Rubber Tolerances ISO 3302-1 (BS3734) - Second edition 2014

Like all production parts rubber components are produced within industry accepted tolerances levels to compensate for variations from batch to batch of rubber.

Rubber component tolerances are covered by standard ISO3302-1 and ISO3302-2 which is what we work to. Within these there are generally 3 tolerance levels, from “High Quality” or “Precision” to “Good Quality” to “Non-Critical”. Wherever possible we will aim to exceed level the highest level but unless agreed independently in writing will be working to the “Good Quality, Non-Critical”.

EMI has a very good reputation for holding tight rubber extrusion tolerances and producing complex profiles. If you have a specific requirement, please speak to us first and we will try and work with you to manufacture the product you need.

Rubber-Tolerances for products-

ISO 3302 Part 1: Dimensional tolerances

ISO 3302 Part 2: Geometrical tolerances

Introduction

Rubber products are subject to changes in their dimensions after processing and vulcanisation. This may be due to a variety of factors, such as mould shrinkage or relaxation of die swell.

These changes should be determined and allowed for when designing such items as moulds and dies used in the manufacture of a given product.

The closer tolerance classes outlined in this specification should not be demanded unless required by the final application and should be restricted to those dimensions deemed to be critical. The greater the degree of accuracy demanded, the closer the control which must be exercised during manufacture, and hence the higher the costs.

When particular physical properties are required in the product, it may not always be possible to provide them in a mix which is capable of fabrication to close tolerances. It is advisable, in these circumstances, that consultation should take place between the interested parties. In general, softer vulcanisates (i.e. those of hardness below 50 IRHD -see ISO 48) need greater tolerances than harder ones.

Rubber -Tolerances for products –

Part 1: Dimensional tolerances

1 Scope

This part of ISO 3302 specifies classes of dimensional tolerances and their values for moulded, extruded, and calendared solid rubber products. The relevant test methods necessary for the establishment of compliance with this part of ISO 3302 are also specified. The tolerances are primarily intended for use with vulcanized rubber but can also be suitable for products made of thermoplastic rubbers.

This part of ISO 3302 does not apply to precision toroidal sealing rings or to calendared composite products such as rubber-coated fabrics or products where a rubber coating is applied by the process of topping or skim coating.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3, Preferred numbers — Series of preferred numbers

ISO 48, Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and100 IRHD)

ISO 2230, Rubber products — Guidelines for storage

ISO 23529, Rubber — General procedures for preparing and conditioning test pieces for physical test methods

3 Measurement of dimensions

3.1 General

For solid products, measurements of dimensions shall not be made until 16 h have elapsed after vulcanization, this minimum time is being extended to 72 h in cases of dispute. Measurements shall be completed within 3 months after the date of despatch to the purchaser or before the product is put into use, whichever is the shorter time. Measurements shall be made at standard temperature, after conditioning, in accordance with ISO 23529. Care shall be taken to ensure that the products are not subjected to adverse storage conditions in accordance with ISO 2230, and that they are not distorted during measurement.

3.2 Test instruments

3.2.1 Depending on the circumstances, measurements shall be made using one or more of the following types of instrument.

3.2.1.1 For solid products, a **micrometre dial gauge**, the foot of which shall exert a pressure of22 kPa ± 5 kPa for rubber of hardness equal to or greater than 35 IRHD or of 10 kPa ± 2 kPa for rubber of hardness less than 35 IRHD as specified in ISO 23529 and ISO 48.

3.2.1.2 A **suitable optical measuring instrument.**

3.2.1.3 Fixed gauges, for upper and lower limits appropriate to the dimensions being measured.

3.2.1.4 Other devices, including tape measures (with or without vernier), sliding calipers, and micrometre calipers.

3.2.2 All instruments shall be capable of measuring the dimension with an error within the tolerances specified.
3.2.3 In all measurements intended to be comparative, the same measuring device shall be used.

4 Tolerances

For the purposes of this part of ISO 3302, nominal dimensions and tolerances are based on the R 5 andR 10 series of preferred numbers, respectively, in accordance with ISO 3.

The dimensions of certain parameters of a particular product may not all require the application of the same class of tolerance. Dimensions of different parameters of the product on the same drawing can have different class tolerances applied to them. When drawings do not indicate a class tolerance, the largest tolerance given in the related table shall be applied.

NOTE 1 Tolerances that are specified in this part of ISO 3302 in terms of a positive value and an equal negative value (e.g. ± 0,35) can also be expressed in terms of unequal positive and negative values, providing the difference between the two values remains the same. For example, ± 0,35 may also be expressed as +02/-05, or +0.7/-0.0 or +0.0/−070, etc.

NOTE 2 Special consideration of tolerances will be necessary for a vulcanizate with a low hardness and a high tensile strength (e.g. natural rubber gum vulcanizate)

5 Mouldings

5.1 General

The dimensional tolerances stated in this part of ISO 3302 may be wider than those used in some other engineering practice.

The following considerations apply.

a) All rubber shows some shrinkage when cooled after moulding, and for this is made in the mould design. The amount of shrinkage is dependent on the rubber type and the mix used, but also varies from batch to batch of the same mix. Products made from some silicone rubbers, Fluorocarbon elastomers, and other special-purpose elastomers are subject to larger shrinkages; therefore, tolerance classes M1 and M2 (see 5.2) are very difficult to obtain with these rubbers.

b) Non-rubber parts bonded to the rubber will affect the shrinkage and, therefore, the practicable tolerances.

c) Moulds are made in various ways depending on the type of product and accuracy demanded. In general, product can be no more accurate than the mould, and the greater the degree of accuracy demanded, the more expensive the moulds and their maintenance become.

d) Care shall be taken in applying the standard tolerances to products having wide sectional variations.

e) In cases where the rubber product is unavoidably distorted during removal from the mould, the dimensions of the products can be affected, and special allowance might be needed.

5.2 Classification

This subclause establishes four classes of tolerance for fixed and closure dimensions (see 5.3) for products moulded in solid rubber.

a) Class M1 for precision mouldings. Such mouldings require precision moulds, fewer cavities per mould, close mix controls, etc., which results in high cost. Optical comparators or other, similar, measuring devices might be required to minimize distortion of the rubber by the measuring instrument. This type of part requires expensive control and inspection procedures.

b) Class M2 for high-quality mouldings involving much of the close control required for class M1.

c) Class M3 for good-quality mouldings.

d) Class M4 for mouldings where dimensional control is non-critical. A classification system for flash is given in 5.5.

5.3 Fixed dimensions and closure dimensions

In moulding a rubber product, more rubber is used than is required to fill the cavity, and the excess is flashed. This flash tends to prevent the mould sections from fully closing and, thus, affects the finished part dimensions.

NOTE For products moulded by transfer or injection, it is possible to regard all dimensions as fixed.

Two sets of tolerances, F and C, are given and are defined below.

5.3.1 Fixed dimensions (F): Dimensions which are not affected by deforming influences like flash thickness or lateral displacement of different mould parts (upper and lower parts or cores). See Figure 1, dimensions l1, l2, and l3.

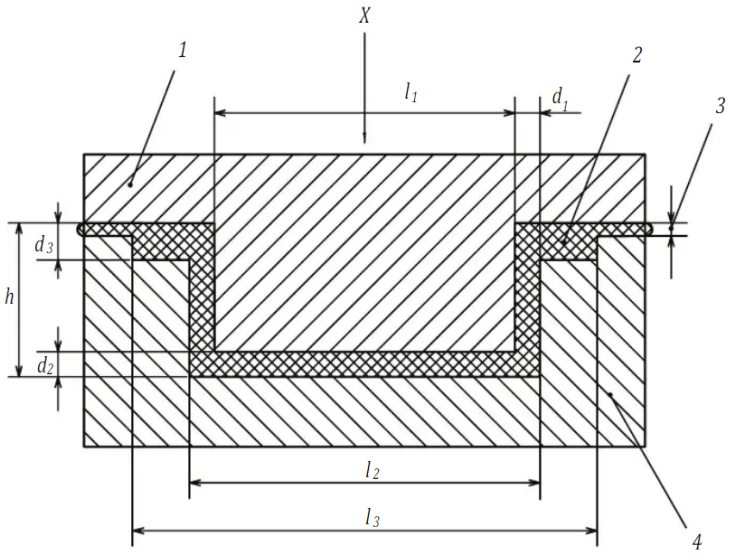
5.3.2 Closure dimensions (C): Dimensions which can be altered by variation in the ☐ash thickness or lateral displacement of different mould parts. See Figure 1, dimensions d1, d2, d3, & h.

NOTE The dimensions for F and C can only be tolerance insofar as they are independent of each other.

5.4 Tolerances

The tolerances to be applied shall be chosen, by agreement between the interested parties, from the classes of tolerance described in 5.2.

Standard tolerances are given in **table 1**. Fixed tolerances (F) are related by size to each dimension. but all closure tolerances (C) are determined by the largest closure dimension (*h*, see figure 1).



Key
X direction of pressure
1 upper half of mould
2 moulded part
3 flash
4 lower half of mould

Figure 1 — Compression mould and moulded part (diagrammatic)

Table 1 -Tolerances for mouldings

Values in millimeters (unless indicated otherwise)

Nominal dimension		Class M1		Class M2		Class M3		Class M4
above	up to and including	F ±	C ±	F ±	C ±	F ±	C ±	F and C ±
0.00	4,00	0,08	0,10	0,10	0,15	0.25	0.40	0.50
4,00	6,30	0,10	0,12	0,15	0,20			
6,30	10.00	0,10	0,15	0,20	0.20	0.30	0.50	0.70
10.00	16.00	0,15	0,20	0,20	0,25	0.40	0,60	0,80
16.00	25.00	0,20	0,20	0,25	0,35	0,50	0,80	1,00
25.00	40.00	0,20	0,25	0,35	0,40	0,60	1,00	1,30
40.00	63.00	0,25	0,35	0.40	0,50	0,80	1,30	1,60
63.00	100.00	0,35	0.40	0,50	0,70	1,00	1,60	2,0
100.00	160.00	0.40	0,50	0,70	0,80	1,30	2,0	2,5
160.00	----	0,3%	0.00	0,5%	0,7%	0,8%	1,3%	1,5%

5.5 Flash

This sub-clause establishes six classes of flash, as listed in Table 2.

Table 2 — Classes of flash

Class	Maximum height of flash mm	Description
X0	0.00	No Flash *
X1	0.10	Precision Flash
X2	0.50	Accurate Flash
X3	1.00	Normal Flash
X4	2.00	Rough Flash
X5	No Limit	Non-Critical
* Class X0 can only apply to those surfaces of an article which do not have parting lines.		

6 Extrusions

6.1 General

Extruded rubber products require greater tolerances in manufacture than those produced by moulding since the rubber undergoes die swell and, during subsequent vulcanisation, shrinkage and deformation usually occur.

Deformation can be reduced by the use of supports during vulcanisation, the nature of the support depending on the section being produced, and the degree of control required. Such features determine the class of tolerance applicable to given dimensions.

In the case of certain synthetic rubbers, extrusion class E1 tolerances are not directly obtainable.

6.2 Classification

This subclause establishes 11 classes of tolerance for extrusions in solid rubber, related to particular ranges of dimensions, namely:

a) Three classes of tolerance on nominal cross-sectional dimensions of unsupported extrusions:

E1	high quality;
E2	good quality;
E3	non-critical.

b) Three classes of tolerance on nominal cross-sectional dimensions of mandrel-supported extrusions:

EN1	precision;
EN2	high quality;
EN3	good quality.

c) Two classes of tolerance (EG) on outside dimensions (nominal diameters) of surface-ground extrusions (tubing) together with two classes of tolerance (EW) on wall thickness of these extrusions:

EG1 and EW1	precision;
EG2 and EW2	good quality.

d) Three classes of tolerance (L) for the cut length of extrusions, and three classes of tolerance (EC) on the thickness of cut sections of extrusions:

L1 and EC1	precision:
L2 and EC2	good quality;
L3 and EC3	non-critical.

6.3 Tolerances

6.3.1 General

The tolerances to be applied shall be chosen, by agreement between the interested parties, from the classes of tolerance described in 6.2.

Standard tolerances are given in tables 3 to 8.

In any extruded cross-section, the dimensions of only two of the three variables (i.e. inside dimensions, outside dimensions and wall thickness) can be tolerance to control the dimensions of the cross-section.

6.3.2 Unsupported extrusions

The tolerances on the cross-sectional dimensions of unsupported extrusions are given in table 3.

For hollow extrusions or extrusions having a complex section, a certain amount of collapse may occur during vulcanisation. It is possible to limit or prevent this collapse by putting the extrusions on mandrels or on formers. The amount of the permitted deformation of the section shall be stated by the purchaser.

Table 3 -Tolerances on cross-sectional dimensions of unsupported extrusions

Values in millimeter's

Nominal dimension		Class E1	Class E2	Class E3
Above	Up to and including	±	±	±
0.00	1.50	0,15	0,25	0.40
1,5	2,5	0,20	0,35	0,50
2,5	4,0	0,25	0.40	0,70
4,0	6,3	0,35	0,50	0,80
6,3	10.00	0.40	0,70	1,00
10.00	16.00	0,50	0,80	1,30
16.00	25.00	0,70	1,00	1,60
25.00	40.00	0,80	1,30	2,00
40.00	63.00	1,00	1,60	2,50
63.00	100.00	1,30	2,00	3,20
100	-	1,3%	2%	3,2

6.3.3 Mandrel-supported extrusions

Vulcanisation of hollow extrusions may be carried out on mandrels to achieve closer tolerances on internal dimensions than can be obtained without support. This can apply to tubing from which rings or washers are subsequently cut. Shrinkage usually occurs when the product is removed from the mandrel, so that the resulting size of the mandrel supported dimension is smaller than the mandrel size. The dimension may, however, be larger should the positive tolerance for the mandrel exceed the shrinkage of the extrudate, and in this case both positive and negative tolerances will need to be applied.

The tolerances on internal dimensions of mandrel supported extrusions are given in table 4. The positive tolerance is intended to cater for any tolerances that may apply to the mandrel itself and for this reason no change of tolerance in either direction is permitted for the internal dimension; the negative tolerances specified in table 4 shall not be increased.

Table 4 -Tolerances on internal dimensions of mandrel-supported extrusions

Values in millimeter's (unless indicated otherwise)

Nominal dimension		Class EN1	Class EN2	Class EN3
Above	Up to and including	±	±	±
0.00	4.00	0,20	0,20	0,35
4.00	6,3	0,20	0,25	0.40
6,3	10.00	0,25	0,35	0,50
10.00	16.00	0,35	0,40	0,70
16.00	25.00	0.40	0,50	0,80
25.00	40.00	0,50	0,70	1,00
40.00	63.00	0,70	0.80	1,30
63.00	100.00	0,80	1,00	1,60
100.00	160.00	1,00	1,30	2,00
160.00	-	0,6%	0,8%	1,2%

6.3.4 Surface-ground extrusions.

6.3.4.1 The tolerances on the outside dimensions (usually diameter) of surface-ground extrusions (normally tubing) are given in table 5.

NOTE 5 These tolerances are also applicable to rings cut from surface-ground tubing.

Table 5 -Tolerances on outside dimensions of surface-ground extrusions

Values in millimeter's (unless indicated otherwise)

Nominal dimension		Class EG1	Class EG2
Above	Up to and including	±	±
0.00	10.00	0,15	0,25
10.00	16.00	0,20	0,35
16.00	25.00	0,20	0.40
25.00	40.00	0,25	0,50
40.00	63.00	0,35	0,70
63.00	100.00	0.40	0,80
100.00	160.00	0,50	1,00
160.00	-	0,3 %	0,5 %

6.3.4.2 The tolerances on the wall thickness of surface-ground extrusions (normally tubing) are given in table 6.

Table 6 -Tolerances on wall thickness of surface-ground extrusions

Values in millimeter's

Nominal dimension		Class EW1	Class EW2
Above	Up to and including	±	±
0.00	4.00	0.10	0.20
4.00	6,3	0,15	0,20
6,3	10.00	0,20	0,25
10.00	16.00	0,20	0,35
16.00	25.00	0,25	0.40

6.3.5 Cut lengths

The tolerances on the cut length of extrusions are given in table 7.

Table 7 - Tolerances on cut length of extrusions

Values in millimeter's (unless indicated otherwise)

Nominal dimension		Class E1	Class E2	Class E3
Above	Up to and including	±	±	±
0	40	0.7	1,0	1,6
40	63	0,8	1,3	2,0
63	100	1,0	1,6	2,5
100	160	1,3	2,0	3,2
160	250	1,6	2,5	4,0
250	400	2,0	3,2	5,0
400	630	2,5	4,0	6,3
630	1,000	3,2	5,0	10,0
1,000	1,600	4,0	6,3	12,5
1,600	2,500	5,0	10,0	16,0
2,500	4,000	6,3	12,5	20,0
4,000	--	0.16%	0.32%	0.50%

6.3.6 Cut sections

The tolerances on the thickness of cut sections (for example rings, washers, discs) are given in table 8.

NOTE 6 Tolerance classes EC1 and EC2 can be obtained only for lathe-cut sections.

Table 8 - Tolerances on thickness of cut sections of extrusions

Values in millimeter's

Nominal dimension		Class EC1	Class EC2	Class EC3
Above	Up to and including	±	±	±
0,63	1,00	0,10	0,15	0,20
1,00	1,60	0,10	0,20	0,25
1,60	2,50	0,15	0,20	0,35
2,50	4,00	0,20	0,25	0.40
4,00	6,30	0,20	0,35	0,50
6,30	10	0,25	0.40	0,70
10	16	0,35	0,50	0,80
16	25	0.40	0,70	1,00

7 Calendered sheet

7.1 General

For calendered sheet, considerations and limitations similar to those for extruded rubber products apply, particularly with regard to swelling of the rubber on passage between calender rolls and to any deformation before and during vulcanisation.

The tolerance chosen will also depend on the surface finish of the sheeting. Larger thickness tolerances are required with cloth-finished sheet than with smooth or press-finished sheet.

7.2 Classification

This sub-clause establishes six classes of tolerance for calendered sheet of solid rubber, related to particular ranges of dimensions, namely:

a) Three classes of tolerance on nominal thickness:

ST1 precision;

ST2 high quality;

ST3 good quality.

b) Three classes of tolerance on nominal width:

SW1 high quality;

SW2 good quality;

SW3 non-critical.

7.3 Tolerances

The tolerances to be applied shall be chosen, by agreement between the interested parties, from the classes of tolerance described in 7.2.

Standard tolerances are given in tables 9 and 10.

Table 9 - Tolerances on thickness of calendared sheet

Dimensions in millimeter's (unless indicated otherwise)

Nominal dimension		Class ST1	Class ST2	Class ST3
Above	Up to and including	±	±	±
0	1,00	0,15	0,2	0,25
1,00	1,60	0,15	0,25	0,35
1,60	2,50	0,2	0,35	0,4
2,50	4,00	0,25	0.4	0,5
4,00	6,30	0,35	0,5	0,7
6,30	10	0.4	0,7	0,8
10	16	0,5	0,8	1,0
16	-	3,5%	5 %	7%

Table 10-Tolerances on width of calendered sheet

Dimensions in millimeter's (unless indicated otherwise)

Nominal dimension		Class ST1	Class ST2	Class ST3
Above	Up to and including	±	±	±
630	1,000	20	25	30
1,000	1,600	30	40	50
1,600	-	2.0%	2.5%	3.0%

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