CAx-IF Recommended Practices

for

PMI Unicode String Specifications

Version 1.0

25 April 2023

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1 Introduction

Product and Manufacturing Information (PMI) is used in 3D Computer-aided Design (CAD) systems to convey information about the product requirements for manufacturing, inspection, and sustainment, which supplements the geometric shape of the product. This includes but is not limited to dimensions, tolerances, surface finish, weld symbols, material specifications, and user-defined attributes defined as 3D annotations. A Unicode string representation of this information allows a consistent definition when translating into STEP.

This report defines **rules** for Unicode strings of Geometric Dimensioning and Tolerancing (GD&T), Surface Finish, and Weld symbols as defined in ASME and ISO standards.

The following Engineering Product Definition and Related Documentation Practices were used as references for this document:

- ASME Y14.5-2018 Dimensioning and Tolerancing
- ASME Y14.36-2018 Surface Texture Symbols
- ISO 2553:2019 Welding and allied processes
- ISO 1101:2017 Geometrical product specifications
- ISO 14405-3:2016 GPS Dimensional Tolerancing of Linear Sizes

1.1 Document History

The previous Revision J of this recommended practice was developed at the request of LOTAR International in July 2009 and released in May 2011. The goal was to build upon previous efforts by LOTAR member companies and suppliers to develop an extensive list of GD&T and Dimensioning and Tolerancing PMI entities that may be encountered in annotated models and within data sets, and subsequently translated into STEP.

Refer to the previous Revision J for many specific examples of GD&T annotations and their representation as Unicode strings. However, there have been a few minor changes in the Unicode string specification. This is noted in the examples below.

This current recommended practice, version 1.0 (now using a numeric version number), defines the **rules** for creating PMI Unicode strings. The intent is to make the document easier to navigate by documenting how information should be formatted rather than providing many cumbersome examples to sort through. This new format also eliminates the possible omission of some entity types, symbols, configurations, and representative examples of PMI that may be encountered in an annotated model data set and eliminates the need for an exhaustive list of examples.

2 Scope

The following are within the scope of this document:

- Rules that define how GD&T, Surface Finish, and Weld symbol information should be represented as Unicode strings.
- 4 letter Unicode representation of GD&T, Surface Finish and Weld symbols.

The following are out of the scope of this document:

- An exhaustive list of GD&T, Surface Finish, and Weld symbol examples.
- Graphical and semantic representation of the GD&T.

3 Rules

PMI Unicode strings are specified by four items:

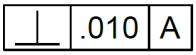
1. **Keywords** for the type of PMI being represented as a Unicode string (section 3.2)
2. **Symbols** used for GD&T, welds, and surface finish that are defined by Unicode characters (section 3)
3. **Delimiters** (section 4) which group information into compartments (section 3.4)
4. **Numeric values and text** related to dimensions, tolerances, etc.

The rules for these four items allow the creation of the most used types of graphic annotation found on a CAD model.

3.1 Example

PMI Unicode strings are used in a STEP file for the PMI validation property for 'equivalent Unicode string.' They are described in the CAx-IF Recommended Practice for the Representation and Presentation of PMI (AP242) for graphic PMI (section 10.2.3.3.1) and semantic PMI (section 10.1.3.3).

For example, the following perpendicularity tolerance:



would be represented by the following equivalent Unicode string:

FCF\w\X2**23CA**\X0\w.**010**\w**A**

where:

- **FCF** is the keyword for a Feature Control Frame,
- **23CA** is the Unicode character for the perpendicularity symbol,
- **.010** is the magnitude of the tolerance zone,
- **A** is the datum reference frame, and
- three delimiters **\w** separates the compartments of the Feature Control Frame.

The delimiters **\X2** and **\X0** are used to indicate that **23CA** is a Unicode character. ISO 10303 Part 21 clause 6.4.3.3 defines the X2 encoding for 4 hexadecimal character representations. Each set of 4 hexadecimal characters represents a character or symbol defined by the Unicode tables. Symbols used for equivalent Unicode strings are defined in section 3.3.

In a STEP file, the equivalent Unicode string appears on the `description` attribute of the `descriptive_representation_item` entity. For example:

```
#1=DESCRIPTIVE_REPRESENTATION_ITEM('equivalent unicode string',
  'FCF\\w\X2\23CA\X0\\w.010\\wA');
```

Note that the backslashes for the \w delimiter are 'escaped' by having a preceding backslash before them. This is defined in ISO 10303 Part 21 clause 6.4.3.1 and applies to any backslash (reverse solidus), except the backslashes associated with X2 and X0 do not have a preceding backslash. Also, note that 'unicode' is lowercase.

The NIST STEP File Analyzer and Viewer (SFA) can interpret the equivalent Unicode string on `DESCRIPTIVE_REPRESENTATION_ITEM`.

The following entities:

```
#1=DESCRIPTIVE_REPRESENTATION_ITEM('equivalent unicode string',
  'FCF\\w\X2\23CA\X0\\w.010\\wA');

#2=DESCRIPTIVE_REPRESENTATION_ITEM('equivalent unicode string',
  'FCF\\w\X2\2313\X0\\\w.020\\wA\\wB\\wC');

#3=DESCRIPTIVE_REPRESENTATION_ITEM('equivalent unicode string',
  'DIM\\w\X2\2300\X0\0.25 \X2\00B1\X0\0.008');

#4=DESCRIPTIVE_REPRESENTATION_ITEM('equivalent unicode string',
  'DIM\\w4X \X2\2300\X0\.250\\u.+003\\n.-001\\u');

#5=DESCRIPTIVE_REPRESENTATION_ITEM('equivalent unicode string','DTM\\wA');
```

are reported by SFA on the `DESCRIPTIVE_REPRESENTATION_ITEM` worksheet as:

	A	B	C	D
1	descriptive_representation_item (5)			
2				
3	**ID**	**name**	**description**	**Equivalent Unicode String**
4	1	equivalent unicode string	FCF\\w⊥\w.010\\wA	FCF | ⊥ | .010 | A
5	2	equivalent unicode string	FCF\\w⌓\\w.020\\wA\\wB\\wC	FCF | ⌓ | .020 | A | B | C
6	3	equivalent unicode string	DIM\\w⌀0.25 ±0.008	DIM | ⌀0.25 ±0.008
7	4	equivalent unicode string	DIM\\w4X ⌀.250\\u.+003\\n.-001\\u	DIM | 4X ⌀.250\u.+003 .-001\u
8	5	equivalent unicode string	DTM\\wA	DTM | A

In column C, the Unicode character is replaced by the correct symbol. In column D, the delimiter **\w** is replaced by a **|** to delimit the compartments of the string. In cell D7, the **\n** is interpreted as a new line.

The \S encoding is no longer recommended.

3.2 Keywords

These are the keywords for GD&T annotations, welds, and surface finishes.

Keyword	Type
DIM	Dimension
FCF	Feature Control Frame (ASME) or Tolerance Frame (ISO)
DTM	Datum Feature Symbol
TGT	Datum Target Symbol
TXT	Text
AAS	All Around Symbol
AOS	All Over Symbol
WLD	Weld (standard)
WLDR	Weld (reversed)
FLG	Flag Note
SRF	Standard Surface Finish
SRFAPA	Surface Finish – Any Process Allowed
SRFMMR	Surface Finish – Material Removal Required
SRFNMR	Surface Finish – No Material Removed
SRFMRRA	Surface Finish – Material Removal Required – All Around
SRFMRRN	Surface Finish – Material Removal Required – Not All Around

3.3 GD&T Characteristic Symbols

The following table shows geometric characteristics and modifying symbols and how they are represented as a Unicode character, plain text, or other format defined in the following sections. The CAx-IF Recommended Practice for Representation and Presentation of Product Manufacturing Information (PMI) (AP242) also shows the symbols and how they are used on specific STEP entities. Subsequent examples in this document show the symbol rather than the Unicode characters associated with the symbol. Symbols that don't have a Unicode representation should use FFFD.

GD&T Characteristic	Symbol	Unicode character or Text string
Angularity	∠	2220
Arc length	⌒	2322
Associated Least Square Feature	Ⓖ	24BC
Associated Minimum Inscribed Feature	Ⓝ	24C3
Associated Maximum Inscribed Feature	Ⓧ	24CD
Associated Min/Max Feature	Ⓒ	24B8
Between	↔	2194
Circular Runout	↗	2197
Circularity	○	25CB
Concentricity	◎	25CE
Conical Taper	⌲	2332
Continuous Feature	⟨CF⟩	<CF> (section 5.2.2)
Controlled Radius	CR	Use plain text
Counterbore	⌴	2334
Countersink	⌵	2335
Cylindricity	⌭	232D
Degree	°	00B0
Depth	↧	21A7
Derived Feature	Ⓐ	24B6
Diameter	⌀	2300
Dimension Origin	⌖	2331
Dynamic Profile	△	25B3
Envelope Requirement	Ⓔ	24BA
Flatness	▱	23E5

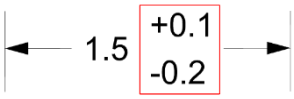
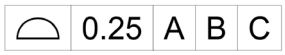
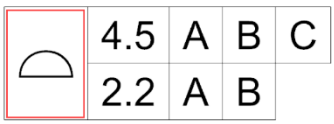
GD&T Characteristic	Symbol	Unicode character or Text string
Free State	Ⓕ	24BB
From To	→	2192
Independency	Ⓘ	24BE
Least Material Condition	Ⓛ	24C1
Max Material Condition	Ⓜ	24C2
Orientation	⟋	003E and 003C
Parallelism	//	2AFD
Perpendicularity	⊥	23CA
Plus/Minus	±	00B1
Position	⌖	2316
Profile of a Line	⌒	2312
Profile of a Surface	⌓	2313
Projected Tolerance Zone	Ⓟ	24C5
Radius	R	Use plain text
Reciprocity	Ⓡ	24C7
Regardless of Feature Size	Ⓢ	24C8
Roundness	○	25CB
Slope	⌲	2333
Small Omega	ω	2375
Spherical Radius	SR	Use plain text
Spotface	⌴	SF (section 6.9)
Square	□	25A1
Statistical Tolerance	⟨ST⟩	<ST> (section 5.2.2)
Straightness	—	23E4
Symmetry	⌯	232F
Tangent Plane or Associated Tangent Feature	Ⓣ	24C9
Taper	⏥	2332
Total Runout	⌰	2330
Translation Modifier	▷	25B7
Unilaterally / Unequally Disposed	Ⓤ	24CA

3.4 Compartments

A compartment is distinct segregated information within an annotation entity that contains a discrete purpose or meaning.

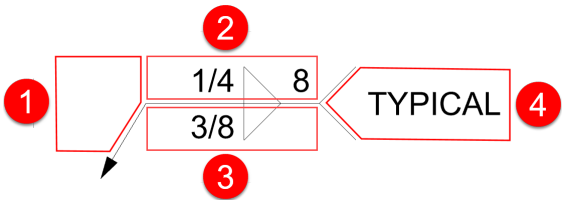
3.4.1 Compartments in GD&T

Certain GD&T entities contain distinct areas that have a particular meaning and are subdivided into separate compartments. Entities that contain compartments include Dimensions, Feature Control Frames (ASME) or Tolerance Frames (ISO), Datum Target Symbols, and Datum Feature Symbols, to name a few.

Entity	Description
	Stacked Tolerance values defined in a compartment.
	Each frame in a feature control frame is a compartment. This example contains 5 comparments.
	Each frame in a feature control frame is a compartment. Compartments can span multiple lines of information (highlighted in red in the image) by inserting a new line at the end of the first line. This example contains 8 comparments.

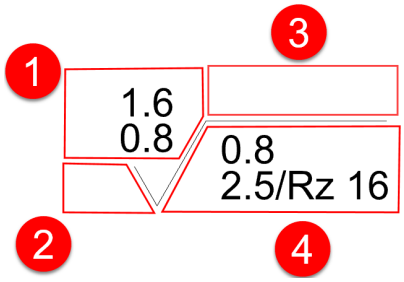
3.4.2 Compartments in Weld Symbols

Weld symbols have a defined layout, containing areas where specific information is located, referred to as zones. Zones are defined in detail in the Basic Welding Symbol Layout definition within the Welding Terms in section 8.

Entity	Description
	Example weld symbol with zones outlined. Zone 1 is empty in this example.

3.4.3 Compartments in Surface Texture

Surface texture symbols have a defined layout, containing areas where specific information is located, referred to as zones, and thus are conducive to compartmentalization. Zones are defined in detail in the Surface Texture Symbol Layout definition within the Surface Texture Terms & Delimiters section 7.

Entity	Description
	Stacked values kept together in compartments within surface finish zones. Zones 2 and 3 are empty in this example.

3.5 Unspecified Symbols

If an annotation contains symbols which are not handled in this document, the unspecified symbols shall be replaced by a Unicode placeholder character, FFFD Shown as:

This may be the case when company-specific guidelines are used to create the original PMI in the 3D model, or when product definition standards are used.

3.6 Other Terms & Definitions

3.6.1 Concatenation

In the context of digital data, string concatenation is the operation of joining more than one character string together. For example, concatenating the strings “hello” and “world” would result in the string “helloworld.”

In this document, each separate annotation entity that contains text or Unicode characters is defined as a separate string. However, as many of these strings are specified in a set and are related to one another, the strings may be concatenated into a larger superstring. Each string that makes up the superstring is readily identifiable as a separate string by its leading keyword, which will aid software queries intending to extract or understand a particular string, and represents a level of the semantic relationship between the constituent strings.

3.6.2 Grouping

Grouping is when a set of objects are combined to make a group of information. Grouping can be used to keep information within a compartment together.

3.6.3 Mapping

Isolating and writing individual characters or groups of characters in an annotation entity into distinct compartments or fields within a Unicode string. Some strings only contain a single field, such as Dimension and Text strings, and some contain multiple fields or compartments, such as Feature Control Frame and Datum Target strings. Each field within a string may be composed of multiple characters, including codes that explain formatting and placement (e.g., stacked upper and lower limits, stacked + and – tolerances, fractional values, etc.)

4 Delimiters / Operator Definitions

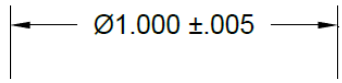
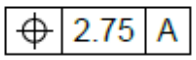
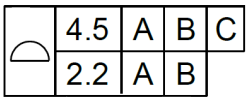
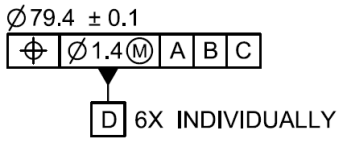
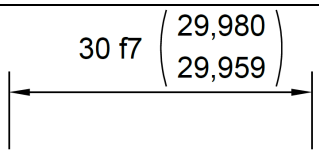
The following sections will discuss the use of the compartments, groupings, new lines, stacked text, concatenation, and fractions.

4.1 Compartment (Symbol: \w)

This delimiter represents a compartment. Unicode text strings are structured in several fields that are separated by \w character set. For annotation entities with compartmentalized data, the fields are mapped to correspond to the appropriate compartment in the annotation entity.

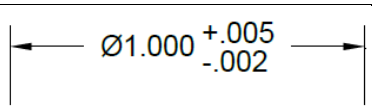
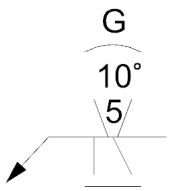
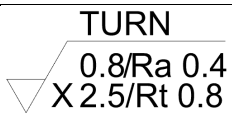
This delimiter is not required at the end of the Unicode string to represent the closing of the compartment, nor is it required to identify additional compartments that do not contain information.

The is always a compartment delimiter after a keyword.

	DIM\wØ1.000 ±.005
	FCF\w⌖\w 2.75\wA \w represents each frame in the feature control frame
	FCF\w⌓\w4.5\wA\wB\wC\n2.2\wA\wB
	DIM\wØ79.4±0.1\nFCF\w⌖\wØ1.4Ⓜ \wA\wB\wC\nDTM\wD\wTXT6X INDIVIDUALLY
	DIM\w30 f7(\u29,980\n29,595\u)

4.2 Grouping (Symbol: \u)

Groups elements together to identify them as one entity, such as stacked dimensions or information within a weld or surface finish zone. Typically used in conjunction with \n. Each group must contain 2 \u delimiters. Groups can be nested.

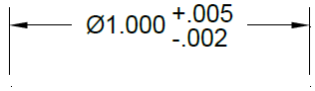
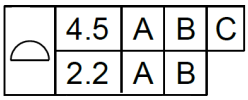
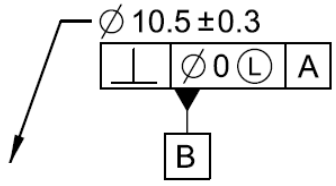
	DIM\wØ1.000\u+.005\n-.002\u
	WLD\w\w\uG\n⌓\n10°\n5\/\u\w\u|/−\u
	SRFMRRN\w\w\wTURN\w\u0.8/Ra0.4\u\nX\u2.5/Rt 0.8\u

4.3 New Line / Stacked Text (Symbol: \n)

Use a hard carriage return to denote the following text occurs on a separate line. This is a literal carriage return because a new line of characters begins below the previous line, within the same string.

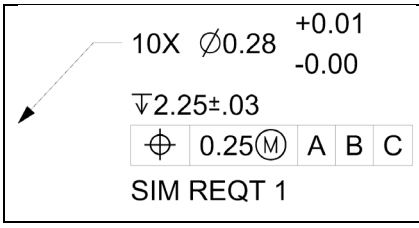
Use a soft return prior to text to denote a semantic separation. This would include texts and symbols that belong to a single string of text, and are on the same line, but are symbolically distinct. For example, the datum identifiers in a feature control frame. This supports the top down left right rule that we have designated for this specification.

Note: \n can also be used as a separator between strings in a concatenated superstring.

	DIM\wØ1.000\u+.005\n-.002
	FCF\w⌓\w4.5\wA\wB\wC\n2.2\wA\wB
	DIM\wØ10.5±0.3\nFCF\w⊥\wø0Ⓛ\wA\nDTM\wB

4.4 Concatenated Representation (Symbol: \x)

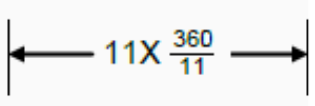
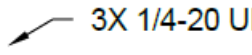
Joining of strings into a larger superstring. In the example, each separate line is mapped as a distinct Unicode String, and each of these strings is concatenated into a larger Unicode String. Without \x, four Unicode strings would be treated as individual strings.

	DIM\w10XØ.281\u+.006\n-.001\u\x\n DIM\w↧2.25±.03\x\n FCF\w⌖\wØ.025Ⓜ\wA\wB\w\C\x\n TXT\wSIM REQT 1

4.5 Fraction (Symbol: \v)

This delimiter adds a horizontal line between information on the upper and lower lines. Similar to \u, \v must be added at the beginning and ending of the fraction. \n between the two values defines which information is above and below the horizontal line.

Note: Dimensions do not have to be represented using the fraction format as shown in the second example. The numerator and denominator can be separated using a / as shown in the second example.

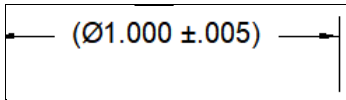
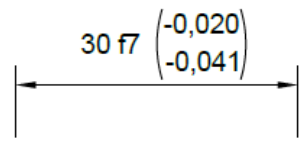
	DIM\w11X \v360\n11\v
	DIM\w3X 1/4-20 UNC-2B

5 Specific Characters and Text

This section defines how characters with specific syntax, such as a character in a circle or a spotface symbol, are identified. Characters that are not in this section are defined as plain text.

5.1 Characters Within Parenthesis

Information displayed inside parenthesis in a dimension does not require special mapping. If it is desired to have parenthesis display as text that is not part of the dimension information, the TXT indicator should be placed in front of it.

	DIM\w(Ø1.000±.005) *Reference dimension with tolerance*
	DIM\w30 f7 (\u-0,020\n-0,041\u)

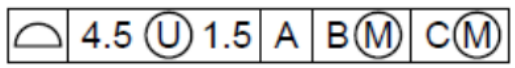
5.2 Characters Within a Shape

A single character surrounded by a circle, or more than one character surrounded by an oval.

5.2.1 Circle

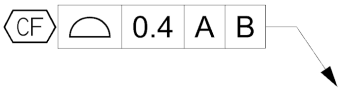
Single letters in a circle used as geometric modifiers, such as Maximum Material Condition. Unicode representations are available for all single letters in a circle. Refer to for commonly used letters in a circle such, as Ⓜ represented with the Unicode string 24C2.

as defined in Section 6.9.3 of the CAx-IF Recommended Practice for Representation and Presentation of PMI (AP242).

	FCF\u⌓\u4.5Ⓤ1.5\uA\uBⓂ\uCⓂ

5.2.2 Hexagon

Denotes letter in a hexagon, used as dimension modifiers as defined in Section 5.3 of the CAx-IF Recommended Practice for Representation and Presentation of PMI (AP242).

	<CF>FCF\w⌓\w0.4\wA\wB

5.3 Characters Within Brackets

DIM with a numeric dimension in square brackets represent a basic dimension (see 6.1).

FCF with square brackets represent a basic dim or degrees of freedom (see below).

TXT with square brackets represents text in a box.

5.3.1 Degree of Freedom

Symbols: [x,y,z,u,v,w] in any combination

Used to indicate which Degrees of Freedom are eliminated by the Datum Feature Simulator, potentially overriding the default conditions. Does not require all 6 symbols be displayed. Does not require the TXT delimiter to display as square brackets in a feature control frame.

⌓ | 3.75 | D [z, u, v] | E Ⓜ [x] | F [y, w]	FCF\w⌓\w3.75\wD**[z,u,v]**\wEⓂ **[x]\w**F**[y,w]**

5.3.2 Special Case – Basic Dimensions

Symbols: [BSC] and [BASIC]

[BASIC], [BSC], and [value] are methods to override the default size/boundary for Datum Feature Simulators. [BSC] is an abbreviation for [BASIC], which means the basic size / shape. Used in a feature control frame, the TXT delimiter is not required.

⌓ | 4.5 Ⓤ 1.5 Ⓕ | A | B [BASIC] | C	FCF\w ⌓\w4.5 Ⓤ 1.5 Ⓕ \wA\wB**[BASIC]**\wC
⌓ | 4.5 Ⓤ 1.5 Ⓕ | A | B [BSC] | C	FCF\w ⌓\w4.5 Ⓤ 1.5 Ⓕ \wA\wB**[BSC]**\wC
⌓ | 4.5 Ⓤ 1.5 Ⓕ | A | B [Ø10.505] | C	FCF\w ⌓\w4.5 Ⓤ 1.5 Ⓕ \wA\wB**[**Ø10.505**]**[\wC

5.4 Text

Text is a string of characters and symbols used to provide further information on an annotation. Sections 5.1 through 0 define text representation in special cases where the text carries specific meaning.

5.4.1 General Text

Keyword: TXT

Denotes text with no context. Does not require its own separator before or after.

Note: A gap between symbols or text denotes a space as entered on a keyboard (white space) and does not require mapping.

6X Ø1.0	**TXT**\w6X\wDIMØ1.0
⊥ | 0.5 | A EACH ELEMENT	FCF\w⊥\w0.5\wA\n**TXT**\wEACH ELEMENT

5.4.2 General Note

Keyword: NOTE

Subtypes of text can be used to provide a more semantic meaning. The delimiters below can be used in place of NOTE.

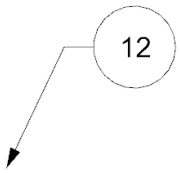
UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS	**NOTE**\wUNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS

5.4.3 Special Cases

Special cases of using text can be used to provide more meaning. As suggested by Siemens.

5.4.3.1 Balloon

Keyword: BAL

	**BAL**12

5.4.3.2 Coordinate Note

Keyword: COR

x=100.0000a y=0.0000b z=100.0000c I=0.0000d J=0.0000e K=0.0000f Label=g Level=h	**COR**\wx=100.0000a\ny=0.0000b\nz=100.0000c\nI=0.0000d\nJ=0.0000e\nK=0.0000f\nLabel=g\nLevel=h

5.4.3.3 Enterprise Identification

Keyword: ENT

Siemens PLM Software 10824 Hope St. Cypress, CA 90630 Development Headquarters A1234	**ENT**\wSiemens PLM Software\n10824 Hope St.Cypress, CA 90630\nDevelopment Headquarters\nA1234

5.4.3.4 Material Specifications

Keyword: MAT

ABS (-1) Nomenclature Text Open Field Text	**MAT**\wABS (-1)\n Nomenclature Text\nOpen Field Text

5.4.3.5 Part ID

Keyword: PID

WorkingPMIExample.prt (-) ASSEMBLY, f1 – g2	**PID**\wWorkingPMIExample.prt (-) ASSEMBLY, f1 – g2
WorkingPMIExample.prt (-) BEARING, f2	**PID**\wWorkingPMIExample.prt (-) BEARING, f2

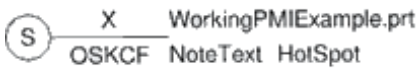
5.4.3.6 Process

Keyword: PRO

Chromium (-) CHROMIUM PLATE open	**PRO**\wChromium (-)\nCHROMIUM PLATE\nopen

5.4.3.7 Locator designator

Keyword: LOC

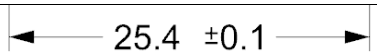
	**LOC**\wS\wX\wOSKCF\wWorkingPMIExample.prt\nNoteText HotSpot

6 GD&T Terms & Delimiters

GD&T is a set of symbols that convey allowable variation in form and size of features on a part as well as variation between those features. The symbols can be captured on 2D engineering drawings or as annotations in CAD models.

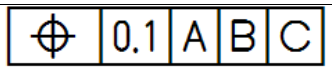
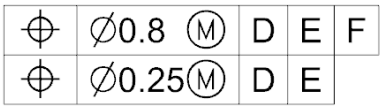
6.1 Dimension (DIM)

Denotes a dimension annotation. Does not require its own separator before or after its contents.

	**DIM**\w25.4±0.1
	TXT\w6X\w**DIM**Ø1.0

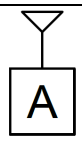
6.2 Feature Control Frame (FCF)

Represents the start of a feature control frame. Each \w following FCF will denote the beginning of the next compartment of the feature control frame.

	**FCF**\w⌖\w0.1\wA\wB\wC
	*There are three ways to represent a composite FCF.* *As two segments:* **FCF**\w⌖\w⌀0.8 Ⓜ\wD\wE\wF\n\w⌖\w⌀0.25Ⓜ \wD\wE *Concatenated:* **FCF**\w⌖\w⌀0.8Ⓜ\wD\wE\wF**\x**\w⌖\w⌀0.25Ⓜ \wD\wE *As two individual feature control frames* **FCF**\w⌖\w⌀0.8Ⓜ\wD\wE\wF **FCF**\w⌖\w⌀0.25Ⓜ\wD\wE

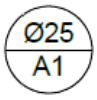
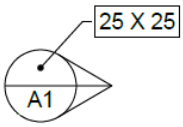
6.3 Datum Feature Symbol (DTM)

Denotes a datum feature.

	**DTM**\wA

6.4 Datum Target (TGT)

Datum targets and moveable datum targets are represented as TGT.

	**TGT**\wØ25\nA1
	**TGT**\w25 X 25\nA1 *Note: Moveable indicator not captured

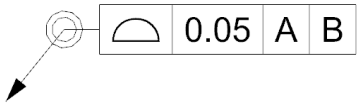
6.5 All Around (AAS)

Prefix to a DIM or FCF keyword.

	**AAS**\w\FCF\w⌓\0.05\wA\wB

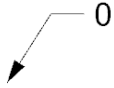
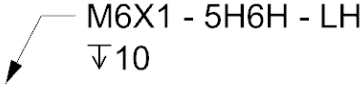
6.6 All Over (AOS)

Prefix to a DIM or FCF designator.

	**AOS**\w\FCF\w⌓\w0.05\wA\wB

6.7 Threads

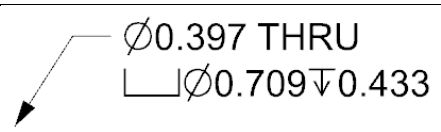
Thread information will be treated as text.

	**TXT**\w0.250-20 UNC-3B
	**TXT**\wM6X1 - 5H6H – LH\n\↧10

6.8 Standard Holes

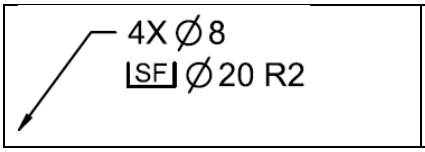
Hole callouts are handled as plain text describing the details of the hole. This includes information such as hole diameter(s), number of threads per inch, single or double thread, form, class, left hand, and other information that may not be listed here.

Symbols in hole callouts may include counterbore, countersink, and chamfer angle information.

	DIM\wØ0.397 THRU\n⌴Ø0.709↧0.433

6.9 Spotface (SF)

Spotface will be identified by the characters “SF”.

	DIM\w4XØ8\n**SF**Ø20 R2

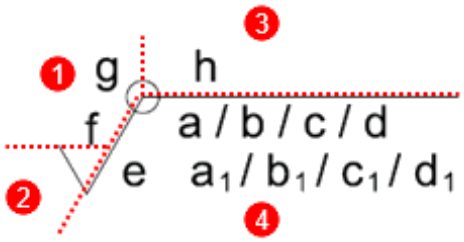
7 Surface Texture Terms & Delimiters

Surface texture (also known as surface finish) symbols define the lay (direction), roughness and waviness of a surface. Various manufacturing processes are used to achieve the desired surface texture on the finished part.

7.1 Surface Texture Symbol Layout

To capture Surface Finish Symbols as a Unicode string, it is divided into distinct regions, referred to as zones. The surface texture symbol layout from Figure 4-2 of ASME Y14.36-2018 is shown and will be used to layout the zones as labeled in that figure.

Information will be treated as plain text. There are no symbols used when representing surface texture.



Following the convention of using compartments for annotations, the Unicode string for a surface finish uses \w to separate zone information. In the example below, zones 1 and 2 are empty as indicated by the first two occurrences of \w\w.

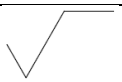
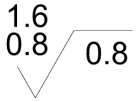
TURN 0.8 / Ra 3.2 ⊥ 2.5 / Wt 0.8	SRFMRR\w\w\wTURN\w0.8 / Ra 3.2\n⊥ 2.5 / Wt 0.8 *Zones 1 and 2 are intentionally blank.*

Delimiters for the surface texture symbol are listed below in order of the zones that information is put in.

7.2 Surface Texture Symbol (SRF)

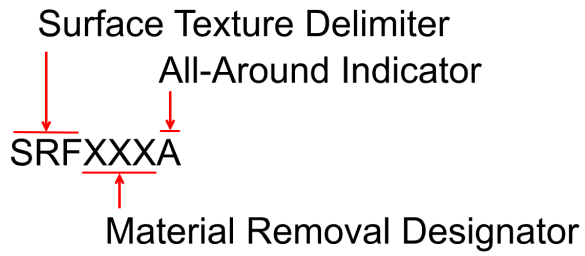
Denotes a surface finish annotation.

Surface Texture Symbols are typically expanded, showing a horizontal line drawn to the right of the longer angled leg of the basic surface texture symbol, unless zones 3 and 4 of the symbol are empty.

	**SRF**
	**SRF**
	**SRF**\w1.6\n0.8\w\w\w0.8

7.3 Symbol Modifiers

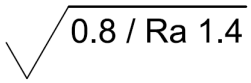
Modifiers indicate parameters to be applied to a surface that vary from those specified on a drawing or referenced specification sheet to specific surfaces.



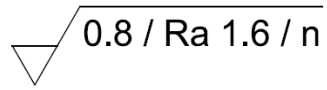
7.4 Material Removal Designator

The material removal designator is appended to the surface texture designator and specifies if material removal is required. Graphically, the angled lines of the surface texture symbol are modified to denote this information. Valid options are listed below.

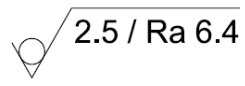
7.4.1 Any Process Allowed (APA)

	SRF**APA**
	SRF**APA**\w\w\w08./Ra 1.4

7.4.2 Material Removal Required (MRR)

	SRF**MRR**
	SRF**MRR**\w\w\w\0.8 / Ra 1.6 / n=3

7.4.3 No Material Removed (NMR)

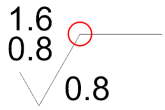
	SRF**NMR**
	SRF**NMR**\w\w\w\2.5 / Ra 6.4

7.5 All Around and All Over Designator

The all around or all over designator define surfaces that require different parameters than those stated in the title block or other specification. This designator is captured as a suffix to the Material Removal designator.

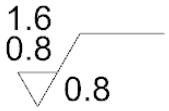
7.5.1 All Around (A)

Suffix to the process indicator on a surface texture annotation callout.

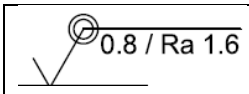
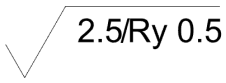
	SRFAPA**A**\w1.6\n0.8\w\w\w0.8

7.5.2 Not All Around (N)

It is recommended that “N” be included in the Unicode string. Without the “N”, it is assumed that any character other than A or no character in the last position implies that it is not all around.

	SRFMRR**N**\w1.6\n0.8\w\w0.8

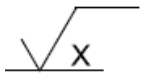
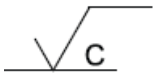
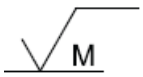
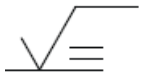
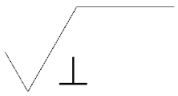
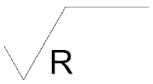
7.5.3 All Over (AOS)

	SRFAPA**AOS**\w\w\wTXT\u0.8/Ra 1.6\u
	SRFAPA\w\w\wTXT2.5/Ry 0.5 *No text after APA indicates the surface finish is not all over.*

7.6 Surface Finish Lay Symbols

The lay symbol indicates the direction of the surface marks of the surface finish. The lay symbol is specified in zone 4 of the surface finish symbol. The symbol is the first character on the second line. Even though some symbols are the same as those used in GD&T, they are represented as plain text to maintain consistency with ASME Y14.36-2018.

Lay Symbols and Examples:

Angular (X)		SRFAPAN\w\w\w\w\n**X**
Circular (C)		SRF\w\w\w\w\n**C**
Multi-directional (M)		SRF\w\w\w\w\n**M**
Parallel (PRL)		SRF\w\w\w\w\n**PRL**
Particulate. (P)		SRF\w\w\w\w\n**P**
Perpendicular (PERP)		SRF\w\w\w\w\n**PERP**
Radial (R)		SRF\w\w\w\w\n**R**

8 Welding Terms & Delimiters

Welding symbols indicate the fabrication process to be used to join materials, usually metals or thermoplastics.

8.1 Basic Welding Symbol Layout

To capture Welding Symbol information as a Unicode string, it is divided into distinct regions, referred to as zones. The layout of a basic welding symbol is shown in Figure 2. Information within each zone will be treated as plain text unless a symbol from the table in section 8.7 “Elementary Weld Symbols” of this document is called out.

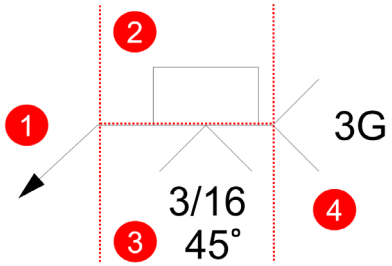
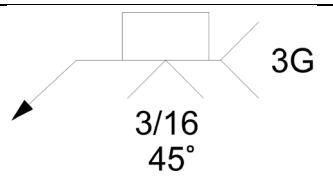


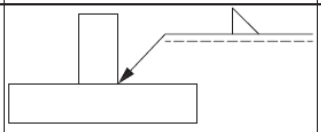
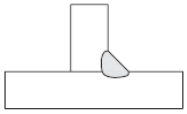
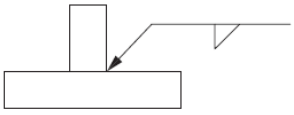
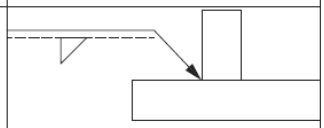
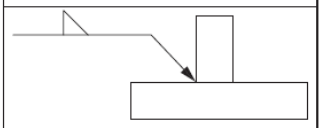
Figure 2

Following the convention of using compartments for annotations, the Unicode string for a weld callout uses \w to separate zone information. In the example below, zone 1 is empty as indicated by the first occurrence of \w immediately followed by another occurrence of \w.

	WLD\w\w□\w$_v$\n3\/16\n45°\w3G *Zone 1 is intentionally empty.*

8.2 Graphical Presentation

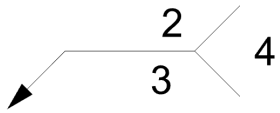
Some systems use a dashed line in addition to the reference line between sections 2 and 3. The dashed line is placed above or below the reference line. The figure below shows examples from ISO 2553:2019. Welding symbols can be placed on the solid reference line or the dashed reference line. Unicode representations do not capture the presence of dashed lines as this is purely graphical information. The welding symbol’s attachment determines whether the weld is located on the arrow side or other size. For the purposes of this document, arrow side information should be located in zone 3 and the other side information in zone 2. As a result, arrow side and other side information may vary graphically based on the system authoring the weld symbol, but information remains captured in a consistent manner.

Weld location	System A	Same weld produced using all four options	System B
Arrow side	 symbol on solid component of reference line		 symbol below reference line
Other side	 symbol on dashed component of reference line		 symbol above reference line
NOTE 1 In system A, the component of the reference line on which the elementary symbol is placed determines the side of the joint which is to be welded - the dashed line can be drawn above or below the solid line.			
NOTE 2 In system B, the position of the elementary symbol above or below the reference line determines the side of the joint on which the weld is made			

ISO 2553:2019 Table 5

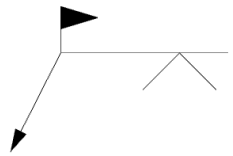
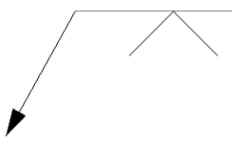
8.3 Weld Delimiter (WLD)

Denotes a weld symbol annotation. Information following WLD will identify what information is located in which zone on the symbol.

	**WLD**\w\w2\w3\w4 *Zone 1 is empty in this example.*

8.4 Field Weld / Flag (F)

Suffix to the WLD designator indicates a weld make outside of the workshop.

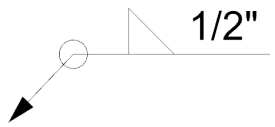
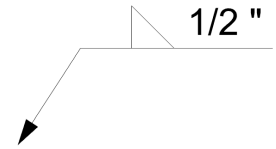
	WLD**F**NN\w\w\w*V* *Weld, Flag, Not All-Around, Not Reversed*
	WLD**N**NN\w\w\w*V* *Weld, No Flag, Not All-Around, Not Reversed*

8.5 All Around & Not All Around

Indicator of the boundaries of a weld.

8.5.1 All Around (A)

Suffix to the Flag indicator on a Weld annotation callout.

	WLDF**A**N\w\w\◺\TXT1/2“ *Weld, Flag, All-Around, Not Reversed*
	WLDF**N**N\w\w\◺\TXT1/2“ *Weld, Flag, Not All-Around, Not Reversed*

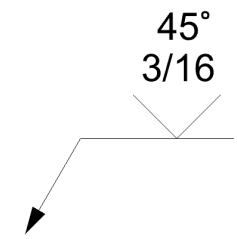
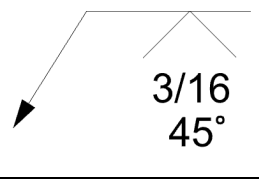
8.5.2 Not All Around (N)

Suffix to the Flag indicator on a Weld annotation callout.

8.6 Arrow Side / Other Side (R)

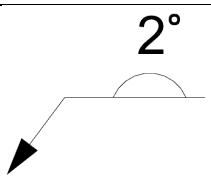
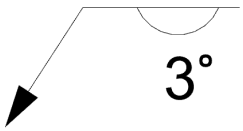
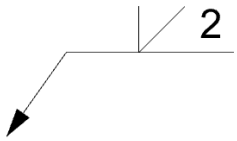
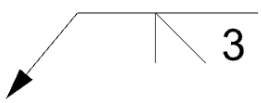
Zone 3 represents the arrow side of the weld when no reversal indicator is used.

Adding the reversal indicator defines Zone 2 as the arrow side and Zone 3 in the other side.

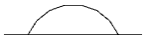
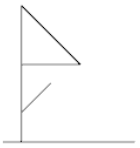
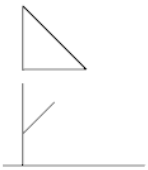
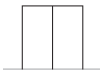
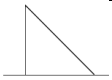
	WLDNN**R**\w\w\w✓ *Weld, No Flag, Not All-Around, Reversed*
	WLDNN**N**\w\w\w✓ *Weld, No Flag, Not All-Around, Not Reversed*

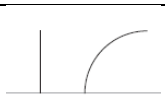
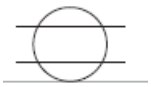
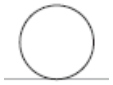
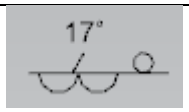
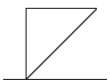
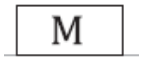
8.7 Elementary Weld Symbols

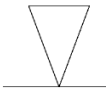
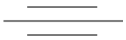
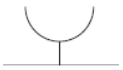
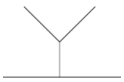
Elementary symbols represent the type of weld to be made. Each weld will be represented with one symbol only. A second symbol that would graphically represent the inversion of a symbol is not used. The direction of the symbol is conveyed defined by the zone the symbol is define in.

	WLDNNN\w\w2°\n◠
	WLDNNN\w\w\w3°\n◠
	WLD\w\w\/2
	WLD\w\w\w\/3

8.8 Weld Unicode Symbols

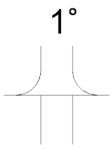
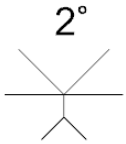
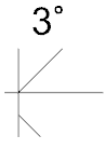
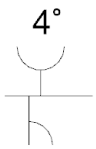
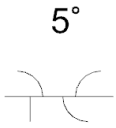
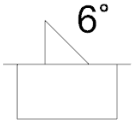
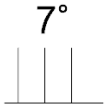
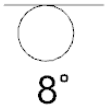
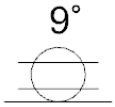
Symbol	Weld Symbol Presentation	Unicode Presentation	Unicode String
Backing		◠	25E0
Backing (unspecified)		▭	25AD
Between Two Points		↔	2194
Bevel Butt		⩗	2A57
Bevel Butt (with Broad Root Face)		⌠	21BE
Concave		⌒	2323
Consumable Insert		□	25A1
Convex		⌢	2322
Double Bevel Butt with Broad Root Face and Fillet Welds	 or 	◺⌠	25FA 21BE *Symbols touching and separated are equivalent.*
Edge		⫼	2980
Flat / Flush		—	2212
Fillet		◺	25FA

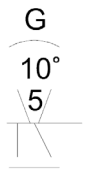
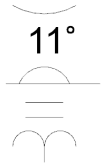
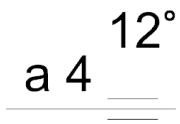
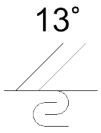
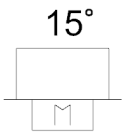
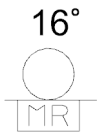
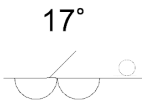
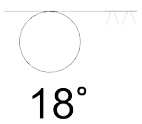
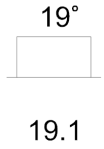
Symbol	Weld Symbol Presentation	Unicode Presentation	Unicode String
Flanged Butt Flanged Corner Butt with Raised Edges			25DE 25DF
Flare			007C
Flare Bevel			007C and 25DC
Flare V Butt Weld with Raised Edges			25DD and 25DC
Fold Joint			20AA
Fusion Seam Resistance Seam			29C3
Fusion Spot			25EF
Fusion Spot			235C
Inclined Joint			2AFD
J-Butt			2441
K-Groove			25F8
Overlay			25E0 25E0
Permanent Backing			[M]
Plug			25AD
Removeable / Temporary Backing			[MR]

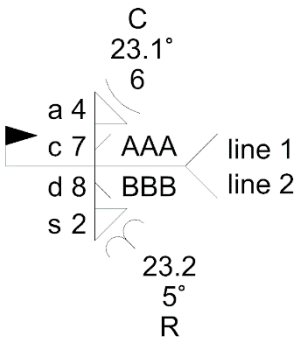
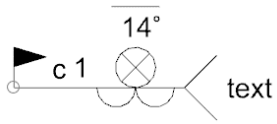
Symbol	Weld Symbol Presentation	Unicode Presentation	Unicode String
Specified Root Reinforcement		◒	25D2
Square Butt		‖	2016
Stake		▽	25BD
Steep Flanked Bevel Butt		Plain Text	| / (plain text: pipe and forward slash)
Steep-flanked V Butt		Plain Text	\ / (plain text: backslash and forward slash)
Stud		ⓧ	24CD
Soldered Joint		÷	232F
Surface Joint		=	= (plain text: equal sign)
Toes Blended Smoothly		⅄	22CF
U-Butt		⅂	2442
V-Butt		v	2304
V-Butt with Broad Root Face		Y	Y
Fold Joint		₪	20AA

8.9 Examples

The following examples have been provided by Siemens PLM:

	Weld Symbol	Unicode string
1		WLDNNN\w\w\u1°\n ⺕ \u\w‖
2		WLDNNN\w\w\u2°\n$_{v}$\u\wY
3		WLDNNN\w\w\u3°\n⺀\u\w丨
4		WLDNNN\w\w\u4°\n⺾\u\wㅓ
5		WLDNNN\w\w\u5°\n ⺍ \u\w|
6		WLDNNN\w\w\u6°\n⺁\u\w□
7		WLDNNN\w\w\u7°\n⫴\u
8		WLDNNN\w\w\w\u◯\n8°\u
9		WLDNNN\w\w\u9°\n〇\u

	Weld Symbol	Unicode string
10		WLDNNN\w\w\uG\n⌒\n10°\n5\n_/\u\w\u|\\n—\u
11		WLDNNN\w\w\u⌓\n11°\n◒\u\w\u=\nʎ\u
12		WLDNNN\w\wa4\u12°\n≒\u
13		WLDNNN\w\w\u13°\n⫽\u\w₪
15		WLDNNN\w\w\u15°\n▭\u\w[M]
16		WLDNNN\w\w\u16°n◯\u\w[MR]
17		WLDNNN\w\w\u17°\n/\u⌓\w⌒⌒
18		WLDNNN\w\w\w\u◯\n18°u◡◡
19		WLDNNN\w\w\u19°\n▭\u\w19.1
20		WLDNNN\w\w\u20°\n|◟ \u

	Weld Symbol	Unicode string
21		WLDFNN\w\w\ua4\nc7\u\uC\n23.1°\n6\n◡\n◣\n|◜ \uAAA\w\ud8\ns2\u\u\n◣\nλ\n23.2\n5°\nR\uBBB\w\uline1\nline2\u
22		WLDFAN\w\wc1\u—\n14°\n⊗\u\w◠◠\wtext