

BS 8888:2020



BSI Standards Publication

Technical product documentation and specification

bsi.

...making excellence a habit.
Documents[™]
Document Sharing Hub

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2019

Published by BSI Standards Limited 2019

ISBN 978 0 539 02682 5

ICS 01.100.01, 01.110

The following BSI references relate to the work on this document:

Committee reference TPR/1/8

Draft for comment 19/30384745 DC

Publication history

First published as BS 308-1, BS 308-2 and BS 308-3, September 1927

Second editions, December 1943

Third editions, December 1953

Fourth editions, November 1964

Fifth editions, October 1972

Sixth editions, August 1984 (BS 308-1), October 1985 (BS 308-2) and August 1990 (BS 308-3)

Seventh edition of BS 308 1, December 1993

First published as BS 8888 August 2000

Second edition, October 2002

Third edition, October 2004

Fourth edition, October 2006

Fifth edition, October 2008

Sixth edition, December 2011

Seventh edition, December 2013

Eighth edition, January 2017

Ninth (present) edition, January 2020

Amendments issued since publication

Date

Text affected

Contents

	Foreword	xii
Section 1	Scope	1
1.1	Scope	1
1.2	Normative references	1
1.3	Terms and definitions	2
1.3.1	date of issue	2
1.3.2	ISO GPS system	2
1.3.3	technical product documentation (TPD)	2
1.3.4	technical product specification (TPS)	2
Section 2	Standards underpinning BS 8888	3
2.1	General	3
Section 3	Technical product specification (TPS): Principles and concepts	4
3.1	Principles of specification	4
3.1.1	Types of technical product specification	4
	<i>Figure 1 – Hole and shaft sizes</i>	5
	<i>Table 1 – Mean and nominal values for 3D CAD model</i>	5
3.1.2	General principles of specification	6
	<i>Table 2 – Level of detail in a TPS</i>	6
3.1.3	Date of issue principle	6
3.1.4	Reference conditions	6
3.1.5	Interpretation	7
3.1.6	Decimal principle	7
3.1.7	Rigid workpiece principle	7
3.1.8	Nonrigid workpieces	7
3.2	Fundamental concepts	8
3.2.1	Properties	8
3.2.2	Feature principle	8
	<i>Figure 2 – Interrelationship of the geometrical feature definitions</i>	10
3.2.3	Interpretations of limits of size for a feature of size	10
	<i>Figure 3 – Possible interpretations of size limits where no form control is defined and the specification is incomplete</i>	11
	<i>Figure 4 – Two-line angular size: Second association with minimax criterion</i>	12
3.3	Geometrical product specification	13
3.3.1	Interpretation and invocation principle	13
3.3.2	Independency principle	14
Section 4	Technical product documentation (TPD)	15
	<i>Figure 5 – Example of assembly drawing</i>	15
	<i>Figure 6 – Example of part drawing</i>	16
	<i>Figure 7 – Example of fabrication drawing</i>	16
4.1	Graphical representation and annotation of 3D data (3D modelling output)	17
4.2	Drawing sheets	17
4.2.1	General	17
4.2.2	Sizes	17
	<i>Table 3 – Sizes of trimmed and untrimmed sheets and the drawing space</i>	17

4.2.3	Graphical features	17
	<i>Figure 8 – Size A4 to A0</i>	18
	<i>Figure 9 – Title block in compact form</i>	18
	<i>Table 4 – Identifying, descriptive and administrative data fields in the title block</i>	18
	<i>Table 5 – Number of fields</i>	19
4.3	Line types and line widths	19
4.3.1	Types of line	19
	<i>Table 6 – Basic line types</i>	20
4.3.2	Line width	20
4.3.3	Colours	20
4.4	Scales	21
	<i>Table 7 – Scales</i>	21
4.5	Lines	21
4.5.1	Lines and terminators	21
4.5.2	Lines, terminators and origin indicators	21
4.6	Number formats	22
4.6.1	General	22
4.6.2	Metric values	22
4.7	Lettering	22
4.7.1	General	22
4.7.2	Lettering size	23
	<i>Table 8 – Preferred line widths and lettering heights for drawing sheet sizes</i>	23
4.7.3	Notes	23
4.8	Projections	23
4.8.1	General	23
4.8.2	Conventions for arrangement of views on a TPD	23
	<i>Figure 10 – Labelled view method</i>	24
	<i>Figure 11 – First angle projection method</i>	25
	<i>Figure 12 – First angle projection method: Graphical symbol</i>	25
	<i>Figure 13 – Third angle projection method</i>	26
	<i>Figure 14 – Third angle projection method: Graphical symbol</i>	26
4.9	Views	26
4.9.1	General	26
4.9.2	Auxiliary views	27
	<i>Figure 15 – Auxiliary view showing true shape of inclined surface</i>	27
4.10	Sections	27
	<i>Figure 16 – Section view in one plane</i>	28
	<i>Figure 17 – Section view in two parallel planes</i>	28
	<i>Figure 18 – Section view in three contiguous planes showing true shape of inclined surface</i>	29
4.11	Representation of components	29
4.11.1	General	29
4.11.2	Representation of moulded, cast and forged components	30
4.11.3	Representation of moulded components	30
Section 5	Dimensioning	31
5.1	General	31
5.2	Dimensioning methods	32
5.2.1	Presentation rules	32
5.2.2	Presentation of decimals	32
5.2.3	Positioning of dimensions	33

	<i>Figure 19 – Positioning of dimensions</i>	33
	<i>Figure 20 – Arrangement and indication of dimensions internal and external features</i>	33
5.2.4	Units of dimensions	34
5.2.5	Elements of dimensioning: usage	34
	<i>Figure 21 – Elements of dimensioning</i>	34
	<i>Figure 22 – Dimension line of feature that is broken</i>	35
	<i>Figure 23 – Dimension lines of holes</i>	35
	<i>Figure 24 – Extension lines</i>	36
	<i>Figure 25 – Oblique extension lines</i>	36
	<i>Figure 26 – Intersection of projected contours of outlines</i>	36
	<i>Figure 27 – Intersection of projected contours of transitions and similar features</i>	37
	<i>Figure 28 – Extension lines of angular dimensions</i>	37
5.2.6	Dimensional values	37
	<i>Figure 29 – Position of dimensional values</i>	38
	<i>Figure 30 – Position of dimensional values</i>	38
	<i>Figure 31 – Orientation of linear dimensions</i>	39
	<i>Figure 32 – Orientation of angular dimensions</i>	39
5.2.7	Indications of special dimensions	39
	<i>Table 9 – Special dimensions</i>	40
	<i>Figure 33 – Indications of special dimensions: Radius</i>	40
	<i>Figure 34 – Indications of special dimensions: Square</i>	40
	<i>Figure 35 – Indications of special dimensions: Spherical diameter</i>	40
	<i>Figure 36 – Indications of special dimensions: Spherical radius</i>	41
	<i>Figure 37 – Indications of special dimensions: Thickness</i>	41
	<i>Figure 38 – Diameter and depth of counterbore</i>	41
	<i>Figure 39 – Size and angle of countersink</i>	42
5.2.8	Auxiliary dimensions	42
5.2.9	Equallyspaced and repeated features	42
	<i>Figure 40 – Number of equallyspaced features and the dimensional value</i>	42
	<i>Figure 41 – Dimensioning of angular spacing</i>	43
	<i>Figure 42 – Angles of spacings</i>	43
	<i>Figure 43 – Indication of features having the same dimensional value</i>	43
	<i>Figure 44 – Indication of features having the same dimensional value</i>	44
5.2.10	Chamfers	44
	<i>Figure 45 – Dimension of external chamfer not equal to 45°</i>	44
	<i>Figure 46 – Dimension of external chamfer equal to 45°</i>	44
	<i>Figure 47 – Dimension of internal chamfer not equal to 45°</i>	45
	<i>Figure 48 – Dimension of internal chamfer equal to 45°</i>	45
5.2.11	Countersink	45
	<i>Figure 49 – Dimension of countersink</i>	45
	<i>Figure 50 – Dimension of countersink: simplification</i>	46
5.2.12	Symmetrical parts	46
	<i>Figure 51 – Symmetrical parts</i>	46
	<i>Figure 52 – Symmetrical parts</i>	47
	<i>Figure 53 – Symmetrical parts</i>	47
5.2.13	Indication of levels	47
	<i>Figure 54 – Indication of level on vertical view</i>	48
	<i>Figure 55 – Indication of level on horizontal view or section</i>	48
5.2.14	Dimensioning of curved features	48
	<i>Figure 56 – Example of curved feature defined by radii</i>	48

	<i>Figure 57 – Example of curved feature defined by radii</i>	48
	<i>Figure 58 – Curved feature defined by coordinate dimensions</i>	49
	<i>Figure 59 – Curved features defined by coordinate dimensions</i>	49
5.2.15	Arrangements of dimensions	49
	<i>Figure 60 – Example of chain dimensioning</i>	50
	<i>Figure 61 – Example of parallel dimensioning</i>	50
	<i>Figure 62 – Example of parallel dimensioning</i>	50
	<i>Figure 63 – Two dimension lines, inclined to each other, and two origins</i>	51
	<i>Figure 64 – Running dimensioning of angles</i>	52
5.2.16	Cartesian coordinate dimensioning	52
	<i>Figure 65 – Cartesian coordinate dimensioning</i>	53
	<i>Figure 66 – Cartesian coordinate dimensioning</i>	53
5.3	Dimensioning common features	54
5.3.1	Dimensioning of slots	54
	<i>Figure 67 – Dimensioning slots with rounded ends</i>	54
5.3.2	Keyways	54
	<i>Figure 68 – Dimensioning of keyways</i>	54
5.3.3	Screw threads	55
5.4	Dimensional tolerancing	55
5.4.1	General	55
5.4.2	Methods of specifying tolerances	55
5.4.3	Indication of tolerances	55
	<i>Figure 69 – Example: expression of two deviations to the same number of decimal places</i>	56
	<i>Figure 70 – Example: expression of two limits of size to the same number of decimal places</i>	56
	<i>Figure 71 – Example: expression of deviations from dimensions displayed in accordance with BS EN ISO 2861</i>	56
	<i>Figure 72 – Components of a toleranced dimension</i>	57
	<i>Figure 73 – Components of a toleranced dimension</i>	57
	<i>Figure 74 – Components of a toleranced dimension</i>	57
	<i>Figure 75 – Limits of dimensions</i>	57
	<i>Figure 76 – Single limit dimension</i>	57
	<i>Figure 77 – Use of general tolerance notes</i>	58
	<i>Table 10 – Permissible deviations for linear dimensions except for broken edges</i>	58
	<i>Table 11 – Permissible deviations for broken edges (external radii and chamfer heights)</i>	58
	<i>Table 12 – Permissible deviations of angular dimensions</i>	59
5.4.4	Functional dimensions	59
	<i>Figure 78 – Application of dimensions to suite functional requirements</i>	59
	<i>Figure 79 – Effect of functional dimensioning on tolerance values</i>	60
Section 6	Datums and datum systems	61
6.1	General	61
6.2	Definitions and explanations	61
6.2.1	Datum	61
6.2.2	Datum feature	61
6.2.3	Common datum	61
6.2.4	Datum system	62
6.2.5	Datum section	62
	<i>Figure 80 – Datum section of a tolerance indicator defining a datum system</i>	62
6.2.6	Primary datum	62
6.2.7	Secondary datum	62

6.2.8	Tertiary datum	62
6.2.9	Six degrees of freedom	63
	<i>Figure 81 – Degrees of freedom</i>	63
6.2.10	Situation feature	63
	<i>Table 13 – Situation features</i>	64
6.2.11	Associated feature	66
6.2.12	Association criterion	66
6.2.13	Objective function (for association)	66
6.2.14	Association constraints	66
6.3	Identifying datum features: Placement of the datum feature indicator	67
6.3.1	Datums based on single feature	67
	<i>Figure 82 – Datum feature indicators attached to an outline and an extension line from an outline</i>	67
	<i>Figure 83 – Datum feature indicators attached to a tolerance frame attached to the feature</i>	67
	<i>Figure 84 – Datum feature indicator attached with leader line ending in a filled dot on surface</i>	67
	<i>Figure 85 – Datum feature indicators attached to surface on 3D TPS</i>	68
	<i>Figure 86 – Datum feature indicator placed in line with dimension line for size dimension</i>	68
	<i>Figure 87 – Datum feature indicators attached to tolerance frame</i>	68
	<i>Table 14 – Example: single datum</i>	69
6.3.2	Datums based on multiple datum features	69
	<i>Figure 88 – Examples of datum indications based on multiple datum features</i>	69
6.3.3	Datums based on threaded features, gears or splines	69
	<i>Figure 89 – Datum feature indicator attached to tolerance frame in line with thread dimension</i>	70
6.4	Deriving datums from datum features	70
6.5	Indications of situation features in a technical product specification	70
	<i>Figure 90 – Example identifiers for situation features</i>	71
6.6	Common datums	71
6.6.1	General	71
	<i>Figure 91 – Common datum established by a group of identical features</i>	72
6.6.2	Common datums based on two coaxial cylinders	72
	<i>Figure 92 – Common datum established from two coaxial cylinders</i>	72
	<i>Figure 93 – Establishing a common datum from two coaxial cylinders</i>	73
6.6.3	Common datums based on two parallel cylinders	73
	<i>Figure 94 – Establishing a common datum from two parallel cylinders</i>	73
6.6.4	Common datums based on a group of cylinders	73
	<i>Figure 95 – Pattern of five cylinders: input for reading (drawing indication) and for writing (design intent)</i>	74
	<i>Figure 96 – Establishing a common datum from a pattern of five cylinders</i>	74
6.6.5	Association for common datums	75
6.6.6	Default association criteria	75
	<i>Figure 97 – Association for a common datum based on two coaxial cylinders</i>	76
6.7	Datum systems and the six degrees of freedom	76
	<i>Table 15 – Examples: datum systems</i>	77
	<i>Table 16 – Examples: datum systems</i>	78
6.8	Datum targets	78
6.8.1	General	78
6.8.2	Datum target frame	79
	<i>Figure 98 – Single datum target frame</i>	79
6.8.3	Datum target symbol	79
	<i>Figure 99 – Datum target point</i>	79
	<i>Figure 100 – Non-closed datum target line</i>	79

	<i>Figure 101 – Datum target area</i>	80
6.8.4	Leader line	80
	<i>Figure 102 – Indicator for single datum target point</i>	80
	<i>Figure 103 – Indicator for single datum target line</i>	80
	<i>Figure 104 – Indicator for single datum target surface</i>	81
6.8.5	Datum target areas	81
	<i>Figure 105 – Indicator for single datum target area</i>	81
	<i>Figure 106 – Direct and indirect indication for single datum target area</i>	81
6.8.6	Datum feature indicators used with datum targets	82
	<i>Figure 107 – Indication of datums established from datum targets</i>	82
	<i>Figure 108 – Simplification of drawing indication when there is only one datum target area</i>	82
6.8.7	Datums based on more than one datum target	82
	<i>Figure 109 – Datums based on more than one datum target</i>	83
	<i>Figure 110 – Application of datum targets</i>	84
	<i>Figure 111 – Application of datum targets</i>	84
6.9	Modifying the effects of datums	85
6.9.1	“Orientation only” modifier	85
	<i>Figure 112 – Application of “orientationonly” modifier</i>	85
6.9.2	Situation feature modifiers	85
	<i>Figure 113 – Indication of which modifier is needed in the set of situation features</i>	86
6.9.3	Specific control of degrees of freedom	86
	<i>Figure 114 – Complimentary datum indication</i>	86
Section 7	Geometrical specifications	87
7.1	Geometric tolerances	87
7.2	Basic concepts	88
7.3	Symbols	88
	<i>Table 17 – Symbols for geometrical characteristics</i>	88
	<i>Table 18 – Additional symbols</i>	89
7.4	Geometrical specification indication	90
	<i>Figure 115 – Elements of a geometrical specification indication</i>	90
7.5	Tolerance indicator	90
7.5.1	General	90
	<i>Figure 116 – Three sections of the tolerance indicator</i>	90
7.5.2	Symbol section	90
7.5.3	Tolerance zone section	90
7.5.4	Datum section	91
7.6	Tolerance zones	91
	<i>Figure 117 – Width of tolerance zone applying to the specified geometry</i>	91
7.7	Toleranced features	92
	<i>Figure 118 – Placement of tolerance indicator when applied to a surface</i>	92
	<i>Figure 119 – Placement of tolerance indicator when applied to a derived feature</i>	93
	<i>Figure 120 – Specification applying to several features individually</i>	93
	<i>Figure 121 – Specification applying to several features individually</i>	93
	<i>Figure 122 – Tolerance applying to more than one feature</i>	94
	<i>Figure 123 – Requirements given in tolerance frames one under the other</i>	94
	<i>Figure 124 – Examples of geometrical tolerancing</i>	94
7.8	Theoretically exact dimensions (TED)	101
	<i>Figure 125 – Use of theoretically exact dimensions (TEDs)</i>	102

7.9	Material condition modifiers	102
7.9.1	Maximum material requirement applied to the toleranced feature	102
	<i>Figure 126 – Indication of the maximum material requirement</i>	102
7.9.2	Maximum material requirement applied with a zero tolerance	103
	<i>Figure 127 – Indication of the maximum material requirement</i>	103
7.9.3	Maximum material requirement applied to a datum reference in a tolerance indicator	103
	<i>Figure 128 – Indication of the maximum material requirement</i>	103
7.9.4	Least material requirement applied to the toleranced feature	104
	<i>Figure 129 – Indication of the least material requirement</i>	104
7.9.5	Least material requirement applied with a zero tolerance	105
	<i>Figure 130 – Indication of the least material requirement applied with a zero tolerance</i>	105
7.9.6	Least material requirement applied to a datum reference in a tolerance indicator	105
	<i>Figure 131 – Least material requirement applied to a datum reference in a tolerance indicator</i>	105
7.9.7	Reciprocity requirement (RPR)	105
	<i>Figure 132 – Reciprocity requirement</i>	105
7.9.8	Direct indication of virtual size	106
	<i>Figure 133 – Direct indication of virtual size</i>	106
7.10	Additional indications relating to the toleranced feature	106
7.10.1	Projected tolerance zone	106
	<i>Figure 134 – Two ways of indicating a geometrical specification with projected tolerance modifier</i>	107
7.10.2	Free-state condition	107
	<i>Figure 135 – Free-state condition</i>	107
	<i>Figure 136 – Use of several specification modifiers</i>	107
7.10.3	Tolerances applied to threaded features	108
	<i>Figure 137 – Example of “MD”</i>	108
7.10.4	Tolerances applied to splines and gears	108
7.11	Unequal tolerance zone (UZ)	108
	<i>Figure 138 – Example of an unequal tolerance zone</i>	109
7.12	Restrictive specifications	109
7.12.1	Tolerance requirements applied to a specific restricted portion of a feature	109
	<i>Figure 139 – Tolerance applied to a restricted part of a feature</i>	110
7.12.2	Tolerance requirements applied to any given restricted portion of a feature	110
	<i>Figure 140 – Examples of tolerances of the same characteristic</i>	111
	<i>Figure 141 – Tolerance applied to an area</i>	111
7.13	The use of profile tolerances applied to derived features	111
7.13.1	General	111
7.13.2	Profile tolerancing	112
	<i>Table 19 – Symbols for geometrical characteristics</i>	112
	<i>Table 20 – Valid geometrical characteristic symbol and nominal tolerance feature combinations</i>	112
	<i>Figure 142 – Line profile specification for a compound derived feature</i>	113
	<i>Figure 143 – Surface profile specification for a compound derived feature</i>	114
7.14	Interrelationship of geometrical tolerances	115
Section 8	Additional indications for geometrical tolerances	116
8.1	Restricted or compound tolerancing of features	116
8.1.1	Between	116
	<i>Figure 144 – Use of between symbol</i>	116
	<i>Figure 145 – Use of between symbol</i>	116
8.1.2	All-around	116
	<i>Figure 146 – Use of all-round symbol</i>	116

8.1.3	All-over	117
	<i>Figure 147 – Use of all-over symbol</i>	117
8.2	United features	117
	<i>Figure 148 – Example united feature</i>	117
8.3	Feature patterns (CZ, CZR, SZ and SIM)	118
8.3.1	Internal and external constraints	118
	<i>Table 21 – Example showing internal and external constraints</i>	118
8.3.2	Specifying a pattern requirement	119
	<i>Figure 149 – Pattern of three flat faces subject to a combined zone flatness tolerance</i>	120
	<i>Figure 150 – Two independent patterns, one of four Ø15 holes, and one of four Ø8 holes</i>	120
8.3.3	Nested pattern requirements	120
	<i>Figure 151 – Eight independent specifications</i>	121
	<i>Table 22 – Use of CZ, SZ and CZR modifiers</i>	121
8.3.4	Combined geometrical specifications	124
	<i>Figure 152 – Two patterns locked together by the SIM indicator</i>	124
	<i>Figure 153 – Examples of indication of simultaneous requirements from two separate specification</i>	125
8.4	Plane and feature indicators	125
8.4.1	Intersection plane indicator	125
	<i>Figure 154 – Intersection plane indicator symbol</i>	126
	<i>Table 23 – Geometrical tolerance symbols</i>	126
	<i>Figure 155 – Example uses of intersection plane indicators</i>	126
8.4.2	Orientation plane indicator	126
	<i>Figure 156 – Orientation plane indicator symbol</i>	127
	<i>Table 24 – Geometrical tolerance symbols</i>	127
	<i>Figure 157 – Example uses of intersection plane indicators</i>	127
8.4.3	Collection plane	128
	<i>Figure 158 – Collection plane indicator symbol</i>	128
	<i>Table 25 – Geometrical tolerance symbols</i>	128
	<i>Figure 159 – Example uses of collection plane indicators</i>	129
8.4.4	Direction feature	129
	<i>Figure 160 – Intersection plane indicator symbol</i>	129
	<i>Table 26 – Geometrical tolerance symbols</i>	130
	<i>Figure 161 – An example use of the direction feature</i>	130
Section 9	Statistical tolerancing	131
	<i>Figure 162 – Statistical tolerance symbol</i>	131
	<i>Figure 163 – Population specification</i>	131
	<i>Figure 164 – Dual specification</i>	131
Section 10	Edges	133
	<i>Table 27 – Examples of indication of edges</i>	133
Section 11	Welding symbols	134
11.1	The use of welding symbols on a TPS	134
11.2	Welding symbol	134
	<i>Figure 165 – Basic welding symbol (joint details and type not specified)</i>	134
11.3	Arrow line	134
	<i>Figure 166 – Use of multiple arrow lines</i>	135
11.4	Reference line	135
	<i>Figure 167 – Reference lines illustrating arrow side and other side for System A and System B</i>	136
11.5	Tail	136

	<i>Figure 168 – Examples of the use of a tail on welding symbols</i>	137
11.6	Elementary symbols	137
	<i>Table 28 – Elementary symbols</i>	137
11.7	Broken arrow lines	140
	<i>Table 29 – Example uses of broken arrow line</i>	140
11.8	Supplementary symbols	140
	<i>Table 30 – Supplementary symbols</i>	141
	<i>Figure 169 – Comprehensive welding symbols showing the location of weld elements</i>	142
Section 12	Surface texture specification	143
12.1	General	143
12.2	Characterization	145
12.2.1	General	145
12.2.2	Profiles	145
	<i>Figure 170 – Use of several specification modifiers</i>	146
12.2.3	Roughness specifications	147
	<i>Figure 171 – Mathematical derivation of R_a and R_q</i>	147
	<i>Figure 172 – Peak height (R_p), valley depth (R_v) and maximum height of profile (R_z)</i>	147
	<i>Figure 173 – Mathematical derivation of surface skewness (R_{sk})</i>	148
	<i>Table 31 – Estimates for choosing roughness sampling lengths for the measurement of nonperiodic profiles (R_a)</i>	148
	<i>Table 32 – Estimates for choosing roughness sampling lengths for the measurement of nonperiodic profiles (R_z)</i>	149
	<i>Table 33 – Estimates for choosing roughness sampling lengths for the measurement of periodic profiles</i>	149
	<i>Figure 174 – Derivation of mean width of profile element (R_{Sm})</i>	149
12.2.4	The 16% rule	150
12.3	Drawing indication of surface texture specification	150
	<i>Figure 175 – Surface texture graphical symbol</i>	150
	<i>Figure 176 – Positions (a to e) for location of texture requirements</i>	150
	<i>Table 34 – Indication of surface lay^{A)}</i>	151
12.4	Position and orientation of graphical symbol	152
	<i>Figure 177 – Attachment of surface texture requirement to workpiece</i>	152
	<i>Figure 178 – Surface texture requirement: Geometrical tolerance indication</i>	152
	<i>Figure 179 – Simplified indication: Majority of surfaces with same surface texture requirement</i>	153
	<i>Table 35 – Example application of surface texture</i>	154
12.5	Surface texture and surface characterization	155
12.5.1	Surface texture: Areal	155
12.5.2	Surface characterization: Filtration	155
12.5.3	Surface characterization: Field parameters	155
12.5.4	Drawing Indication	155
	<i>Figure 180 – Example of Areal surface texture indication</i>	156
Section 13	Symbols and abbreviations	157
13.1	Symbols and abbreviations	157
13.1.1	General	157
13.1.2	Standard symbols and abbreviations	157
Section 14	Document handling	159
14.1	Types of documentation	159
14.1.1	General	159
14.1.2	Presentation media	159

14.2	Security	159
14.2.1	Introduction	159
14.2.2	General security	159
14.2.3	Enhanced security	160
14.2.4	Security level identification	160
14.3	Storage	160
14.4	Marking	160
14.4.1	General	160
14.4.2	Enhanced security	160
14.5	Protection notices	160
Annex A	(normative) Normative references	161
Annex B	(informative) Bibliography	169
Annex C	(informative) Associations	171
C.1	Association operations	171
C.2	Default association operations	172
	<i>Table C.1 – Default association operations used when defining datums</i>	172
C.3	Non default association operations	172
	<i>Figure C.1 – Example of individual specification operator for a datum association</i>	173
C.4	Examples of datums obtained from different datum features	174
C.4.1	Datum based on a planar datum feature	174
	<i>Figure C.2 – Primary datum based on a planar datum feature</i>	174
	<i>Figure C.3 – Associated feature</i>	175
C.4.2	Datum based on two parallel, opposed planes (external)	175
C.4.3	Datum based on two parallel, opposed planes (internal)	175
	<i>Figure C.4 – Primary datum based on two parallel opposed planes</i>	176
C.4.4	Datum based on an external cylindrical feature	176
C.4.5	Datum based on an internal cylindrical feature	177
	<i>Figure C.5 – Primary datum based on an external cylindrical feature</i>	177
C.4.6	Datum based on an external spherical feature	178
	<i>Figure C.6 – Primary datum based on an external spherical feature</i>	178
C.4.7	Datum based on an internal spherical feature	178
C.4.8	Datum based on an external or internal cone	179
	<i>Figure C.7 – Primary datum feature based on a conical feature</i>	179
C.4.9	Datum based on an external or internal wedge	180
	<i>Figure C.8 – Primary datum based on a wedge</i>	180
C.4.10	Prismatic feature	181
	<i>Figure C.9 – Datum for prismatic feature</i>	181
	<i>Figure C.10 – Nonideal prismatic surface</i>	181
	<i>Figure C.11 – Situation features for prismatic surface</i>	182
	<i>Figure C.12 – Primary datum based on a prismatic surface</i>	183
C.4.11	Complex surface	183
	<i>Figure C.13 – Primary datum based on a complex surface</i>	184
Annex D	(normative) Document security – Enhanced	185
D.1	Enhanced security	185
D.2	Identification of security classification	185
D.3	Marking for enhanced security	185
Annex E	(informative) Implementation in CAD	186
E.1	General	186

E.2	Implementation according to BS 8888 and BS EN ISO 5459	186
	<i>Figure E.1 – Implementation according to BS 8888 and BS EN ISO 5459</i>	186
E.3	Implementation according to most CAD software	187
	<i>Figure E.2 – Implementation according to most CAD software</i>	187
Annex F	(informative) Tolerancing system: Former practice	188
	<i>Figure F.1 – BS 8888 independency system symbol</i>	188
	<i>Figure F.2 – BS 8888 dependency system symbol</i>	188
Annex G	(informative) Selected ISO fits: Hole and shaft basis	189
	<i>Table G.1 – Selected ISO fits: Hole basis</i>	190
	<i>Figure G.2 – Selected ISO fits: Shaft basis</i>	192
Annex H	(informative) Filtration	194
H.1	Introduction	194
H.2	Filter types	194
H.3	Filters and nesting indices	195
H.4	Default filters	195
H.5	Examples	195
Annex I	(informative) Dimensioning of slots	196
I.1	Defining the size of the slot	196
	<i>Figure I.1 – Dimensioning slots with rounded ends</i>	196
	<i>Figure I.2 – Profile tolerance</i>	197
I.2	Defining the location of the slot	197
	<i>Figure I.3 – Defining the location of a slot</i>	197

Summary of pages

This document comprises a front cover, an inside front cover, pages i to xiv, pages 1 to 197, and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2020. It was prepared by Technical Committee TDW/4/8, *BS 8888 Technical product specification*, under the authority of Technical Committee TDW/4, *Technical product realization*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This British Standard supersedes BS 8888:2017, which is withdrawn.

Information about this document

This edition of the standard is a full revision. It introduces relevant international standards published since the 2017 edition. It also incorporates more fully than previous editions some of the fundamental requirements of the key international standards relevant to the preparation of technical product specifications, such as [BS EN ISO 1101](#) and [BS EN ISO 5459](#). It is hoped that UK industry will find this edition of BS 8888 more user-friendly than previous editions. It aims to help organizations better understand and implement the full complement of international standards developed by ISO/TC 213, *Geometrical product specifications and verification*, and ISO/TC 10, *Technical product documentation*.

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Several figures are used with kind permission of Iain Macleod Associates Ltd.

Relationship with other publications

The function of BS 8888 is to draw together, in an easily accessible manner, the full complement of international standards relevant to the preparation of technical product specifications. However, it is not the intention for BS 8888 to be a “stand-alone” standard. TDW/4 is responsible for a suite of related national standards, including the various parts of [BS 8887](#), [BS 8889](#) and [PD 68888](#), a new training document.

BS 8888 was taken up by the Ministry of Defence in 2006 as part of its DEF-STAN for defence project specification.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

In addition, information boxes provide additional informative material that might otherwise have appeared in informative annexes but was felt to be best placed in the main body of text.

All dimensions shown in the figures in this British Standard are in millimetres.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

THIS PAGE DELIBERATELY LEFT BLANK

Section 1 Scope

1.1 Scope

This British Standard specifies requirements for technical product documentation and specification, principally for manufacturing industries and organizations associated with engineering disciplines, such as mechanical, electrical, nuclear, automotive, aerospace and medical devices.

The needs of building, architectural, civil, and structural engineering and construction services industries continue to be covered by the [BS 1192](#) series of standards.

Most of this British Standard consists of an implementation of the ISO system for technical product documentation and specification. The ISO system is defined in a large number of interlinked and related international standards which are referenced in this British Standard.

The purpose of this British Standard is to facilitate the use of the ISO system by providing:

- an index to the international standards which make up the ISO system, referencing them according to their area of application;
- key elements of the ISO standards to facilitate their application;
- references to additional British and European standards where they provide information or guidance over and above that provided by ISO standards; and
- commentary and recommendations on the application of the standards where this is deemed useful.

The requirements refer to international and European standards which have been implemented as British Standards, either in the BS EN, BS EN ISO, BS ISO series or as international standards renumbered as British Standards.

[Annex A \(normative\)](#) contains a list of normative references, indispensable for the application of this British Standard.

[Annex B \(informative\)](#) contains a list of informative references.

[Annex C \(informative\)](#) gives information about association.

[Annex D \(normative\)](#) contains requirements for enhanced document security.

[Annex E \(informative\)](#) gives information about the implementation of datums and datum features in CAD.

[Annex F \(informative\)](#) demonstrates former practice for tolerancing.

[Annex G \(informative\)](#) gives selected ISO fits for holes and shafts.

[Annex H \(informative\)](#) explains how data representing a manufactured surface are filtered by the measurement process.

[Annex I \(informative\)](#) gives further information about the dimensioning of slots.

1.2 Normative references

The documents listed in [Annex A](#) are referred to in the text in such a way that some or all of their content constitutes provisions of this document¹⁾. For dated references, only the edition cited applies.

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography ([Annex B](#)).

For undated references, the latest edition of the referenced document (including any amendments) applies.

1.3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in [BS EN ISO 10209](#) and [BS EN ISO 14660-1](#) apply, together with the following.

1.3.1 date of issue

point in time at which the technical product specification is officially released for its intended use

NOTE 1 The date of issue is important for legal reasons, e.g. patent rights, traceability.

NOTE 2 For the implications of the date of issue, see [3.1.3](#).

1.3.2 ISO GPS system

geometrical product specification and verification system developed in ISO by ISO/TC 213

1.3.3 technical product documentation (TPD)

means of conveying all or part of a design definition or specification of a product

1.3.4 technical product specification (TPS)

technical product documentation comprising the complete design definition and specification of a product for manufacturing and verification purposes

NOTE A TPS, which might contain drawings, 3D models, parts lists or other documents forming an integral part of the specification, in whatever format they might be presented, might consist of one or more TPDs.

Section 2 Standards underpinning BS 8888

2.1 General

The following documents shall be applied as “global” standards in support of BS 8888.

[ISO/IEC Guide 98-3](#)

Guide to the expression of uncertainty in measurement (GUM)

[ISO/IEC Guide 99](#)

International vocabulary of metrology – Basic and general concepts and associated terms (VIM)

The principles in [Section 3](#) shall always be applied where conformity with BS 8888 is claimed.

Section 3 Technical product specification (TPS): Principles and concepts

3.1 Principles of specification

3.1.1 Types of technical product specification

3.1.1.1 2D TPS (2D drawing only)

COMMENTARY ON [3.1.1.1](#)

This subclause relates to a 2D drawing in hardcopy or electronic format. Although 3D CAD can be used to derive the 2D drawing, the 3D model does not form any part of the TPS.

A 2D TPS shall consist of 2D drawing information only. The drawing(s) shall provide all the necessary views, sections, datums, dimensions, tolerances and general notation to provide suitable and sufficient information to manufacture and verify the workpiece.

NOTE A workpiece can consist of a component or an assembly.

3.1.1.2 Combined 3D and 2D TPS

COMMENTARY ON [3.1.1.2](#)

This subclause relates to a 2D drawing (specification) with 3D CAD geometry (definition) which in combination fully specifies a component or assembly. A 3D/2D TPS uses both 3D models and 2D drawings in combination to provide suitable and sufficient information to manufacture and verify the workpiece.

A combined 2D and 3D TPS shall conform to [BS ISO 16792](#).

In the absence of any dimension on the drawing, values shall be obtained from an interrogation of the 3D model geometry.

Unless otherwise stated, all tolerance requirements shall appear on the 2D drawing.

Unless otherwise stated, any dimension explicitly defined in any 2D TPS shall take precedence over any dimension obtained by interrogating the 3D model.

3.1.1.3 3D TPS (3D CAD model only)

COMMENTARY ON [3.1.1.3](#)

This subclause relates to 3D CAD data in electronic format. There is no 2D drawing.

A 3D TPS shall conform to [BS ISO 16792](#).

The 3D TPS shall fully specify all geometry, datums, dimensions and tolerances in order to provide suitable and sufficient information to manufacture and verify the workpiece. A 3D TPS shall consist of 3D model information only. The 3D model(s) shall provide the CAD nominal geometry and sufficient datums, dimensions, tolerances and general notation necessary to provide suitable and sufficient information to manufacture and verify the workpiece.

3.1.1.4 Working with 3D CAD data

COMMENTARY ON [3.1.1.4](#)

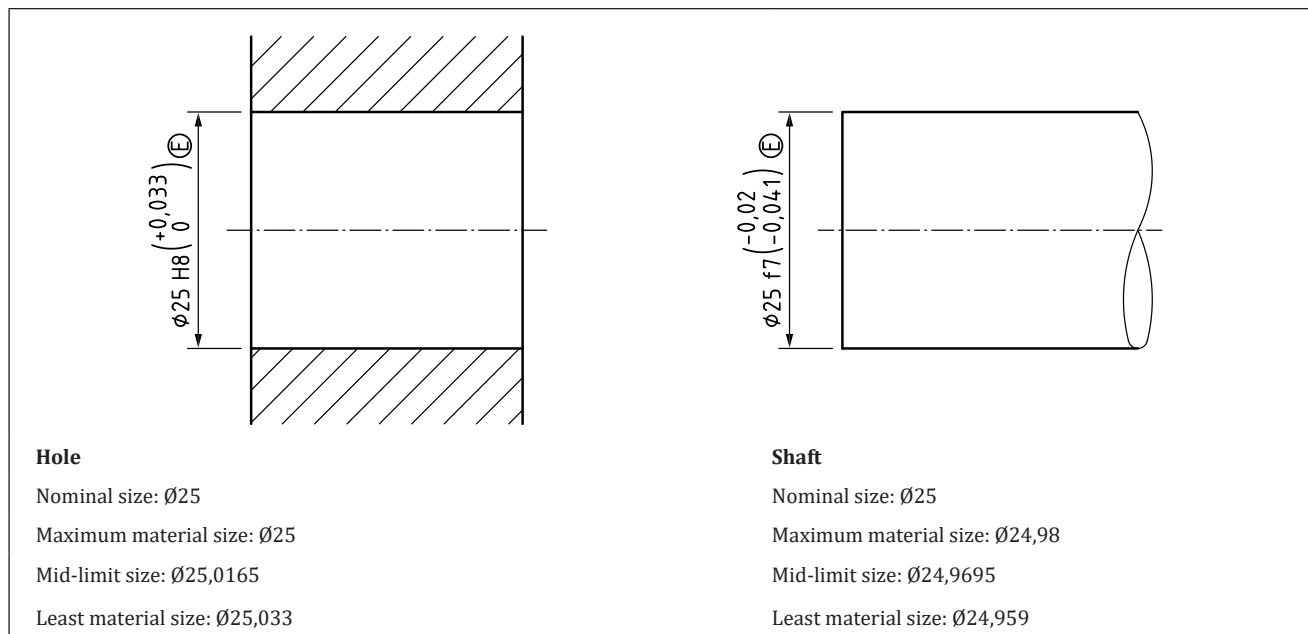
See [BS ISO 16792](#).

Where the 3D CAD geometry includes features of size, two different practices are widely used. These are to model the feature at "nominal" size or to model the feature at "mid-limit" size (see [Figure 1](#)).

"Nominal" size is the dimension size to which the tolerance is applied. "Mid-limit" size is the size half-way through the tolerance range.

Where symmetrical size tolerances are used, “nominal” and “mid-limit” are the same. When non-symmetrical tolerances are used, such as limit and fit codes, they are different.

Figure 1 – Hole and shaft sizes



When a nominal size is provided by means of a specification or dimension, all features of size can be modelled to nominal size or to mid-limit value of the tolerance limits. Where a nominal size is not provided, all features of size shall be modelled to the mid-limit value of the tolerance limits, unless otherwise stated (see [Table 1](#)).

Within a 3D CAD model, wherever non-symmetrical size tolerances are used, one practice shall be consistently followed.

Table 1 – Mean and nominal values for 3D CAD model

Dimension	Nominal value	Value to be modelled when working to nominal	Mid-limit value	Value to be modelled when working to “mid-limit”
Ø15 Ø13	Not stated	Ø14	Ø14	Ø14
20,4 19,6	Not stated	20	20	20
10 ±1	10	10	10	10
Ø25 H8E	25	25	25,0165	Ø25,0165
Ø 25 f7E	25	25	24,9695	Ø24,9695
+1,5 Ø13,5 -0,5	13,5	13,5	14	Ø14
+1 Ø14 0	14	14	14,5	Ø14,5
R0,5 max.	R0,5	R0,5	R0,25 ^{A)}	R0,25

^{A)} Min. value = 0.

3.1.2 General principles of specification

The specifier shall determine what level of detail is required in a specification and define the workpiece in an appropriate manner (see [Table 2](#)).

COMMENTARY ON 3.1.2

When a specification leaves certain requirements undefined, or open to more than one interpretation, it is ambiguous.

The more ambiguity which exists in a specification, the greater the risk that a manufactured product conforms to that specification but is still unfit for purpose. Conversely, there is also greater risk of rejecting a workpiece which is fit for purpose.

The less ambiguity which exists in a specification, the greater the likelihood that the conforming manufactured product is fit for purpose.

It is not always necessary to minimize or eliminate the ambiguity in a specification. A high level of ambiguity can be acceptable when the specifier is willing to rely on the skill, craftsmanship and knowledge of the manufacturer or fitter to achieve a satisfactory result. The benefit is a very simple specification, but the consequences could include a high degree of variation from one part to the next, a lack of interchangeability and inconsistent quality.

Higher levels of ambiguity also mean much greater probability of disputes over whether a manufactured product is acceptable or not.

The use of datums, geometrical tolerances, surface texture requirements and edge tolerances is not obligatory. However, not using these specification elements results in greater ambiguity.

Table 2 – Level of detail in a TPS Technical product documentation – Digital product definition data

Specification elements included	Level of detail			
	Sketch	Technical model/ drawing	Technical model/drawing with geometrical tolerancing	ISO GPS specification
3D/2D geometry	✓	✓	✓	✓
Dimensions		✓	✓	✓
+/- Tolerances		✓	✓	✓
Datums			✓	✓
Geometrical tolerances			✓	✓
Surface texture requirements				✓
Edge tolerances				✓
Level of ambiguity in the specification	Very high	High	Low	Very low

3.1.3 Date of issue principle

A TPS shall always be interpreted according to those versions of the standards which governed its interpretation on its date of issue, unless otherwise indicated.

3.1.4 Reference conditions

Unless otherwise stated, all geometrical properties and tolerances for a workpiece given in a TPS shall be considered to apply at 20 °C.

NOTE 1 See [BS EN ISO 1](#).

By default, all GPS specifications shall apply at reference conditions, including the workpiece's freedom from contaminants.

NOTE 2 See [BS EN ISO 8015](#).

Any additional or other conditions that apply, e.g. humidity conditions, shall be defined on the drawing.

3.1.5 Interpretation

A TPS shall indicate which standards, or systems of standards, govern its interpretation.

When the format of data in a TPS conforms to the British and ISO standards identified in BS 8888, a reference to BS 8888 itself shall be sufficient to indicate that these standards apply to the specification. Such a reference shall take the following form.

CONFORMS TO BS 8888

NOTE 1 This note may be placed in the title block, in a drawing note, or elsewhere within the drawing frame.

NOTE 2 The phrase "format of data" refers to 2D and 3D TPS, and includes aspects such as format of attributes, layout of drawing borders and title blocks, layout of views and projections, format of letters, numbers, dimensions and tolerances, and use of different line types and thicknesses.

When the geometry of a workpiece is defined according to the requirements of ISO GPS (see 3.3), which are documented in standards such as [BS EN ISO 5459](#) and [BE EN ISO 1101](#), a reference to [BS EN ISO 8015](#) is sufficient to indicate that all ISO GPS standards apply to the interpretation of that specification. Such a reference shall take the following form.

TOLERANCING ISO 8015

NOTE 3 This note may be placed in the title block, in a drawing note, or elsewhere within the drawing frame. This note is required in addition to any reference to BS 8888.

This marking is a BS 8888 requirement, and not a requirement of [BS EN ISO 8015](#). This is necessary to avoid possible misinterpretation of which system of standards govern the interpretation of a TPS.

3.1.6 Decimal principle

Non-indicated decimals shall be taken as zeroes.

NOTE 1 0,2 is the same as 0,200 000 000 000 000 000 000 000 000 ... etc.

NOTE 2 10 is the same as 10,000 000 000 000 000 000 000 000 000 ... etc.

3.1.7 Rigid workpiece principle

Unless otherwise stated, a workpiece shall be considered as having infinite stiffness, and all geometrical properties and tolerances given in a TPS shall be considered to apply in the absence of deformation from any external forces (including gravity). Any additional or other conditions that apply shall be defined in the drawing.

3.1.8 Non-rigid workpieces

A non-rigid workpiece is one that deforms to an extent that in the free state it is beyond the dimensional and/or geometrical tolerances on the drawing. A non-rigid workpiece shall therefore have the free-state deformation removed for verification by applying pressure or forces that replicate, but do not exceed, those expected under normal assembly conditions.

NOTE 1 This is known as the "restrained condition". The restrained condition normally corresponds to the assembly condition but might also correspond to certain operational conditions. Dimensions, tolerances and geometrical tolerances may be applied to either the free state or to the restrained condition, or to both.

NOTE 2 Free state is the condition of a part subjected only to the force of gravity.

NOTE 3 This is particularly important when aligning and/or measuring large and/or flexible constructions.

A TPS for a non-rigid workpiece shall include:

- the indication ISO10579-NR near the title block or in the notes;
- a definition of restraint, e.g. use of tooling, application of forces or pressure, and if necessary an indication of the direction of gravity;
- if required, a definition of the condition under which free-state tolerances apply, e.g. orientation and direction of gravity.

When ISO 10579-NR is indicated on the drawing, all dimensions, tolerances and geometrical tolerances shall apply to the restrained condition unless otherwise stated. Any dimensions, tolerances and geometrical tolerances which apply to the free state shall be identified with the (F) symbol (see [7.10.2](#)).

3.2 Fundamental concepts

3.2.1 Properties

A TPS defines various properties and requirements. Some properties or requirements may be defined for an entire workpiece (e.g. a material specification), some for part of a workpiece (e.g. a particular surface treatment), and some for individual features on a workpiece (e.g. a size requirement).

Properties or requirements may also be defined for a process or procedure.

Properties which may be specified include:

- size;
- location;
- orientation;
- form;
- surface texture;
- surface imperfections;
- properties of edges;
- material;
- coatings and finishes;
- hardness;
- chemical composition;
- treatments which are to be applied to the workpiece;
- processing requirements;
- recycling requirements;
- packaging requirements; and
- handling requirements.

Properties of location and orientation may be defined solely with toleranced dimensions (see [Section 5](#)), but this results in ambiguous specifications which are open to a wide range of interpretations.

For an unambiguous definition of the size, location, orientation and form of features on the workpiece, the ISO system of Geometrical Product Specification shall be used.

NOTE This utilizes datums and geometrical tolerances to minimize ambiguity (see [Section 6](#) and [Section 7](#)).

3.2.2 Feature principle

A workpiece shall be considered to be made up of a number of features limited by natural boundaries. By default, every specification requirement for a feature or relation between features shall apply to the entire feature and each specification requirement shall apply only to one feature or one relation between features.

NOTE This default can only be overridden by explicit indications on the drawing. The system for classifying features is outlined in the following information box.

Classification of features

ISO GPS defines several different types of feature. The main types of features are:

- a) integral features: features which consist of, or represent, surfaces on the workpiece;
- b) features of size: integral features which have a size characteristic and include (but are not limited to) the following types of feature:
 - 1) two parallel opposed planes;
 - 2) a cylinder;
 - 3) a sphere;
 - 4) two non-parallel planes (a wedge);
 - 5) a cone;
 - 6) the two rounded ends of a slot or protrusion (see [Annex I](#)); and
 - 7) a torus;
- c) derived features: theoretical features such as axes or median lines, which are derived from a feature of size (axis or median line, median plane or median surface and centre points).

ISO GPS also defines a number of different “worlds” or “states” in which features can exist. In some “worlds” the features exist in an ideal form, such as in the specification, while in other states they exist in a non-ideal form, such as surfaces on the manufactured workpiece (see [Figure 2](#)).

Nominal features

In the “world” of the specification, features are represented in an ideal state. These features have ideal form, and ideal relationships with each other. Features in this world are known as nominal features.

Real features

In the “world” of the manufactured workpiece (the physical world), features are non-ideal and are known as real features.

Extracted features

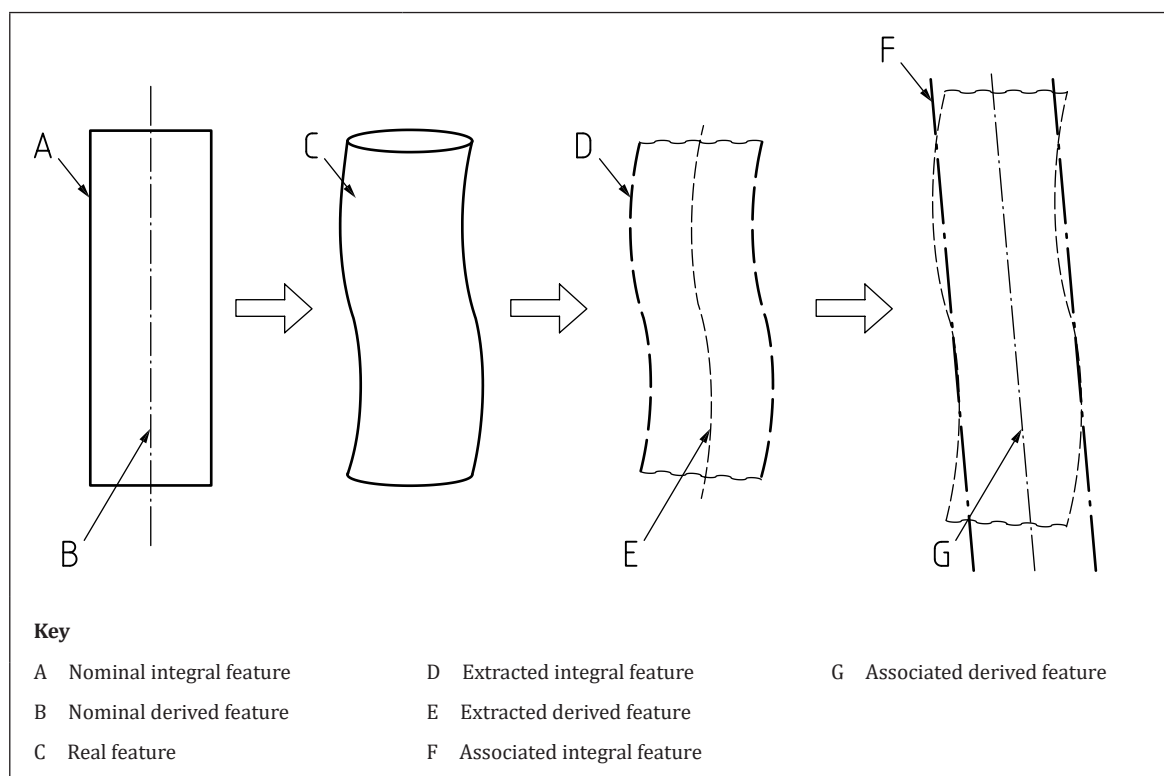
In the “world” of verification, a feature is represented by a set of data obtained by sampling the workpiece with measuring instruments. This set of data represents the non-ideal real feature and is known as an extracted feature.

NOTE 1 The extracted feature is used when determining whether a tolerance requirement has been met.

Associated features

In the “world” of verification, an ideal feature may be “fitted” to, or associated with, either the real feature or the extracted feature. This ideal feature is known as an associated feature.

NOTE 2 The associated feature is used when determining the orientation of size measurements, or when defining a datum. A range of different association methods may be used.

Figure 2 – Interrelationship of the geometrical feature definitions

3.2.3 Interpretations of limits of size for a feature of size

3.2.3.1 Relevant standards

Limits of size for a feature of size shall be interpreted according to the principles and rules defined in the following standards.

[BS EN ISO 8015](#)

Geometrical product specifications (GPS) – Fundamentals – Concepts, principles and rules

[BS EN ISO 14405-1](#)

Geometrical product specifications (GPS) – Dimensional tolerancing – Part 1: Linear sizes

[BS EN ISO 14405-2](#)

Geometrical product specifications (GPS) – Dimensional tolerancing – Part 2: Dimensions other than linear or angular sizes.

[BS EN ISO 14405-3](#)

Geometrical product specifications (GPS) – Dimensional tolerancing – Part 3: Angular sizes

[BS EN ISO 17450-1](#)

Geometrical product specifications (GPS) — General concepts — Part 1: Model for geometrical specification and verification

[BS EN ISO 17450-2](#)

Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators, uncertainties and ambiguities

[BS EN ISO 17450-3](#)

Geometrical product specifications (GPS) — General concepts — Part 3: Toleranced features

[BS EN ISO 22432](#)

Geometrical product specifications (GPS) — Features used in specification and verification

3.2.3.2 Interpretations of limits of size for a linear feature of size

A linear size specification shall be interpreted as a two-point size requirement unless otherwise indicated.

When a different specification operator is required, it shall be invoked using the appropriate modifier applied to the individual size specification, or by defining a different default linear size specification operator for the entire TPS (see [BS EN ISO 14405-1](#)).

If the default size specification operator is to be changed for an entire TPS, the following indication shall appear in or near the title block of each drawing:

LINEAR SIZE ISO 14405 X

where X is the modifier representing the required operator.

For example, if the envelope requirement is to be made the default interpretation of linear size specifications for the entire TPS, the indication shall be:

LINEAR SIZE ISO 14405 Ⓔ

NOTE 1 It is recommended that a note on the drawing be used in addition to the ISO 14405 reference, for clarity.

The consequence of using the default “two-point” definition of a linear size tolerance is that size limits only apply to any “two-point” size measurement of a feature. Therefore, the size limits do not control the form deviations of the feature. For example:

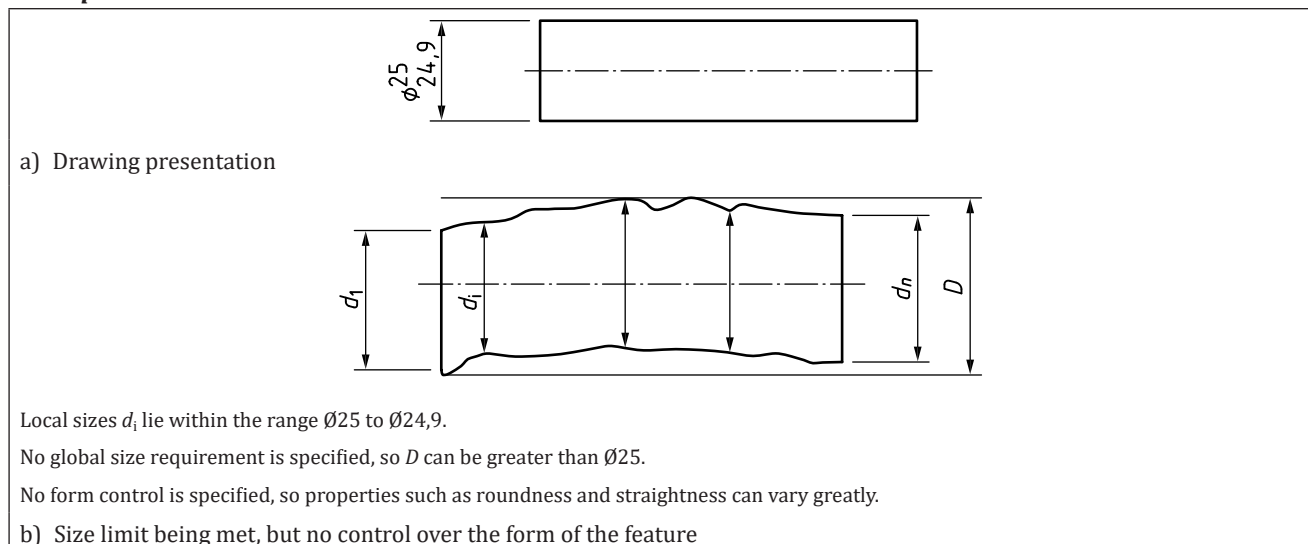
- the size limits on a cylindrical feature do not control its roundness or straightness; and
- the size limits on a feature consisting of two parallel, opposed planes do not control the flatness of the two planes.

Form deviations can be controlled by:

- individually specified geometrical tolerances;
- general geometrical tolerances;
- the use of the envelope requirement, Ⓔ [where the maximum material limit of size defines an envelope of perfect form for the relevant surfaces (see [BS EN ISO 14405-1](#))]; or
- the use of another global size characteristic (see [BS EN ISO 14405-1](#)).

NOTE 2 [Figure 3](#) gives examples of how size limits could be interpreted where no form control is defined and the specification is incomplete.

Figure 3 – Possible interpretations of size limits where no form control is defined and the specification is incomplete



Some national standards apply (or have applied in the past) the envelope requirement to all linear features of size by default. As the envelope requirement has been the default, they have not used a symbol to indicate this requirement; rather, they use (or used) a note to indicate when this is not required. This system of tolerancing is sometimes described as the principle of dependency, or the application of the Taylor Principle.

Standards which apply, or have applied, the envelope requirement by default include:

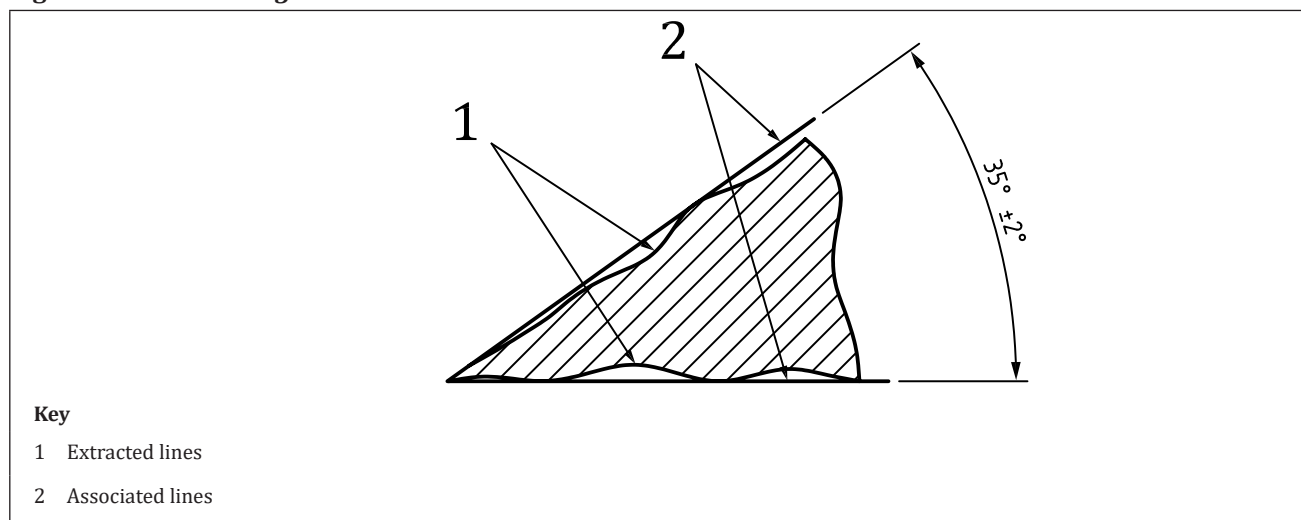
- BS 308²⁾;
- ASME Y14.5 [1]³⁾; and
- DIN 7167.

3.2.3.3 Interpretations of limits of size for an angular feature of size

An angular size specification shall be interpreted as a two-line angular size requirement, with minimax association, unless otherwise indicated.

NOTE 1 For angular size, the angle applies to an ideal line or plane fitted (associated) to the manufactured surface. “Minimax” association (also known as a “Chebyshev” association) is a method used for fitting an ideal feature to a manufactured surface (see Figure 4). The minimax association works by minimizing the maximum deviations between the ideal feature and the manufactured feature. It can be further modified by applying a material constraint such as “outside the material” or “inside the material”, but as this makes no difference to the orientation of the ideal feature, no material constraint is specified when evaluating angular sizes.

Figure 4 – Two-line angular size: Second association with minimax criterion



When a different specification operator is required, it shall be invoked using the appropriate modifier applied to the individual angular size specification, or by defining a different default angular size specification operator for the entire TPS (see [BS EN ISO 14405-3](#)).

If the default size specification operator is to be changed for an entire TPS, the following indication shall appear in or near the title block of each drawing:

ANGULAR SIZE ISO 14405 X

where X is the modifier representing the required operator.

²⁾ Withdrawn

³⁾ The requirement that there is an envelope of perfect form corresponding to the maximum material size of the feature is defined as Rule #1 in ASME Y14.5 [1].

For example, if the global angular size with least squares association is to be made the default interpretation of angular size specifications for the entire TPS, the indication shall be:

ANGULAR SIZE ISO 14405 H

NOTE 2 It is recommended that a note on the drawing be used in addition to the ISO 14405 reference, for clarity.

3.2.3.4 Implied dimensions

NOTE Implied dimensions are dimensional requirements which are not explicitly indicated on a 2D engineering drawing, but which have the same meaning as a dimensional requirement which is explicitly stated.

The following rules shall govern the use and interpretation of implied annotation on engineering drawings.

These rules do not apply to 3D specifications; where all dimensional requirements are defined in the model, implied dimensions shall not be used where there is a significant risk of misinterpretation.

- a) Where two features are aligned, there is no requirement to indicate a linear dimension of 0 or an angular dimension of 0°.
- b) Where two features are parallel to each other, there is no requirement to indicate an angular dimension of 0° or 180°.
- c) Where two features are at 90° to each other, there is no requirement to indicate an angular dimension of 90°.
- d) Where several features are equispaced around a pitch circle (see [BS ISO 129-1](#)), there is no requirement to indicate an angular dimension, although it might be advisable to do so. Terms such as “equispaced” and “equally spaced” shall not be used.
- e) If the features concerned have their locations and/or orientations controlled through the use of geometrical tolerances, the implied dimensions shall be taken as theoretically exact dimensions (TEDs; see [7.8](#)).
- f) If the features concerned have their locations and/or orientations controlled through the use of +/– or limit tolerances, the implied dimensions shall also be toleranced. In the absence of other indications, they shall be subject to a general tolerance, or else the TPS would remain incomplete (see [5.4](#)).

Tolerances can never be implied and shall always be indicated.

Datums can never be implied and shall always be indicated.

3.3 Geometrical product specification

3.3.1 Interpretation and invocation principle

Once a portion of the ISO GPS system is invoked on a mechanical engineering product specification, the entire ISO GPS system shall be invoked, unless otherwise indicated on the specification e.g. by reference to a relevant document.

“Unless otherwise indicated on the specification” means that it is indicated on the specification that this has been prepared in accordance with a certain standard. That standard, and not the ISO GPS system, shall be used to interpret those elements of the specification which are covered by that standard.

NOTE 1 The ISO GPS system is defined in a hierarchy of standards that includes the following types of standards in the given order:

- *fundamental GPS standards;*
- *general GPS standards; and*
- *complementary GPS standards.*

See [BS EN ISO 14638](#) for further details.

The “entire ISO GPS system shall be invoked” means that fundamental and general GPS standards shall apply and, consequently, that the reference temperature given in [BS EN ISO 1](#) and the decision rules given in [BS EN ISO 14253-1](#) shall apply, unless otherwise indicated.

NOTE 2 The purpose of the invocation principle is to provide the formal traceability for these GPS standards and rules.

The rules given in standards at a higher level in the hierarchy shall apply in all cases, unless rules in standards at lower levels in the hierarchy specifically give other rules.

All rules given in fundamental GPS standards shall apply, in addition to those specifically given in general GPS standards, e.g. [BS EN ISO 1101](#), except where the rules in the general GPS standard are explicitly different from the rules given in fundamental GPS standards and unless the rules in a specific complementary GPS standard give other rules that apply within its scope.

All rules given in fundamental and general GPS standards shall apply in addition to the rules specifically given in complementary GPS standards, e.g. [BS EN 22768-1](#), except in the cases where the rules in the complementary GPS standard are explicitly different from the rules given in fundamental and general GPS standards.

3.3.2 Independency principle

By default, every GPS requirement for a feature or relation between features shall be fulfilled independently of other requirements, except when it is stated in a standard or by special indication (e.g. modifiers $\textcircled{M}$ or $\textcircled{L}$ according to [BS EN ISO 2692](#) or CZ or CZR according to [BS EN ISO 5458](#)) as part of the actual specification.

Section 4 Technical product documentation (TPD)

Various types of documents are used to provide appropriate technical information to define the features and requirements for a component or assembly (see [Section 3](#)). A parts list can be included on the drawing. The most commonly used document types are as follows (see [BS ISO 29845](#) for further document types).

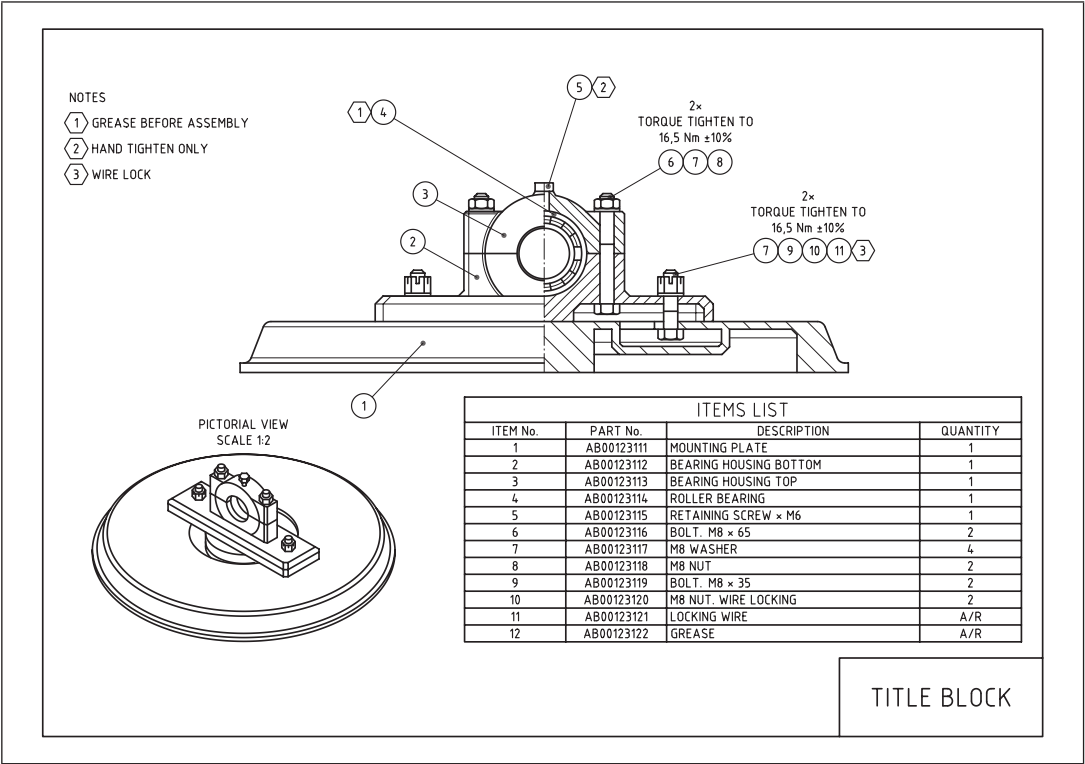
Assembly drawing

An assembly drawing (see [Figure 5](#)) represents the relative position and/or shape of a group of assembled parts. It depicts the constituents of a parts list.

The list of parts is normally provided in a separate document, i.e. a parts list, but can be included within the drawing, with the individual parts annotated with ballooned numbers matching the item numbers in the parts list.

Relevant information can also be added, torque settings can either be shown adjacent to the item balloon or in a torque table, and other information, e.g. lubricating grease, thread adhesive, can be shown alongside corresponding flag notes. Overall and key dimensions can also be included, along with mass and centre of gravity.

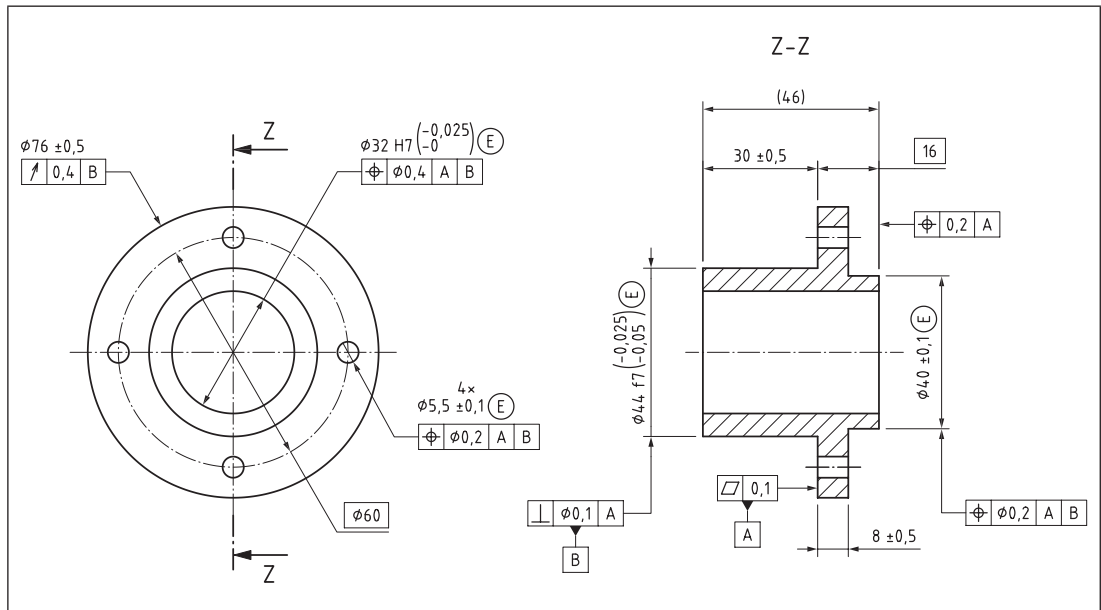
Figure 5 – Example of assembly drawing



Part drawing

A part drawing includes all the necessary information required for the definition of the part, e.g. material properties, dimensions, tolerances, surface texture (see [Figure 6](#) over page).

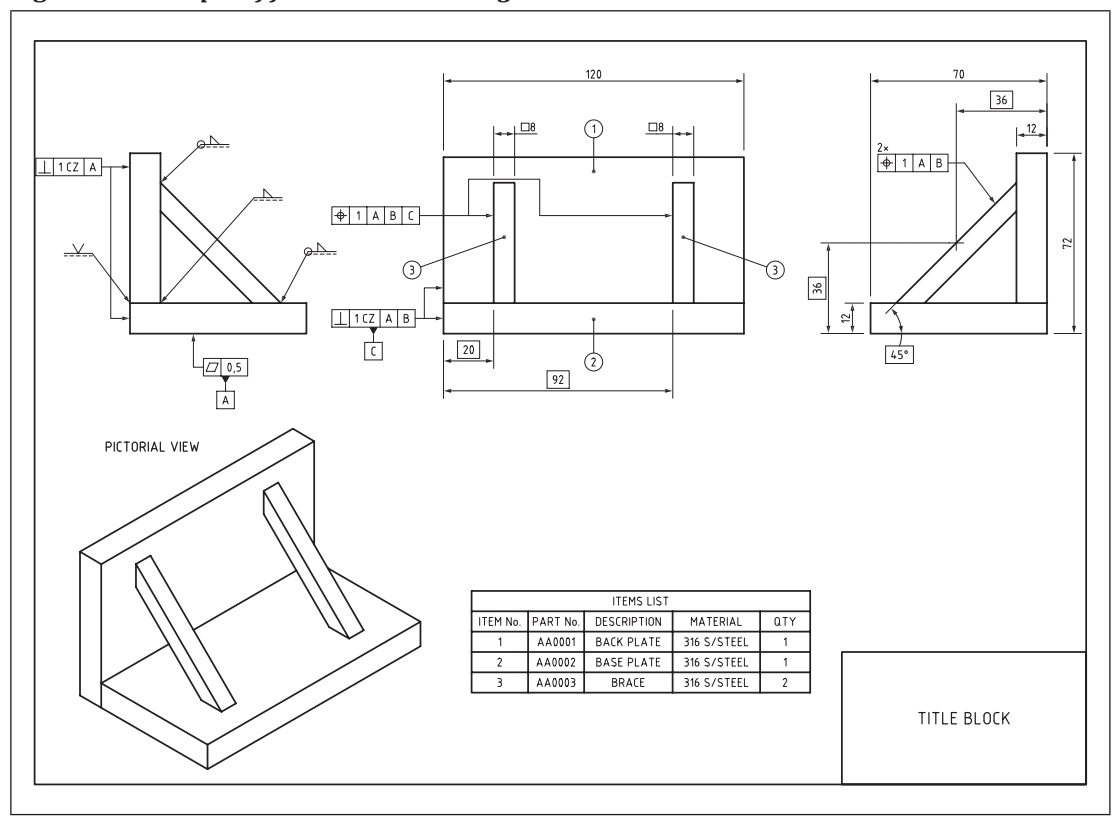
Figure 6 – Example of part drawing



Fabrication drawing

A fabrication drawing depicts a workpiece which is permanently joined together by means of welding, brazing, adhesion or other method. The constituents need to be fully specified (see [Figure 7](#)).

Figure 7 - Example of fabrication drawing



4.1 Graphical representation and annotation of 3D data (3D modelling output)

Graphical representation and annotation of 3D models shall conform to the following standard.

[BS ISO 16792, Technical product documentation – Digital product definition data practices](#)

NOTE See [Section 3](#).

4.2 Drawing sheets

COMMENTARY ON [4.2](#)

The complete drawing sheet comprises the drawing space, title block, border and frame.

4.2.1 General

The drawing sheet shall conform to [BS EN ISO 5457](#) and [BS EN ISO 7200](#).

4.2.2 Sizes

As required by [BS EN ISO 5457](#), the original drawing shall be made on the smallest sheet permitting the necessary clarity and resolution.

NOTE 1 The preferred sizes of the trimmed and untrimmed sheets, as well as the drawing space, are given in [Table 3](#).

NOTE 2 The range of sheet sizes chosen could be rationalized through the use of scales (see [4.4](#)).

Table 3 – Sizes of trimmed and untrimmed sheets and the drawing space^{A)}

Designation	Trimmed sheet (T)		Drawing space		Untrimmed sheet (U)	
	a ₁ ^{B)}	b ₁ ^{B)}	a ₂ ±0,5	b ₂ ±0,5	a ₃ ±2	b ₃ ±2
A0 ^{C)}	841	1 189	821	1 159	880	1 230
A1	594	841	574	811	625	880
A2	420	594	400	564	450	625
A3	297	420	277	390	330	450
A4 landscape	210	297	190	267	240	330
A4 portrait	297	210	277	180	330	240

^{A)} Dimensions in millimetres.

^{B)} For tolerances see [BS EN ISO 216](#).

^{C)} For sizes >A0 see [BS EN ISO 216](#).

4.2.3 Graphical features

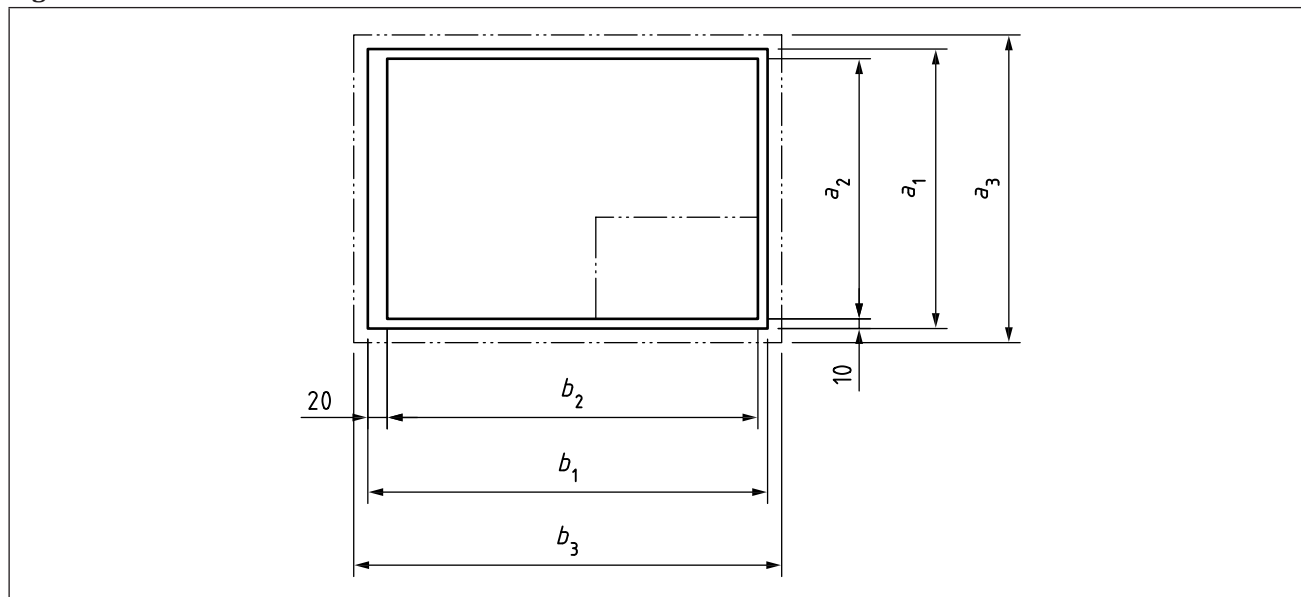
4.2.3.1 Title block

NOTE 1 For the dimensions and layout of title blocks, see [BS EN ISO 7200](#).

Sheet sizes A0 to A3 shall be used in landscape orientation only (see [Figure 8](#)) and the title block shall be located in the bottom right-hand corner of the drawing space.

NOTE 2 A4 sheets can be used in landscape or portrait orientation.

For sheet size A4, the title block shall be situated in the bottom right-hand corner when used in landscape orientation, or the shorter (bottom) part of the drawing space when used in portrait orientation.

Figure 8 – Size A4 to A0

The total width of the title block shall be 180 mm to fit an A4 portrait sheet where the left margin is 20 mm and the right margin 10 mm. The same title block shall be used for all paper sizes (see [Figure 9](#)).

NOTE 3 In a TPS there is a minimum of eight mandatory data fields which can appear in the title block or elsewhere in the TPS or data management system (see [Table 4](#)).

Figure 9 – Title block in compact form

Responsible dept. ABC 2	Technical reference Patricia Johnson	Document type Sub-assembly drawing	Document status Released
Legal owner	Created by Jane Smith	Title, Supplementary title Apparatus plate	AB123 456-7
	Approved by: David Brown	Complete with brackets	
		Rev. A	Date of issue 2002-05-14
			Lang. en
			Sheet 1/5
180			

Table 4 – Identifying, descriptive and administrative data fields in the title block

Field name	Language-dependent	Recommended number of characters	Field type
Legal owner	–	Unspecified	Identifying
Identification number	No	16	Identifying
Date of issue	No	10	Identifying
Segment/sheet number	No	4	Identifying
Title	Yes	25/30 ^{A)}	Descriptive
Approval person	No/Yes ^{B)}	20	Administrative
Creator	No/Yes ^{B)}	20	Administrative
Document type	Yes	20	Administrative

^{A)} 30 to support two-byte-character languages such as Japanese or Chinese.

^{B)} “Yes” to support presentation in different types of alphabet.

4.2.3.2 Borders and frame

Borders enclosed by the edges of the trimmed sheet and the frame limiting the drawing space shall be provided with all sizes. The border shall be 20 mm wide on the left edge, including the frame, and it can be used as a filing margin. All other borders shall be 10 mm wide.

The frame for limiting the drawing space shall be executed with continuous wide lines.

4.2.3.3 Grid reference system

The sheets shall be divided into fields in order to permit easy location of details, additions, revisions, etc., on the drawing. The individual fields shall be referenced using capital letters (I and O shall not be used) in the left and right borders, and numerals in the top and bottom borders. For the size A4, they shall be located only at the top and the right side. The start of the ascending sequences of letters and numerals shall begin at the sheet origin, which can either be determined manually or defined by the CAD tool.

The size of letters and characters shall be 3.5 mm. The length of the fields shall be 50 mm, starting either at the sheet origin or from the centring mark.

NOTE The number of fields depends on sheet size (see [Table 5](#)).

The letters and numerals shall be placed in the grid reference border and shall be written in vertical characters in accordance with [BS EN ISO 3098-2](#).

The number of fields shall be extended as required for non-standard sheet sizes.

The grid reference system lines shall be executed with continuous narrow lines.

Table 5 – Number of fields

Designation	A0	A1	A2	A3	A4
Long side	24	16	12	8	6
Short side	16	12	8	6	4

4.3 Line types and line widths

4.3.1 Types of line

Lines shall conform to [BS EN ISO 128-20](#).

NOTE 1 Examples of the most common line type and width combinations for engineering drawings are given in [Table 6](#).

NOTE 2 See [BS EN ISO 128-20](#) and [BS ISO 128-24](#) for more information on lines.

Table 6 – Basic line types

No.	Representation	Description	Application
01.1		Continuous narrow line	Dimension lines, extension lines, leader lines, hatching, roots of screw threads, termination of interrupted views
01.2		Continuous wide line	Visible edges, visible outlines, crests of threads, limit of thread length, section arrows
02.1		Dashed narrow line	Hidden edges, hidden outlines
02.2		Dashed wide line	Permissible areas of surface treatment
04.1		Long dashed-dotted narrow line	Centre lines, lines and planes of symmetry, pitch circle of gears or holes, spread of surface-hardened areas
04.2		Long dashed-dotted wide line	Position of cutting planes, restricted area for surface treatment or application of tolerance requirement
05.1		Long dashed-double-dotted narrow line	Outline of adjacent parts, extreme positions of moveable parts, initial outline prior to forming, projected tolerance zones and outline of datum target areas

NOTE Example applications in the use of line types can be found in [Figure 5](#), [Figure 6](#), [Figure 8](#) and [Figure 15](#) to [Figure 18](#).

4.3.2 Line width

In accordance with [BS EN ISO 128-20](#), the width, d , of all types of line shall be one of the following, depending on the type and size of drawing.

0,13 mm, 0,18 mm, 0,25 mm, 0,35 mm, 0,5 mm, 0,7 mm, 1 mm, 1,4 mm, 2 mm.

NOTE 1 The widths of extra wide, wide and narrow lines are in the ratio 4:2:1.

NOTE 2 For mechanical engineering drawings, two line thicknesses (typically 0,7 and 0,35 or 0,5 with 0,25) are sufficient for most purposes.

The line width of any one line shall be constant throughout the whole line (see also [4.7.2](#), [Table 8](#)).

4.3.3 Colours

According to the requirements of [BS EN ISO 128-20](#), lines shall be drawn black or white depending on the background. Other standardized colours can also be used for drawing standardized lines and, in this case, the meaning of the colours shall be explained.

4.4 Scales

COMMENTARY ON 4.4

With the advent of CAD systems and the ability to view drawings electronically at any size, the importance of using a standard range of scales has greatly diminished.

Traditionally, the recommended scales for use on technical drawings were as set out in [Table 7](#).

Table 7 – Scales

Category	Recommended scales		
Enlargement scales	50:1	20:1	10:1
	5:1	2:1	
Full size	1:1	1:1	1:1
Reduction scales	1:2	1:5	1:10
	1:20	1:50	1:100
	1:200	1:500	1:1 000
	1:2 000	1:5 000	1:10 000

The scale for a drawing shall be chosen according to the complexity of the object to be depicted and the purpose of the representation. In all cases, the selected scale shall be large enough to permit easy and clear interpretation of the information depicted. The scale and the size of the object, in turn, shall determine the size of the drawing. Where no scaleable views are presented, for example a chart drawing or item list, the term N/A (“Not applicable”) shall be indicated in the title block scale field.

Details that are too small for complete dimensioning in the main representation shall be shown adjacent to the main representation in a separate detail view (or section) which is drawn to a larger scale.

3D models produced on CAD systems shall always be produced at 1:1.

NOTE For more information on scales, see [BS EN ISO 5455](#).

4.5 Lines

4.5.1 Lines and terminators

Lines shall conform to the following standards, as appropriate.

BS EN ISO 128-20	<i>Technical drawings – General principles of presentation – Part 20: Basic conventions for lines</i>
BS EN ISO 128-21	<i>Technical drawings – General principles of presentation – Part 21: Preparation of lines by CAD systems</i>
BS ISO 128-22	<i>Technical drawings – General principles of presentation – Part 22: Basic conventions and applications for leader lines and reference lines</i>
BS ISO 128-23	<i>Technical drawings – General principles of presentation – Part 23: Lines on construction drawings</i>
BS ISO 128-24	<i>Technical drawings – General principles of presentation – Part 24: Lines on mechanical engineering drawings</i>
BS ISO 128-25	<i>Technical drawings – General principles of presentation – Part 25: Lines on shipbuilding drawings</i>

4.5.2 Lines, terminators and origin indicators

Arrows and terminators composed of lines shall conform to the following standard.

BS ISO 129-1	<i>TPD – Presentation of dimensions and tolerances – Part 1: General principles</i>
------------------------------	---

4.6 Number formats

4.6.1 General

Numbers used in dimensions and tolerances shall conform to 4.6.2. Where a “thousands” separator is required, a space shall be used; this can be used with metric and imperial numbers, and both before and after the decimal marker.

4.6.2 Metric values

The decimal marker shall be a comma.

Numbers smaller than 1 shall have a zero in front of the decimal marker:

e.g. 0,25 not ,25.

Non-indicated decimals shall be taken as zeros; i.e. 0,25 is the same as 0,250 000 000 000 000 and not rounded up to 0,25.

Trailing zeros shall be omitted:

e.g. 16 not 16,0.

A note on imperial numbers:

ISO standards make no provision for the use of imperial units, so when they are used, it is recommended that the American ASME Y14.5 [1] standard conventions are used. ASME Y14.5 [1] specifies the following requirements for imperial (inch) dimension and tolerance values:

- *the decimal marker shall be a full stop;*
- *values smaller than 1 shall not have a zero in front of the decimal marker, e.g.:*
Ø.25 not Ø0.25;
- *trailing zeros shall be added where necessary, to ensure that the dimension and tolerance have the same number of decimal places, e.g.:*
.500±.005.

4.7 Lettering

4.7.1 General

Lettering shall conform to the following standards, as appropriate.

BS EN ISO 3098-0	<i>Technical Product Documentation – Lettering – Part 0: General requirements⁴⁾</i>
BS EN ISO 3098-2	<i>Technical product documentation – Lettering – Part 2: Latin alphabet, numerals and marks</i>
BS EN ISO 3098-3	<i>Technical product documentation – Lettering – Part 3: Greek alphabet</i>
BS EN ISO 3098-4	<i>Technical product documentation – Lettering – Part 4: Diacritical and particular marks for the Latin alphabet</i>
BS EN ISO 3098-5	<i>Technical product documentation – Lettering – Part 5: CAD lettering of the Latin alphabet, numerals and marks</i>
BS EN ISO 3098-6	<i>Technical product documentation – Lettering – Part 6: Cyrillic alphabet</i>

⁴⁾ Withdrawn.

4.7.2 Lettering size

Lettering heights and line widths shall be appropriate for the sheet size and method of reproduction.

NOTE Two types of lettering are described within [BS EN ISO 3098-0^{5\)}](#), type A and type B. Upper case characters of type B have a height of 10 times the line width. Type A take the same character width as type B but with the height increased by a factor of $\sqrt{2}$. [BS ISO 129-1](#) recommends the use of type B lettering. Preferred sizes are summarized in [Table 8](#).

Table 8 – Preferred line widths and lettering heights for drawing sheet sizes

Sheet size designation	A0	A1	A2	A3	A4
Line group (wide line)	0,7	0,7	0,7	0,5	0,5
Narrow line	0,35	0,35	0,35	0,25	0,25
Type B lettering height	3,5	3,5	3,5	2,5	2,5
Type B lower case height	2,5	2,5	2,5	1,75	1,75
Type B alternative height (line width)	5,0 (0,5)	5,0 (0,5)	5,0 (0,5)	3,5 (0,35)	3,5 (0,35)

4.7.3 Notes

Notes of a general nature shall, wherever practicable, be grouped together and not distributed over the drawing. Notes relating to specific details shall appear near the relevant feature, but not so near as to crowd the view.

Where emphasis is required, larger characters shall be used.

NOTE Underlining of notes is not recommended.

4.8 Projections

4.8.1 General

Projections shall conform to one of the following standards.

[BS EN ISO 5456-2](#) *Technical drawings – Projection methods – Part 2: Orthographic representations*

[BS EN ISO 5456-3](#) *Technical drawings – Projection methods – Part 3: Axonometric representations*

[BS ISO 5456-4](#) *Technical drawings – Projection methods – Part 4: Central projection*

[BS EN ISO 10209](#) *Technical product documentation – Vocabulary – Terms relating to technical drawings, product definition and related documentation*

NOTE [BS EN ISO 5456-1](#) contains a survey of the various projection methods.

4.8.2 Conventions for arrangement of views on a TPD

4.8.2.1 General

Three main conventions shall be used for arranging the views on a TPD:

- labelled views (see [4.8.2.3](#));
- first angle orthographic projection (see [4.8.2.4](#));
- third angle orthographic projection (see [4.8.2.5](#)).

NOTE 1 The order of this list is not meant to indicate a preference.

NOTE 2 Other projection methods exist. See [BS EN ISO 5456](#) (all parts).

⁵⁾ Withdrawn.

4.8.2.2 Choice of views

When views (including sections and sectional views) are needed, these shall be selected according to the following principles.

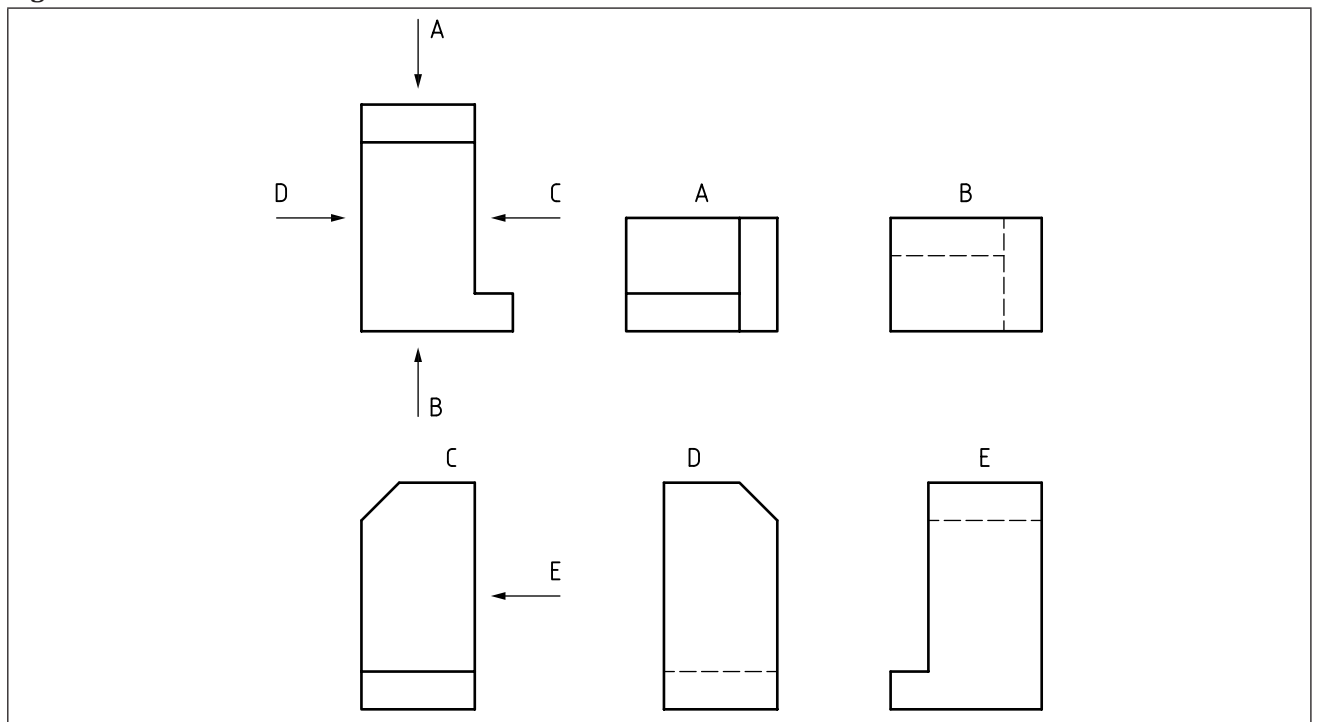
- The number of views (and sections and sectional views) shall be limited to the minimum necessary but shall be sufficient to fully delineate the object without ambiguity.
- The need for hidden outlines and edges shall be avoided.
- The unnecessary repetition of a detail shall be avoided.

4.8.2.3 Labelled view method

As required by [BS ISO 128-30](#), the most informative view of an object shall be used as the front or principal figure, taking into consideration, for example, its functioning position, position of manufacturing or mounting. Each view, with the exception of the front or principal figure (view, plan, principal figure), shall be given clear identification with a capital letter, repeated near the reference arrow needed to indicate the direction of the viewing for the relevant view. Whatever the direction of viewing, the capital letter shall always be positioned in normal relation to the direction of reading and be indicated either above or on the right side of the reference arrow.

The capital letters identifying the referenced views shall be placed immediately above the relevant views (see [Figure 10](#)).

Figure 10 – Labelled view method



4.8.2.4 First angle projection method

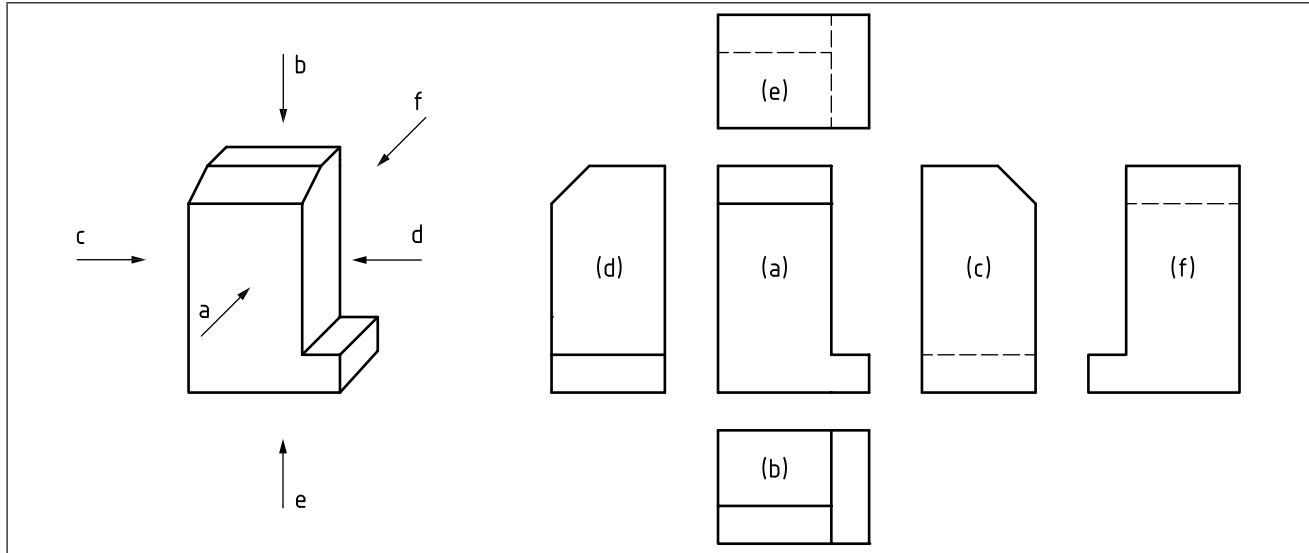
4.8.2.4.1 General

NOTE A more detailed description of the first angle projection method is to be found in [BS ISO 128-30](#) and [BS EN ISO 5456-2](#).

With reference to the front view (a), the other views shall be arranged as follows (see [Figure 11](#)).

- The view from above (b) shall be placed underneath.
- The view from below (e) shall be placed above.
- The view from the left (c) shall be placed on the right.
- The view from the right (d) shall be placed on the left.
- The view from the rear (f) shall be placed on the left or right, as convenient.

Figure 11 – First angle projection method

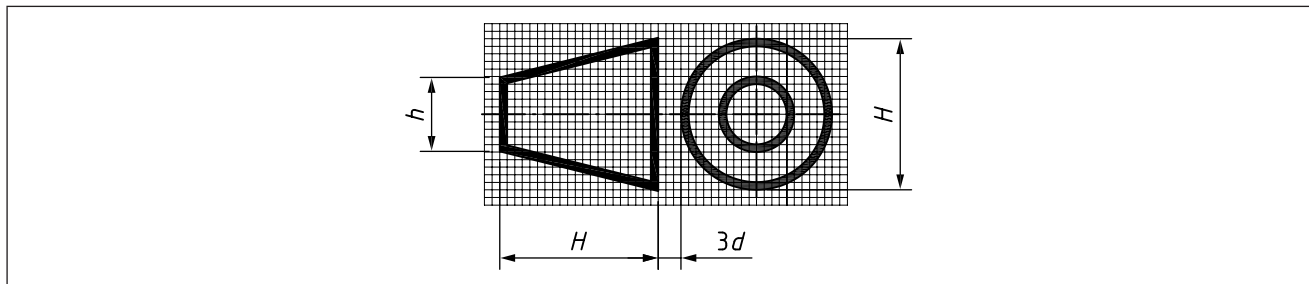


4.8.2.4.2 First angle projection method – Graphical symbol

As specified by [BS ISO 128-30](#), the graphical symbol for the first angle projection method shall be as shown in [Figure 12](#).

The proportions and dimensions of this graphical symbol shall be as specified in [BS ISO 128-30](#).

Figure 12 – First angle projection method: Graphical symbol



4.8.2.5 Third angle projection method

COMMENTARY ON [4.8.2.5](#)

A more detailed description of the third angle projection method is given in [BS ISO 128-30](#) and [BS EN ISO 5456-2](#).

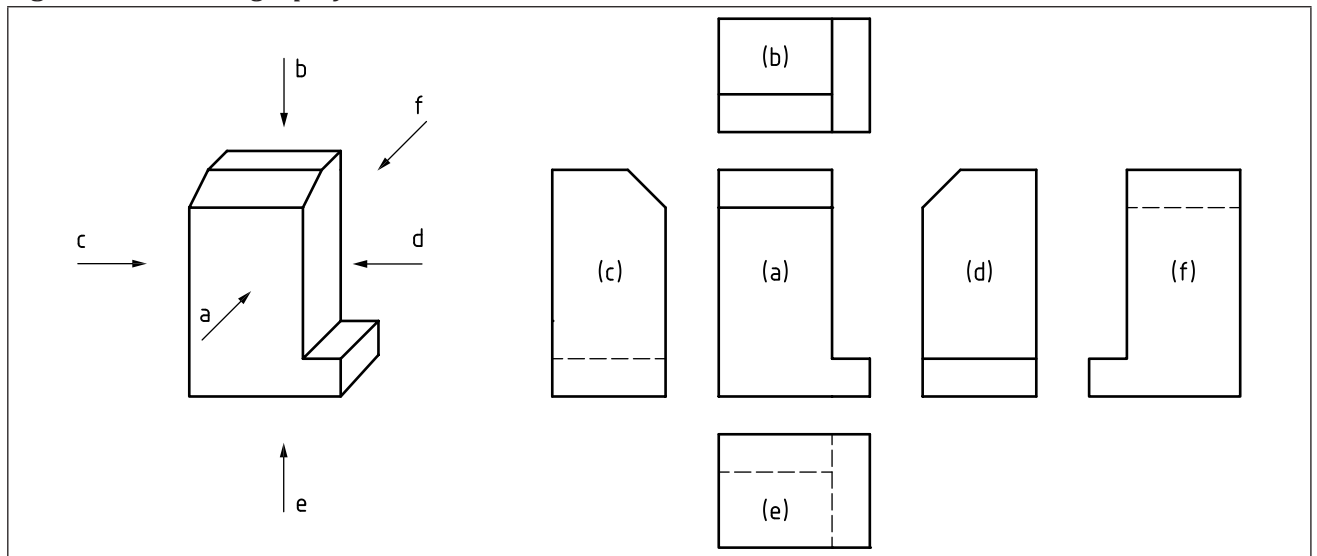
4.8.2.5.1 General

With reference to the front view (a), the other views shall be arranged as follows (see [Figure 13](#)).

- The view from above (b) shall be placed above.
- The view from below (e) shall be placed underneath.
- The view from the left (c) shall be placed on the left.

- The view from the right (d) shall be placed on the right.
- The view from the rear (f) shall be placed on the left or right, as convenient.

Figure 13 – Third angle projection method

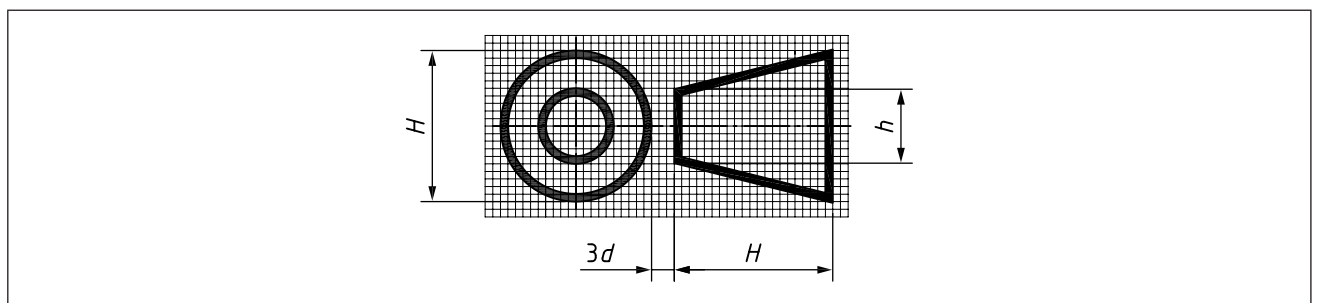


4.8.2.5.2 Third angle projection method – Graphical symbol

As specified by [BS ISO 128-30](#), the graphical symbol for the third angle projection method shall be as shown in [Figure 14](#).

The proportions and dimensions of this graphical symbol shall be as specified in [BS ISO 128-30](#).

Figure 14 – Third angle projection method: Graphical symbol



4.9 Views

4.9.1 General

Views shall conform to the following standards.

[BS ISO 128-30](#)

Technical drawings – General principles of presentation – Part 30: Basic conventions for views

[BS ISO 128-34](#)

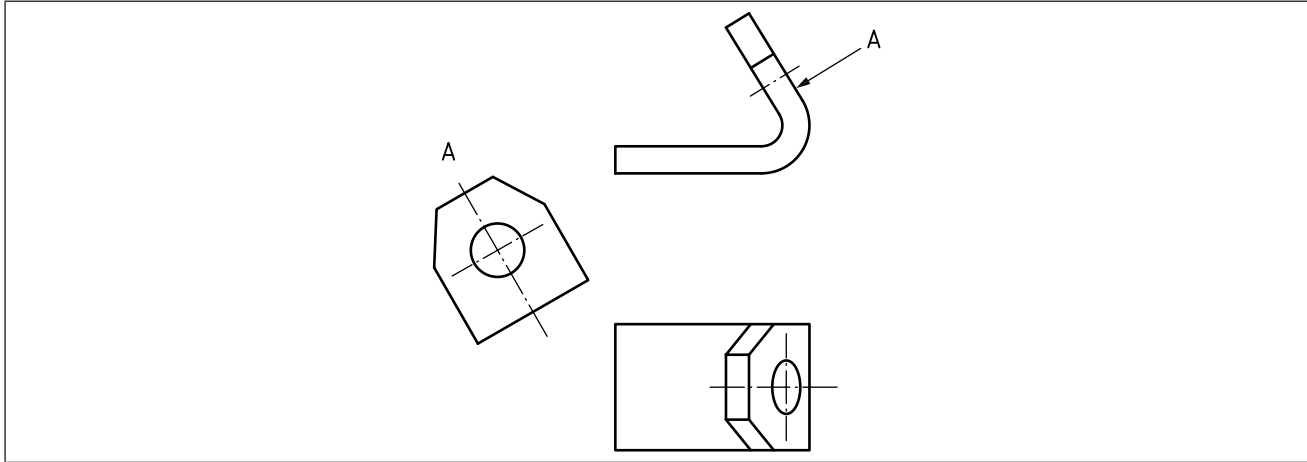
Technical drawings – General principles of presentation – Part 34: Views on mechanical engineering drawings

4.9.2 Auxiliary views

Where true representation of features is necessary, but cannot be achieved on the orthographic views, the features shall be shown in projected auxiliary views.

NOTE An example is shown in [Figure 15](#).

Figure 15 – Auxiliary view showing true shape of inclined surface



4.10 Sections

Sections shall conform to the following standards.

[BS ISO 128-40](#) *Technical drawings – General principles of presentation – Part 40: Basic conventions for cuts and sections*

[BS ISO 128-44](#) *Technical drawings – General principles of presentation – Part 44: Sections on mechanical engineering drawings*

[BS ISO 128-50](#) *Technical drawings – General principles of presentation – Part 50: Basic conventions for representing areas on cuts and sections*

NOTE 1 [BS ISO 128-44](#) and [BS ISO 128-50](#) contain presentational defects in some figures (e.g. line types, line thickness, terminators and letter heights). It is stressed that the text of these standards is technically correct and users should, therefore, regard the figures as illustrations only.

As specified by [BS ISO 128-44](#), ribs, fasteners, shafts, spokes of wheels, etc. shall not be cut in longitudinal sectional views and shall therefore not be represented as sections.

NOTE 2 In practice, it is not normally possible to avoid cutting ribs and spokes of wheels.

NOTE 3 Like views, sections might be shown in a position other than that indicated by the arrows for the direction of their viewing.

NOTE 4 A section in one plane is shown in [Figure 16](#).

NOTE 5 A section in two parallel planes is shown in [Figure 17](#).

NOTE 6 A section in three contiguous planes is shown in [Figure 18](#).

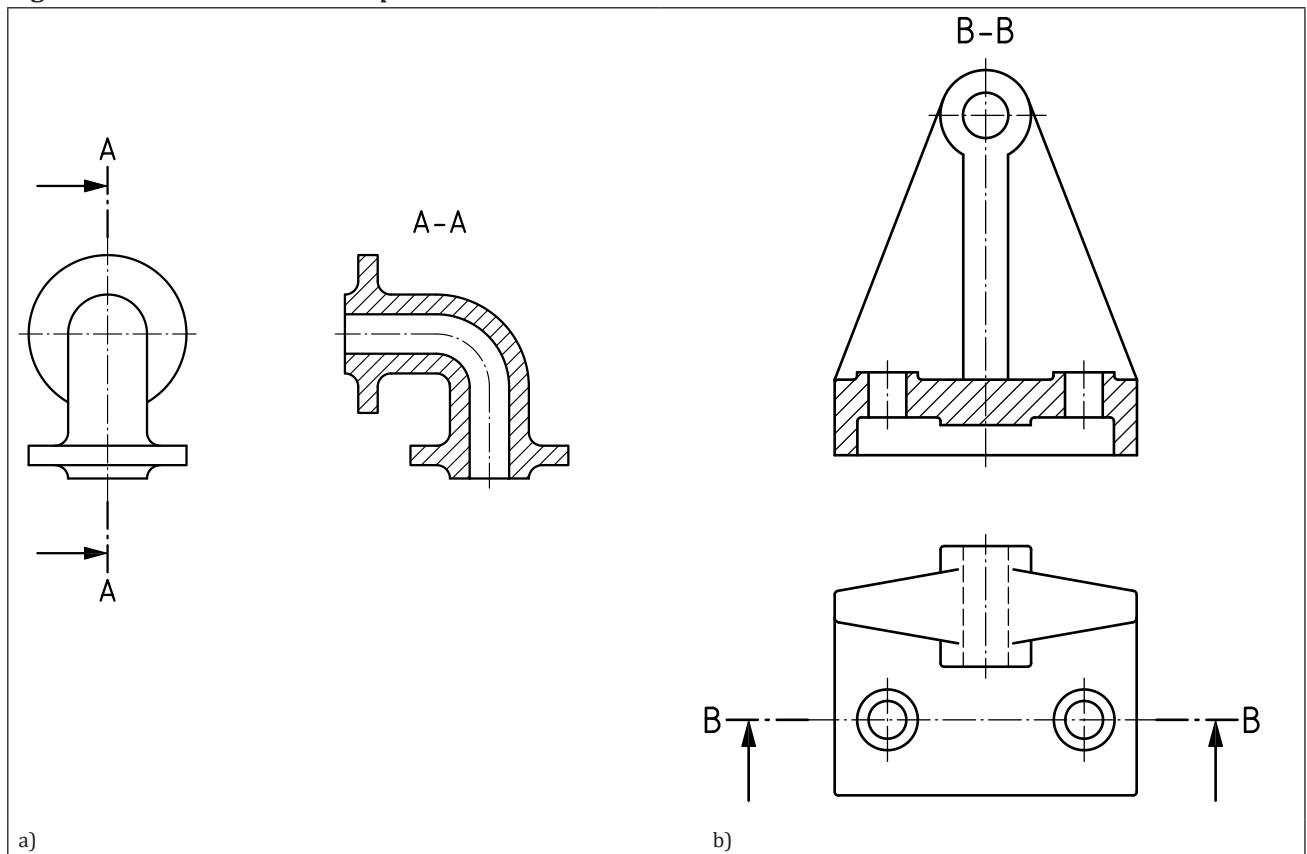
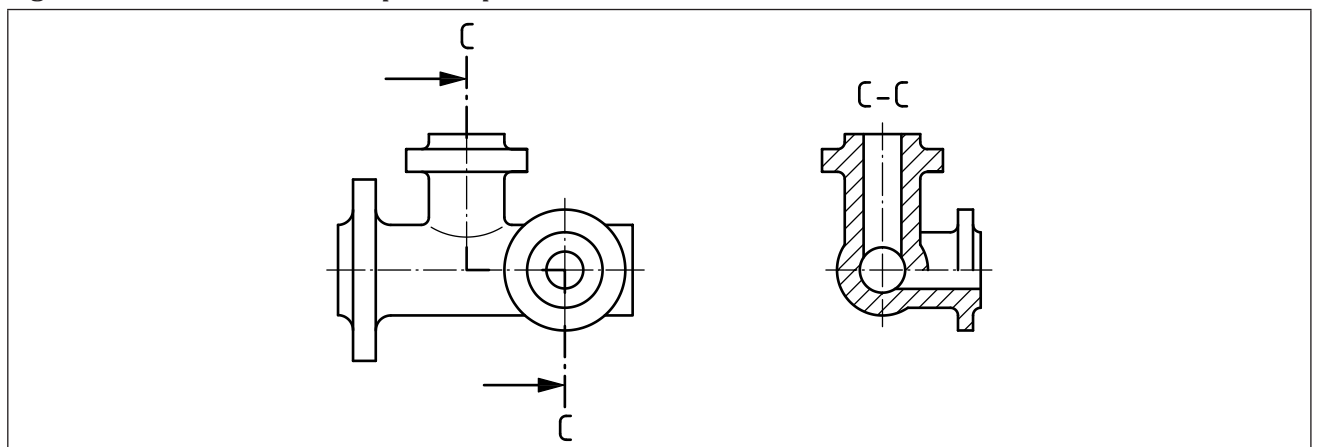
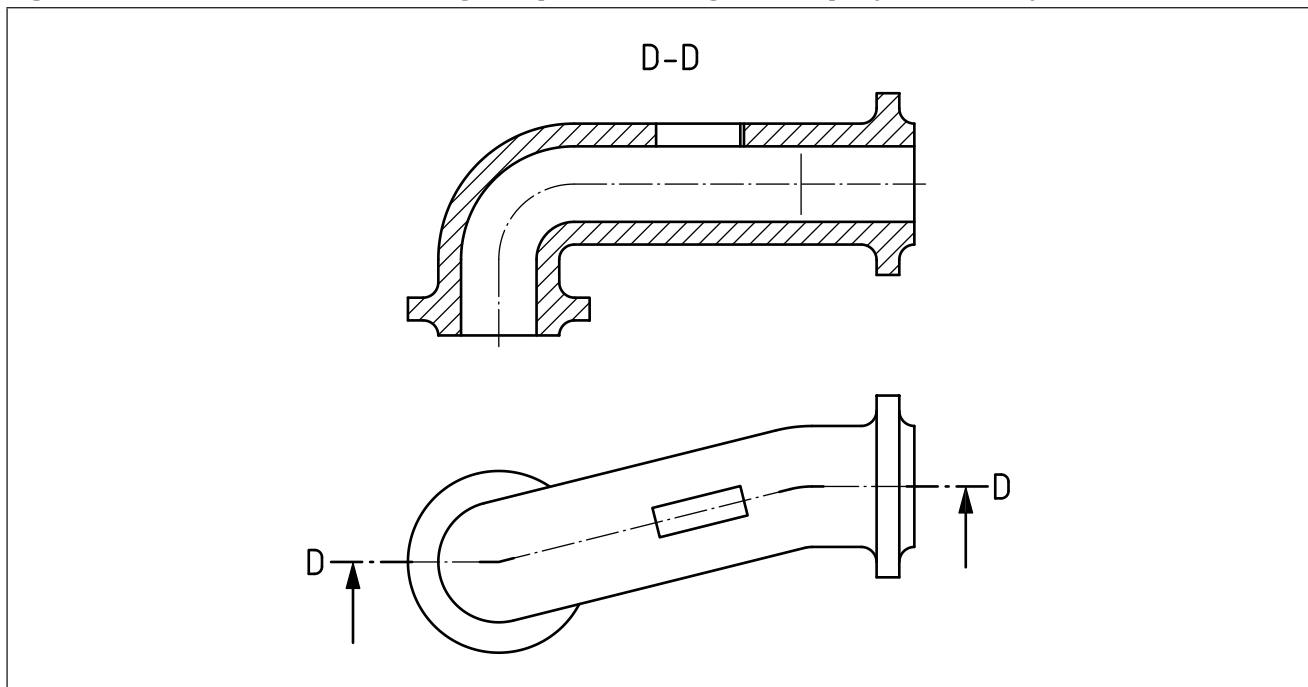
Figure 16 – Section view in one plane**Figure 17 – Section view in two parallel planes**

Figure 18 – Section view in three contiguous planes showing true shape of inclined surface

4.11 Representation of components

4.11.1 General

Conventions used for the representation of components shall conform to the following standards, as appropriate.

BS EN ISO 2162-1	<i>Technical product documentation – Springs – Part 1: Simplified representation</i>
BS EN ISO 2162-2	<i>Technical product documentation – Springs – Part 2: Presentation of data for cylindrical helical compression springs</i>
BS EN ISO 26909	<i>Springs – Vocabulary</i>
BS EN ISO 2203	<i>Technical drawings – Conventional representation of gears</i>
BS ISO 1219-1	<i>Fluid power systems and components – Graphical symbols and circuit diagrams – Part 1: Graphical symbols for conventional use and data-processing applications</i>
BS 3238-1	<i>Graphical symbols for components of servo-mechanisms – Part 1: Transducers and Magnetic Amplifiers</i>
BS 3238-2	<i>Graphical symbols for components of servo-mechanisms – Part 2: General Servo-mechanisms</i>
BS EN ISO 13715	<i>TPD – Edges of undefined shape – Indication and dimensioning</i>
BS EN ISO 2553	<i>Welded and allied processes – Symbolic representation on drawings – Welded joints</i>
BS EN ISO 4063	<i>Welding and allied processes – Nomenclature of processes and reference numbers</i>

BS EN ISO 5261	<i>Technical drawings – Simplified representation of bars and profile sections</i>
BS EN ISO 5845-1	<i>Technical drawings – Simplified representation of the assembly of parts with fasteners – Part 1: General principles</i>
BS EN ISO 6410-1	<i>Technical drawings – Screw threads and threaded parts – Part 1: General conventions</i>
BS EN ISO 6410-2	<i>Technical drawings – Screw threads and threaded parts – Part 2: Screw thread inserts</i>
BS EN ISO 6410-3	<i>Technical drawings – Screw threads and threaded parts – Part 3: Simplified representation</i>
BS EN ISO 6411	<i>Technical drawings – Simplified representation of centre holes</i>
BS EN ISO 6412-1	<i>TPD – Simplified representation of pipelines – Part 1: General rules and orthogonal representation</i>
BS EN ISO 6412-2	<i>TPD – Simplified representation of pipelines – Part 2: Isometric projection</i>
BS EN ISO 6412-3	<i>TPD – Simplified representation of pipelines – Part 3: Terminal features of ventilation and drainage systems</i>
BS EN ISO 6413	<i>Technical drawings – Representation of splines and serrations</i>
BS EN ISO 8826-1	<i>Technical drawings – Roller bearings – Part 1: General simplified representation</i>
BS EN ISO 8826-2	<i>Technical drawings – Roller bearings – Part 2: Detailed simplified representation</i>
BS EN ISO 9222-1	<i>Technical drawings – Seals for dynamic application – Part 1: General simplified representation</i>
BS EN ISO 9222-2	<i>Technical drawings – Seals for dynamic application – Part 2: Detailed simplified representation</i>
BS EN ISO 15785	<i>Technical drawings – Symbolic presentation and indication of adhesive, fold and pressed joints</i>

NOTE The [BS ISO 128](#) series of standards covers the general subject of component representation.

4.11.2 Representation of moulded, cast and forged components

Dimensional tolerancing for metal and metal alloy castings shall conform to the following standards, as appropriate.

BS EN ISO 8062-1	<i>Geometrical product specifications (GPS) – Dimensional and geometrical tolerances for moulded parts – Part 1: Vocabulary</i>
PD CEN ISO/TS 8062-2	<i>Geometrical Product Specifications (GPS) – Dimensional and geometrical tolerances for moulded parts – Part 2: Rules</i>
BS EN ISO 8062-3	<i>Geometrical product specifications (GPS) – Dimensional and geometrical tolerances for moulded parts – Part 3: General dimensional and geometrical tolerances and machine allowances for casting</i>

4.11.3 Representation of moulded components

Indications for parting lines, draft angles and other elements of moulded components shall conform to the following standard.

BS EN ISO 10135	<i>Geometrical product specifications (GPS) – Drawing indications for moulded parts in technical product documentation (TPD)</i>
---------------------------------	--

Section 5 Dimensioning

5.1 General

Dimensioning and tolerancing shall conform to the following standards, as appropriate.

BS ISO 129-1	<i>TPD – Presentation of dimensions and tolerances – Part 1: General principles</i>
BS EN ISO 14405-2	<i>Geometrical product specifications (GPS) – Dimensional tolerancing – Part 2: Dimensions other than linear sizes</i>
BS EN ISO 1119	<i>Geometrical product specifications (GPS) – Series of conical tapers and taper angles</i>
BS EN ISO 1660	<i>Geometrical product specifications (GPS) – Geometrical tolerancing – Profile tolerancing</i>
BS 1916-1	<i>Limits and fits for engineering – Part 1: Guide to limits and tolerances</i>
BS 1916-2	<i>Limits and fits for engineering – Part 2: Guide to the selection of fits in BS 1916-1</i>
BS 1916-3	<i>Limits and fits for engineering – Part 3: Guide to tolerances, limits and fits for large diameters</i>
BS EN ISO 3040	<i>Geometrical product specifications (GPS) – Dimensioning and tolerancing – Cones</i>
BS 3734-1	<i>Rubber – Tolerances for products – Part 1: Dimensional tolerances⁶⁾</i>
BS 4500	<i>Limits and fits – Guidance for system of cone (taper) fits and tolerances for cones from $C = 1:3$ to $1:500$, lengths from 6 mm to 630 mm and diameters up to 500 mm</i>
BS EN ISO 5458	<i>Geometrical Product Specifications (GPS) – Geometrical tolerancing – Pattern and combined geometrical specification</i>
BS EN ISO 6410-1	<i>Technical drawings – Screw threads and threaded parts – Part 1: General conventions</i>
BS 7010	<i>Code of practice for a system of tolerances for the dimensions of plastic mouldings</i>
BS EN ISO 7083	<i>Technical drawings – Symbols for geometrical tolerancing – Proportions and dimensions</i>
BS EN ISO 8015	<i>Geometrical product specifications (GPS) – Fundamentals – Concepts, principles and rules</i>
BS ISO 10579	<i>Geometrical product specifications (GPS) – Dimensioning and tolerancing – Non-rigid parts</i>
BS EN ISO 13920	<i>Welding – General tolerances for welded constructions – Dimensions for lengths and angles – Shape and position</i>
BS EN ISO 8062-1	<i>Geometrical product specifications (GPS) – Dimensional and geometrical tolerances for moulded parts – Part 1: Vocabulary</i>

⁶⁾ Withdrawn.

PD CEN ISO/TS 8062-2	<i>Geometrical Product Specifications (GPS) – Dimensional and geometrical tolerances for moulded parts – Part 2: Rules</i>
BS EN ISO 8062-3	<i>Geometrical product specifications (GPS) – Dimensional and geometrical tolerances for moulded parts – Part 3: General dimensional and geometrical tolerances and machining allowances for castings</i>
BS EN ISO 286-1	<i>Geometrical product specifications (GPS) – ISO code system for tolerances on linear sizes – Part 1: Basis of tolerances, deviations and fits</i>
BS EN ISO 286-2	<i>Geometrical product specifications (GPS) – ISO code system for tolerances on linear sizes – Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts</i>

5.2 Dimensioning methods

5.2.1 Presentation rules

5.2.1.1 Dimensioning shall conform to [BS ISO 129-1](#).

NOTE The dimensioning of shipbuilding drawings is specified in [BS ISO 129-4](#).

5.2.1.2 Only the dimensions which are necessary to unambiguously define the nominal geometry of the product shall be specified.

NOTE The dimensions shown should be for the purposes of describing the function, production or verification of the product. Auxiliary dimensions may also be included, but do not form part of the specification.

5.2.1.3 The size of a feature or relationship between features shall be dimensioned only once.

5.2.1.4 Unless otherwise specified, dimensions shall be indicated for the finished state of the dimensioned feature.

NOTE However, it might be necessary to give additional dimensions at intermediate stages of production if they are shown on the same drawing (e.g. the size of a feature prior to carburizing and finishing).

5.2.1.6 All dimensions, graphical symbols and annotations shall be indicated such that they can be read from the bottom or right-hand side (main reading directions) of the drawing. Dimensioning and annotations of 3D models shall be in accordance with [BS ISO 16792](#).

NOTE Dimensions alone are not sufficient to define the requirements of a product.

5.2.1.7 Dimension shall be used with other specification techniques as applicable, e.g. geometrical tolerancing or surface texture requirements.

5.2.1.8 Lettering on drawings shall be in accordance with [BS EN ISO 3098](#) (all parts).

5.2.1.9 There shall be only one lettering height for dimension and tolerance indication for a TPS.

5.2.1.10 All dimensions shall be toleranced, either via a general tolerance or by direct indication of tolerance or limit indications, except for the following cases:

- a) min. (see [5.4.3](#));
- b) max. (see [5.4.3](#));
- c) auxiliary dimension (see [5.2.8](#)); and
- d) theoretically exact dimension (TED) (see [7.8](#)).

5.2.2 Presentation of decimals

Dimensional values indicated in decimal notation shall use a comma as the decimal marker.

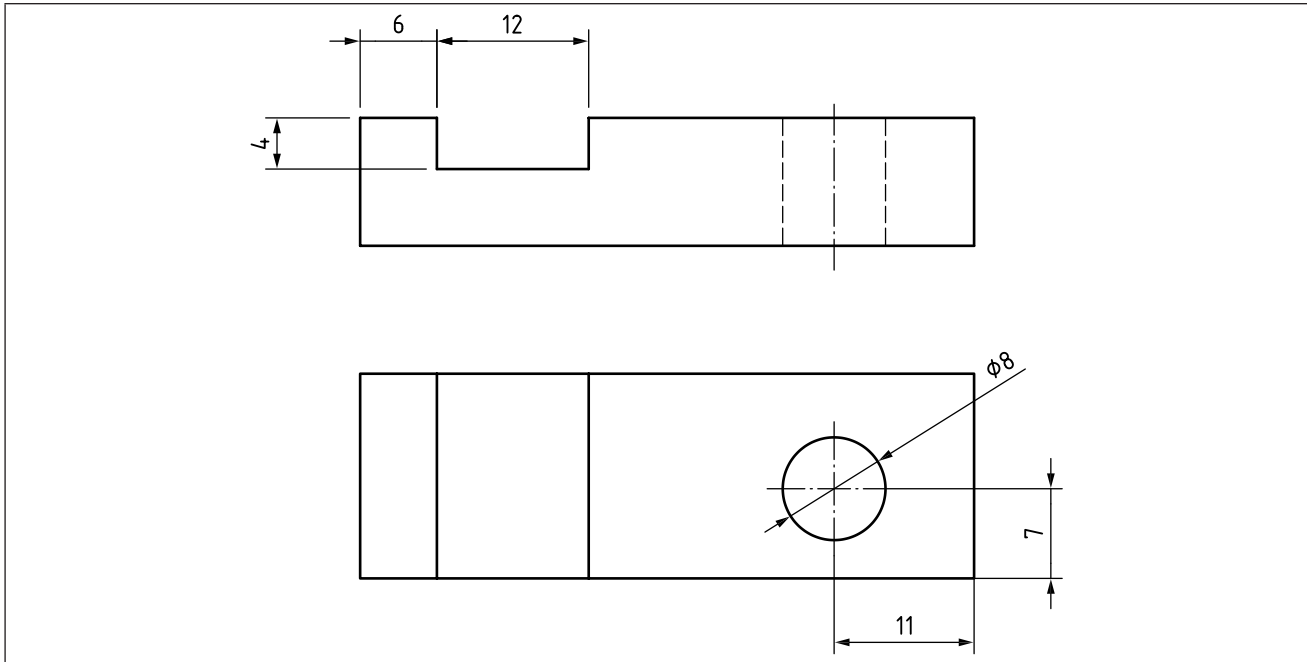
Each group of three digits, counting from the decimal marker to the left and to the right, shall be separated from other digits by a small space (e.g. 12 345,067 8).

NOTE The use of a comma or a point for this purpose is deprecated. It is further recommended that items in lists are separated by semicolons.

5.2.3 Positioning of dimensions

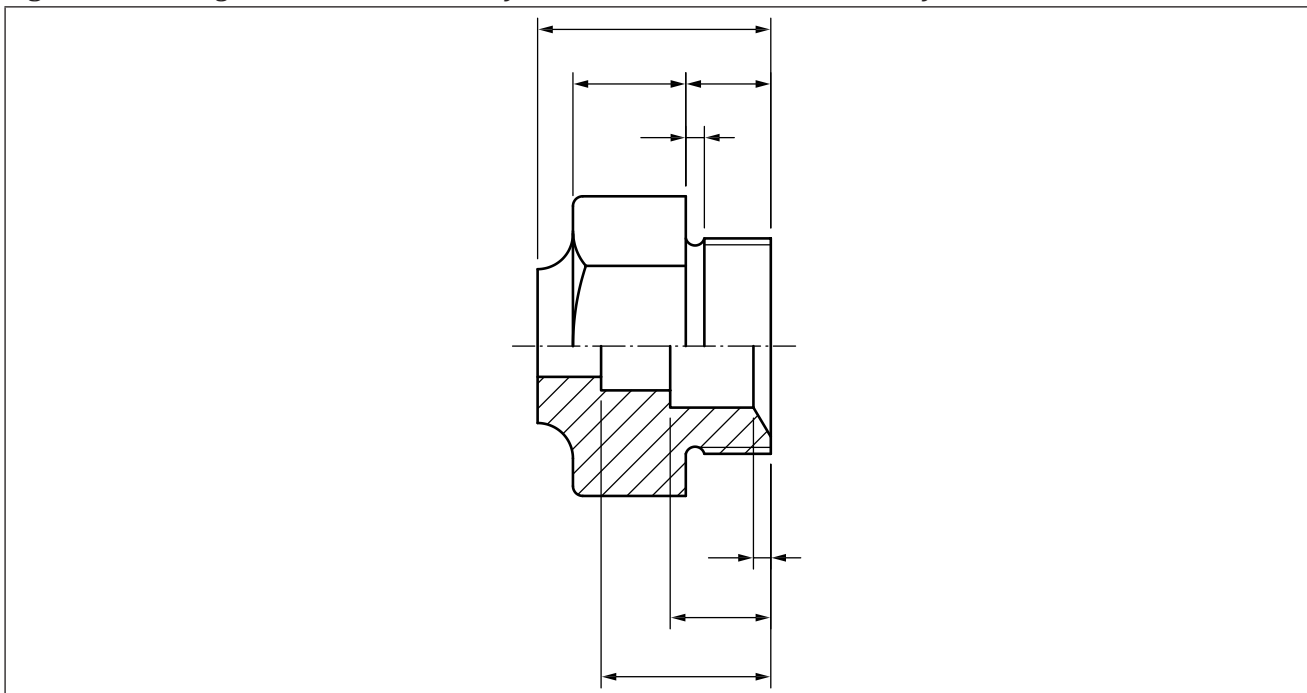
Dimensions shall be placed on that view or section which shows the relevant feature(s) most clearly (see [Figure 19](#)).

Figure 19 – Positioning of dimensions



Dimensions for internal features and dimensions for external features shall, where possible, be arranged and indicated in separate groups of dimensions to improve readability (see [Figure 20](#)).

Figure 20 – Arrangement and indication of dimensions internal and external features



Whenever possible, dimensions shall not be placed within the contour of the depicted item.

5.2.4 Units of dimensions

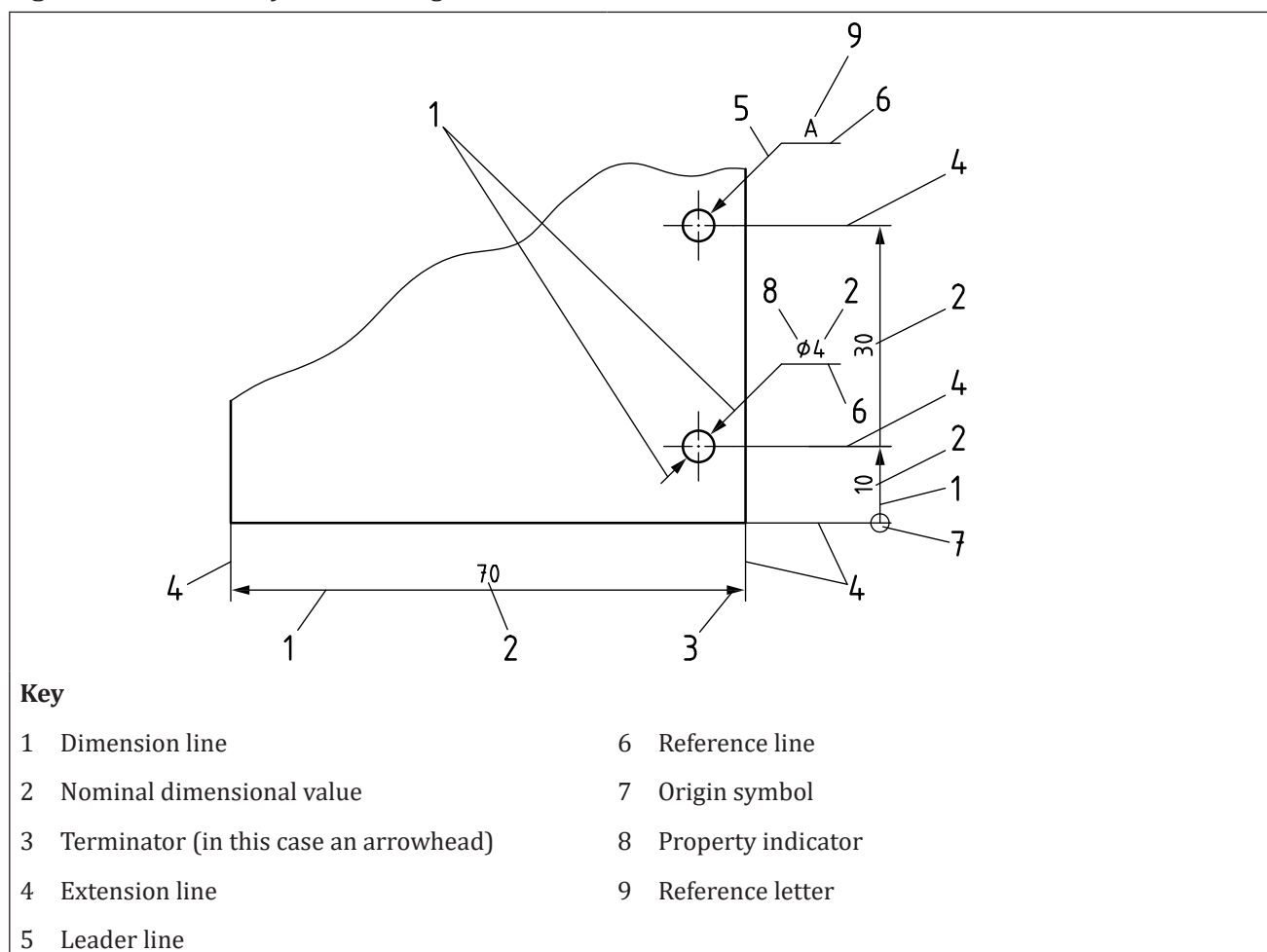
The units of a dimension shall be specified with the dimension. Typically, the predominant unit of measure on a drawing is specified in the drawing title block and the unit omitted from the individual dimensions. Any dimensions expressed in a different unit of measure shall indicate that unit of measure.

5.2.5 Elements of dimensioning: usage

5.2.5.1 General

The various elements of dimensioning shall be indicated as illustrated in [Figure 21](#).

Figure 21 – Elements of dimensioning



5.2.5.2 Dimension line

Dimension lines shall be indicated as continuous narrow lines in accordance with [BS EN ISO 128-20](#).

Where the feature is shown broken, the corresponding dimension line shall be shown unbroken (see [Figure 22](#)).