# TOYOTA ENGINEERING STANDARD

NO. : TSZ2205G

TITLE : SYSTEM OF DIMENSIONAL TOLERANCES FOR PLASTIC PARTS

CLASS : C2

Established/Revised : Rev.5(Nov.2005)

This standard has been revised in consequence of the modification of terms and explanations in part.

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# SYSTEM OF DIMENSIONAL TOLERANCES FOR PLASTIC PARTS

## 1. Scope

This standard covers the system of dimensional tolerances for finished parts of the thermosetting plastics and thermoplastics compounds produced by compression molding or injection molding. This standard applies to general dimensional tolerances as collectively specified on drawings. It is also applicable to individual dimensional tolerances directly indicated after a specific dimension. Note that those directly indicated dimensional tolerances may preferably be selected from the numerical values specified for tolerance classes established. The standard is also applicable to parts produced by extrusion molding, blow molding, foam molding, sintering and cutting.

Remark:
Dimensions and dimensional tolerances control only the actual dimensions of features, as set forth in TSZ2001G, but not its form deviations. Unless otherwise specified, requirements on dimensional and form tolerances shall be treated independently.

## 2. Definitions

Definitions of terms referred to in this standard shall be as follows or as defined in TSZ2300G.

(1) Finished dimensions
Finished dimensions are the dimensions of a finished part specified in drawings or associated documents, when the part satisfies the standard environmental conditions set forth in Section 3. For parts requiring post-molding treatment (plating, hot stamping, vacuum metallizing, painting, etc.), "finished dimensions" refers to the dimensions of post-treatment parts.

(2) Dimensions directly related to mold forms
Dimensions directly related to mold forms are the dimensions of a feature defined by the dimensions of the mold (dimension "*a*" in Fig. 1).

(3) Dimensions not directly related to mold forms
Dimensions not directly related to mold forms are the dimensions of a feature whose form is defined by components of a mold. Examples are the thickness of the bottom and wall of a unit (dimension "*c*" in Fig. 1), and such dimensions which are affected by inserts, moving slides and cores (dimension "*b*" in Fig. 1).

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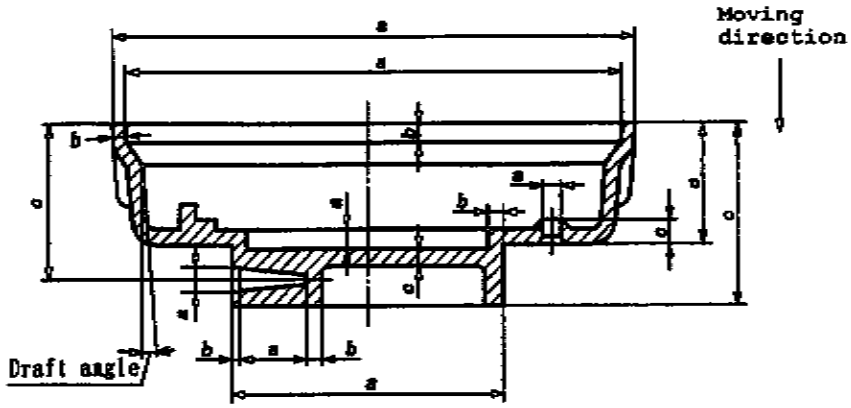


**Explanatory notes:**
**a: Dimensions directly related to mold forms**
**b: Dimensions not directly related to mold forms**
**c: Dimensions not directly related to mold (holding mold) forms in moving direction**

Fig. 1 Dimensions of Plastic Parts

(4) Contraction factor

The contraction factor, $K$, shall be calculated by using the equation (1). The contraction factor shall be as indicated in Table 1.

$$K = A + |A - B| \quad \text{----- (1)}$$

where,
$A$: contraction along the derection of flow in %
$B$: contraction across the direction of flow in %

Table 1 Contraction Factors

| Contraction factor (calculation) | Contraction factor (indication) |
|---|---|
| $0 \leqq K \leqq 1$ | 0 - 1 |
| $1 < K \leqq 2$ | 1 - 2 |
| $2 < K \leqq 3$ | 2 - 3 |
| $3 < K \leqq 4$ | 3 - 4 |

(5) Dimensional tolerance groups

The dimensional tolerance groups indicate the ratios determined by materials, contraction factors and tolerance levels.

(6) Form defect propensity

The form defect propensity indicates the relative trend of a molded part to deviate from the geometry produced by the molding tool after being injection-molded, transfer-molded or compression-molded.



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3. Standard Environmental Conditions

The standard environmental conditions shall comprise the following:

(1) Minimum of 24 h of time lapse following the molding and finishing of plastic part. If not reaching 24 h, however, temperature correction needs to be carried out.

(2) Temperature of the plastic part shall be 23±3 ℃.

(3) Ambient temperature shall be 23±3 ℃ and relative humidity 50±5 %.

4. Resin Classification and Dimensional Tolerance Groups

Classification of resins and corresponding tolerance groups (tolerance classes of PLTA, PLTB and PLTC) are as given in Table 2.

(1) Tolerance class PLTC

Tolerance of this class is obtained under normal production conditions.

(2) Tolerance class PLTB

This class has a smaller tolerance over the tolerance class PLTC. PLTB tolerance class can normally be attained through appropriate mold adjustment and production control, but generally by specially controlled production conditions.

(3) Tolerance class PLTA

This class has a smaller tolerance over the tolerance class PLTB. PLTA tolerance class is attained by specially controlled production conditions.

Remark:

Note that carrying out mold adjustment and special production control can lead to an increase in costs.



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Table 2 Resin Classification and Dimensional Tolerance Groups

| Molding resins | | | Contraction factor | Tolerance group | | | Pore defect propensity |
|---|---|---|---|---|---|---|---|
| Code | Resin name | | | Tolerance class PLTC | Tolerance class PLTB | Tolerance class PLTA | |
| PF | Phenol | mineral-filled | 0 to 1 | 130 | 120 | 110 | Small |
| | | organic-filled | 1 to 2 | 140 | 130 | 120 | |
| UF | Urea, organic-filled | | | | | | |
| MF | Melamine, mineral-filled | | 0 to 1 | 130 | 120 | 110 | |
| MF/PF | Amino/Phenol, organic/mineral-filled | | 1 to 2 | 140 | 130 | 120 | |
| UP | Unsaturated polyester | | | | | | |
| PE | Polyethylene, unfilled(1) | | 2 to 3 | 150 | 140 | 130 | Large |
| PP | Polypropylene, unfilled(1) | | | | | | Medium |
| | Polypropylene, mineral (talc/chalk)-filled(1) | | 1 to 2 | 140 | 130 | 120 | |
| | Polypropylene, glass-reinforced | | | | | | Large |
| PCTFE | Polychloro-trifluoro-ethylene | | 2 to 3 | 150 | 140 | 130 | Medium |
| FEP | Perfluoro (ethylene propylene) resin | | | | | | |
| PA | Polyamide 6, 66, 610, 11, 12, unfilled | | 1 to 2 | 140 | 130 | 120 | |
| | Polyamide 6, 66, 610, 11, 12, glass-reinforced | | 0 to 1 | 130 | 120 | 110 | Large |
| POM | Polyacetal, unfilled | Molded length < 150 mm(1) | 1 to 2 | 140 | 130 | 120 | Small |
| | | Molded length ≥ 150 mm(1) | 2 to 3 | 150 | 140 | 130 | Medium |
| | Polyacetal, glass-reinforced | | 0 to 1 | 130 | 120 | 110 | Large |
| PBT | Poly-butylene-terephtalate | | 1 to 2 | 140 | 130 | 120 | Medium |
| | Poly-butylene-terephtalate, glass-reinforced | | 0 to 1 | 130 | 120 | 110 | Large |
| PET (a) | Polyetylene terephtalate, amorphous | | | | | | Small |
| PET (k) | Polyetylene terephtalate, crystalline | Unfilled | 1 to 2 | 140 | 130 | 120 | Medium |
| | | Glass-reinforced | 0 to 1 | 130 | 120 | 110 | Large |
| PPS | Polyphenylene sulfide | | | | | | Small |
| PS | Polystyrene | | | | | | |
| SAN | Styrene-acrylonitrile | | | | | | |
| SB | Polystyrene-butadiene | | | | | | |
| ABS | Acrylonitrile-butadiene-styrene | | | | | | |
| PMMA | Polymethyl methacrylate | | | | | | |
| PVC | Polyvinyl chloride, rigid | | | | | | Medium |

Note: (1)
One level higher tolerance shall apply when the wall thickness is greater than 4 mm.



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Table 2 (Continued)

| Molding resins | | Contraction factor | Tolerance group | | | Form defect propensity |
|---|---|---|---|---|---|---|
| Code | Resin name | | Tolerance class PLTC | Tolerance class PLTB | Tolerance class PLTA | |
| CA | Cellulose acetate | 1 to 2 | 140 | 130 | 120 | Small |
| CAB | Cellulose acetate butylate | | | | | |
| CAP | Cellulose acetate propionate | | | | | |
| CP | Cellulose propionate | | | | | |
| PSU | Polysulfone | 0 to 1 | 130 | 120 | 110 | |
| Mod. PPO | Modified polyphenyleneoxide | | | | | |
| PPE | Polyphenylene-ether, glass-reinforced | | | | | Medium |
| PC | Polycarbonate | | | | | Small |
| | Polycarbonate, glass-reinforced | | | | | Medium |

Remark:
For resins which can not be located in Table 2, refer to Section 5.

5. General Permissible Dimensional Deviation

General permissible dimensional deviation and dimensional tolerance of each dimensional tolerance group that corresponds to tolerance class shall be as specified in Attached Table 1. For resins that are not listed in Table 2, determine the contraction coefficient first. Then, see Table 3 and determine the tolerance class of the dimensional tolerance group that has a dimensional tolerance required due to the function of the part.

Table 3 Tolerance Classes Corresponding to Resin Contraction Factor and Dimensional Tolerance Group

| Contraction factor | Dimensional tolerance group | | |
|---|---|---|---|
| | Tolerance class PLTC | Tolerance class PLTB | Tolerance class PLTA |
| 0 - 1 | 130 | 120 | 110 |
| 1 - 2 | 140 | 130 | 120 |
| 2 - 3 | 150 | 140 | 130 |
| 3 - 4 | 160 | 150 | 140 |



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6. Tolerance for Angular Dimensions

Dimensional tolerance group is not applicable to angular dimensions ($\theta$ in Fig. 2) indicated for the features with inclined surfaces. The dimensional tolerance for the particular angular dimension shall be selected from Table 4 classifying the tolerance by classes of PLTA, PLTB and PLTC in combination with basic size ($L$ in Fig. 2).

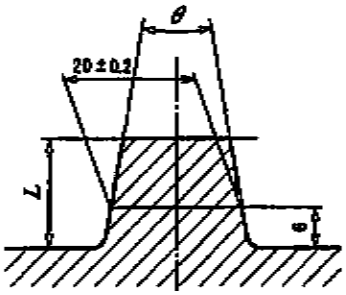


Fig. 2 Example of Angular Dimension Indication to Inclined Features

Table 4 Tolerance for Angular Dimensions

| Basic size ($L$) range (mm) | Tolerance class PLTC | Tolerance class PLTB | Tolerance class PLTA |
|---|---|---|---|
| 10 max. | ±3° | ±1° 30' | ±1° |
| Over 10 to 50 incl. | ±2° | ±0° 50' | ±0° 30' |
| Over 50 to 120 incl. | ±1° | ±0° 25' | ±0° 20' |
| Over 120 | ±0° 30' | ±0° 15' | ±0° 10' |



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## 7. Tolerances Related to Forms

### 7.1 Draft Angle

Unless otherwise specified, draft angles shall be 0 to 1°. Specially required draft angle must be specified on the drawing. Since all dimensional tolerances apply to the basic size described on the drawing, the draft angle shall be added in principle (Fig. 4 (a)) to the basic form of the mold (Fig. 3). When specifying a negative draft angle applicable to the basic size, note as such clearly on the drawing (Fig. 4 (b)).

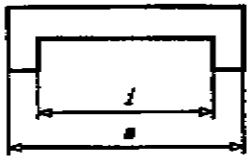
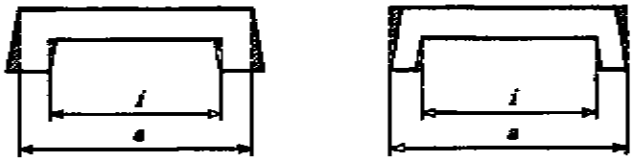



Fig. 3 Basic Form




(a) Positive Draft Angle (b) Negative Draft Angle

Fig. 4 Draft Angles

### 7.2 Mismatch

(1) For separate-type molds

Applicable to the maximum of all the dimensions, denoted as "Y", in a part (Fig. 5) and the allowable maximum value for mismatch of a separate-type mold shall be 0.1 mm.

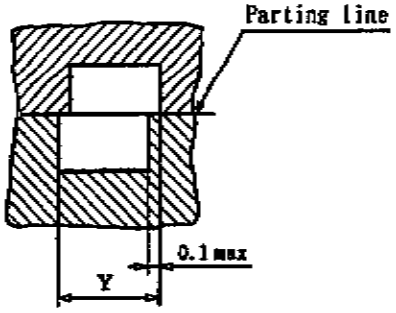



Fig. 5 Allowable Value for Mismatch (Separate-Type Mold) (Unit: mm)



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(2) For single-type molds
Applicable to the maximum of all the dimensions, denoted as "Y", in a part (Fig. 6) and the allowable maximum value for mismatch of a single-type mold shall be 0.05 mm.


Fig. 6 Allowable Value for Mismatch (Single-Type Mold) (Unit: mm)

(3) For composite-type molds
Applicable to the maximum of all the dimensions, denoted as "Y", in a part (Fig. 7) and the allowable maximum value for mismatch of a composite-type mold shall be 0.15 mm.

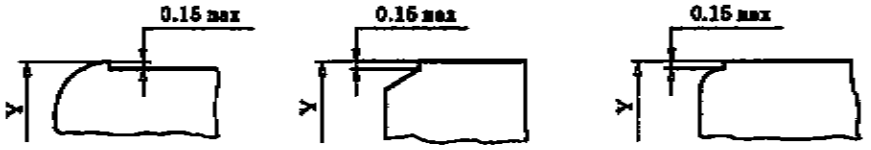


Fig. 7 Allowable Value for Mismatch (Composite-Type Mold) (Unit: mm)

7.3 Pin Holes
The allowable maximum value for pin hole depth shall be as follows determined in accordance with the thickness ratio, $B/A$, of a feature (Fig. 8).
$B/A \fallingdotseq 1$: $X$ = 0.1 mm (max.)
$B/A \fallingdotseq 2$: $X$ = 0.2 mm (max.)
$B/A > 2$: $X$ = 0.3 mm (max.)

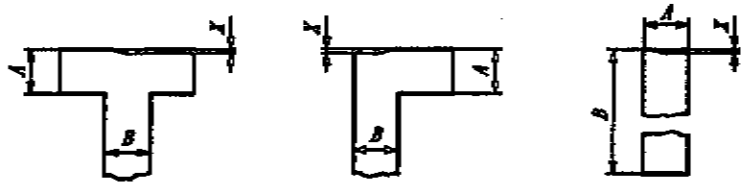


Fig. 8 Pin Hole



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7.4 General Geometrical Tolerances

7.4.1 Tolerance on Straightness
Unless individually specified, tolerance on straightness shall be as specified in TSZ2305G.

7.4.2 Tolerance on Flatness
Unless individually specified, tolerance on flatness shall be as specified in TSZ2305G.

7.4.3 Tolerance on Circularity
Unless individually specified, tolerance on circularity shall be equal to the numerical value of the diameter tolerance for a feature.

8. Indication on Drawings

8.1 General Dimensional Tolerances
General dimensional tolerances for molded plastic parts shall be indicated on drawings or associated specifications by the standards number of this standard, followed by the designation for the tolerance class. Only the designation for the tolerance class, however, shall be marked if indicating on the title block on the drawing.

Indication example for tolerance class PLTB:
Drawing or related document: TSZ2205G-PLTB
Drawing title block: PLTB

8.2 Dimensional Tolerance Individually Indicated for Basic Size
(1) A dimensional tolerance to be individually indicated to the basic size on a drawing shall preferably be selected from the permissible dimensional deviations given in Attached Table 1. The tolerances zone shall generally be symmetrically disposed with respect to a basic size, with one half on the positive side and one half on the negative side.

Example:
For a basic size directly determined by the mold of 55 mm (dimension "a") and dimension tolerance group 140 is applied, indicate as follows:
$55 \pm 0.4$

(2) Tolerances may also be asymmetrically disposed with respect to a basic size, on either the positive or negative side, with the tolerance zone unchanged.

Example:
For a basic size directly determined by the mold of 55 mm (dimension "a") and dimension tolerance group 120 is applied, indicate as follows:
$55^{+0.4}_{\ \ 0}$ or $55^{\ \ 0}_{-0.4}$



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(3) In the case where a tolerance that is smaller or larger than the dimensional tolerance group classified by a specified general dimensional tolerance is required for the basic size, such should be indicated in appropriate numerical values.

**Applicable Standards**

| | |
|---|---|
| TSZ2001G | Fundamental Tolerancing Principle |
| TSZ2300G | Geometrical Tolerancing |
| TSZ2305G | General Geometrical Tolerances |



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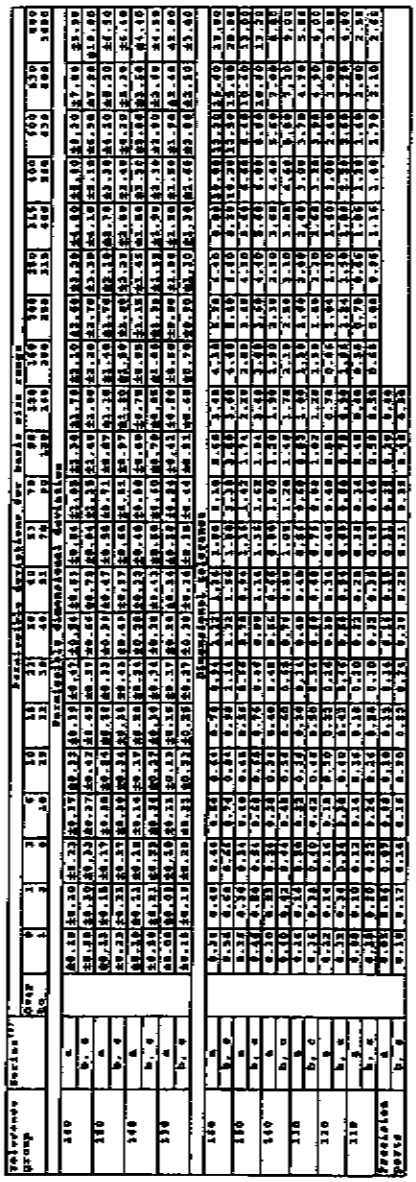
Attached Table 1 Permissible Dimensional Deviation and Tolerance (Unit: mm)



Note:(2)
The symbol "a" is used for a dimension directly related to mold, "b" for a dimension not directly related to mold, and "c" for a dimension in the moving direction not directly related to mold.



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