125 135	120 130	120 130	90 215	70 10	150 210	150 -
Thermal conductivity	W/mK	DIN 52612 ASTM C 177	0.17	0.18	0.2	0.23	-	-	-	-	0.6
Glow hot wire test	°C with mm	ISO 695 DIN 0471/2-1	-	650/2	850/1	960/3,2	960/2	-	850/1	-	-
Combustibility	Grade from mm	UL 94	HB/1.47	HB/1.6	V2/1.14	V1/1.47	V0/1.6	V0/1	V2/1.6	HB/1.6	V0/4
Water absorption	%	ISO 62 DIN 53495 ASTM D 570	< 0.1	0.4	0.35	0.22	-	2.2	2.5	2.2	0.7
Surface resistivity	Ohm	IEC 93	$> 10^{13}$	$> 10^{14}$	$> 10^{15}$	$> 10^{15}$	-	$> 10^{15}$	$> 10^{12}$	-	$> 10^{12}$
Special volume resistivity	Ohm x cm	IEC 93 DIN 53482 VDE 303 T3 ASTM 27	$> 10^{16}$	$> 10^{15}$	$> 10^{16}$	$> 10^{15}$	-	$> 10^{15}$	$> 10^{15}$	$> 10^{12}$	$> 10^{13}$
Dielectric strength	KV/mm	IEC 243 DIN EN 53481 VDE 303 T2 ASTM 149	-	-	28	26	-	-	-	-	18

1) The ability of the enclosures to maintain their shape when subject to heat depends on a seal being inserted. The temperature resistance can still be affected by mechanical stress.

All the above data are for guidance only. They have been determined using standardized test pieces and can vary within normal tolerances. The combustibility classification always refers to the raw material, which was tested on ideal test pieces. In the case of manufactured parts, deviations caused by different material thicknesses and the effects of processing are unavoidable.

Technical Information I Plastics

Chemical resistance of plastics

	PS	ABS	PC	PC/ABS-blend	PA	UP-GF Polyester
Acetone	---	---	---	---	+	---
Formic acid	40 %	---	---	---	---	10 %
Ammonia	+	25 %	---	---	10 %	---
Benzene	---	---	o	---	+	---
Brake fluid	Δ	o	---	---	+	+
Butane	---	+	+	+	+	Δ
Butanol	Δ	Δ	Δ	Δ	+	+
Calcium chloride	+	+	+	Δ	10 %	+
Chlorine benzole	---	---	---	---	+	+
Diesel oil	---	+	o	Δ	+	+
Acetic acid	50 %	25 %	10 %	10 %	5 %	10 %
Formaldehyde	40 %	30 %	Δ	Δ	o	30 %
Frigen 113	Δ	---	+	---	+	+
Fruit juice	Δ	Δ	+	Δ	+	+
Glycerine	+	+	o	Δ	+	+
Heating oil	---	o	o	Δ	+	+
Hydraulic oil	Δ	Δ	+	---	+	+
Caustic potash solution	50 %	50 %	---	---	50 %	---
Potassium chloride	+	Δ	+	Δ	10 %	+
Potassium hydroxide	Δ	Δ	Δ	Δ	Δ	---
Linseed oil	+	+	+	+	+	+
Methanol	Δ	Δ	---	Δ	o	---
Methylene chloride	---	---	---	---	o	---
Lactic acid	80 %	80 %	+	+	o	+
Mineral oils	Δ	Δ	+	Δ	+	+
Engine oils	o	+	+	Δ	+	+
Sodium carbonate	+	+	+	Δ	10 %	+
Sodium chloride	+	+	+	+	---	+
Sodium hydroxide	Δ	+	Δ	Δ	Δ	---
Soda lye	50 %	50 %	---	---	+	40 %
Nitric acid	10 %	---	10 %	Δ	---	10 %
Hydrochloric acid	10 %	o	20 %	Δ	---	---
Lubricating oil	Δ	Δ	+	Δ	+	+
Carbon disulphide	---	---	---	---	+	---
Sulphuric acid	50 %	50 %	50 %	50 %	---	---
Soap suds	Δ	Δ	o	Δ	Δ	+
Detergents	Δ	Δ	+	+	Δ	Δ
Turpentine oil	---	Δ	o	Δ	+	+
Hydrocarbon tetrachloride	---	---	Δ	---	+	+
Toluol	---	---	---	---	+	---
Trichloroethylene	---	---	---	---	+	---
Water (distilled, river, tap, sea)	+	+	+	+	+	+
Tartaric acid	+	+	+	+	10 %	+
Xylol	---	---	---	---	+	+
Zinc sulphate	+	+	+	+	Δ	+
Citric acid	+	+	10 %	+	Δ	+

Symbols

+ resistant to all concentrations °C resistant to this max. °C
% resistant to this max. percentage concentration
o resistant under certain conditions
--- not resistant
Δ no information available

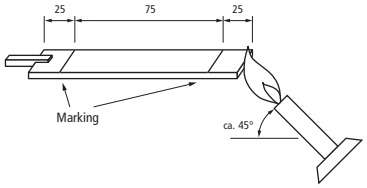
Unless otherwise stated, the tests were carried out at room temperature.
If different media coincide, the resistances may change and consequently we cannot accept any liability for these data.

Technical Information I Plastics

Flame retardance of plastics

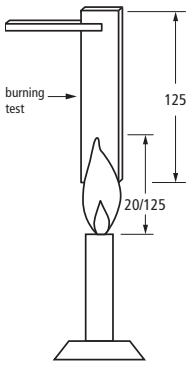
Standard 94 of the Underwriters Laboratories (UL94) is accepted worldwide as the predominant standard for classifying the flame retardance of plastics. The procedure according to UL94 is to test the ability of the material to extinguish itself after flaming. The classification is according to the speed of burning and the extinguishing time, droplet formation, and the duration of afterglow time. Depending on the wall thickness, several classifications are possible for each material. The basis for the appropriate specification of a material should correspond to the thickness of the moulding's main wall. Information on the UL 94 classification is only comparable and meaningful if it specifies the relevant wall thickness.

UL 94 HB
The test specimen is held horizontally and a flame brought up to it. For wall thicknesses up to 3 mm, the rate of combustion must be less than 75 mm/min, and less than 40 mm/min for wall thicknesses of 3 mm and over.



Often misunderstood:
Non-flame-retardant qualities (or materials which are not intended for flame-retardant applications) do not automatically meet horizontal burning criteria. Although the least rigorous, UL 94 HB is a category of flammability and can only be achieved by means of testing.

UL 94 V0, V1 und V2
In this category, test bars with the same dimensions and with a flame height as used for HB tests are tested vertically, but not horizontally. In addition to the burn and glowing combustion time, the decisive factor is whether burning drops form and whether they ignite the cotton wool underneath the test bar, which is only permissible for V2.



UL 94 V2
Test specimen vertical, flame height 20 mm; self-extinguishing up to 30 s after the flame has been removed; burning droplets are permissible; afterglow = max. 60 s.

UL 94 V1
Test specimen vertical, flame height 20 mm; self-extinguishing up to 30 s after the flame has been removed; no burning droplets; afterglow = max. 60 s.

UL 94 V0
Test specimen vertical, flame height 20 mm; self-extinguishing up to 10 s after the flame has been removed; no burning droplets; afterglow = max. 30 s.

UL 94 5V
This burning test is used to determine flammability classes UL 94 5VB and UL 94 5VA. In addition, plastics which meet at least classification V-2 can be tested – in this case, the flame height is 125 mm. The process exposes a vertically-mounted specimen 5 times for a period of 5 seconds with pauses of 5 seconds.
In addition to the test criteria as per UL 94 V, this flammability test also takes into consideration the formation of holes in panels.

	UL 94 5VA	UL 94 5VB
Afterflame time / afterglow time of the test specimens after the 5th flame application [sec]	< 60	< 60
Burning droplets	no	no
Hole formation (in panels)	no	yes

The flammability category always refers to the raw material, tested using ideal test pieces. In the case of manufactured parts, deviations caused by different material thicknesses and the effects of processing are unavoidable.

Material characteristics of seals

Test specifications: DIN 53461	Neoprene CR	Polyurethane PU	EPDM	Silicone Si	Perbuan N NBR	TPE
Permitted temperature range	– 30 to + 90 °C	– 30 to + 100 °C	– 35 to + 120 °C	– 60 to + 200 °C	– 35 to + 100 °C	– 40 to + 70 °C

The chemical resistance of seals

	Neoprene CR	Polyurethena PU	EPDM	Silicone Si	Perbunane N NBR	TPE
Aceton	o	o	+	o	---	---
Formic acid	o	Δ	+	o	Δ	o at 10 %
Ammonia	+	---	+	+	+	+
Benzene	o	+	---	+	o	Δ
Brake fluid	o	Δ	o	+	o	Δ
Butane	Δ	+	---	---	+	Δ
Butanol	+	---	+	Δ	+	Δ
Calcium chloride	Δ	+	+	Δ	+	Δ
Chlorine benzole	---	---	---	---	---	Δ
Diesel oil	o	+	---	o	+	Δ
Acetic acid	75 %	Δ	+	---	---	5 %
Formaldehyde	+	+	+	+	40 %	Δ
Frigen 113	o	Δ	---	Δ	+	Δ
Fruit juice	+	+	+	+	---	+
Glycerine	+	+	+	+	+	+
Heating oil	o	+	---	o	+	Δ
Hydraulic oil	---	+	---	o	o	Δ
Caustic potash solution	+	Δ	+	Δ	o	Δ
Potassium chloride	Δ	Δ	+	+	+	Δ
Potassium hydroxide	+	---	+	o	o	+
Linseed oil	+	+	---	o	+	Δ
Methanol	+	---	+	+	+	Δ
Methylene chloride	---	---	---	---	---	Δ
Lactic acid	+	+	+	Δ	+	o
Mineral oils	o	o	---	+	+	Δ
Engine oils	o	o	---	+	+	Δ
Sodium carbonate	Δ	Δ	+	Δ	+	Δ
Sodium chloride	+	Δ	+	+	+	Δ
Sodium hydroxide	50 %	---	+	o	o	+
Soda lye	50 %	---	+	---	o	50 %
Nitric acid	---	---	10 %	---	---	+
Hydrochloric acid	o	---	+	Δ	---	+
Lubricating oil	o	Δ	---	+	+	Δ
Carbon disulphide	---	o	---	+	---	Δ
Sulphuric acid	50 %	---	20 %	25 %	o	+
Soap suds	---	+	+	+	+	Δ
Detergents	o	+	+	+	+	Δ
Turpentine oil	---	---	---	---	+	Δ
Hydrocarbon tetrachloride	---	---	---	---	---	Δ
Toluol	---	---	---	---	---	Δ
Trichloroethylene	---	---	---	---	---	Δ
Water (distilled, river, tap, sea)	+	+	+	+	+	+
Tartaric acid	o	Δ	+	+	---	Δ
Xylol	---	---	---	---	---	Δ
Zinc sulphate	Δ	Δ	+	+	+	Δ
Citric acid	Δ	Δ	+	+	---	Δ

Symbols
+ resistant to all concentrations °C resistant to this max. °C
% resistant to this max. percentage concentration
o resistant under certain conditions
--- not resistant
Δ no information available

Unless otherwise stated, the tests were carried out at room temperature.
If different media coincide, the resistances may change and consequently we cannot accept any liability for these data.

Technical information I Aluminium

The Euromas and Bocube enclosures have a tongue and groove system; they have a foam rubber gasket that is resistant to oil and benzene and provides protection class IP 66. Special seals can be inserted for special requirements. These are particularly resistant, e.g. to heat and chemicals or will guarantee improved EMC shielding. The standard enclosures are made of Al Si 12 alloy and are low-corrosive. Under the effect of oxygen the aluminium forms a thick firmly-adhering oxide layer on its surface. This is highly resistant to corrosion and protects the metal underneath from further oxidation.
In cases where this natural corrosion protection is not sufficient, special surface treatments can give greater protection against corrosion. These treatments include passivating, lacquering or a combination of passivating and lacquering. This process is especially suitable if corrosion-proofing against sea water is needed. When lacquering an additional prime coat or several final coats, this will ensure greater protection. Standard powder-coating is carried out, independently of the colour chosen on an electrostatic belt. The coating is then annealed in a 45-minute process at a temperature of about 120°C. This gives a permanent hard surface which will not rub off.

Our standard powder-coating processes are:

a) Degreasing
b) Powder-coating
Depth of layer > 50 µm
Base: polyester amino-resin
Pigment: lead, chromate-free
Surface: structured, silicone-free

Our standard lacquering has shown good resistance to chemicals: mineral oils, motor fuels, drilling emulsions, cleaning fluids, weak acids and lyes, weak solvents and weathering. On request, we can also use other lacquers or processes. A different surface structure or gloss can also be obtained.

On principle, always take into consideration that the various aluminium casting processes result in different surface qualities. While die casting gives a smooth, even surface and chill casting results in a slightly grainy surface. This affects special requirements regarding surface quality, e.g. for screen-printing, engraving, etc.

Notes on seawater-resistant version

SBGL: Seawater-resistant primed and lacquered. This version has a special lacquer and the following design:
- Seawater-resistant priming
- 2K - PUR lacquer or as per specification

SWB: This version is powder-coated:
- Polyester powder, silk gloss (fine) / structure (coarser) or as per specification
- Internal parts completely powder-coated

Before being coated to give corrosion protection, these parts are either passivated (Cr(III)-based) or depending on specification and release, yellow-chromated (Cr(VI)-based). These parts also meet the salt spray test according to DIN EN ISO 9227 NSS (1000 hours).

These lacquering processes are only suitable for aluminium parts. Polyester enclosures cannot be supplied in seawater-resistant primed and lacquered (SBGL) or seawater-resistant (SWB) versions because the temperatures needed to burn on the lacquers are too hot for the material.

General advice for machining aluminium enclosures

Please make sure that all residues of any coolants or lubricants used in machining are removed if plastic parts must be attached to aluminium enclosures (e.g. plastic cable glands, adapters, plugs, etc.). Coolants and lubricants can cause plastic parts to become brittle and split. Also, remember that when aluminium castings are machined, enclosed air bubbles, known as shrinkage holes, can be revealed. The casting process and alloys we use result in very few shrinkage holes.

Instructions for machining aluminium enclosures

For reasons of design and stability, we offer aluminium front panels for many of our plastic enclosures. These panels are cut from anodised plate material, so the surfaces have an anodised layer but the cut edges do not.

Please remember that screen-printing or tampon printing on the anodised layer may not always adhere properly. When machining and imprinting front panels to customer specifications, we use aluminium plate material which – depending on the requirements – is only anodised after imprinting. The advantages are that all the edges are corrosion-proof and any imprinting will not rub off.

Technical information I Aluminium

The properties of aluminium alloys

Properties	Units	GD-Al Si 9 CU 3 (diecasting)	GD-Al Si 12 (diecasting)	GK-Al Si12 (chill casting)	Al Mg Si 0,5 (wrought alloy)
Density	g/cm³	2.65	2.65	2.65	2.7
App. yielding point	N/mm²	140	130	80	160
Tensile strength	N/mm²	240	240	170	215
Ductile yield	%	< 1	1	6	12
Brinell hardness	HB	80	60	55	no inform. avail.
Electr. resistivity	m/Ohm mm²	no inform. avail.	17 - 27	17 - 27	28 - 34
Therm. conductivity	W/mK	110 - 120	130 - 160	140 - 170	190 - 210
Heat resistance	°C	200	200	200	200
Cold resistance	°C	–100	–100	–100	–100

The chemical resistance of aluminium

	Reaction	Remarks
Acetone	+	
Formic acid	o	
Ammonia	+	
Benzene	+	
Benzole	o	contains no H_2O = + contains H_2O = o
Drilling oil, cutting oil	+	
Butane	+	
Calcium chloride	+	
Chlorine benzole	+	
Acetic acid	+	
Fat, wax	+	
Formaldehyde	+	free of formic acid
Glycerine	+ ---	contains NaCi = ---
Heating oil	+	
Potassium chloride	o	
Potassium hydroxide	---	
Linseed oil	+	< 250 °C
Methanol	+	
Methylene chloride	+	
Lactic acid	+	
Sodium carbonate	o	

	Reaction	Remarks
Sodium chloride	o	
Sodium hydroxide	+	free of H2 when molten
Petroleum	+	
Propane	+	
Nitric acid	+	
Lubricating oil	+	
Soap suds	+	
Carbon disulphide	+	
Sulphuric acid	o	
Hydrocarbon tetrachloride	+	
Toluol	+	
Trichloroethylene	+	light metal tri
Water vapour	+	
Hydrogen	+	
Xylol	+	
Zinc sulphate	o	
Citric acid	+	

Symbols: + resistant o resistant under certain conditions --- not resistant

Unless otherwise stated, the tests were carried out at room temperature.
If different media coincide, the resistances may change and consequently we cannot accept any liability for these data.

Technical information I Aluminium

Tolerances for pressure die castings (DIN 1688, part 4 : 1986-08)*

Table 1: Tolerances of dimensions not related to the shape, linear dimensions

(lengths, widths, heights, central distances, diameters, roundings)

			Nominal measuring range													
Spatial diagonal area[1]	**Degree of accuracy**	**Shape dependency**	**up to 18**	**over 18 to 30**	**over 30 to 50**	**over 50 to 80**	**over 80 to 120**	**over 120 to 180**	**over 180 to 250**	**over 250 to 315**	**over 315 to 400**	**over 400 to 500**	**over 500 to 630**	**over 630 to 800**	**over 800 to 1000**	**over 1000 to 1250**
up to 180	GTA 13	shape-related	±0.14	±0.17	±0.20	±0.23	±0.27	±0.,32								
		non-shape-related	±0.24	±0.27	±0.30	±0.33	±0.37	±0.42								
over 50 to 500	GTA 13/5	shape-related	±0.17	±0.20	±0.25	±0.30	±0.35	±0.40	±0.45	±0.50	±0.55	±0.60				
		non-shape-related	±0.32	±0.35	±0.40	±0.,45	±0.50	±0.55	±0.60	±0.65	±0.70	±0.75				
over 180	GTA 14	shape-related	±0.22	±0.26	±0.31	±0.37	±0.44	±0.50	±0.60	±0.65	±0.70	±0.80	±0.90	±1.00	±1.20	±1.30
		non-shape-related	±0.42	±0.,46	±0.51	±0.57	±0.64	±0.70	±0.80	±0.85	±0.90	±1.00	±1.10	±1.20	±1.40	±1.50
over 500	GTA 14/5	shape-related	±0.25	±0.35	±0.40	±0.45	±0.55	±0.65	±0.75	±0.80	±0.85	±0.95	±1.10	±1.20	±1.40	±1.60
		non-shape-related	±0.55	±0.65	±0.70	±0.75	±0.85	±0.95	±1.00	±1.10	±1.10	±1.20	±1.40	±1.50	±1.70	±1.90

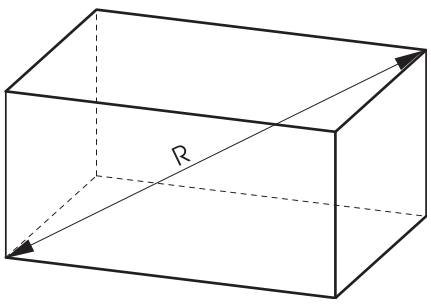
Table 2: Dimensional cast variations for thicknesses

(wall thicknesses, fins, ribs)

			Nominal measuring range		
Spatial diagonal area[1]	**Degree of accuracy**	**Shape depeddency**	**up to 18**	**over 18 to 30**	**over 30 to 50**
up to 180	GTA 13	shape-related	±0.15	±0.20	±0.20
		non-shape-related	±0.25	±0.30	±0.30
over 50 to 500	GTA 13/5	shape-related	±0.20	±0.25	±0.30
		non-shape-related	±0.35	±0.40	±0.45
over 180	GTA 14	shape-related	±0.25	±0.30	±0.35
		non-shape-related	±0.45	±0.50	±0.55
over 500	GTA 14/5	shape-related	±0.30	±0.40	±0.45
		non-shape-related	±0.55	±0.65	±0.70

1) Determining the spatial diagonal:
The spatial diagonal R is determined by the extreme points of the casting. It is calculated from the nominal dimensions of the prismatic body which delimits the casting whatever its shape.

$R = \sqrt{l^2 + b^2 + h^2}$ (spatial diagonal)



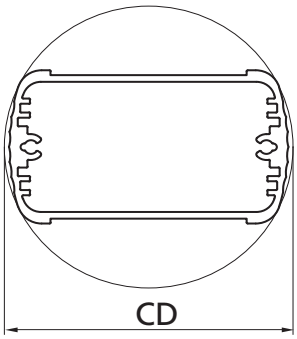
Shape-related dimensions are those in the same parts of the tool. Non-shape-related dimensions are those created by the interaction of movable tool components, e.g. wall thicknesses, base thicknesses and dimensions affected by additives or slides.

*** Important: We assume no liability for cited standards!**

Technical information I Aluminium

Tolerances for aluminium profiles (DIN EN 12020-2 : 2001-07)*

Cross-section dimensions
General information



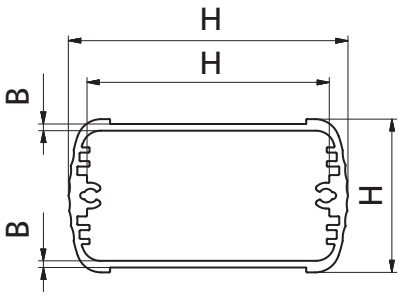
The limit deviations of the following dimensions are specified in the corresponding tables 1 and 2.

- A: Wall thicknesses, except for those which enclose the hollow spaces in hollow profiles
- B: Wall thicknesses which enclose the hollow spaces in hollow profiles, except for wall thicknesses between two hollow spaces
- H: All dimensions except for wall thickness
- CD: Circumscribing circle

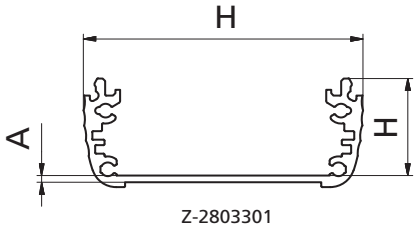
Limit deviations for dimensions other than wall thickness
Table 1 – Limit deviations for cross-section dimensions

Dimension H		Limit deviations for H
over	up to	
–	10	±0.15
10	15	±0.20
15	30	±0.25
30	45	±0.30
45	60	±0.40
60	90	±0.45
90	120	±0.60
120	150	±0.80
150	180	±1.0
180	240	±1.2
240	300	±1.5

Hollow profile



Solid profile



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Limit deviations of wall thicknesses of solid and hollow profile
Table 2 – Limit deviations of the wall thicknesses

Nominal wall thickness A and B		Limit deviations for			
		Wall thickness A (Circumscribing circle)		Wall thickness B (Circumscribing circle)	
over	up to	CD ≤ 100	100 < CD ≤ 300	CD ≤ 100	100 < CD ≤ 300
–	1.5	±0.15	±0.20	±0.20	±0.30
1.5	3	±0.15	±0.25	±0.25	±0.40
3	6	±0.20	±0.30	±0.40	±0.60
6	10	±0.25	±0.35	±0.60	±0.80

*** Important: We assume no liability for cited standards!**

All dimensions in mm.

Overview of standards I defined standards in the 19″ sector

As a company which operates internationally in the field of enclosures and a major partner to the electronics markets, we always do our best to offer our products in a standard which applies worldwide.
For the 19″ sector in particular, this means that internationally valid standards are required which define dimensions depending on the model and the possibility of physical integration. In addition our criteria for electrical compatibility, shock and vibration resistance are defined most precisely in individual standards to ensure reliability worldwide.

Depending on the model, the following standards apply to our products:

Internal and external dimensions correspond	**Refers to product group**
IEC 60297-3-101 (DIN EN 60297-3-101) / IEEE 1101.1 (subracks and plug-in units)	Intertego (in part sections), Internorm Stil, Interzoll Plus, Internorm (for fitting 19″ plug-in units), Interzoll Modul, Interzoll, part front and plug-in front panels, extractor handles (HGS), frame-type plug-in units
IEC 60297-3-102 (DIN EN 60297-3-102) / IEEE 1101.10/11 (injector/extractor handles)	Internorm Stil, Interzoll Modul, extractor handles (HGS)
IEC 60297-3-103 (DIN EN 60297-3-103) (coding and alignment pin)	Interzoll Modul, extractor handles (HGS)
Earth conductor connections correspond	**Refers to product group**
DIN EN 50178 / VDE 0160	Internorm Stil
DIN EN 60950 Teil 1 / VDE 0805 Part 1	Internorm Stil
DIN EN 61010-1 / VDE 0411 Part 1	Internorm Stil
EMV test acc. to	**Refers to product group**
VG 95373 part 15	Intertego, Internorm Stil
IEC 61587-3	Interzoll Modul
Shock and vibration test acc. to	**Refers to product group**
IEC 61587-2	Interzoll Modul
BN 411002	Interzoll Modul, Interzoll
BN 411003	Interzoll Modul
EN 50155	Interzoll Modul
For direct screw-type connectors acc. to:	**Refers to product group**
IEC 60603-2 (DIN EN 60603-2, formerly: DIN 41612)	Internorm Stil, Interzoll Plus, Interzoll Modul, Interzoll, Intertego, CombiCard 1000-7000
For plug-in units acc. to:	**Refers to product group**
IEC 60297-3-101 (DIN EN 60297-3-101)	Internorm Stil, Interzoll Plus, Interzoll Modul, extractor handles (HGS), plug-in front panels, frame-type plug-in units, Interzoll, Intertego, Combi-Card 1000-7000
For plug-in units with insertion and extraction function acc. to:	**Refers to product group**
IEC 60297-3-102 (DIN EN 60297-3-102) / IEEE 1101.10/11	Internorm Stil, Interzoll Modul, extractor handles (HGS)
Protection class acc. to	**Refers to product group**
DIN EN 60529; VDE 0470-1	Internorm Stil (IP 20), Internorm (IP 54), Interzoll Modul (IP 20), Interzoll (IP 20), Interzoll Plus (IP 20), Intertego (IP 40 / 20 – with ventilation)

Electro-magnetic compatibility

European EMC directive 2004/108/EC was developed within the framework of the standardization of national regulations and has been in force since 20th July 2007. This makes it necessary to submit to EMC tests not only radio equipment but also all electrical and electronic equipment, plants and systems. The purpose of this test is to obtain the awarding of the CE mark which is the pre-condition for the operation of all electrical equipment.

If electro-magnetic compatibility cannot be achieved by means of EMC compatible circuit design and/or metallic internal encapsulation, appropriate measures can be taken in respect of the enclosure. For the choice of an enclosure, this means that an electrical component with EMC can be used in any desired enclosure in 90% of cases without any further work or costs.
To achieve shielding, there is no need to sacrifice the essential advantages of plastic enclosures:

- an attractive design
- considerable price savings
- much lighter and more variable

Shielding with plastic enclosures

Plastic enclosures can also be screened effectively without losing the advantages of plastic. Shielding is also achieved by adding a metal coating inside or outside the enclosure.

We prefer to use copper conductive lacquer for reasons of cost and time. In view of the regulations relating to the disposal of electrical scrap, these costs now have to be taken into consideration when calculations are made. Please note that we are unable to take back enclosures which have been specially coated at the customer's request. The aluminium vapour-blasting process is performed in high-vacuum plants. We use a coating of at least 2.5 µm as standard. However, greater thicknesses are possible at any time depending on the enclosure material.

The mechanical properties of the plastic are not altered by the vapourblasting, so no brittleness or tears will result. The new type of copperchrome-nickel coating (CU/Ni/Cr) gives the modular and fully-insulated enclosures an increased level of EMC protection. Coating masks are now available for most of our standard enclosures so that these can be screened at very low cost.
In all cases where the procedures described above are not sufficient to provide shielding, the use of contact seals may increase the shielding efficiency. We can recommend or specify these special seals and then deliver them on the basis of customer-specific requirements as well as the type of enclosure used.

Another effective screening measure is to provide an inner metal cap for components, component groups or the entire electronics, if these parts are highly sensitive to radiation interference. This capping can also intensify the screening measures described above.

To complete EMC measures, for cable insertion we supply the appropriate plastic or metal cable glands with the possibility of connecting the cable screening to the enclosure earthing connection. If you require information on the damping values for various BOPLA enclosures with the appropriate screening, please ask for our specific EMC information.

Shielding in the case of aluminium enclosures

Under certain circumstances, the material used for aluminium enclosures may provide some EMC reduction. However, the joints (tongue and groove) need to be fitted with the appropriate conductive seals for optimal EMC applications. Please also note that the lacquer coatings must be bridged. This can be done with the appropriate conductive seals or by removing the lacquer coatings. The amount of work involved must be made clear when the requirements are specified. If necessary, we will give you the addresses of competent contact persons and institutes who will help you with EMC problems. They will carry out the necessary tests and measurements for you and can issue certificates.