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## Thermoplastic polymers for plain bearings — Classification and designation

*Polymères thermoplastiques pour paliers lisses — Classification et désignation*

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# Contents

Page

<b>Foreword</b> .....	<b>iv</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>2</b>
<b>4 Classification and designation system</b> .....	<b>2</b>
4.1 General .....	2
4.2 Data block 1 .....	3
4.3 Data block 2 .....	3
4.4 Data block 3 .....	4
4.4.1 General .....	4
4.4.2 Polyamides .....	4
4.4.3 Polyethylenes .....	6
4.4.4 Polyalkyleneterephthalates .....	7
4.4.5 Other polymers .....	8
4.5 Data block 4 .....	8
<b>5 Designation examples</b> .....	<b>10</b>
<b>6 Ordering information</b> .....	<b>12</b>
<b>Annex A (informative) Properties and applications of the most common unfilled thermoplastic polymers</b> .....	<b>13</b>
<b>Annex B (informative) Fundamental application parameters</b> .....	<b>21</b>
<b>Bibliography</b> .....	<b>27</b>

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

This third edition cancels and replaces the second edition (ISO 6691:2000), which has been technically revised.

The main changes compared to the previous edition are as follows:

- references in 4.5, Data Block 4 for position 3 and 4, have been made precise;
- Annexes A and B have been revised.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

# Thermoplastic polymers for plain bearings — Classification and designation

## 1 Scope

This document specifies a classification and designation system for a selection of the most common unfilled thermoplastic polymers for plain bearings.

The unfilled thermoplastic polymers are classified on the basis of appropriate levels of distinctive properties, additives and information about their application for plain bearings. The designation system does not include all properties; thermoplastic polymers having the same designation cannot therefore be interchanged in all cases.

It also provides an outline of the properties and applications of the most common unfilled thermoplastic polymers as well as listing some of the fundamental parameters that influence the selection of thermoplastic polymers for use for plain bearings.

NOTE In the further course of the work, it is intended to prepare standards on “thermosetting polymers” and “mixed polymers” for plain bearings.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 307, *Plastics — Polyamides — Determination of viscosity number*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

ISO 527-5, *Plastics — Determination of tensile properties — Part 5: Test conditions for unidirectional fibre-reinforced plastic composites*

ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 1183-3, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pycnometer method*

ISO 1628-5, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 5: Thermoplastic polyester (TP) homopolymers and copolymers*

ISO 16396-1, *Plastics — Polyamide (PA) moulding and extrusion materials — Part 1: Designation system, marking of products and basis for specifications*

ISO 16396-2, *Plastics — Polyamide (PA) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

ISO 17855-1, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

ISO 17855-2, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

ISO 20028-1, *Plastics — Thermoplastic polyester (TP) moulding and extrusion materials — Part 1: Designation system and basis for specification*

### 3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

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### 4 Classification and designation system

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#### 4.1 General

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The classification and designation are based on a block system consisting of a “description block” and “Identity block” (see [Table 1](#)). The “Identity block” comprises an “International Standard number block” and an “individual item block”. For unambiguous coding of all thermoplastic polymers, the “individual item block” is subdivided into four data blocks.

**Table 1 — Classification and designation**

Designation					
Description block	Identity block				
	International Standard number block	Individual item block			
		Data block 1	Data block 2	Data block 3	Data block 4

The “individual item block” starts with a dash. The data blocks are separated by commas.

Data blocks 1 to 4 include the following information:

- data block 1: material symbol (see [4.2](#), [Table 2](#));
- data block 2: intended application or method of processing (see [4.3](#));
- data block 3: distinctive properties (see [4.4](#));
- data block 4: type and content of fillers or reinforcing materials (see [4.5](#));

The meaning of the letters and digits is different for each data block (see [4.2](#) to [4.5](#)).

Data block 2 comprises up to 4 positions. If at least one of positions 2 to 4 is used, but no information is given in position 1, then the letter “X” shall be placed in position 1. The letters in positions 2 to 4 shall be arranged in alphabetical order.

If a data block is not used, this shall be indicated by consecutive data block separators, i.e. two commas (,,).

Designation examples are given in [Clause 5](#).

## 4.2 Data block 1

The chemical nature of the thermoplastic polymer is designated by its symbol in accordance with ISO 1043-1.

**Table 2 — Symbols for the chemical structure of the materials**

Thermoplastic polymers		Name and chemical structure
Group/Name	Symbol	
Polyamide	PA 6	Polyamide 6; homopolymer based on $\epsilon$ -caprolactam
	PA 6 cast	Polyamide 6, cast; homopolymer based on $\epsilon$ -caprolactam
	PA 66	Polyamide 66; homopolycondensate based on hexamethylenediamine and adipic acid
	PA 12	Polyamide 12; homopolymer based on $\omega$ -laurinlactam or $\omega$ -aminodecanoic acid
	PA 12 cast	Polyamide 12, cast; homopolymer based on $\omega$ -laurinlactam or $\omega$ -aminodecanoic acid
	PA 46	Polyamide 46; a co-condensate based on 1,4-diaminobutane and adipic acid
Polyoxymethylene	POM	Polyacetal (homopolymer), Polyacetal (copolymer)
Polyalkyleneterephthalate	PET	Polyethylene terephthalate
	PBT	Polybutylene terephthalate
Polyethylene	PE-UHMW	Polyethylene with ultra high molecular weight
	PE-HD	High density polyethylene
Polyfluorocarbon	PTFE	Polytetrafluoroethylene
Polyimide	PI	Polyimides from polyaddition reactions are available as thermosetting plastics. Polyimides from polycondensation reactions are available as thermoplastics and thermosetting plastics, as well as copolymers of the imide group. Some thermoplastic polyimides are “apparent thermosetting plastics” because their thermoplastic range lies above the decomposition temperature. Because of their intermediate position, polyimides and imide copolymers are only treated marginally in this document.
Polyaryletherketone	PEEK	Polyetheretherketone
Polyvinylidene fluoride	PVDF	Homopolymer based on vinylidene difluoride
Polyphenylene sulfide	PPS	Polyphenylene sulfide, linearly structured phenyl ring and sulfur atoms (tribologically modified material)
Poly(amide-imide)	PAI	Poly(amide-imide) reacted by polycondensation is a hard/tough, amorphous thermoplastic. After postcuring the PAI parts cannot be used for re-processing (“pseudo-thermoset plastics”).

## 4.3 Data block 2

Position 1 gives the code for the intended application (see [Table 3](#)).

**Table 3 — Data block 2 — Position 1**

Code	Intended application
E	Extrusion
G	General use
M	Injection moulding
Q	Compression moulding
R	Rotational moulding
X	No indication

Up to three important properties and/or additives can be indicated in positions 2 to 4 (see [Table 4](#)).

**Table 4 — Data block 2 — Positions 2 to 4**

Code	Important properties and/or additives
A	Processing stabilizer
F	Special burning characteristics
H	Heat ageing stabilizer
L	Light and weather stabilizer
R	Release agent
S	Slip agent, lubricant

#### 4.4 Data block 3

##### 4.4.1 General

The levels of distinctive properties are coded by letters and numbers.

The properties used for the designation are different for every thermoplastic polymer.

Owing to manufacturing tolerances, single property values can lie on, or to either side of, two intervals. It is up to the manufacturer to state which interval will designate the thermoplastic polymer.

##### 4.4.2 Polyamides

Polyamides are designated in data block 3 by their viscosity number, represented by two digits (see [Table 5](#)) in accordance with ISO 16396-1 and, separated by a dash, their modulus of elasticity represented by three digits (see [Table 6](#)).

In the last position, rapid-setting products may be indicated with the letter N.

The viscosity number shall be determined in accordance with ISO 307 using the solvents given in [Table 5](#). The modulus of elasticity shall be determined in the dry state in accordance with ISO 527-1, ISO 527-2, ISO 527-3, ISO 527-4 and ISO 527-5, under the conditions specified in ISO 16396-2.



Table 5 — Viscosity number for polyamides

Polyamide	Code	Viscosity number, ml/g			
		Solvent			
		Sulfuric acid 96 % (mass fraction)		<i>m</i> -cresol	
		>	≤	>	≤
PA 6 PA 6 cast PA 66	09	—	90	—	
	10	90	110		
	12	110	130		
	14	130	160		
	18	160	200		
	22	200	240		
	27	240	290		
	32	290	340		
	34	340	—		
PA 12 PA 12 cast	11	—		—	110
	12			110	130
	14			130	150
	16			150	170
	18			170	200
	22			200	240
	24			240	—

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**Table 6 — Modulus of elasticity**

Code	Modulus of elasticity N/mm <sup>2</sup>	
	>	≤
001	50	150
002	150	250
003	250	350
004	350	450
005	450	600
007	600	800
010	800	1 500
020	1 500	2 500
030	2 500	3 500
040	3 500	4 500
050	4 500	5 500
060	5 500	6 500
070	6 500	7 500
080	7 500	8 500
090	8 500	9 500
100	9 500	10 500
110	10 500	11 500
120	11 500	13 000
140	13 000	15 000
160	15 000	17 000
190	17 000	20 000
220	20 000	23 000
250	23 000	—

#### 4.4.3 Polyethylenes

Polyethylenes are designated by their density represented by two digits (see [Table 7](#)) in accordance with ISO 17855-1 and, separated by a dash, their melt flow rate (MFR) represented by one letter and three digits (see [Table 8](#)).

The density of the base material shall be determined in accordance with ISO 1183-1, ISO 1183-2 and ISO 1183-3 under the conditions specified in ISO 17855-2.

The melt mass-flow rate shall be determined in accordance with ISO 1133-1 at 190 °C with a load of 2,16 kg (symbol *D*). For thermoplastic polymers with a melt mass-flow rate <0,1 g/10 min, a test under a load of 5 kg (symbol *T*) is recommended. If the melt mass-flow rate is still <0,1 g/10 min, the test should then be carried out under a load of 21,6 kg (symbol *G*).

The symbols *D*, *T* and *G* shall precede the code for melt flow rate given in [Table 8](#).

**Table 7 — Density**

Code	Density <sup>a</sup> g/cm <sup>3</sup>	
	>	≤
15	—	0,917
20	0,917	0,922
25	0,922	0,927
30	0,927	0,932
35	0,932	0,937
40	0,937	0,942
45	0,942	0,947
50	0,947	0,952
55	0,952	0,957
60	0,957	0,962
65	0,962	—

<sup>a</sup> Density ranges for uncoloured and unfilled polyethylene materials.

**Table 8 — Melt mass-flow rate (MFR)**

Code	Melt flow rate g/10 min	
	>	≤
000	—	0,1
001	0,1	0,2
003	0,2	0,4
006	0,4	0,8
012	0,8	1,5
022	1,5	3
045	3	6
090	6	12
200	12	25
400	25	50
700	50	100

#### 4.4.4 Polyalkyleneterephthalates

The distinctive property of polyalkyleneterephthalates is the viscosity number according to ISO 20028-1, determined in accordance with ISO 1628-5, and designated by two digits (see [Table 9](#)).

**Table 9 — Viscosity number for polyalkyleneterephthalate**

Polyalkylene-terephthalate	Code	Viscosity number	
		ml/g	
		>	≤
PET	06	—	60
	07	60	70
	08	70	80
	09	80	90
	10	90	100
	11	100	120
	13	120	140
	15	140	—
PBT	08	—	90
	10	90	110
	12	110	130
	14	130	150
	16	150	170
	18	170	—

**4.4.5 Other polymers****iTeh STANDARD PREVIEW**

The coding for the distinctive properties of polyoxymethylene, polytetrafluoroethylene, poly(amide-imide), polyimide, Polyetheretherketone, Polyvinylidene fluoride and Polyphenylene sulfide will be included in a future edition of this document. [ISO/FDIS 6691](https://standards.iteh.ai/catalog/standards/sist/ad1bf5a5-f710-4b82-ad9a-a7a4cc328041/iso-fdis-6691)

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**4.5 Data block 4**

The fillers and reinforcing materials, as well as additives specific for the application in plain bearings, are coded as follows:

- position 1: types of fillers and/or reinforcing materials, coded by a letter (see [Table 10](#));
- position 2: physical forms of fillers and/or reinforcing materials, coded by a letter (see [Table 11](#));
- positions 3: mass content of fillers and/or reinforcing materials, coded by two digits (see [Table 12](#));
- positions 4: Types of lubricants, coded by two letters (see [Table 13](#)).