



MTConnect® Standard

Part 4.0 – Asset Information Model

Version 2.0.0

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The normative XMI is located at the following URL: MTConnectSysMLModel.xml

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1 Purpose of This Document

2 This document, *MTConnect Standard: Part 4.0 - Asset Information Model* of the MTCon-
3 nect Standard, details information that is common to all types of *Assets*. Part 4.0 of the
4 MTConnect Standard provide semantic models for entities that are used in the manufactur-
5 ing process, but are not considered to be a piece of equipment. These entities are defined
6 as *Assets*. These assets may be removed from a piece of equipment without detriment to
7 the function of the equipment and can be associated with other pieces of equipment dur-
8 ing their lifecycle. The data associated with these assets may be retrieved from multiple
9 sources that are each responsible for providing their knowledge of the asset.

10 2 Terminology and Conventions

11 Refer to *MTConnect Standard Part 1.0 - Fundamentals* for a dictionary of terms, reserved
12 language, and document conventions used in the MTConnect Standard.

13 2.1 MTConnect References

14 [MTConnect Part 1.0] *MTConnect Standard Part 1.0 - Fundamentals*. Version 2.0.

15 [MTConnect Part 2.0] *MTConnect Standard: Part 2.0 - Device Information Model*. Ver-
16 sion 2.0.

17 [MTConnect Part 3.0] *MTConnect Standard: Part 3.0 - Observation Information Model*.
18 Version 2.0.

19 [MTConnect Part 4.0] *MTConnect Standard: Part 4.0 - Asset Information Model*. Ver-
20 sion 2.0.

21

22 3 Asset Information Model

23 The MTConnect Standard supports a simple distributed storage mechanism that allows ap-
 24 plications and equipment to share and exchange complex information models in a similar
 25 way to a distributed data store. The *Asset Information Model* associates each MTConnec-
 26 tAssets entity with a unique identifier and allows for some predefined mechanisms to
 27 find, create, request, update, and delete these electronic documents in a way that provides
 28 for consistency across multiple pieces of equipment.

29 The protocol provides a limited mechanism of accessing *Assets* using the following prop-
 30 erties: assetId, asset type (element name of asset root), and the piece of equipment
 31 associated with the asset. These access strategies will provide the following services and
 32 answer the following questions: What assets are from a particular piece of equipment?
 33 What are the assets of a particular type? What asset is stored for a given assetId?

34 Although these mechanisms are provided, an *agent* should not be considered a data store
 35 or a system of reference. The *agent* is providing an ephemeral storage capability that will
 36 temporarily manage the data for applications wishing to communicate and manage data
 37 as needed by the various processes. An application cannot rely on an *agent* for long term
 38 persistence or durability since the *agent* is only required to temporarily store the asset data
 39 and may require another system to provide the source data upon initialization. An *agent* is
 40 always providing the best-known equipment centric view of the data given the limitations
 41 of that piece of equipment.

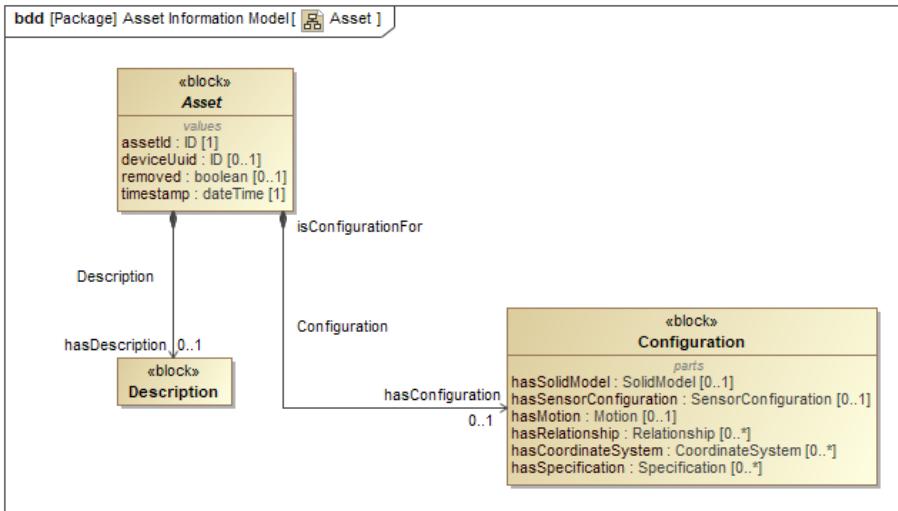
42 The MTConnect Standard has two data item types to support change notification when an
 43 *Asset* is added, updated or removed. AssetChanged states the assetId of the *Asset*
 44 that has been added or updated. AssetRemoved states the assetId of the *Asset* that
 45 has been removed. See *MTConnect Standard: Part 3.0 - Observation Information Model*
 46 for more details.

47 3.1 Asset

48 abstract *Asset*.

49 It is used in the manufacturing process, but is not permanently associated with a single
 50 piece of equipment. It can be removed from the piece of equipment without compromising
 51 its function, and can be associated with other pieces of equipment during its lifecycle.

52 Note: See *Section B.1 - Assets Schema Diagrams* for XML schema.

**Figure 1:** Asset

53 3.1.1 Value Properties of Asset

54 *Table 1* lists the Value Properties of Asset.

Value Property name	Value Property type	Multiplicity
assetId	ID	1
deviceUuid	ID	0..1
removed	boolean	0..1
timestamp	dateTime	1

Table 1: Value Properties of Asset

55 Descriptions for Value Properties of Asset:

- 56 • assetId
- 57 unique identifier for an Asset.
- 58 • deviceUuid
- 59 associated piece of equipment's Universally Unique Identifier (UUID) that supplied
- 60 the Asset's data.
- 61 It references to the `uuid` property of the Device defined in *MTConnect Standard: Part 2.0 - Device Information Model*.
- 63 • removed
- 64 indicator that the Asset has been removed from the piece of equipment.

- 65 • timestamp
 66 time the Asset data was last modified.

67 3.1.2 Part Properties of Asset

68 *Table 2* lists the Part Properties of Asset.

Part Property name	Multiplicity
Description	0..1
Configuration	0..1

Table 2: Part Properties of Asset

69 Descriptions for Part Properties of Asset:

- 70 • Description
 71 descriptive content.
 72 This can contain configuration information and manufacturer specific details.
 73 • Configuration
 74 technical information about an entity describing its physical layout, functional char-
 75 acteristics, and relationships with other entities.
 76 See Configuration in *MTConnect Standard: Part 2.0 - Device Information Model*.

78 4 Cutting Tool Asset Information Model

79 There are two *information models* used to represent a cutting tool, *CuttingToolArchetype*
 80 and *CuttingTool*. The *CuttingToolArchetype* represents the static cutting tool
 81 geometries and nominal values as one would expect from a tool catalog and the *Cut-
 82 tingTool* represents the use or application of the tool on the shop floor with actual
 83 measured values and process data. In Version 1.3.0 of the MTConnect Standard it was de-
 84 cided to separate out these two concerns since not all pieces of equipment will have access
 85 to both sets of information. In this way, a generic definition of the cutting tool can coexist
 86 with a specific assembly *information model* with minimal redundancy of data.

87 MTConnect Standard will adopt the ISO 13399 structure when formulating the vocabulary
 88 for Cutting Tool geometries and structure to be represented in the *CuttingToolArchetype*.
 89 The nominal values provided in the *CuttingToolLifeCycle* section are only con-
 90 cerned with two aspects of the Cutting Tool; the Cutting Tool and the cutting item. The
 91 tool item, Adaptive Item, and Assembly Item will only be covered in the *Cutting-
 92 ToolDefinition* section of this document since this section contains the full ISO
 93 13399 information about a Cutting Tool.



Figure 2: Cutting Tool Parts

94 The Figure 2 illustrates the parts of a Cutting Tool. The Cutting Tool is the aggregate of all
 95 the components and the cutting item is the part of the tool that removes the material from
 96 the workpiece. These are the primary focus of the MTConnect Standard.

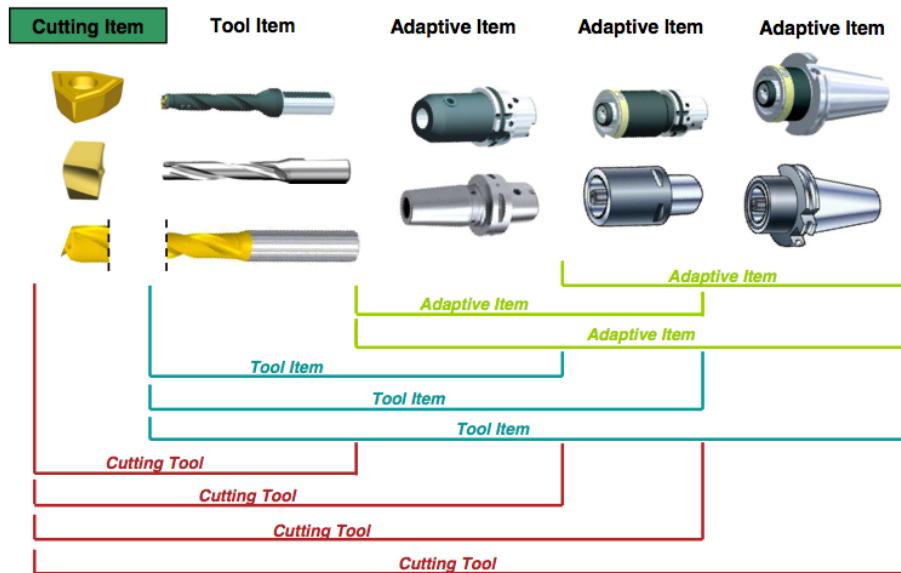


Figure 3: Cutting Tool Composition

97 Figure 3 provides another view of the composition of a Cutting Tool. The Adaptive Items
 98 and tool items will be used for measurements, but will not be modeled as separate entities.
 99 When we are referencing the Cutting Tool we are referring to the entirety of the assembly
 100 and when we provide data regarding the cutting item we are referencing each individual
 101 item as illustrated on the left of the previous diagram.

102 Figure 4 and Figure 5 further illustrates the components of the Cutting Tool. As we com-
 103 pose the tool item, cutting item, Adaptive Item, we get a Cutting Tool. The tool item,
 104 Adaptive Item, and Assembly Item will only be in the `CuttingToolDefinition` sec-
 105 tion that will contain the full ISO 13399 information. These figures also use the ISO 13399
 106 codes for each of the measurements. These codes will be translated into the MTConnect
 107 Standard vocabulary as illustrated below. The measurements will have a maximum, mini-
 108 mum, and nominal value representing the tolerance of allowable values for this dimension.

109 The MTConnect Standard will not define the entire geometry of the Cutting Tool, but will
 110 provide the information necessary to use the tool in the manufacturing process. Addi-
 111 tional information can be added to the definition of the Cutting Tool by means of schema
 112 extensions.

113 Additional diagrams will reference these dimensions by their codes that will be defined in
 114 the measurement tables. The codes are consistent with the codes used in ISO 13399 and
 115 have been standardized. MTConnect Standard will use the full text name for clarity in the
 116 *response documents*.

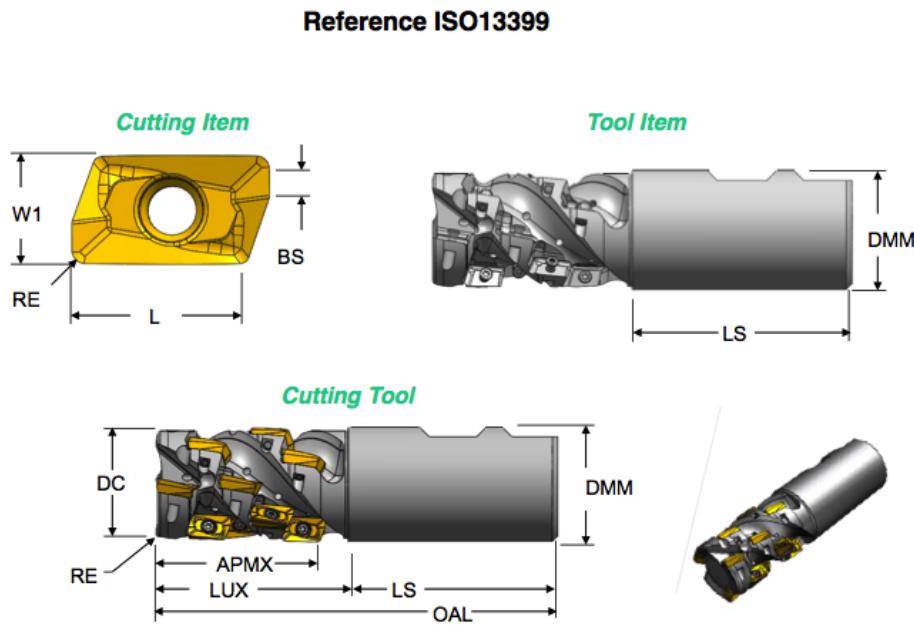


Figure 4: Cutting Tool, Tool Item, and Cutting Item

117 4.1 Cutting Tool

118 This section provides semantic information for the `CuttingTool` and `CuttingToolArchetype`
119 models.

120 Note: See *Section B.2 - CuttingTool Schema Diagrams* for XML schema.

121 4.1.1 CuttingTool

122 Asset that physically removes the material from the workpiece by shear deformation.

123 4.1.1.1 Value Properties of CuttingTool

124 *Table 3* lists the Value Properties of `CuttingTool`.

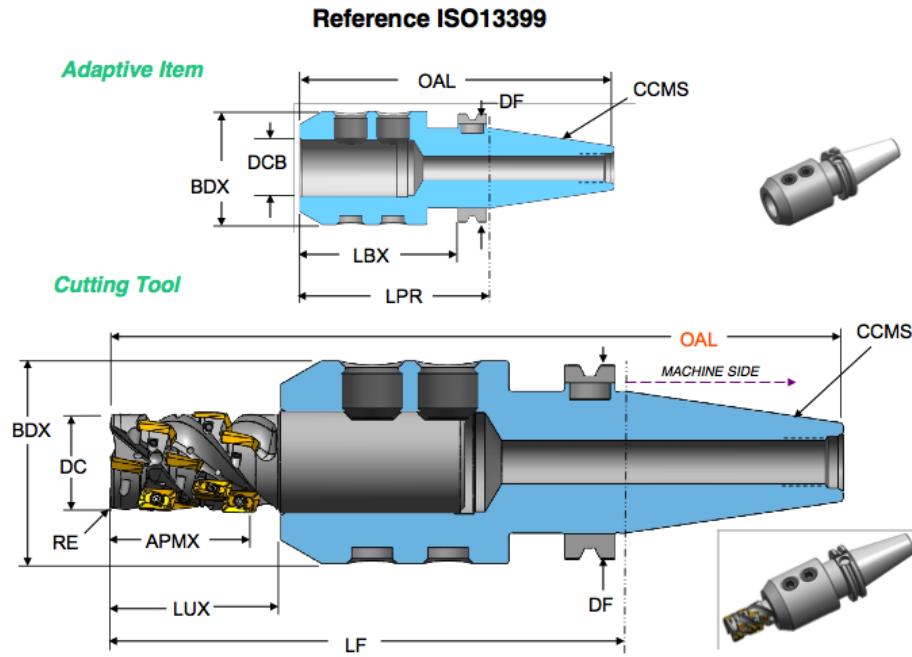


Figure 5: Cutting Tool, Tool Item, and Cutting Item 2

Value Property name	Value Property type	Multiplicity
manufacturers	string	0..*
serialNumber	string	1
toolId	string	1

Table 3: Value Properties of CuttingTool

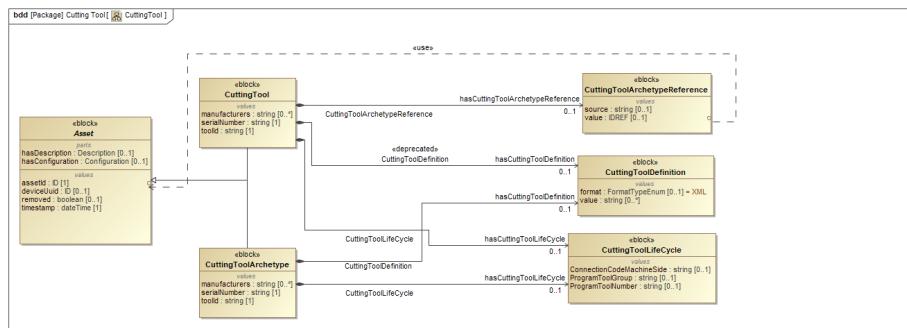


Figure 6: CuttingTool

125 Descriptions for Value Properties of CuttingTool:

126 • manufacturers
 127 manufacturers of the cutting tool.
 128 This will reference the tool item and adaptive items specifically. The cutting items
 129 manufacturers' will be a property of CuttingItem.

130 Note: In Extensible Markup Language (XML), the representation **MUST**
 131 be a comma(,) delimited list of manufacturer names. See Figure 22.

132 • serialNumber
 133 unique identifier for this assembly.
 134 • toolId
 135 identifier for a class of cutting tools.

136 4.1.1.2 Part Properties of CuttingTool

137 *Table 4* lists the Part Properties of CuttingTool.

Part Property name	Multiplicity
CuttingToolLifeCycle	0..1
CuttingToolArchetypeReference	0..1
<<deprecated>> CuttingToolDefinition	0..1

Table 4: Part Properties of CuttingTool

138 Descriptions for Part Properties of CuttingTool:

139 • CuttingToolLifeCycle
 140 data regarding the application or use of the tool.
 141 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
 142 and statistical process control applications. Life cycle data will not remain static,
 143 but will change periodically when a tool is used or measured.
 144 See *Section 4.2.1 - CuttingToolLifeCycle*.
 145 • CuttingToolArchetypeReference
 146 reference information about the assetId and/or the URL of the data source of
 147 CuttingToolArchetype.

- 148 • CuttingToolDefinition
 149 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO*
 150 *13399.*
 151 **DEPRECATED** in *Version 1.3.0* for CuttingTool.

152 4.1.2 CuttingToolArchetype

153 Asset that describes the static cutting tool geometries and nominal values as one would
 154 expect from a tool catalog.

155 4.1.2.1 Value Properties of CuttingToolArchetype

156 *Table 5* lists the Value Properties of CuttingToolArchetype.

Value Property name	Value Property type	Multiplicity
manufacturers	string	0..*
serialNumber	string	1
toolId	string	1

Table 5: Value Properties of CuttingToolArchetype

157 Descriptions for Value Properties of CuttingToolArchetype:

- 158 • manufacturers
 159 manufacturers of the cutting tool.
 160 This will reference the tool item and adaptive items specifically. The cutting items
 161 manufacturers' will be a property of CuttingItem.

162 Note: In XML, the representation will be a comma(,) delimited list of
 163 manufacturer names. See Figure 22.

- 164 • serialNumber
 165 unique identifier for this assembly.
 166 • toolId
 167 identifier for a class of cutting tools.

168 **4.1.2.2 Part Properties of CuttingToolArchetype**169 *Table 6* lists the Part Properties of CuttingToolArchetype.

Part Property name	Multiplicity
CuttingToolDefinition	0..1
CuttingToolLifeCycle	0..1

Table 6: Part Properties of CuttingToolArchetype

170 Descriptions for Part Properties of CuttingToolArchetype:

- 171 • CuttingToolDefinition

172 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO
173 13399.*174 See *Section 4.1.4 - CuttingToolDefinition*.

- 175 • CuttingToolLifeCycle

176 data regarding the application or use of the tool.

177 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
178 and statistical process control applications. Life cycle data will not remain static,
179 but will change periodically when a tool is used or measured.180 See *Section 4.2.1 - CuttingToolLifeCycle*.181 **4.1.3 CuttingToolArchetypeReference**182 reference information about the assetId and/or the URL of the data source of Cut-
183 tingToolArchetype.184 The value of CuttingToolArchetypeReference **MUST** be IDREF. See *Section 8.1.10
185 - IDREF*.186 **4.1.3.1 Value Properties of CuttingToolArchetypeReference**187 *Table 7* lists the Value Properties of CuttingToolArchetypeReference.

Value Property name	Value Property type	Multiplicity
source	string	0..1

Table 7: Value Properties of CuttingToolArchetypeReference

188 Descriptions for Value Properties of CuttingToolArchetypeReference:

189 • source

190 Uniform Resource Locator (URL) of the CuttingToolArchetype *information*
 191 *model*.

192 4.1.4 CuttingToolDefinition

193 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO 13399.*

194 The value of CuttingToolDefinition **MUST** be a list of string of size 0 .. *.

195 4.1.4.1 Value Properties of CuttingToolDefinition

196 *Table 8* lists the Value Properties of CuttingToolDefinition.

Value Property name	Value Property type	Multiplicity
format	FormatTypeEnum	0..1

Table 8: Value Properties of CuttingToolDefinition

197 Descriptions for Value Properties of CuttingToolDefinition:

198 • format

199 identifies the expected representation of the enclosed data.

200 FormatTypeEnum Enumeration:

201 – EXPRESS

202 document will conform to the ISO 10303 Part 21 standard.

203 – TEXT

204 document will be a text representation of the tool data.

- 205 - UNDEFINED
 206 document will be provided in an undefined format.
 207 - XML
 208 default value for the definition. The content will be an XML document.

209 4.2 Cutting Tool Life Cycle

210 This section provides semantic information for the CuttingToolLifeCycle model.

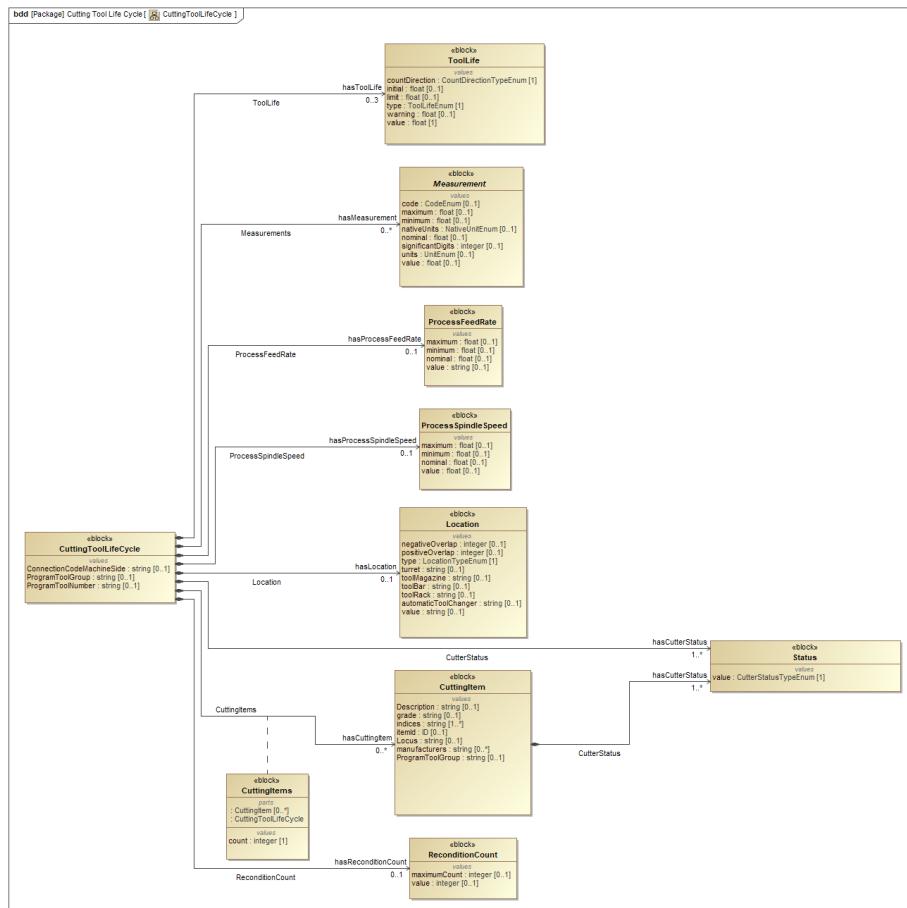


Figure 7: CuttingToolLifeCycle

211 Note: See *Section B.3 - CuttingToolLifeCycle Schema Diagrams* for XML
 212 schema.

213 **4.2.1 CuttingToolLifeCycle**

214 data regarding the application or use of the tool.

215 This data is provided by various pieces of equipment (i.e. machine tool, presetter) and
 216 statistical process control applications. Life cycle data will not remain static, but will
 217 change periodically when a tool is used or measured.

218 **4.2.1.1 Value Properties of CuttingToolLifeCycle**

219 *Table 9* lists the Value Properties of CuttingToolLifeCycle.

Value Property name	Value Property type	Multiplicity
ConnectionCodeMachineSide	string	0..1
ProgramToolGroup	string	0..1
ProgramToolNumber	string	0..1

Table 9: Value Properties of CuttingToolLifeCycle

220 Descriptions for Value Properties of CuttingToolLifeCycle:

- 221 • ConnectionCodeMachineSide
- 222 identifier for the capability to connect any component of the cutting tool together,
 223 except Assembly Items, on the machine side. Code: CCMS
- 224 • ProgramToolGroup
- 225 tool group this tool is assigned in the part program.
- 226 • ProgramToolNumber
- 227 number of the tool as referenced in the part program.

228 **4.2.1.2 Part Properties of CuttingToolLifeCycle**

229 *Table 10* lists the Part Properties of CuttingToolLifeCycle.

Part Property name	Multiplicity
ProcessFeedRate	0..1
ToolLife	0..3
ProcessSpindleSpeed	0..1
Status (organized by CutterStatus)	1..*
CuttingItem (organized by CuttingItems)	0..*
Measurement (organized by Measurements)	0..*
ReconditionCount	0..1
Location	0..1

Table 10: Part Properties of CuttingToolLifeCycle

230 Descriptions for Part Properties of CuttingToolLifeCycle:

231 • ProcessFeedRate

232 constrained process feed rate for the tool in mm/s.

233 The value **MAY** contain the nominal process target feed rate if available. If Pro-
234 cessFeedRate is provided, at least one value of maximum, nominal, or min-
235 imum **MUST** be specified.

236 See *Section 4.2.6 - ProcessFeedRate*.

237 • ToolLife

238 cutting tool life as related to the assembly.

239 See *Section 4.2.2 - ToolLife*.

240 • ProcessSpindleSpeed

241 constrained process spindle speed for the tool in revolutions/minute.

242 The value **MAY** contain the nominal process target spindle speed if available. If
243 ProcessSpindleSpeed is provided, at least one value of maximum, nomi-
244 nal, or minimum **MUST** be specified.

245 See *Section 4.2.5 - ProcessSpindleSpeed*.

246 • Status

247 status of the cutting tool.

248 CutterStatus provides the status of the assembly and *organize* one or more
249 Status entities. See *Section 4.2.7 - Status*.

250 The following combinations of Status entities **MUST NOT** occur for a Cut-
251 terStatus:

- 252 – NEW **MUST NOT** be used with USED, RECONDITIONED, or EXPIRED.
 253 – UNKNOWN **MUST NOT** be used with any other status.
 254 – ALLOCATED and UNALLOCATED **MUST NOT** be used together.
 255 – AVAILABLE and UNAVAILABLE **MUST NOT** be used together.
 256 – If the tool is EXPIRED, BROKEN, or NOT_REGISTERED it **MUST NOT** be
 257 AVAILABLE.
- 258 • CuttingItem
 259 part of the tool that physically removes the material from the workpiece by shear
 260 deformation.
 261 CuttingItems groups one or more CuttingItem entities. See *Section 4.3.1 -*
 262 *CuttingItem* and *Section 4.3 - Cutting Item* for more detail.
- 263 • Measurement
 264 constrained scalar value associated with a cutting tool.
 265 Measurements groups one or more Measurement subtypes. See *Section 4.2.8*
 266 - *Measurement*.
- 267 • ReconditionCount
 268 number of times the cutter has been reconditioned.
 269 See *Section 4.2.4 - ReconditionCount*.
- 270 • Location
 271 location of the pot or spindle the cutting tool currently resides in.
 272 If negativeOverlap or positiveOverlap is provided, the tool reserves ad-
 273 ditional locations on either side, otherwise if they are not given, no additional loca-
 274 tions are required for this tool.
 275 If the pot occupies the first or last location, a rollover to the beginning or the end of
 276 the indexable values may occur. For example, if there are 64 pots and the tool is in
 277 pot 64 with a positiveOverlap of 1, the first pot **MAY** be occupied as well.
 278 See *Section 4.2.3 - Location* for more detail.

279 4.2.2 ToolLife

280 cutting tool life as related to the assembly.

281 ToolLife **MUST** be defined only for the CuttingToolLifeCycle of Cutting-
 282 Tool and **MUST NOT** be defined for the CuttingToolLifeCycle of Cutting-
 283 ToolArchetype.

284 The value of ToolLife **MUST** be float.

285 **4.2.2.1 Value Properties of ToolLife**

286 *Table 11* lists the Value Properties of ToolLife.

Value Property name	Value Property type	Multiplicity
countDirection	CountDirectionTypeEnum	1
initial	float	0..1
limit	float	0..1
type	ToolLifeEnum	1
warning	float	0..1

Table 11: Value Properties of ToolLife

287 Descriptions for Value Properties of ToolLife:

288 • countDirection

289 indicates if the tool life counts from zero to maximum or maximum to zero.

290 CountDirectionTypeEnum Enumeration:

291 – DOWN

292 tool life counts down from the maximum to zero.

293 – UP

294 tool life counts up from zero to the maximum.

295 • initial

296 initial life of the tool when it is new.

297 • limit

298 end of life limit for the tool.

299 • type

300 type of tool life being accumulated.

301 ToolLifeEnum Enumeration:

302 - MINUTES
303 tool life measured in minutes.
304 All units for minimum, maximum, and nominal **MUST** be provided in min-
305 utes.
306 - PART_COUNT
307 tool life measured in parts.
308 All units for minimum, maximum, and nominal **MUST** be provided as the
309 number of parts.
310 - WEAR
311 tool life measured in tool wear.
312 Wear **MUST** be provided in millimeters as an offset to nominal. All units for
313 minimum, maximum, and nominal **MUST** be given as millimeter offsets as
314 well. The standard will only consider dimensional wear at this time.
315 • warning
316 point at which a tool life warning will be raised.

317 4.2.3 Location

318 location of the pot or spindle the cutting tool currently resides in.
319 If negativeOverlap or positiveOverlap is provided, the tool reserves additional
320 locations on either side, otherwise if they are not given, no additional locations are required
321 for this tool.
322 If the pot occupies the first or last location, a rollover to the beginning or the end of the
323 indexable values may occur. For example, if there are 64 pots and the tool is in pot 64 with
324 a positiveOverlap of 1, the first pot **MAY** be occupied as well.
325 Location **MUST** be defined only for the CuttingToolLifeCycle of Cutting-
326 Tool and **MUST NOT** be defined for the CuttingToolLifeCycle of Cutting-
327 ToolArchetype.
328 The value of Location **MUST** be string.

329 4.2.3.1 Value Properties of Location

330 *Table 12* lists the Value Properties of Location.

Value Property name	Value Property type	Multiplicity
negativeOverlap	integer	0..1
positiveOverlap	integer	0..1
type	LocationTypeEnum	1
turret	string	0..1
toolMagazine	string	0..1
toolBar	string	0..1
toolRack	string	0..1
automaticToolChanger	string	0..1

Table 12: Value Properties of Location

331 Descriptions for Value Properties of Location:

- 332 • negativeOverlap
333 number of locations at lower index values from this location.
- 334 • positiveOverlap
335 number of locations at higher index value from this location.
- 336 • type
337 type of location being identified.
338 When a POT or STATION type is used, value of Location **MUST** be a numeric
339 value.
- 340 LocationTypeEnum Enumeration:
 - 341 – CRIB
342 location with regard to a tool crib.
 - 343 – END_EFFECTOR
344 location associated with an end effector.
 - 345 – EXPIRED_POT
346 location for a tool that is no longer usable and is awaiting removal from a tool
347 magazine or turret.
 - 348 – POT
349 number of the pot in the tool handling system.
 - 350 – REMOVAL_POT
351 location for a tool removed from a tool magazine or turret awaiting transfer to
352 a location outside of the piece of equipment.

- 353 - RETURN_POT
 - 354 location for a tool removed from a *spindle* or turret and awaiting return to a
 - 355 tool magazine.
- 356 - SPINDLE
 - 357 location associated with a *spindle*.
- 358 - STAGING_POT
 - 359 location for a tool awaiting transfer to a tool magazine or turret from outside
 - 360 of the piece of equipment.
- 361 - STATION
 - 362 tool location in a horizontal turning machine.
- 363 - TRANSFER_POT
 - 364 location for a tool awaiting transfer from a tool magazine to spindle or a turret.
- 365 • turret
 - 366 turret associated with a tool.
- 367 • toolMagazine
 - 368 tool magazine associated with a tool.
- 369 • toolBar
 - 370 tool bar associated with a tool.
- 371 • toolRack
 - 372 tool rack associated with a tool.
- 373 • automaticToolChanger
 - 374 automatic tool changer associated with a tool.

375 4.2.4 ReconditionCount

376 number of times the cutter has been reconditioned.

377 ReconditionCount **MUST** be defined only for the CuttingToolLifeCycle of
378 CuttingTool and **MUST NOT** be defined for the CuttingToolLifeCycle of
379 CuttingToolArchetype.

380 The value of ReconditionCount **MUST** be integer.

381 **4.2.4.1 Value Properties of ReconditionCount**382 *Table 13* lists the Value Properties of ReconditionCount.

Value Property name	Value Property type	Multiplicity
maximumCount	integer	0..1

Table 13: Value Properties of ReconditionCount

383 Descriptions for Value Properties of ReconditionCount:

- 384 • maximumCount
 385 maximum number of times the tool may be reconditioned.

386 **4.2.5 ProcessSpindleSpeed**

387 constrained process spindle speed for the tool in revolutions/minute.

388 The value **MAY** contain the nominal process target spindle speed if available. If **ProcessSpindleSpeed** is provided, at least one value of **maximum**, **nominal**, or **minimum** **MUST** be specified.

391 The value of **ProcessSpindleSpeed** **MUST** be float.392 **4.2.5.1 Value Properties of ProcessSpindleSpeed**393 *Table 14* lists the Value Properties of ProcessSpindleSpeed.

Value Property name	Value Property type	Multiplicity
maximum	float	0..1
minimum	float	0..1
nominal	float	0..1

Table 14: Value Properties of ProcessSpindleSpeed

394 Descriptions for Value Properties of ProcessSpindleSpeed:

- 395 • maximum
 396 upper bound for the tool's target spindle speed.

- 397 • minimum
 398 lower bound for the tools spindle speed.
 399 • nominal
 400 nominal speed the tool is designed to operate at.

401 4.2.6 ProcessFeedRate

402 constrained process feed rate for the tool in mm/s.

403 The value **MAY** contain the nominal process target feed rate if available. If `Process-`
 404 `FeedRate` is provided, at least one value of maximum, nominal, or minimum **MUST**
 405 be specified.

406 The value of `ProcessFeedRate` **MUST** be string.

407 4.2.6.1 Value Properties of ProcessFeedRate

408 *Table 15* lists the Value Properties of `ProcessFeedRate`.

Value Property name	Value Property type	Multiplicity
maximum	float	0..1
minimum	float	0..1
nominal	float	0..1

Table 15: Value Properties of `ProcessFeedRate`

409 Descriptions for Value Properties of `ProcessFeedRate`:

- 410 • maximum
 411 upper bound for the tool's process target feedrate.
 412 • minimum
 413 lower bound for the tool's feedrate.
 414 • nominal
 415 nominal feedrate the tool is designed to operate at.

416 4.2.7 Status

417 status of the cutting tool.

418 CutterStatusTypeEnum Enumeration:

- 419 • ALLOCATED
 - 420 tool is has been committed to a piece of equipment for use and is not available for
 - 421 use in any other piece of equipment.
- 422 • AVAILABLE
 - 423 tool is available for use.
 - 424 If this is not present, the tool is currently not ready to be used.
- 425 • BROKEN
 - 426 premature tool failure.
- 427 • EXPIRED
 - 428 tool has reached the end of its useful life.
- 429 • MEASURED
 - 430 tool has been measured.
- 431 • NEW
 - 432 new tool that has not been used or first use.
 - 433 Marks the start of the tool history.
- 434 • NOT_REGISTERED
 - 435 tool cannot be used until it is entered into the system.
- 436 • RECONDITIONED
 - 437 tool has been reconditioned.
- 438 • UNALLOCATED
 - 439 tool has not been committed to a process and can be allocated.
- 440 • UNAVAILABLE
 - 441 tool is unavailable for use in metal removal.
- 442 • UNKNOWN
 - 443 tool is an indeterminate state. This is the default value.

- 444 • USED
 445 tool is in process and has remaining tool life.

446 4.2.8 Measurement

- 447 constrained scalar value associated with a cutting tool.
 448 A Measurement is specific to the tool management policy at a particular shop. The tool
 449 zero reference point or gauge line will be different depending on the particular implemen-
 450 tation and will be assumed to be consistent within the shop. MTConnect Standard does
 451 not standardize the manufacturing process or the definition of the zero point.
 452 The value of Measurement **MUST** be float.

453 4.2.8.1 Value Properties of Measurement

454 *Table 16* lists the Value Properties of Measurement.

Value Property name	Value Property type	Multiplicity
code	CodeEnum	0..1
maximum	float	0..1
minimum	float	0..1
nativeUnits	NativeUnitEnum	0..1
nominal	float	0..1
significantDigits	integer	0..1
units	UnitEnum	0..1

Table 16: Value Properties of Measurement

455 Descriptions for Value Properties of Measurement:

- 456 • code
 457 shop specific code for the measurement.
 458 ISO 13399 codes **MAY** be used for these codes as well.
 459 See *Section 4.4 - Cutting Tool Measurement Subtypes* and *Section 4.5 - Cutting*
 460 *Item Measurement Subtypes* for details on Measurement types and their respec-
 461 tive code values.

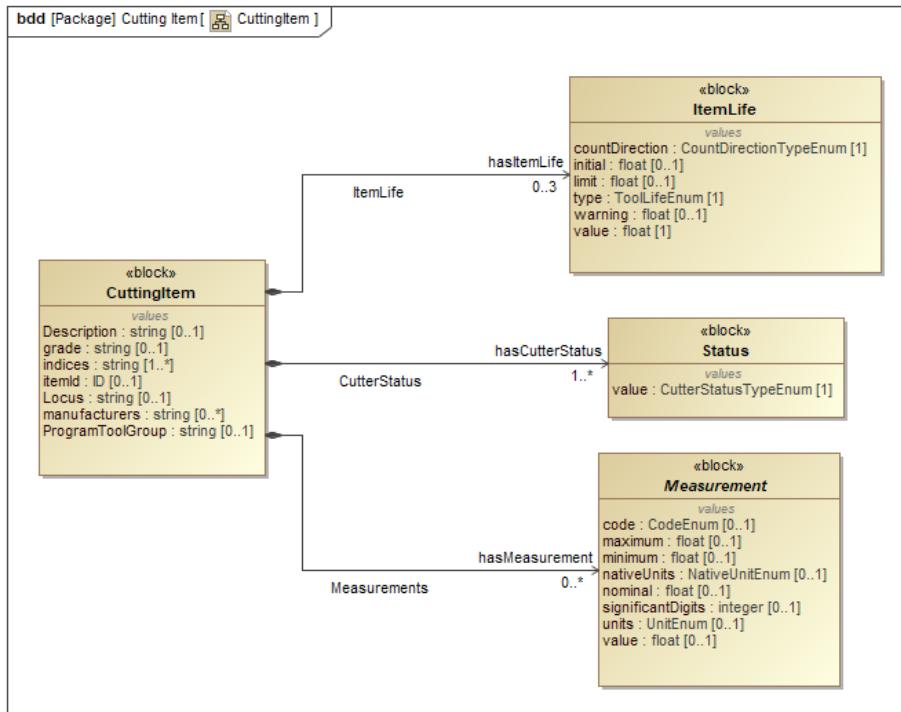
- 462 • maximum
 463 maximum value for the measurement.
- 464 • minimum
 465 minimum value for the measurement.
- 466 • nativeUnits
 467 units the measurement was originally recorded in. See *MTConnect Standard: Part*
 468 *2.0 - Device Information Model* for the complete list of nativeUnits.
 469 The value of nativeUnits **MUST** be one of the NativeUnitEnum enumera-
 470 tion.
- 471 • nominal
 472 as advertised value for the measurement.
- 473 • significantDigits
 474 number of significant digits in the reported value.
- 475 • units
 476 units for the measurements. See *MTConnect Standard: Part 2.0 - Device Informa-*
 477 *tion Model* for the complete list of units.
 478 The value of units **MUST** be one of the UnitEnum enumeration.

479 4.3 Cutting Item

480 A CuttingItem is the portion of the tool that physically removes the material from the
 481 workpiece by shear deformation. The cutting item can be either a single piece of mate-
 482 rial attached to the CuttingTool or it can be one or more separate pieces of material
 483 attached to the CuttingTool using a permanent or removable attachment. A Cuttin-
 484 gItem can be comprised of one or more cutting edges. Cutting items include: replaceable
 485 inserts, brazed tips and the cutting portions of solid CuttingTools.

486 MTConnect Standard considers CuttingItems as part of the CuttingTool. A Cut-
 487 ttingItems **MUST NOT** exist in MTConnect unless it is attached to a CuttingTool.
 488 Some of the measurements, such as FunctionalLength, **MUST** be made with refer-
 489 ence to the entire CuttingTool to be meaningful.

490 Note: See *Section B.4 - CuttingItem Schema Diagrams* for XML schema.

**Figure 8:** CuttingItem

491 4.3.1 CuttingItem

492 part of the tool that physically removes the material from the workpiece by shear deformation.
 493

494 4.3.1.1 Value Properties of CuttingItem

495 *Table 17* lists the Value Properties of CuttingItem.

Value Property name	Value Property type	Multiplicity
Description	string	0..1
grade	string	0..1
indices	string	1..*
itemId	ID	0..1
Locus	string	0..1
manufacturers	string	0..*
ProgramToolGroup	string	0..1

Table 17: Value Properties of CuttingItem

496 Descriptions for Value Properties of CuttingItem:

- 497 • Description
498 free-form description of the cutting item.
- 499 • grade
500 material composition for this cutting item.
- 501 • indices
502 number or numbers representing the individual cutting item or items on the tool.
503 Indices **SHOULD** start numbering with the inserts or CuttingItem furthest from
504 the gauge line and increasing in value as the items get closer to the gauge line. Items
505 at the same distance **MAY** be arbitrarily numbered.

506 Note: In XML, the representation **MUST** be a single number ("1") or a
507 comma separated set of individual elements ("1,2,3,4"), or as a inclusive
508 range of values as in ("1-10") or any combination of ranges and numbers
509 as in "1-4,6-10,22". There **MUST NOT** be spaces or non-integer values
510 in the text representation.

- 511 • itemId
512 manufacturer identifier of this cutting item.
- 513 • Locus
514 free form description of the location on the cutting tool.
515 For clarity, the words FLUTE, INSERT, and CARTRIDGE **SHOULD** be used to
516 assist in noting the location of a CuttingItem. Locus **MAY** be any free form
517 string, but **SHOULD** adhere to the following rules:

- 518 – The location numbering **SHOULD** start at the furthest CuttingItem and
519 work it's way back to the CuttingItem closest to the gauge line.
- 520 – Flutes **SHOULD** be identified as such using the word FLUTE:. For example:
521 FLUTE: 1, INSERT: 2 - would indicate the first flute and the second furthest
522 insert from the end of the tool on that flute.
- 523 – Other designations such as CARTRIDGE **MAY** be included, but should be
524 identified using upper case and followed by a colon (:).

- 525 • manufacturers
526 manufacturers of the cutting item.
527 This will reference the tool item and adaptive items specifically. The cutting items
528 manufacturers' will be a property of CuttingItem.

529 Note: In XML, the representation **MUST** be a comma(,) delimited list of
 530 manufacturer names. See Figure 34.

- 531 • ProgramToolGroup
 532 tool group this item is assigned in the part program.

533 **4.3.1.2 Part Properties of CuttingItem**

534 *Table 18* lists the Part Properties of CuttingItem.

Part Property name	Multiplicity
Status (organized by CutterStatus)	1..*
ItemLife	0..3
Measurement (organized by Measurements)	0..*

Table 18: Part Properties of CuttingItem

535 Descriptions for Part Properties of CuttingItem:

- 536 • Status
 537 status of the cutting tool.
 538 CutterStatus provides the status of the assembly and *organize* one or more
 539 Status entities. See *Section 4.2.7 - Status*.
 540 The following combinations of Status entities **MUST NOT** occur for a Cut-
 541 terStatus:

- 542 – NEW **MUST NOT** be used with USED, RECONDITIONED, or EXPIRED.
- 543 – UNKNOWN **MUST NOT** be used with any other status.
- 544 – ALLOCATED and UNALLOCATED **MUST NOT** be used together.
- 545 – AVAILABLE and UNAVAILABLE **MUST NOT** be used together.
- 546 – If the tool is EXPIRED, BROKEN, or NOT_REGISTERED it **MUST NOT** be
 547 AVAILABLE.

548 CutterStatus **MUST** be defined only for the CuttingToolLifeCycle of
 549 CuttingTool and **MUST NOT** be defined for the CuttingToolLifeCycle
 550 of CuttingToolArchetype.

- 551 • ItemLife
 552 life of a CuttingItem.
 553 See *Section 4.3.3 - ItemLife*.

554 • Measurement
 555 constrained scalar value associated with a cutting tool.
 556 Measurements groups one or more Measurement subtypes. See *Section 4.2.8*
 557 - *Measurement*.

558 4.3.2 CuttingItems

559 CuttingItems groups one or more CuttingItem entities. See *Section 4.3.1 - CuttingItem* and *Section 4.3 - Cutting Item* for more detail.

561 4.3.2.1 Value Properties of CuttingItems

562 *Table 19* lists the Value Properties of CuttingItems.

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 19: Value Properties of CuttingItems

563 Descriptions for Value Properties of CuttingItems:

564 • count
 565 number of CuttingItem organized by CuttingItems.

566 4.3.3 ItemLife

567 life of a CuttingItem.

568 The value of ItemLife **MUST** be float.

569 4.3.3.1 Value Properties of ItemLife

570 *Table 20* lists the Value Properties of ItemLife.

Value Property name	Value Property type	Multiplicity
countDirection	CountDirectionTypeEnum	1
initial	float	0..1
limit	float	0..1
type	ToolLifeEnum	1
warning	float	0..1

Table 20: Value Properties of ItemLife

571 Descriptions for Value Properties of ItemLife:

- 572 • countDirection

573 indicates if the item life counts from zero to maximum or maximum to zero.

574 The value of countDirection **MUST** be one of the CountDirectionType-
575 Enum enumeration.
- 576 • initial

577 initial life of the item when it is new.
- 578 • limit

579 end of life limit for this item.
- 580 • type

581 type of item life being accumulated.

582 The value of type **MUST** be one of the ToolLifeEnum enumeration.
- 583 • warning

584 point at which a item life warning will be raised.

585 4.4 Cutting Tool Measurement Subtypes

586 This section lists the Measurement subtypes for CuttingTool.

587 These Measurement subtypes for CuttingTool are specific to the entire assembly
588 and **MUST NOT** be used for the Measurement pertaining to a CuttingItem. Fig-
589 ure 9 and Figure 10 will be used to reference the assembly specific Measurement sub-
590 types.

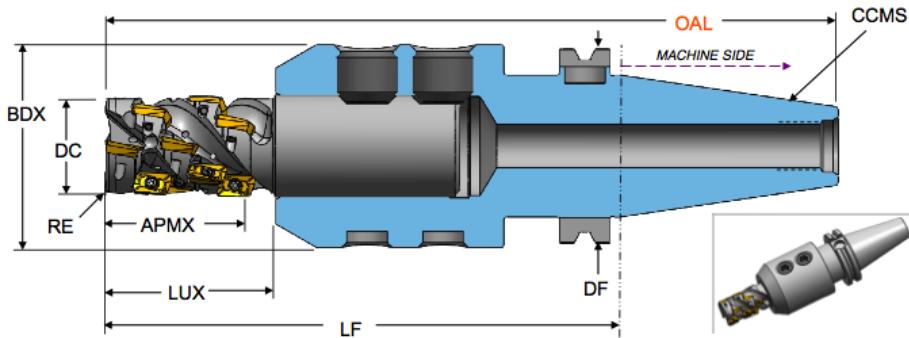


Figure 9: Cutting Tool Measurement 1

591 4.4.1 BodyDiameterMax

592 largest diameter of the body of a tool item.

593 The code of BodyDiameterMax **MUST** be BDX.

594 The units of BodyDiameterMax **MUST** be MILLIMETER.

595 4.4.2 BodyLengthMax

596 distance measured along the X axis from that point of the item closest to the workpiece,
 597 including the cutting item for a tool item but excluding a protruding locking mechanism
 598 for an adaptive item, to either the front of the flange on a flanged body or the beginning of
 599 the connection interface feature on the machine side for cylindrical or prismatic shanks.

600 The code of BodyLengthMax **MUST** be LBX.

601 The units of BodyLengthMax **MUST** be MILLIMETER.

602 4.4.3 DepthOfCutMax

603 maximum engagement of the cutting edge or edges with the workpiece measured perpen-
 604 dicular to the feed motion.

605 The code of DepthOfCutMax **MUST** be APMX.

606 The units of DepthOfCutMax **MUST** be MILLIMETER.

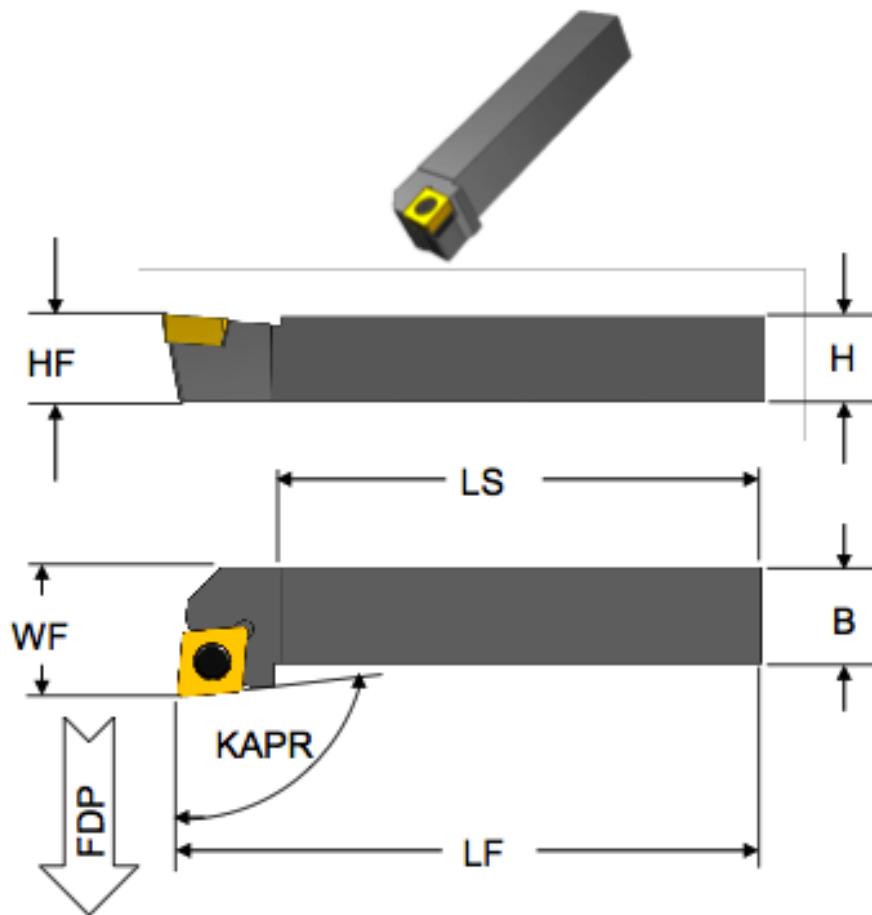


Figure 10: Cutting Tool Measurement 2

607 4.4.4 CuttingDiameterMax

608 maximum diameter of a circle on which the defined point Pk of each of the master inserts
 609 is located on a tool item.

610 The normal of the machined peripheral surface points towards the axis of the cutting tool.

611 The code of CuttingDiameterMax **MUST** be DC.

612 The units of CuttingDiameterMax **MUST** be MILLIMETER.

613 **4.4.5 FlangeDiameterMax**

614 dimension between two parallel tangents on the outside edge of a flange.

615 The code of FlangeDiameterMax **MUST** be DF.

616 The units of FlangeDiameterMax **MUST** be MILLIMETER.

617 **4.4.6 OverallToolLength**

618 largest length dimension of the cutting tool including the master insert where applicable.

619 The code of OverallToolLength **MUST** be OAL.

620 The units of OverallToolLength **MUST** be MILLIMETER.

621 **4.4.7 ShankDiameter**

622 dimension of the diameter of a cylindrical portion of a tool item or an adaptive item that
623 can participate in a connection.

624 The code of ShankDiameter **MUST** be DMM.

625 The units of ShankDiameter **MUST** be MILLIMETER.

626 **4.4.8 ShankHeight**

627 dimension of the height of the shank.

628 The code of ShankHeight **MUST** be H.

629 The units of ShankHeight **MUST** be MILLIMETER.

630 **4.4.9 ShankLength**

631 dimension of the length of the shank.

632 The code of ShankLength **MUST** be LS.

633 The units of ShankLength **MUST** be MILLIMETER.

634 4.4.10 UsableLengthMax

635 maximum length of a cutting tool that can be used in a particular cutting operation includ-
636 ing the non-cutting portions of the tool.

637 The code of UsableLengthMax **MUST** be LUX.

638 The units of UsableLengthMax **MUST** be MILLIMETER.

639 4.4.11 ProtrudingLength

640 dimension from the yz-plane to the furthest point of the tool item or adaptive item mea-
641 sured in the -X direction.

642 The code of ProtrudingLength **MUST** be LPR.

643 The units of ProtrudingLength **MUST** be MILLIMETER.

644 4.4.12 FunctionalLength

645 distance from the gauge plane or from the end of the shank to the furthest point on the
646 tool, if a gauge plane does not exist, to the cutting reference point determined by the main
647 function of the tool.

648 The CuttingTool functional length will be the length of the entire tool, not a single
649 cutting item. Each CuttingItem can have an independent FunctionalLength rep-
650 resented in its measurements.

651 The code of FunctionalLength **MUST** be LF.

652 The units of FunctionalLength **MUST** be MILLIMETER.

653 4.4.13 Weight

654 total weight of the cutting tool in grams.

655 The force exerted by the mass of the cutting tool.

656 The code of Weight **MUST** be WT.

657 The units of Weight **MUST** be GRAM.

658 4.5 Cutting Item Measurement Subtypes

659 This section lists the Measurement subtypes for CuttingItem.

660 These Measurement subtypes for CuttingItem are specific to an individual CuttingItem and **MUST NOT** be used for the Measurement pertaining to an assembly.
 661 Figures below will be used to for reference for the CuttingItem specific Measure-
 662 ment types.

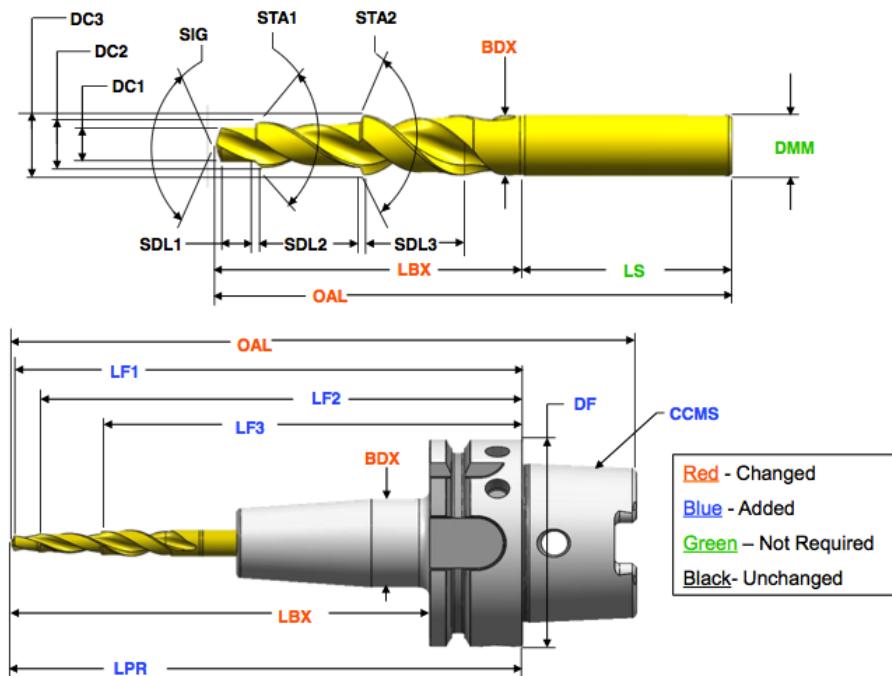


Figure 11: Cutting Tool

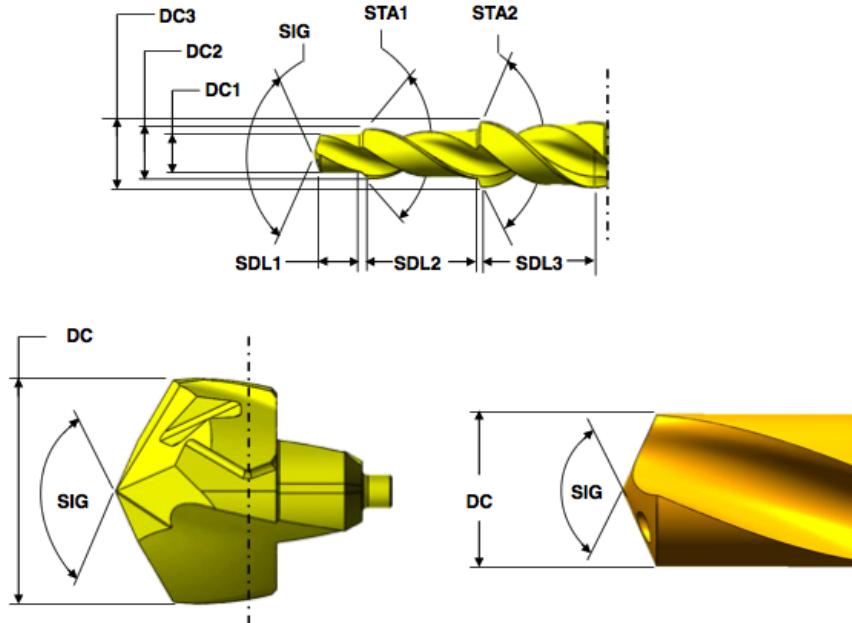


Figure 12: Cutting Item

664 4.5.1 FunctionalLength

665 distance from the gauge plane or from the end of the shank of the cutting tool, if a gauge
 666 plane does not exist, to the cutting reference point determined by the main function of the
 667 tool.

668 This measurement will be with reference to the cutting tool and **MUST NOT** exist without
 669 a cutting tool.

670 The code of FunctionalLength **MUST** be LFx.

671 The units of FunctionalLength **MUST** be MILLIMETER.

672 4.5.2 CuttingReferencePoint

673 theoretical sharp point of the cutting tool from which the major functional dimensions are
 674 taken.

675 The code of CuttingReferencePoint **MUST** be CRP.

676 The units of CuttingReferencePoint **MUST** be MILLIMETER.

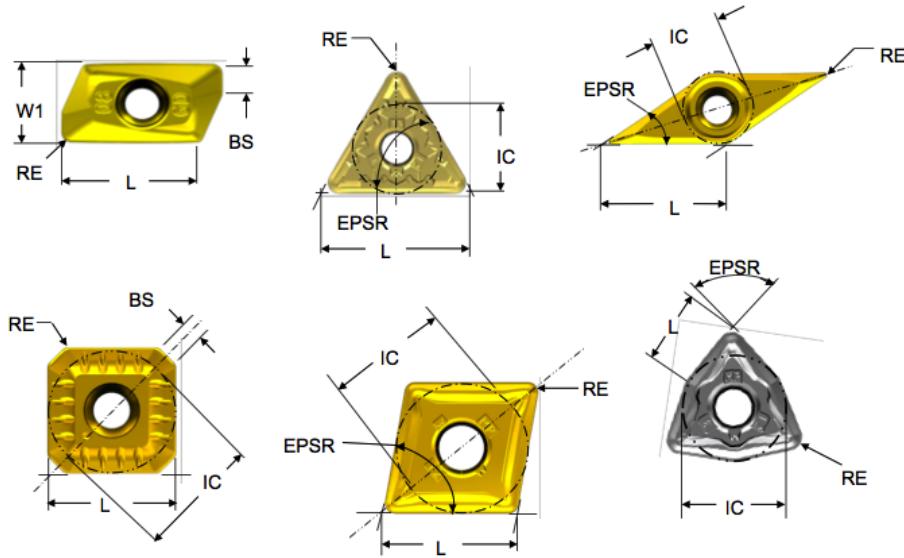


Figure 13: Cutting Item Measurement

677 4.5.3 CuttingEdgeLength

678 theoretical length of the cutting edge of a cutting item over sharp corners.

679 The code of CuttingEdgeLength **MUST** be L.

680 The units of CuttingEdgeLength **MUST** be MILLIMETER.

681 4.5.4 DriveAngle

682 angle between the driving mechanism locator on a tool item and the main cutting edge.

683 The code of DriveAngle **MUST** be DRVA.

684 The units of DriveAngle **MUST** be DEGREE.

685 4.5.5 FlangeDiameter

686 dimension between two parallel tangents on the outside edge of a flange.

687 The code of FlangeDiameter **MUST** be DF.

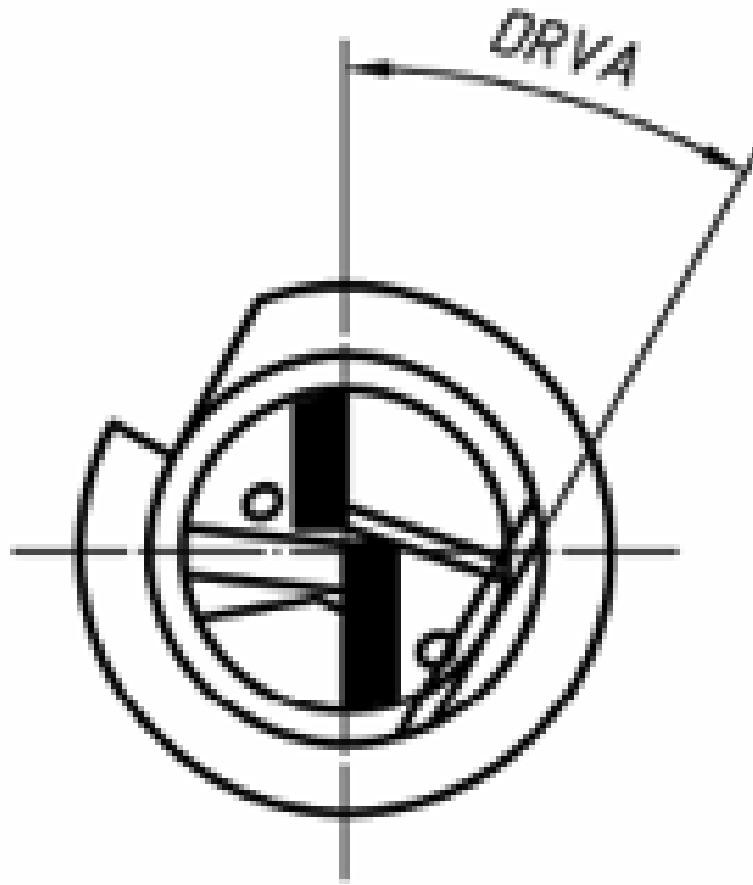


Figure 14: Cutting Item Drive Angle

688 The units of FlangeDiameter **MUST** be MILLIMETER.

689 4.5.6 FunctionalWidth

690 distance between the cutting reference point and the rear backing surface of a turning tool
691 or the axis of a boring bar.

692 The code of FunctionalWidth **MUST** be WF.

693 The units of FunctionalWidth **MUST** be MILLIMETER.

694 4.5.7 IncribedCircleDiameter

695 diameter of a circle to which all edges of a equilateral and round regular insert are tangen-
696 tial.

697 The code of IncribedCircleDiameter **MUST** be IC.

698 The units of IncribedCircleDiameter **MUST** be MILLIMETER.

699 4.5.8 PointAngle

700 angle between the major cutting edge and the same cutting edge rotated by 180 degrees
701 about the tool axis.

702 The code of PointAngle **MUST** be SIG.

703 The units of PointAngle **MUST** be DEGREE.

704 4.5.9 ToolCuttingEdgeAngle

705 angle between the tool cutting edge plane and the tool feed plane measured in a plane
706 parallel the xy-plane.

707 The code of ToolCuttingEdgeAngle **MUST** be KAPR.

708 The units of ToolCuttingEdgeAngle **MUST** be DEGREE.

709 4.5.10 ToolLeadAngle

710 angle between the tool cutting edge plane and a plane perpendicular to the tool feed plane
711 measured in a plane parallel the xy-plane.

712 The code of ToolLeadAngle **MUST** be PSIR.

713 The units of ToolLeadAngle **MUST** be DEGREE.

714 4.5.11 ToolOrientation

715 angle of the tool with respect to the workpiece for a given process.

716 The value is application specific.

717 The code is N/A for ToolOrientation.

718 The units of ToolOrientation **MUST** be DEGREE.

719 4.5.12 StepDiameterLength

720 length of a portion of a stepped tool that is related to a corresponding cutting diameter
721 measured from the cutting reference point of that cutting diameter to the point on the next
722 cutting edge at which the diameter starts to change.

723 The code of StepDiameterLength **MUST** be SDLx.

724 The units of StepDiameterLength **MUST** be MILLIMETER.

725 4.5.13 StepIncludedAngle

726 angle between a major edge on a step of a stepped tool and the same cutting edge rotated
727 180 degrees about its tool axis.

728 The code of StepIncludedAngle **MUST** be STAx.

729 The units of StepIncludedAngle **MUST** be DEGREE.

730 4.5.14 WiperEdgeLength

731 measure of the length of a wiper edge of a cutting item.

732 The code of WiperEdgeLength **MUST** be BS.

733 The units of WiperEdgeLength **MUST** be MILLIMETER.

734 4.5.15 CuttingDiameter

- 735 diameter of a circle on which the defined point Pk located on this cutting tool.
- 736 The normal of the machined peripheral surface points towards the axis of the cutting tool.
- 737 The code of CuttingDiameter **MUST** be DCx.
- 738 The units of CuttingDiameter **MUST** be MILLIMETER.

739 4.5.16 CuttingHeight

- 740 distance from the basal plane of the tool item to the cutting point.
- 741 The code of CuttingHeight **MUST** be HF.
- 742 The units of CuttingHeight **MUST** be MILLIMETER.

743 4.5.17 CornerRadius

- 744 nominal radius of a rounded corner measured in the X Y-plane.
- 745 The code of CornerRadius **MUST** be RE.
- 746 The units of CornerRadius **MUST** be MILLIMETER.

747 4.5.18 Weight

- 748 total weight of the cutting tool in grams.
- 749 The force exerted by the mass of the cutting tool.
- 750 The code of Weight **MUST** be WT.
- 751 The units of Weight **MUST** be GRAM.

752 **4.5.19 ChamferFlatLength**

753 flat length of a chamfer.

754 The code of ChamferFlatLength **MUST** be BCH.

755 The units of ChamferFlatLength **MUST** be MILLIMETER.

756 **4.5.20 ChamferWidth**

757 width of the chamfer.

758 The code of ChamferWidth **MUST** be CHW.

759 The units of ChamferWidth **MUST** be MILLIMETER.

760 **4.5.21 InsertWidth**

761 W1 is used for the insert width when an inscribed circle diameter is not practical.

762 The code of InsertWidth **MUST** be W1.

763 The units of InsertWidth **MUST** be MILLIMETER.

764 **5 Files Asset Information Model**

765 Manufacturing processes require various documents, programs, setup sheets, and digital
766 media available at the device for a given process. The File and FileArchetype As-
767 sets provide a mechanism to communicate specific “Files” that are relevant to a process
768 where the media is located on a server and represented by a Universal Resource Locator
769 (URL).

770 The FileArchetype contains metadata common to all File Assets for a certain
771 purpose. The File Asset references the file specific to a given device or set of devices.
772 The File Asset does not hold the contents of the file, it contains a reference to the
773 location (URL) used to access the information. The metadata associated with the File
774 provides semantic information about the representation (mime-type) and the application
775 associated with the File. The application of the file is an extensible controlled vocabulary
776 with common manufacturing uses provided.

777 **5.1 Files**

778 This section provides semantic information for the File model.

779 Note: See *Section B.7 - File Schema Diagrams* for XML schema.

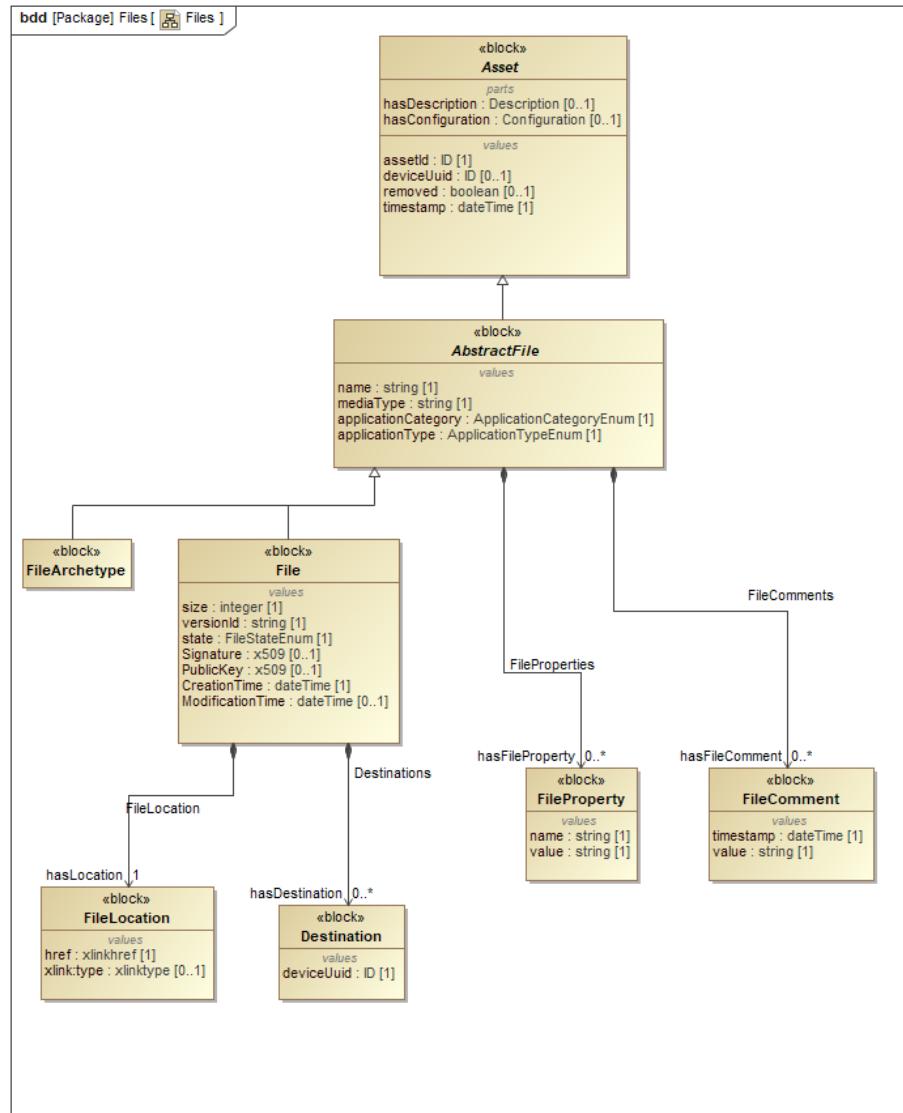
780 **5.1.1 AbstractFile**

781 abstract Asset that contains the common properties of the File and FileArchetype
782 types.

783 **5.1.1.1 Value Properties of AbstractFile**

784 *Table 21* lists the Value Properties of AbstractFile.

Value Property name	Value Property type	Multiplicity
name	string	1
mediaType	string	1
applicationCategory	ApplicationCategoryEnum	1
applicationType	ApplicationTypeEnum	1

Table 21: Value Properties of AbstractFile**Figure 15:** Files

785 Descriptions for Value Properties of `AbstractFile`:

- 786 • `name`
787 name of the file.
- 788 • `mediaType`
789 mime type of the file.
- 790 • `applicationCategory`
791 category of application that will use this file.
792 ApplicationCategoryEnum Enumeration:
 - 793 – ASSEMBLY
794 files regarding the fully assembled product.
 - 795 – DEVICE
796 device related files.
 - 797 – HANDLING
798 files relating to the handling of material.
 - 799 – INSPECTION
800 files related to the quality inspection.
 - 801 – MAINTENANCE
802 files relating to equipment maintenance.
 - 803 – PART
804 files relating to a part.
 - 805 – PROCESS
806 files related to the manufacturing process.
 - 807 – SETUP
808 files related to the setup of a process.
- 809 • `applicationType`
810 type of application that will use this file.
811 ApplicationTypeEnum Enumeration:
 - 812 – DATA
813 generic data.
 - 814 – DESIGN
815 computer aided design files or drawings.

- 816 - DOCUMENTATION
 817 documentation regarding a category of file.
 818 - INSTRUCTIONS
 819 user instructions regarding the execution of a task.
 820 - LOG
 821 data related to the history of a machine or process.
 822 - PRODUCTION_PROGRAM
 823 machine instructions to perform a process.

824 **5.1.1.2 Part Properties of AbstractFile**

825 *Table 22* lists the Part Properties of AbstractFile.

Part Property name	Multiplicity
FileProperty (organized by FileProperties)	0..*
FileComment (organized by FileComments)	0..*

Table 22: Part Properties of AbstractFile

826 Descriptions for Part Properties of AbstractFile:

- 827 • FileProperty
 828 key-value pair providing additional metadata about a File.
 829 FileProperties groups one or more FileProperty entities for a File. See
 830 *Section 5.1.4 - FileProperty*.
 831 • FileComment
 832 remark or interpretation for human interpretation associated with a File or FileArchetype.
 833 FileComments groups one or more FileComment entities for a File. See
 834 *Section 5.1.5 - FileComment*.

835 **5.1.2 File**

836 AbstractFile type that provides information about the File instance and its URL.

837 **5.1.2.1 Value Properties of File**

838 *Table 23* lists the Value Properties of File.

Value Property name	Value Property type	Multiplicity
size	integer	1
versionId	string	1
state	FileStateEnum	1
Signature	x509	0..1
PublicKey	x509	0..1
CreationTime	dateTime	1
ModificationTime	dateTime	0..1

Table 23: Value Properties of File

839 Descriptions for Value Properties of File:

- 840 • size
841 size of the file in bytes.
- 842 • versionId
843 version identifier of the file.
- 844 • state
845 state of the file.
- 846 FileStateEnum Enumeration:
 - 847 – EXPERIMENTAL
848 used for processes other than production or otherwise defined.
 - 849 – PRODUCTION
850 used for production processes.
 - 851 – REVISION
852 content is modified from PRODUCTION or EXPERIMENTAL.
- 853 • Signature
854 secure hash of the file.
- 855 • PublicKey
856 public key used to verify the signature.
- 857 • CreationTime
858 time the file was created.
- 859 • ModificationTime
860 time the file was modified.

861 **5.1.2.2 Part Properties of File**

862 *Table 24* lists the Part Properties of File.

Part Property name	Multiplicity
FileLocation	1
Destination (organized by Destinations)	0..*

Table 24: Part Properties of File

863 Descriptions for Part Properties of File:

- 864 • FileLocation

865 URL reference to the file location.

866 See *Section 5.1.6 - FileLocation*.

- 867 • Destination

868 reference to the target Device for this File.

869 Destinations groups one or more Destination entities. See *Section 5.1.7 - Destination*.

871 **5.1.3 FileArchetype**

872 AbstractFile type that provides information common to all versions of a file.

873 **5.1.4 FileProperty**

874 key-value pair providing additional metadata about a File.

875 The value of FileProperty **MUST** be string.

876 **5.1.4.1 Value Properties of FileProperty**

877 *Table 25* lists the Value Properties of FileProperty.

Value Property name	Value Property type	Multiplicity
name	string	1

Table 25: Value Properties of FileProperty

878 Descriptions for Value Properties of FileProperty:

- 879 • name
 880 name of the FileProperty.

881 5.1.5 FileComment

882 remark or interpretation for human interpretation associated with a File or FileArchetype.
 883 The value of FileComment **MUST** be string.

884 5.1.5.1 Value Properties of FileComment

885 *Table 26* lists the Value Properties of FileComment.

Value Property name	Value Property type	Multiplicity
timestamp	dateTime	1

Table 26: Value Properties of FileComment

886 Descriptions for Value Properties of FileComment:

- 887 • timestamp
 888 time the comment was made.

889 5.1.6 FileLocation

890 URL reference to the file location.

891 5.1.6.1 Value Properties of FileLocation

892 *Table 27* lists the Value Properties of FileLocation.

Value Property name	Value Property type	Multiplicity
href	xlink:href	1
xlink:type	xlinktype	0..1

Table 27: Value Properties of FileLocation

893 Descriptions for Value Properties of FileLocation:

- 894 • href
 - 895 URL reference to the file.
 - 896 href is of type xlink:href from the W3C XLink specification.
- 897 • xlink:type
 - 898 type of href for the xlink href type.
 - 899 MUST be locator referring to a URL .

900 5.1.7 Destination

901 reference to the target Device for this File.

902 5.1.7.1 Value Properties of Destination

903 *Table 28* lists the Value Properties of Destination.

Value Property name	Value Property type	Multiplicity
deviceUuid	ID	1

Table 28: Value Properties of Destination

904 Descriptions for Value Properties of Destination:

- 905 • deviceUuid
 - 906 uuid of the target device or application.

907 **6 Raw Material Asset Information Model**

908 Raw material represents the source of material for immediate use and sources of material
909 that may or may not be used during the manufacturing process.

910 The RawMaterial Asset holds the references to the content stored in the actual Raw-
911 Material container or derived about the RawMaterial by the system during opera-
912 tion.

913 **6.1 Raw Material**

914 This section provides semantic information for the RawMaterial model.

915 Note: See *Section B.8 - RawMaterial Schema Diagrams* for XML schema.

916 **6.1.1 RawMaterial**

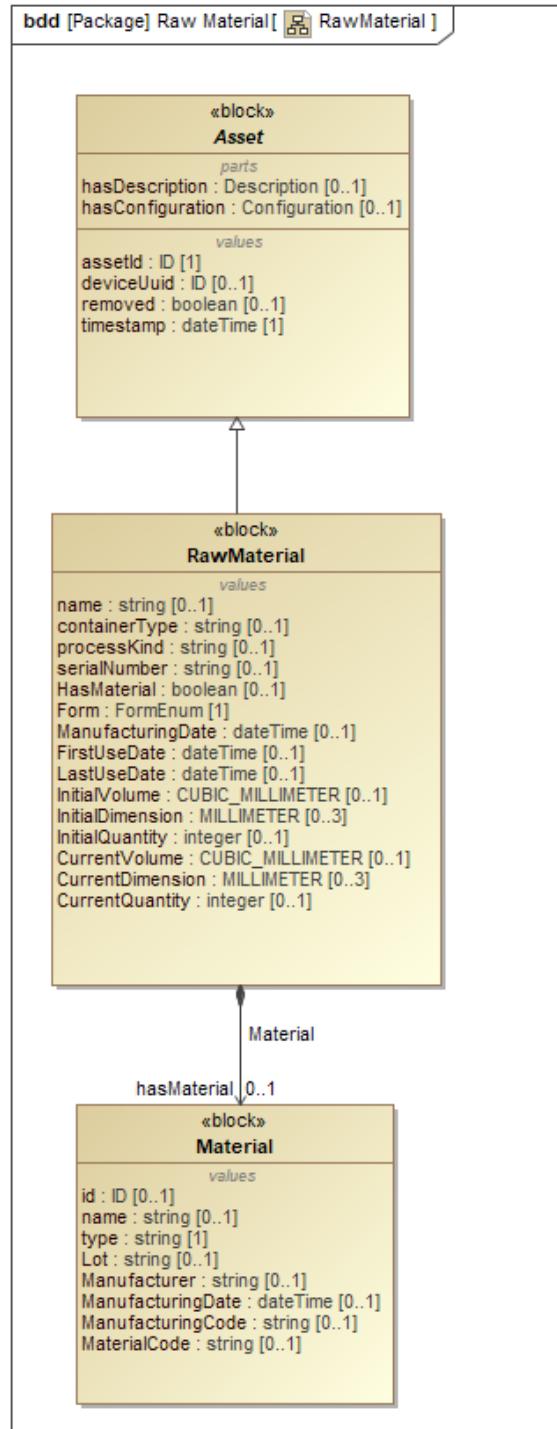
917 Asset that represents raw material.

918 **6.1.1.1 Value Properties of RawMaterial**

919 *Table 29* lists the Value Properties of RawMaterial.

Value Property name	Value Property type	Multiplicity
name	string	0..1
containerType	string	0..1
processKind	string	0..1
serialNumber	string	0..1
HasMaterial	boolean	0..1
Form	FormEnum	1
ManufacturingDate	dateTime	0..1
FirstUseDate	dateTime	0..1
LastUseDate	dateTime	0..1
InitialVolume	CUBIC_MILLIMETER	0..1
InitialDimension	MILLIMETER	0..3
InitialQuantity	integer	0..1
CurrentVolume	CUBIC_MILLIMETER	0..1
CurrentDimension	MILLIMETER	0..3
CurrentQuantity	integer	0..1

Table 29: Value Properties of RawMaterial

**Figure 16:** RawMaterial

920 Descriptions for Value Properties of RawMaterial:

921 • name

922 name of the raw material.

923 Examples: Container1 and AcrylicContainer.

924 • containerType

925 type of container holding the raw material.

926 Examples: Pallet, Canister, Cartridge, Tank, Bin, Roll, and Spool.

927 • processKind

928 ISO process type supported by this raw material.

929 Examples include: VAT_POLYMERIZATION, BINDER_JETTING, MATERIAL_EXTRUSION,
930 MATERIAL_JETTING, SHEET_LAMINATION, POWDER_BED_FUSION and DI-
931 RECTED_ENERGY_DEPOSITION.

932 • serialNumber

933 serial number of the raw material.

934 • HasMaterial

935 Material has existing usable volume.

936 • Form

937 form of the raw material.

938 FormEnum Enumeration:

939 – BAR

940 – BLOCK

941 – CASTING

942 – FILAMENT

943 – GAS

944 – GEL

945 – LIQUID

946 – POWDER

947 – SHEET

948 • ManufacturingDate

949 date the raw material was created.

- 950 • FirstUseDate
 951 date raw material was first used.
- 952 • LastUseDate
 953 date raw material was last used.
- 954 • InitialVolume
 955 amount of material initially placed in raw material when manufactured.
- 956 • InitialDimension
 957 dimension of material initially placed in raw material when manufactured.
- 958 • InitialQuantity
 959 quantity of material initially placed in raw material when manufactured.
- 960 • CurrentVolume
 961 amount of material currently in raw material.
- 962 • CurrentDimension
 963 dimension of material currently in raw material.
- 964 • CurrentQuantity
 965 quantity of material currently in raw material.

966 **6.1.1.2 Part Properties of RawMaterial**

967 *Table 30* lists the Part Properties of RawMaterial.

Part Property name	Multiplicity
Material	0..1

Table 30: Part Properties of RawMaterial

968 Descriptions for Part Properties of RawMaterial:

- 969 • Material
 970 material used as the RawMaterial.
 971 See *Section 6.1.2 - Material*.

972 6.1.2 Material

973 material used as the RawMaterial.

974 6.1.2.1 Value Properties of Material

975 *Table 31* lists the Value Properties of Material.

Value Property name	Value Property type	Multiplicity
id	ID	0..1
name	string	0..1
type	string	1
Lot	string	0..1
Manufacturer	string	0..1
ManufacturingDate	dateTime	0..1
ManufacturingCode	string	0..1
MaterialCode	string	0..1

Table 31: Value Properties of Material

976 Descriptions for Value Properties of Material:

977 • id

978 unique identifier for the material.

979 • name

980 name of the material.

981 Examples: ULTM9085, ABS, 4140.

982 • type

983 type of material.

984 Examples: Metal, Polymer, Wood, 4140, Recycled, Prestine and Used.

985 • Lot

986 manufacturer's lot code of the material.

987 • Manufacturer

988 name of the material manufacturer.

- 989 • ManufacturingDate
- 990 manufacturing date of the material from the material manufacturer.
- 991 • ManufacturingCode
- 992 lot code of the raw feed stock for the material, from the feed stock manufacturer.
- 993 • MaterialCode
- 994 American Society for Testing and Materials (ASTM) standard code that the material
- 995 complies with.

996 7 QIF Asset Information Model

997 The Quality Information Framework (QIF) is an American National Standards Institute
998 (ANSI) accredited standard developed by the Digital Metrology Standards Consortium
999 (DMSC) standards development organization. The DMSC is an A-liaison to the Interna-
1000 tional Standards Organization (ISO) Technical Committee (TC) 184. QIF addresses the
1001 needs of the metrology community to have a semantic information model for the exchange
1002 of metrology data throughout the verification lifecycle from product design to execution,
1003 analysis, and reporting.

1004 The MTConnect QIF Asset Information Model provides a wrapper around a QIF document
1005 (i.e., a dataset conforming to the QIF Information model) in its native XML representation.
1006 The MTConnect standard does not alter or extend the QIF standard and regards the QIF
1007 standard as a passthrough.

1008 Information about the QIF standards is at the following location: <https://qifstandards.org>

1009 7.1 QIF

1010 This section provides semantic information for the `QIFDocumentWrapper` model.

1011 Note: See *Section B.9 - QIFDocumentWrapper Schema Diagrams* for XML
1012 schema.

1013 7.1.1 QIFDocument

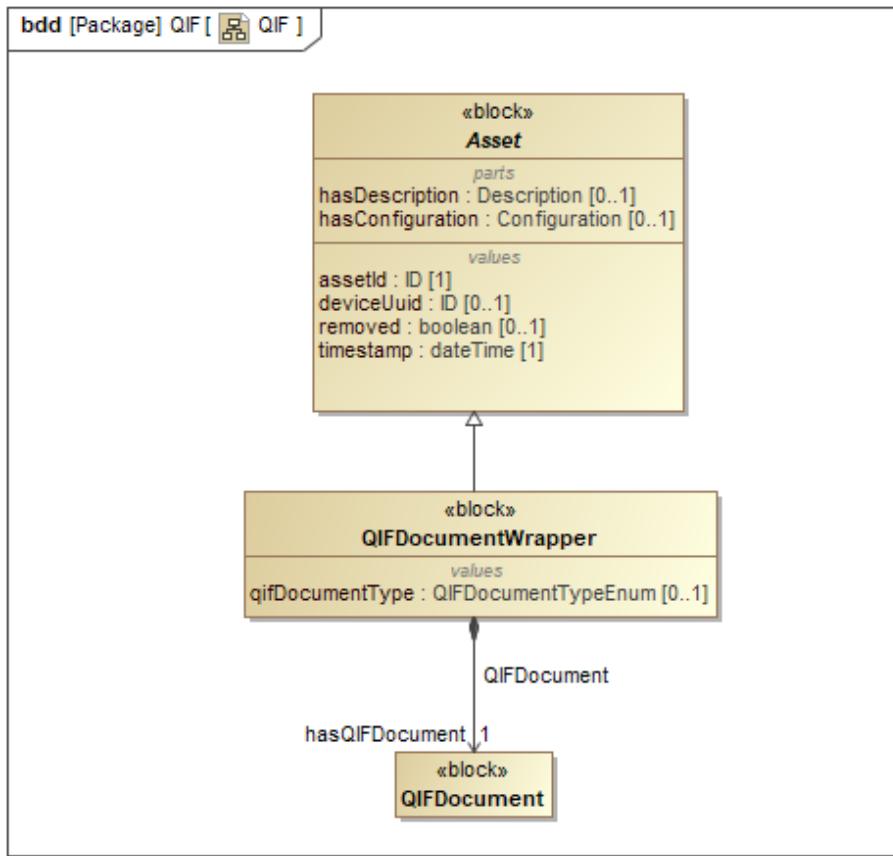
1014 QIF Document as given by the QIF standard.

1015 7.1.2 QIFDocumentWrapper

1016 Asset that carries the QIF Document.

1017 7.1.2.1 Value Properties of QIFDocumentWrapper

1018 *Table 32* lists the Value Properties of `QIFDocumentWrapper`.

**Figure 17:** QIFDocumentWrapper

Value Property name	Value Property type	Multiplicity
qifDocumentType	QIFDocumentTypeEnum	0..1

Table 32: Value Properties of QIFDocumentWrapper

1019 Descriptions for Value Properties of QIFDocumentWrapper:

- 1020 • qifDocumentType
 1021 contained QIF Document type as defined in the QIF Standard.
 1022 QIFDocumentTypeEnum Enumeration:
 1023 – MEASUREMENT_RESOURCE
 1024 – PLAN
 1025 – PRODUCT
 1026 – RESULTS

- 1027 – RULES
1028 – STATISTICS

1029 **7.1.2.2 Part Properties of QIFDocumentWrapper**

1030 *Table 33* lists the Part Properties of QIFDocumentWrapper.

Part Property name	Multiplicity
QIFDocument	1

Table 33: Part Properties of QIFDocumentWrapper

1031 Descriptions for Part Properties of QIFDocumentWrapper:

- 1032 • QIFDocument
1033 QIF Document as given by the QIF standard.

1034 8 Profile

1035 MTConnect Profile is a *profile* that extends the Systems Modeling Language (SysML) metamodel for the MTConnect domain using additional data types and *stereotypes*.

1037 8.1 DataTypes

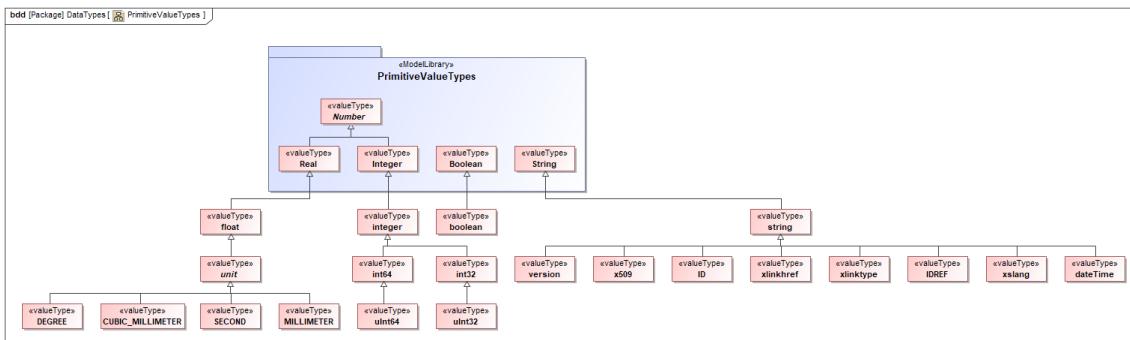


Figure 18: DataTypes

1038 8.1.1 boolean

1039 primitive type.

1040 8.1.2 ID

1041 string that represents an identifier (ID).

1042 8.1.3 string

1043 primitive type.

1044 8.1.4 float

1045 primitive type.

1046 8.1.5 dateTIme

1047 string that represents timestamp in ISO 8601 format.

1048 8.1.6 integer

1049 primitive type.

1050 8.1.7 xlinktype

1051 string that represents the type of an XLink element. See <https://www.w3.org/TR/xlink11/>.

1053 8.1.8 xslang

1054 string that represents a language tag. See <http://www.ietf.org/rfc/rfc4646.txt>.

1056 8.1.9 SECOND

1057 float that represents time in seconds.

1058 8.1.10 IDREF

1059 string that represents a reference to an ID.

1060 8.1.11 xlinkhref

1061 string that represents the locator attribute of an XLink element. See <https://www.w3.org/TR/xlink11/>.

1063 **8.1.12 x509**

1064 string that represents an x509 data block. *Ref ISO/IEC 9594-8:2020.*

1065 **8.1.13 int32**

1066 32-bit integer.

1067 **8.1.14 int64**

1068 64-bit integer.

1069 **8.1.15 version**

1070 series of four numeric values, separated by a decimal point, representing a *major*, *minor*,
1071 and *revision* number of the MTConnect Standard and the revision number of a specific
1072 *schema*.

1073 **8.1.16 uInt32**

1074 32-bit unsigned integer.

1075 **8.1.17 uInt64**

1076 64-bit unsigned integer.

1077 **8.2 Stereotypes**

1078 **8.2.1 organizer**

1079 element that *organizes* other elements of a type.

1080 8.2.2 deprecated

1081 element that has been deprecated.

1082 8.2.3 extensible

1083 enumeration that can be extended.

1084 8.2.4 informative

1085 element that is descriptive and non-normative.

1086 8.2.5 valueType

1087 extends SysML <<ValueType>> to include Class as a value type.

1088 8.2.6 normative

1089 element that has been added to the standard.

1090 8.2.7 observes

1091 association in which a *Component* makes *Observations* about an observable *DataItem*.

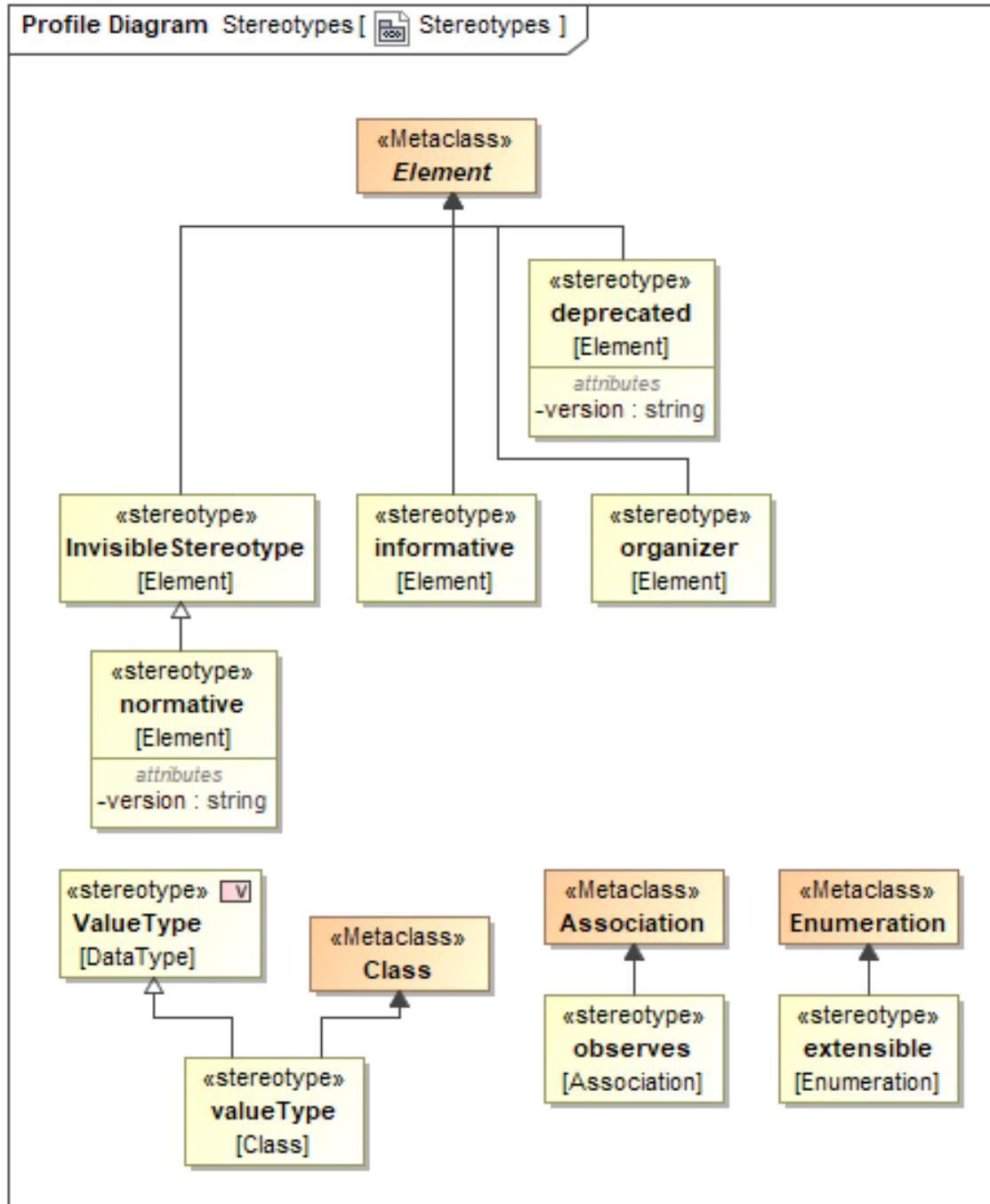


Figure 19: Stereotypes

1092 Appendices

1093 A Bibliography

- 1094 Engineering Industries Association. EIA Standard - EIA-274-D, Interchangeable Variable,
1095 Block Data Format for Positioning, Contouring, and Contouring/Positioning Numerically
1096 Controlled Machines. Washington, D.C. 1979.
- 1097 ISO TC 184/SC4/WG3 N1089. ISO/DIS 10303-238: Industrial automation systems and
1098 integration Product data representation and exchange Part 238: Application Protocols: Ap-
1099 plication interpreted model for computerized numerical controllers. Geneva, Switzerland,
1100 2004.
- 1101 International Organization for Standardization. ISO 14649: Industrial automation sys-
1102 tems and integration – Physical device control – Data model for computerized numerical
1103 controllers – Part 10: General process data. Geneva, Switzerland, 2004.
- 1104 International Organization for Standardization. ISO 14649: Industrial automation sys-
1105 tems and integration – Physical device control – Data model for computerized numerical
1106 controllers – Part 11: Process data for milling. Geneva, Switzerland, 2000.
- 1107 International Organization for Standardization. ISO 6983/1 – Numerical Control of ma-
1108 chines – Program format and definition of address words – Part 1: Data format for posi-
1109 tioning, line and contouring control systems. Geneva, Switzerland, 1982.
- 1110 Electronic Industries Association. ANSI/EIA-494-B-1992, 32 Bit Binary CL (BCL) and
1111 7 Bit ASCII CL (ACL) Exchange Input Format for Numerically Controlled Machines.
1112 Washington, D.C. 1992.
- 1113 National Aerospace Standard. Uniform Cutting Tests - NAS Series: Metal Cutting Equip-
1114 ment Specifications. Washington, D.C. 1969.
- 1115 International Organization for Standardization. ISO 10303-11: 1994, Industrial automa-
1116 tion systems and integration Product data representation and exchange Part 11: Descrip-
1117 tion methods: The EXPRESS language reference manual. Geneva, Switzerland, 1994.
- 1118 International Organization for Standardization. ISO 10303-21: 1996, Industrial automa-
1119 tion systems and integration – Product data representation and exchange – Part 21: Imple-
1120 mentation methods: Clear text encoding of the exchange structure. Geneva, Switzerland,
1121 1996.
- 1122 H.L. Horton, F.D. Jones, and E. Oberg. Machinery's Handbook. Industrial Press, Inc.

1123 New York, 1984.

1124 International Organization for Standardization. ISO 841-2001: Industrial automation sys-
1125 tems and integration - Numerical control of machines - Coordinate systems and motion
1126 nomenclature. Geneva, Switzerland, 2001.

1127 ASME B5.57: Methods for Performance Evaluation of Computer Numerically Controlled
1128 Lathes and Turning Centers, 1998.

1129 ASME/ANSI B5.54: Methods for Performance Evaluation of Computer Numerically Con-
1130 trolled Machining Centers. 2005.

1131 OPC Foundation. OPC Unified Architecture Specification, Part 1: Concepts Version 1.00.
1132 July 28, 2006.

1133 IEEE STD 1451.0-2007, Standard for a Smart Transducer Interface for Sensors and Ac-
1134 tuators – Common Functions, Communication Protocols, and Transducer Electronic Data
1135 Sheet (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The In-
1136 stitute of Electrical and Electronics Engineers, Inc., New York, N.Y. 10016, SH99684,
1137 October 5, 2007.

1138 IEEE STD 1451.4-1994, Standard for a Smart Transducer Interface for Sensors and Ac-
1139 tuators – Mixed-Mode Communication Protocols and Transducer Electronic Data Sheet
1140 (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The Institute of
1141 Electrical and Electronics Engineers, Inc., New York, N.Y. 10016, SH95225, December
1142 15, 2004.

1143 B XML Schema Diagrams

1144 B.1 Assets Schema Diagrams

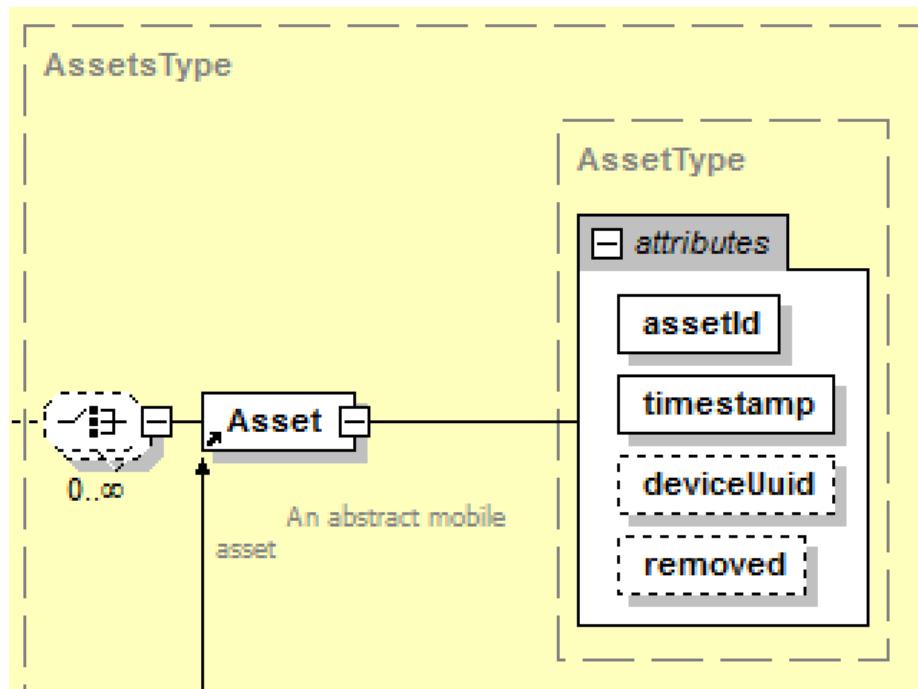


Figure 20: Asset Schema

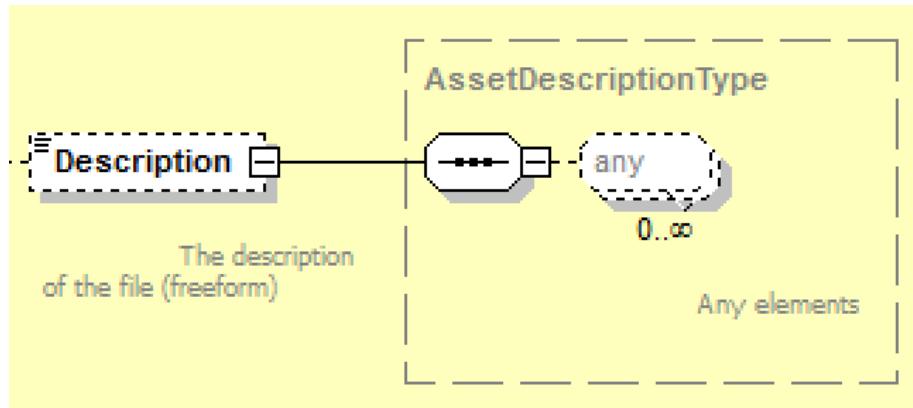
1145 B.2 CuttingTool Schema Diagrams

1146 B.3 CuttingToolLifeCycle Schema Diagrams

1147 B.4 CuttingItem Schema Diagrams

1148 B.5 ISO 13399 Diagrams

1149 B.5.1 Measurement Diagrams

**Figure 21:** Description Schema

1150 B.6 Cutting Tool Examples

1151 B.6.1 Shell Mill

Example 1: Example for Indexable Insert Measurements

```

1152 1  <?xml version="1.0" encoding="UTF-8"?>
1153 2  <MTConnectAssets
1154 3  xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1155 4  xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1156 5  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1157 6  xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1158 7  http://mtconnect.org/schemas/MTConnectAssets\textunderscore 1.2.xsd"
1159 8  >
1160 9  <Header_creationTime="2011-05-11T13:55:22"
1161 10 <assetBufferSize="1024" _sender="localhost"
1162 11 <assetCount="2" _version="1.2" _instanceId="1234"/>
1163 12 <Assets>
1164 13 <CuttingTool_serialNumber="1" _toolId="KSSP300R4SD43L240"
1165 14 <timestamp="2011-05-11T13:55:22" _assetId="KSSP300R4SD43L240.1"
1166 15 <manufacturers="KMT, Parlec">
1167 16 <CuttingToolLifeCycle>
1168 17 <CutterStatus><Status>NEW</Status></CutterStatus>
1169 18 <ProcessSpindleSpeed_maximum="13300"
1170 19 <nominat="605">10000</ProcessSpindleSpeed>
1171 20 <ProcessFeedRate
1172 21 <nominat="9.22">9.22</ProcessSpindleSpeed>
1173 22 <ConnectionCodeMachineSide>CV50
1174 23 </ConnectionCodeMachineSide>
1175 24 <Measurements>
1176 25 <BodyDiameterMax_code="BDX">73.25
1177 26 </BodyDiameterMax>
1178 27 <OverallToolLength_nominal="222.25"
1179 28 <nominat="221.996" _maximum="222.504"
```

```

1180 28   <OverallToolLength_code="OAL">222.25</OverallToolLength>
1181 29   <UsableLengthMax_code="LUX" nominal="82.55">82.55
1182 30   </UsableLengthMax>
1183 31   <CuttingDiameterMax_code="DC" nominal="76.2">
1184 32   <maximum="76.213" minimum="76.187">76.2
1185 33   </CuttingDiameterMax>
1186 34   <BodyLengthMax_code="LF" nominal="120.65">
1187 35   <maximum="120.904" minimum="120.404">120.65
1188 36   </BodyLengthMax>
1189 37   <DepthOfCutMax_code="APMX">
1190 38   <nominal="60.96">60.95</DepthOfCutMax>
1191 39   <FlangeDiameterMax_code="DF" nominal="98.425">98.425</FlangeDiameterMax>
1192 40   </Measurements>
1193 41   <CuttingItems_count="24">
1194 42     <CuttingItem_indices="1-24" itemId="SDET43PDER8GB" manufacturers="KMT" grade="KC725M">
1195 43       <Measurements>
1196 44         <CuttingEdgeLength_code="L" nominal="12.7" minimum="12.675" maximum="12.725">12.7
1197 45       </CuttingEdgeLength>
1198 46         <WiperEdgeLength_code="BS" nominal="2.56">2.56</WiperEdgeLength>
1199 47         <InscribedCircleDiameter_code="IC" nominal="12.7">12.7
1200 48       </InscribedCircleDiameter>
1201 49         <CornerRadius_code="RE" nominal="0.8">0.8</CornerRadius>
1202 50       </Measurements>
1203 51     </CuttingItem>
1204 52   </CuttingItems>
1205 53   </CuttingToolLifeCycle>
1206 54   </CuttingTool>
1207 55 </Assets>
1208 56 </MTConnectAssets>
1209 57
1210 58
1211 59
1212 60
1213 61
1214 62

```

1215 **B.6.2 Step Drill****Example 2:** Example for Step Mill Side View

```

1216 1  <?xml version="1.0" encoding="UTF-8"?>
1217 2  <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1218 3  xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1219 4  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1220 5  xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1221 6  http://mtconnect.org/schemas/MTConnectAssets\textunderscore1.2.xsd"
1222 7  >
1223 8  <Header creationTime="2011-05-
1224 9  _11T13:55:22" assetBufferSize="1024"
1225 10  sender="localhost" assetCount="2" version="1.2" instanceId="1234"
1226 11  />
1227 12  <Assets>
1228 13  <CuttingTool serialNumber="1" toolId="B732A08500HP"
1229 14  timestamp="2011-05-11T13:55:22" assetId="B732A08500HP"
1230 15  manufacturers="KMT, Parlec">
1231 16  <Description>
1232 17  Step Drill - KMT, B732A08500HP Grade KC7315
1233 18  Adapter - Parlec, C50-M12SF300-6
1234 19  </Description>
1235 20  <CuttingToolLifeCycle>
1236 21  <CutterStatus><Status>NEW</Status></CutterStatus>
1237 22  <ProcessSpindleSpeed nominal="5893">5893</
1238 23  ProcessSpindleSpeed>
1239 24  <ProcessFeedRate nominal="2.5">2.5</ProcessFeedRate>
1240 25  <ConnectionCodeMachineSide>CV50 Taper</
1241 26  ConnectionCodeMachineSide>
1242 27  <Measurements>
1243 28  <BodyDiameterMax code="BDX">31.8</BodyDiameterMax>
1244 29  <BodyLengthMax code="LBX" nominal="120.825" maximum="
1245 30  126.325"
1246 31  minimum="115.325">120.825</BodyLengthMax>
1247 32  <ProtrudingLength code="LPR" nominal="155.75" maximum="
1248 33  161.25"
1249 34  minimum="150.26">155.75</ProtrudingLength>
1250 35  <FlangeDiameterMax code="DF"
1251 36  nominal="98.425">98.425</FlangeDiameterMax>
1252 37  <OverallToolLength nominal="257.35" minimum="251.85"
1253 38  maximum="262.85" code="OAL">257.35</OverallToolLength>
1254 39  </Measurements>
1255 40  <CuttingItems count="2">
1256 41  <CuttingItem indices="1" manufacturers="KMT" grade="KC7315
1257 42  ">>
1258 43  <Measurements>
1259 44  <CuttingDiameter code="DC1" nominal="8.5" maximum="
1260 45  8.521"
1261 46  minimum="8.506">8.5135</CuttingDiameter>
1262 47  <StepIncludedAngle code="STA1" nominal="90" maximum="
1263 48  91"

```

```

1264 40      minimum="89">90</StepIncludedAngle>
1265 41      <FunctionalLength code="LF1" nominal="154.286"
1266 42          minimum="148.786"
1267 43          maximum="159.786">154.286</FunctionalLength>
1268 44      <StepDiameterLength code="SDL1"
1269 45          nominal="9">9</StepDiameterLength>
1270 46      <PointAngle code="SIG" nominal="135" minimum="133"
1271 47          maximum="137">135</PointAngle>
1272 48      </Measurements>
1273 49      </CuttingItem>
1274 50      <CuttingItem indices="2" manufacturers="KMT" grade="KC7315
1275      "">>>
1276 51      <Measurements>
1277 52          <CuttingDiameter code="DC2" nominal="12" maximum="
1278      12.011">
1279 53              minimum="12">12</CuttingDiameter>
1280 54              <FunctionalLength code="LF2" nominal="122.493"
1281 55                  maximum="127.993"
1282 56                  minimum="116.993">122.493</FunctionalLength>
1283 57              <StepDiameterLength code="SDL2"
1284 58                  nominal="9">9</StepDiameterLength>
1285 59          </Measurements>
1286 60      </CuttingItem>
1287 61      </CuttingItems>
1288 62      </CuttingToolLifeCycle>
1289 63      </CuttingTool>
1290 64      </Assets>
1291 65  </MTConnectAssets>
```

1292 **B.6.3 Shell Mill with Individual Loci****Example 3:** Example for Shell Mill with Explicate Loci

```

1293 1 <?xml version="1.0" encoding="UTF-8"?>
1294 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1295 3   xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1296 4   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1297 5   xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1298 6   http://mtconnect.org/schemas/MTConnectAssets\textunderscore1.2.xsd"
1299 7     >
1300 8   <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
1301 9     sender="localhost" assetCount="2" version="1.2" instanceId="1234"
1302 10    />
1303 11  <Assets>
1304 12    <CuttingTool serialNumber="1" toolId="KSSP300R4SD43L240"
1305 13      timestamp="2011-05-11T13:55:22" assetId="KSSP300R4SD43L240.1"
1306 14      manufacturers="KMT, Parlec">
1307 15        <Description>Keyway: 55 degrees</Description>
1308 16        <CuttingToolLifeCycle>
1309 17          <CutterStatus><Status>NEW</Status></CutterStatus>
1310 18          <Measurements>
1311 19            <UsableLengthMax code="LUX"
1312 20              nominal="82.55">82.55</UsableLengthMax>
1313 21            <CuttingDiameterMax code="DC" nominal="76.2" maximum="
1314 22              76.213"
1315 23              minimum="76.187">76.2</CuttingDiameterMax>
1316 24            <DepthOfCutMax code="APMX" nominal="60.96">60.95</
1317 25              DepthOfCutMax>
1318 26        </Measurements>
1319 27        <CuttingItems count="24">
1320 28          <CuttingItem indices="1" itemId="SDET43PDER8GB"
1321 29            manufacturers="KMT">
1322 30              <Locus>FLUTE: 1, ROW: 1</Locus>
1323 31              <Measurements>
1324 32                <DriveAngle code="DRVA" nominal="55">55</DriveAngle>
1325 33              </Measurements>
1326 34            </CuttingItem>
1327 35            <CuttingItem indices="2-24" itemId="SDET43PDER8GB"
1328 36            manufacturers="KMT">
1329 37              <Locus>FLUTE: 2-4, ROW: 1; FLUTE: 1-4, ROW 2-6</Locus>
1330 38            </CuttingItem>
1331 39          </CuttingItems>
1332 40        </CuttingToolLifeCycle>
1333 41      </CuttingTool>
1334 42    </Assets>
1335 43  </MTConnectAssets>
```

1336 **B.6.4 Drill with Individual Loci****Example 4:** Example for Step Drill with Explicate Loci

```

1337 1  <?xml version="1.0" encoding="UTF-8"?>
1338 2  <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1339 3  xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1340 4  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1341 5  xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1342 6  http://mtconnect.org/schemas/MTConnectAssets\textunderscore1.2.xsd"
1343 7  >
1344 8  <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
1345 9  sender="localhost" assetCount="2" version="1.2" instanceId="1234"
1346 10 />
1347 11 <Assets>
1348 12   <CuttingTool serialNumber="1" toolId="KSEM0781LD"
1349 13   timestamp="2011-05-11T13:55:22" assetId="KSEM0781LD.1"
1350 14   manufacturers="KMT">
1351 15     <CuttingToolLifeCycle>
1352 16       <CutterStatus><Status>NEW</Status></CutterStatus>
1353 17       <ConnectionCodeMachineSide>HSK63A</ConnectionCodeMachineSide>
1354 18     >
1355 19     <Measurements>
1356 20       <BodyDiameterMax code="BDX">52.75</BodyDiameterMax>
1357 21       <OverallToolLength nominal="172.29"
1358 22         code="OAL">172.29</OverallToolLength>
1359 23       <UsableLengthMax code="LUX" nominal="49">49</
1360 24         UsableLengthMax>
1361 25       <FlangeDiameterMax code="DF"
1362 26         nominal="62.94">62.94</FlangeDiameterMax>
1363 27     </Measurements>
1364 28     <CuttingItems count="3">
1365 29       <CuttingItem indices="1" itemId="KSEM0781LD" manufacturers
1366 30         ="KMT"
1367 31         grade="KC7015">
1368 32           <Locus>FLUTE: 1, ROW: 1</Locus>
1369 33           <Measurements>
1370 34             <FunctionalLength code="LF1" nominal="154.42">154.42</
1371 35               FunctionalLength>
1372 36             <CuttingDiameter code="DC1" nominal="19.844">19.844</
1373 37               CuttingDiameter>
1374 38             <PointAngle code="SIG" nominal="140">140</PointAngle>
1375 39             <ToolCuttingEdgeAngle code="KAPR1" nominal="45">45</
1376 40               ToolCuttingEdgeAngle>
1377 41             <StepDiameterLength code="SLD1" nominal="39.8">39.8</
1378 42               StepDiameterLength>
1379 43             </Measurements>
1380 44           </CuttingItem>
1381 45           <CuttingItem indices="2-3" itemId="TPMT-21.52-FP"
1382 46             manufacturers="KMT" grade="KCM15">
1383 47             <Locus>FLUTE: 1-2, ROW: 2</Locus>
1384 48             <Measurements>
```

```
1385 39      <FunctionalLength code="LF2" nominal="112.9">119.2</
1386 40      FunctionalLength>
1387 40          <CuttingDiameter code="DC2" nominal="31">31</
1388 41              CuttingDiameter>
1389 41          </Measurements>
1390 42      </CuttingItem>
1391 43      </CuttingItems>
1392 44      </CuttingToolLifeCycle>
1393 45      </CuttingTool>
1394 46  </Assets>
1395 47 </MTConnectAssets>
```

1396 **B.6.5 Shell Mill with Different Inserts on First Row****Example 5:** Example for Shell Mill with Different Inserts on First Row

```

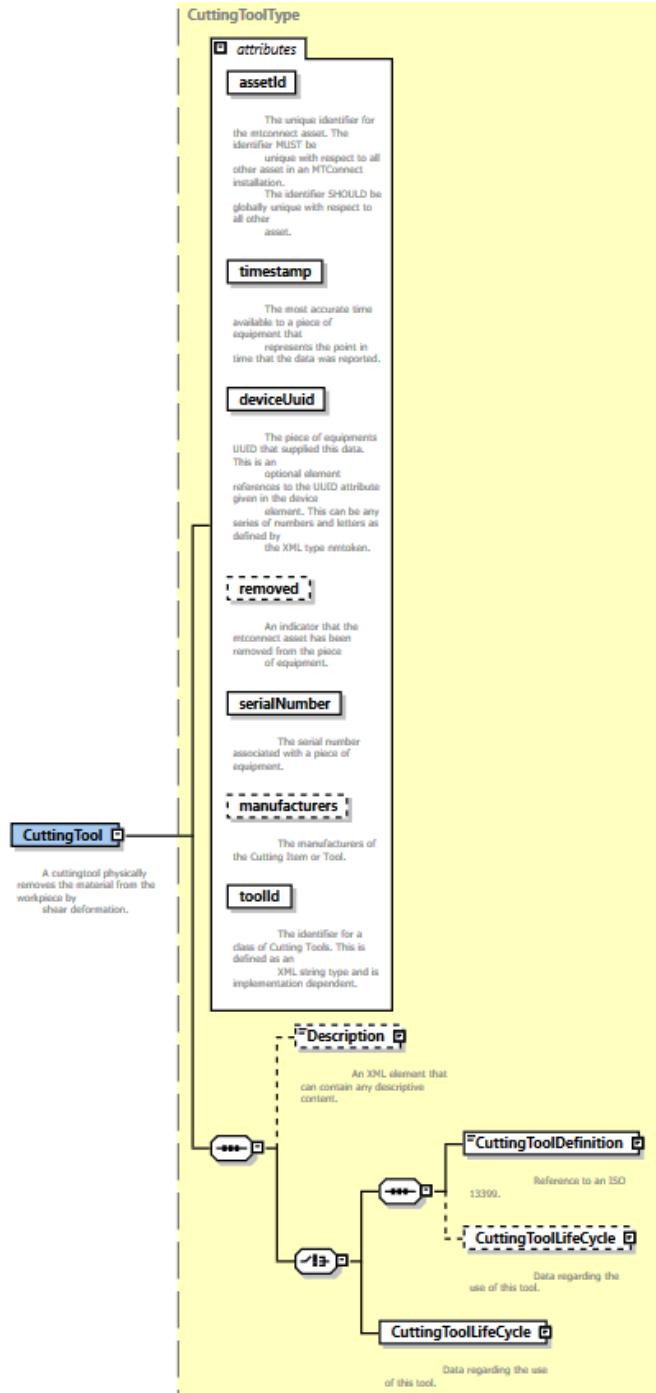
1397 1 <?xml version="1.0" encoding="UTF-8"?>
1398 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1399 3   xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1400 4   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1401 5   xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1402 6   http://mtconnect.org/schemas/MTConnectAssets\textunderscore1.2.xsd"
1403 7     >
1404 8   <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
1405 9     sender="localhost" assetCount="2" version="1.2" instanceId="1234"
1406 10    />
1407 11  <Assets>
1408 12    <CuttingTool serialNumber="1" toolId="XXX" timestamp="2011-05-11
1409 13      T13:55:22"
1410 14      assetId="XXX.1" manufacturers="KMT">
1411 15        <CuttingToolLifeCycle>
1412 16          <CutterStatus><Status>NEW</Status></CutterStatus>
1413 17          <Measurements>
1414 18            <DepthOfCutMax code="APMX" nominal="47.8">47.8</
1415 19            DepthOfCutMax>
1416 20              <CuttingDiameterMax code="DC"
1417 21                nominal="50.8">50.8</CuttingDiameterMax>
1418 22              <UsableLengthMax code="LUX"
1419 23                nominal="78.74">78.74</UsableLengthMax>
1420 24            </Measurements>
1421 25            <CuttingItems count="9">
1422 26              <CuttingItem indices="1-3" itemId="EDPT180564PDER-LD"
1423 27                manufacturers="KMT">
1424 28                <Locus>FLUTE: 1-3, ROW: 1</Locus>
1425 29                <Measurements>
1426 30                  <CornerRadius code="RE" nominal="6.25">6.35</
1427 31                  CornerRadius>
1428 32                  </Measurements>
1429 33                </CuttingItem>
1430 34                <CuttingItem indices="4-9" itemId="EDPT180508PDER-LD"
1431 35                  manufacturers="KMT">
1432 36                  <Locus>FLANGE: 1-4, ROW: 2-3</Locus>
1433 37                </CuttingItem>
1434 38              </CuttingItems>
1435 39            </CuttingToolLifeCycle>
1436 40          </CuttingTool>
1437 41        </Assets>
1438 42      </MTConnectAssets>

```

1439 **B.7 File Schema Diagrams**

1440 B.8 RawMaterial Schema Diagrams

1441 B.9 QIFDocumentWrapper Schema Diagrams

**Figure 22:** CuttingTool Schema

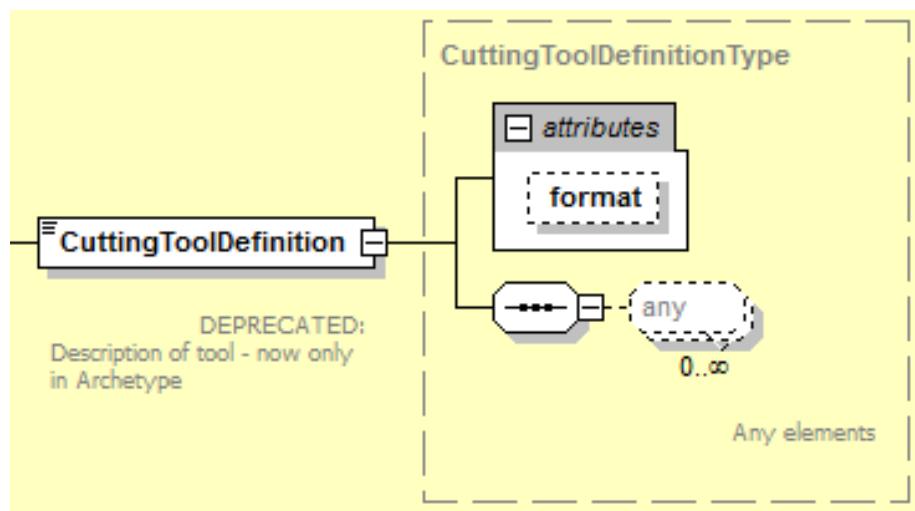
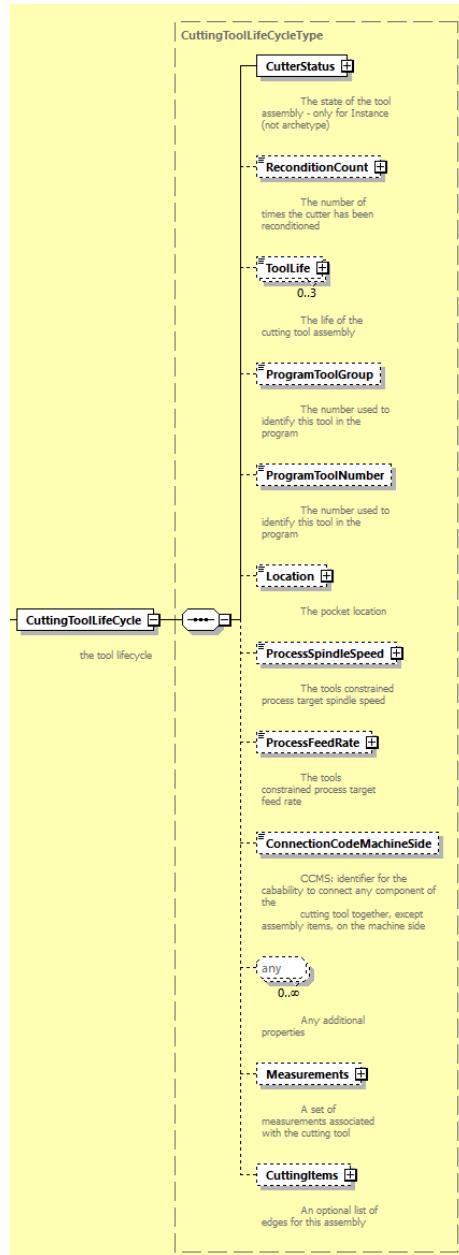


Figure 23: CuttingToolDefinition Schema



Figure 24: CuttingToolArchetypeReference Schema

**Figure 25:** CuttingToolLifeCycle Schema

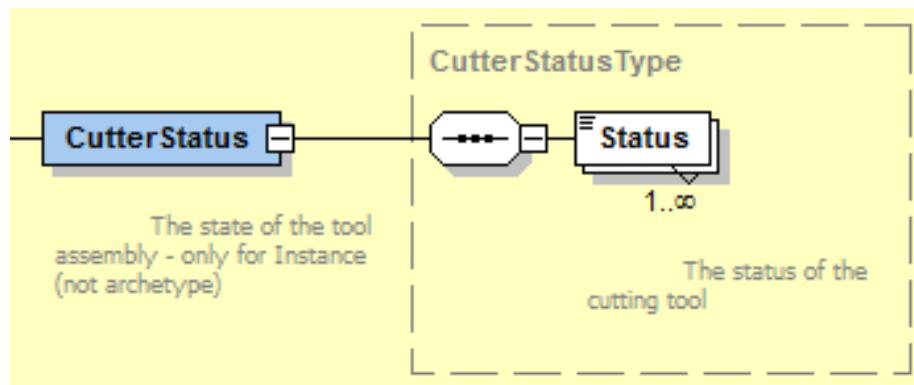


Figure 26: CutterStatus Schema

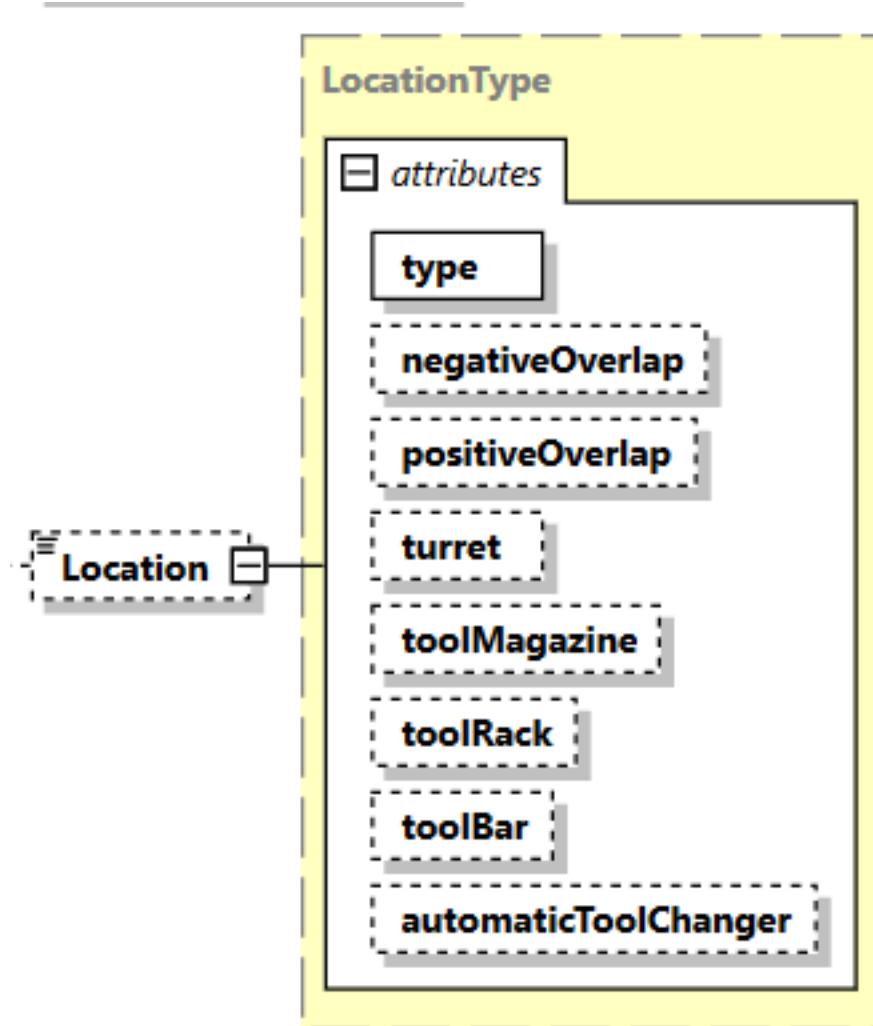


Figure 27: Location Schema

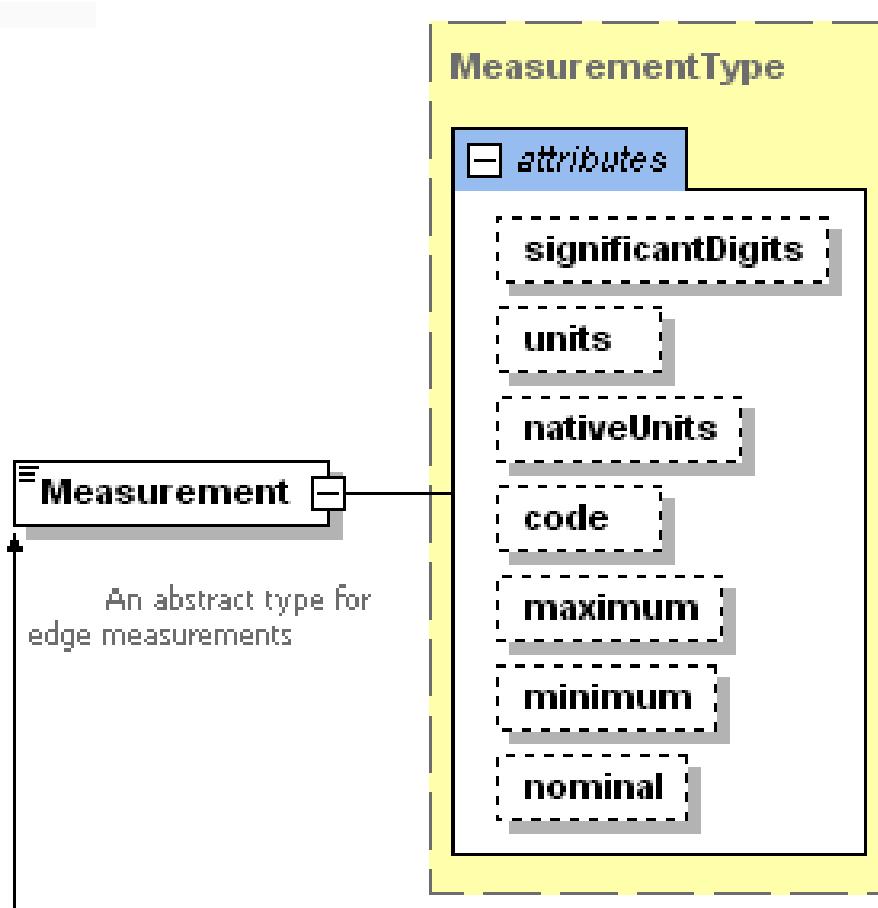


Figure 28: Measurement Schema

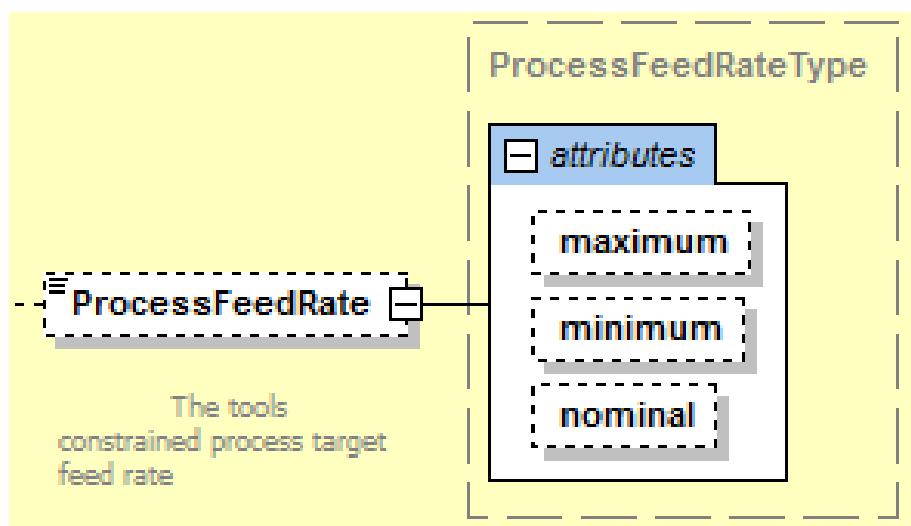


Figure 29: ProcessFeedRate Schema

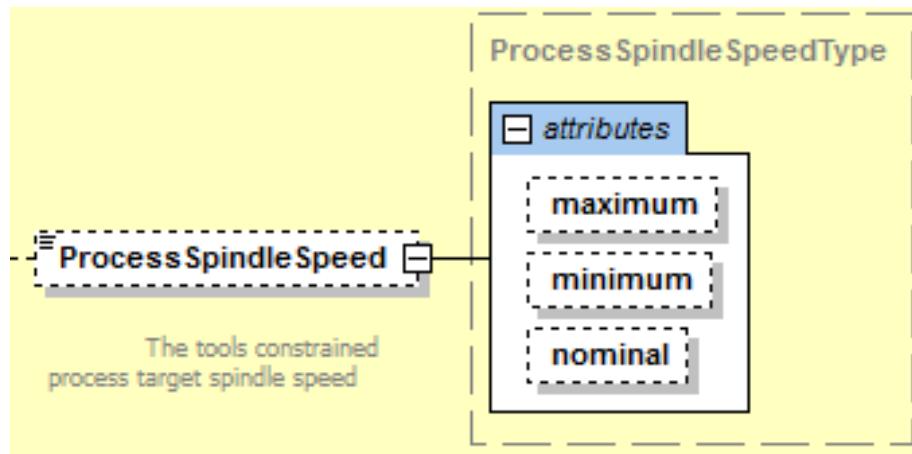


Figure 30: ProcessSpindleSpeed Schema

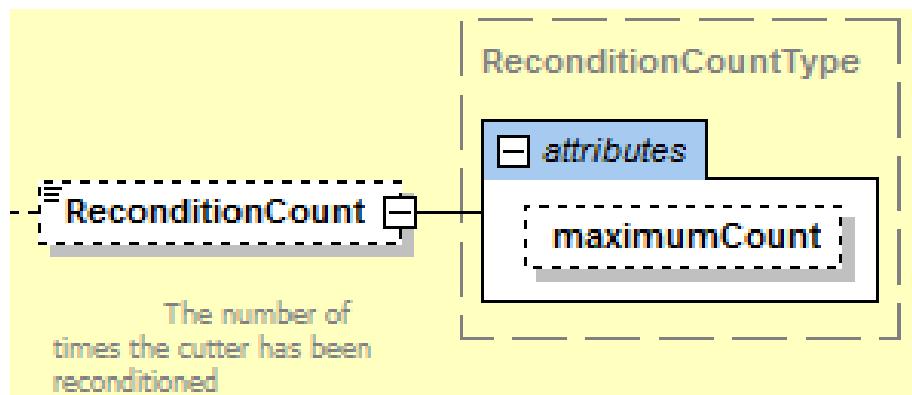


Figure 31: ReconditionCount Schema

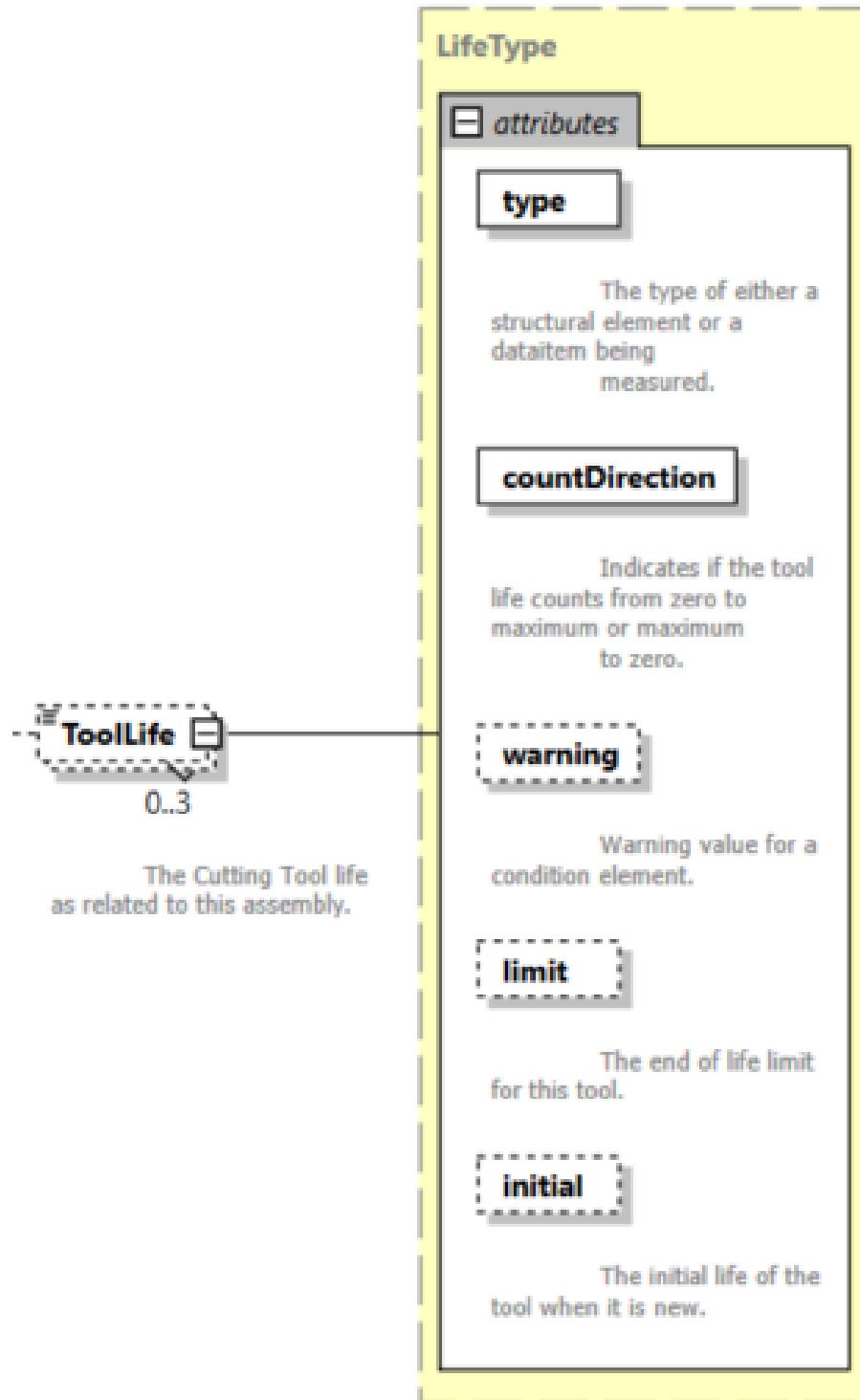


Figure 32: ToolLife Schema

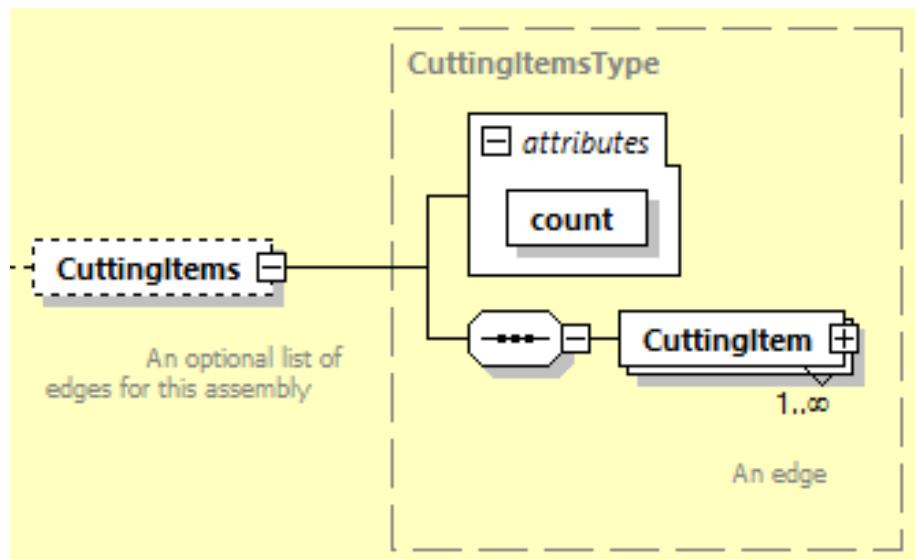


Figure 33: CuttingItems Schema

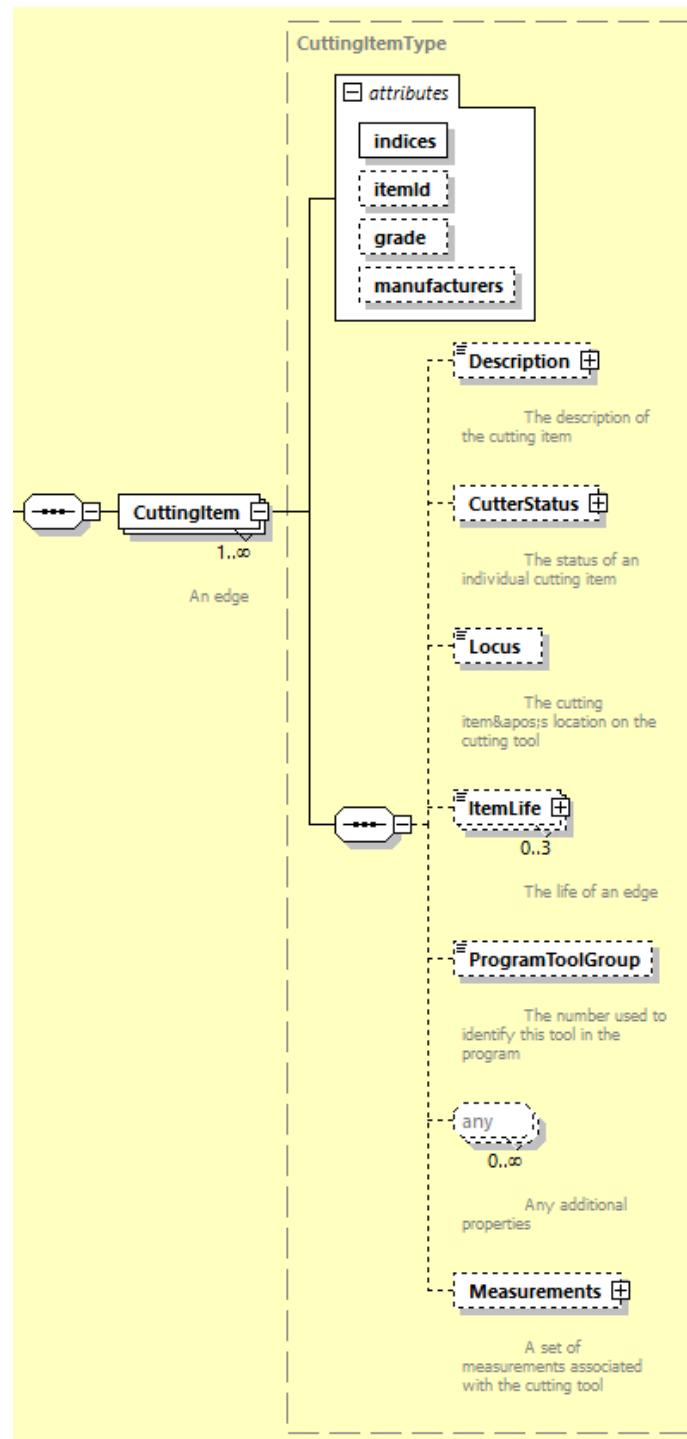


Figure 34: CuttingItem Schema

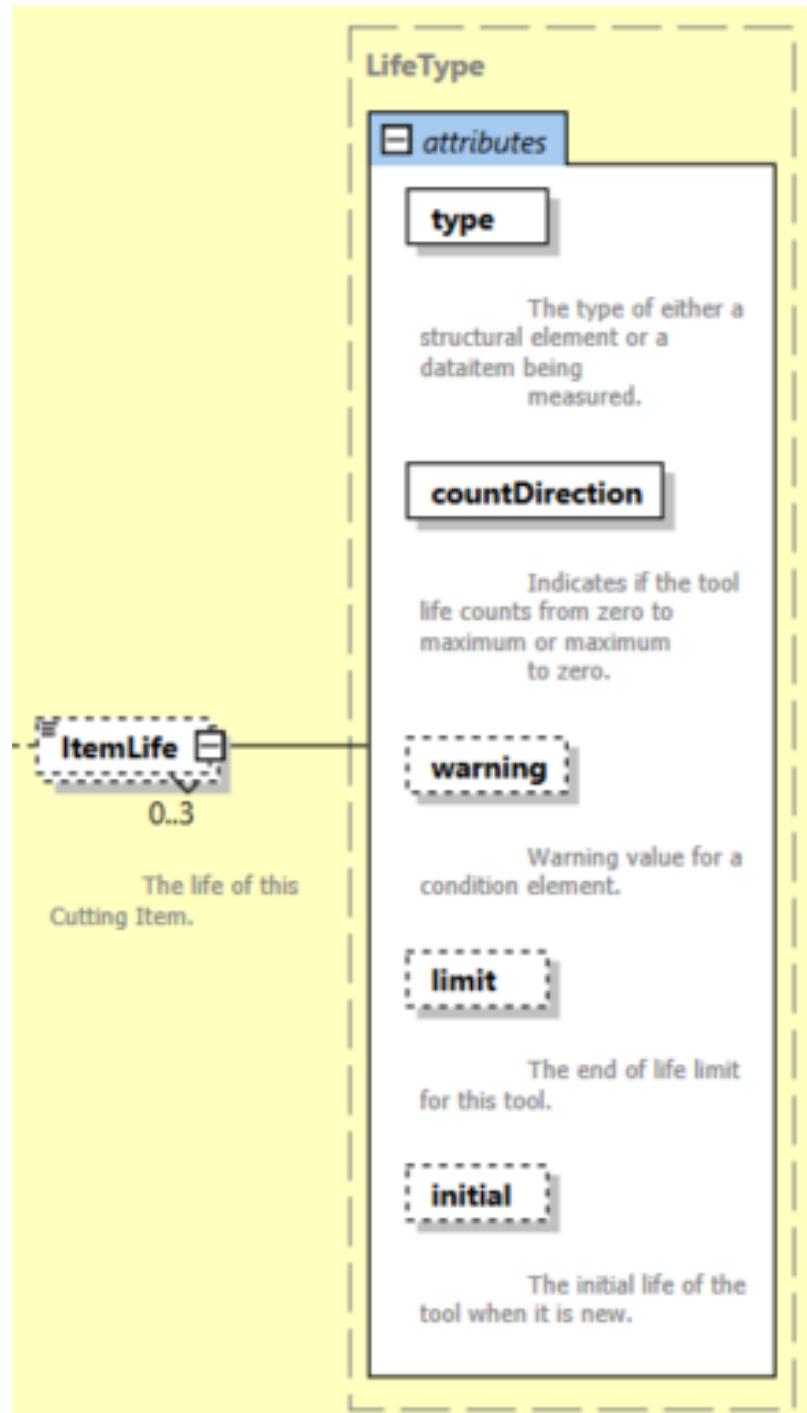


Figure 35: ItemLife Schema

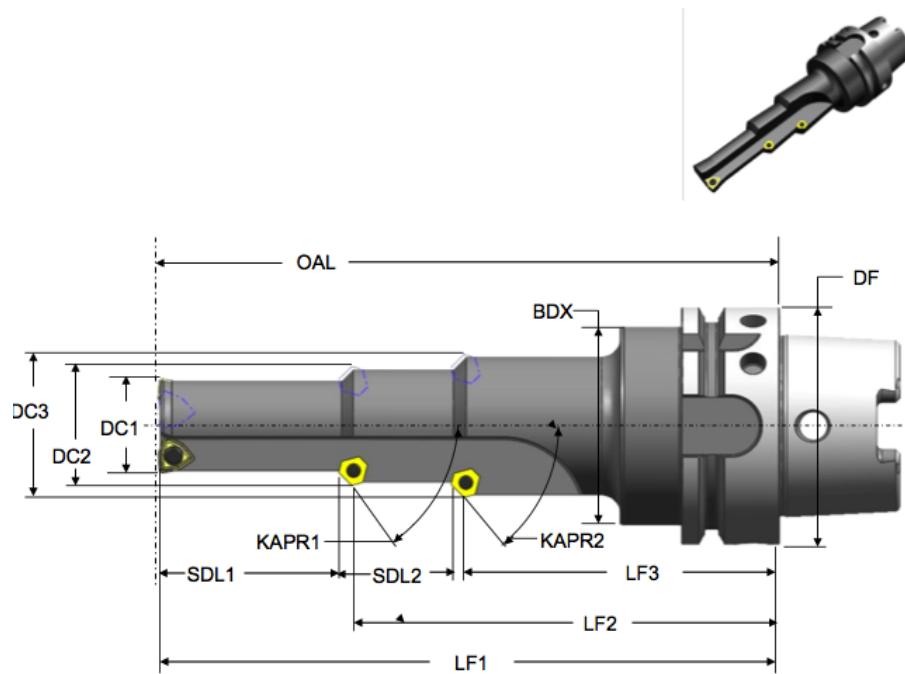


Figure 36: Cutting Tool Measurement 3

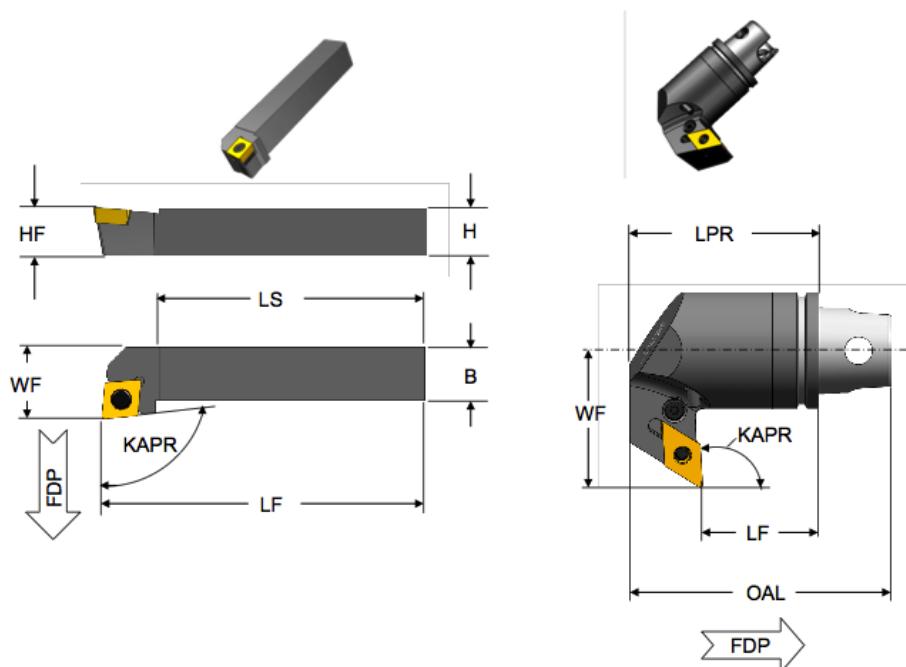


Figure 37: Cutting Tool Measurement 4

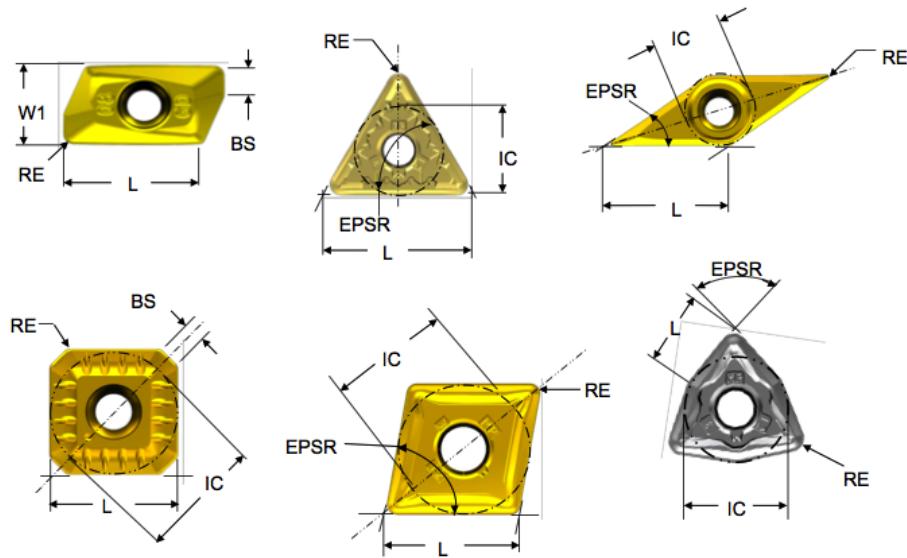
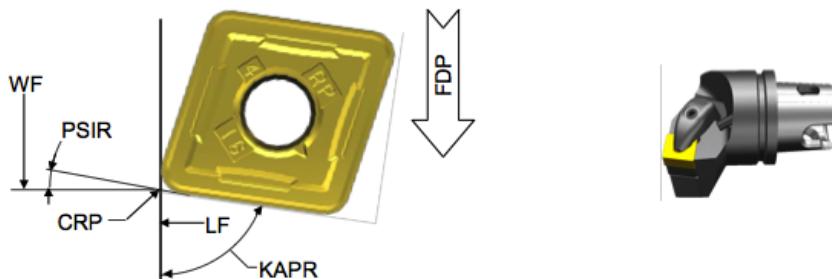


Figure 38: Cutting Tool Measurement 5

SIDE CUTTING TOOLS $KAPR \leq 90^\circ$



SIDE CUTTING TOOLS $KAPR > 90^\circ$

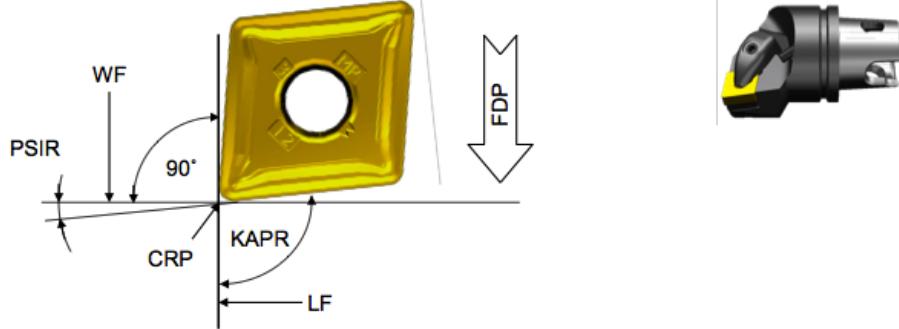
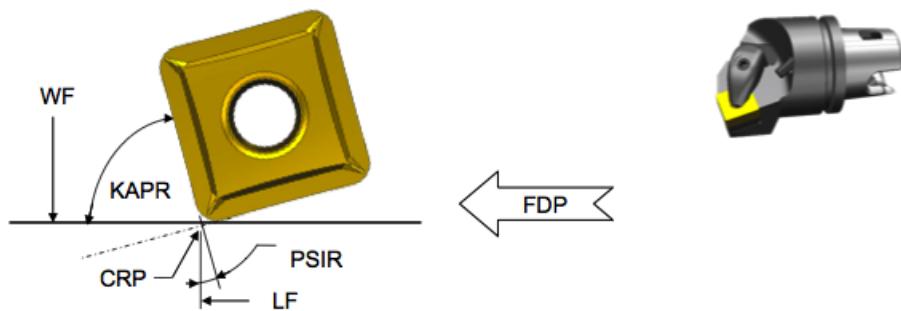


Figure 39: Cutting Tool Measurement 6

END CUTTING TOOLS KAPR $\leq 90^\circ$



END CUTTING TOOLS KAPR >90°

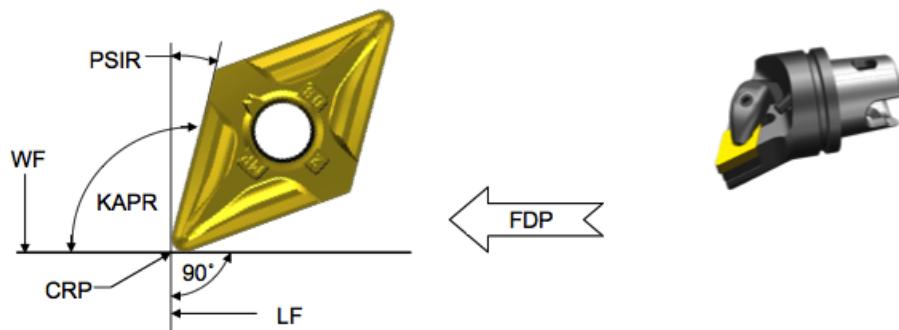


Figure 40: Cutting Tool Measurement 7

BCH = CHAMFER FLAT LENGTH

CHW = CHAMFER WIDTH

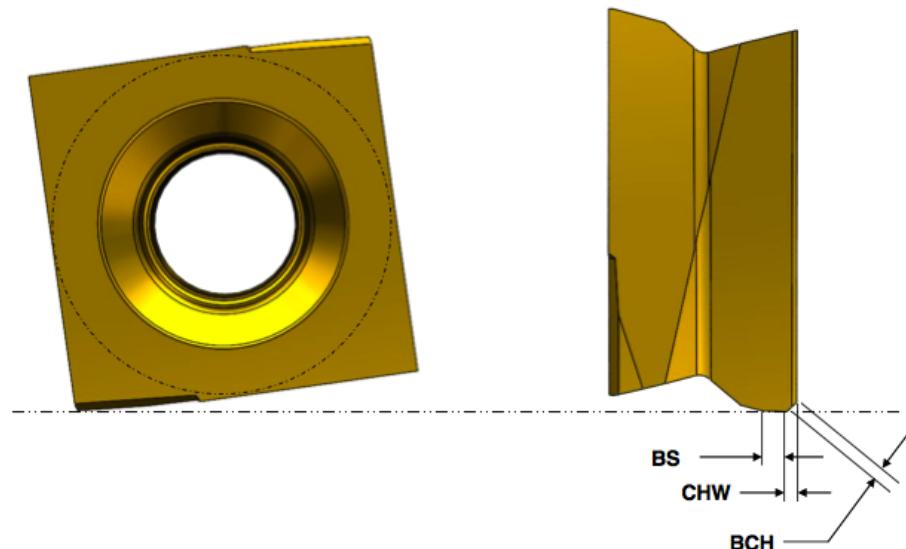


Figure 41: Cutting Tool Measurement 8

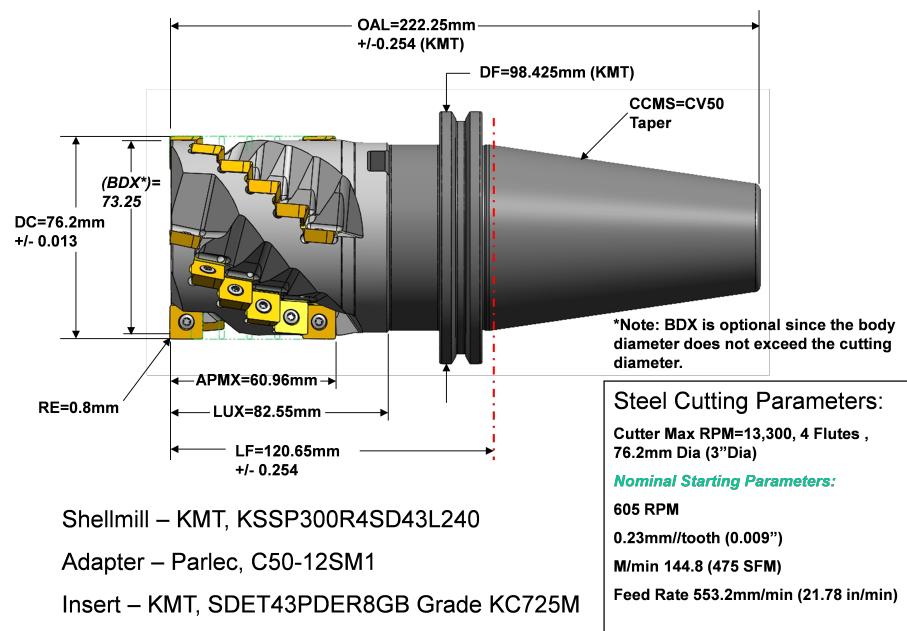


Figure 42: Shell Mill Side View

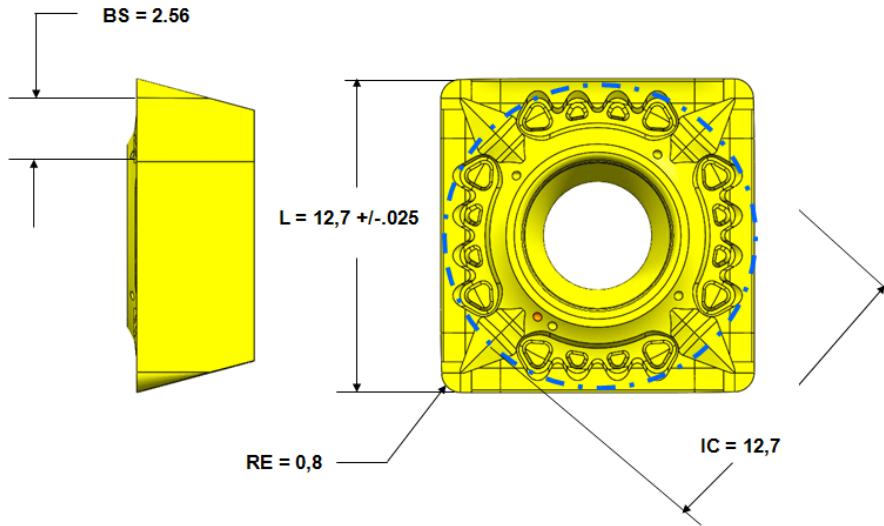


Figure 43: Indexable Insert Measurements

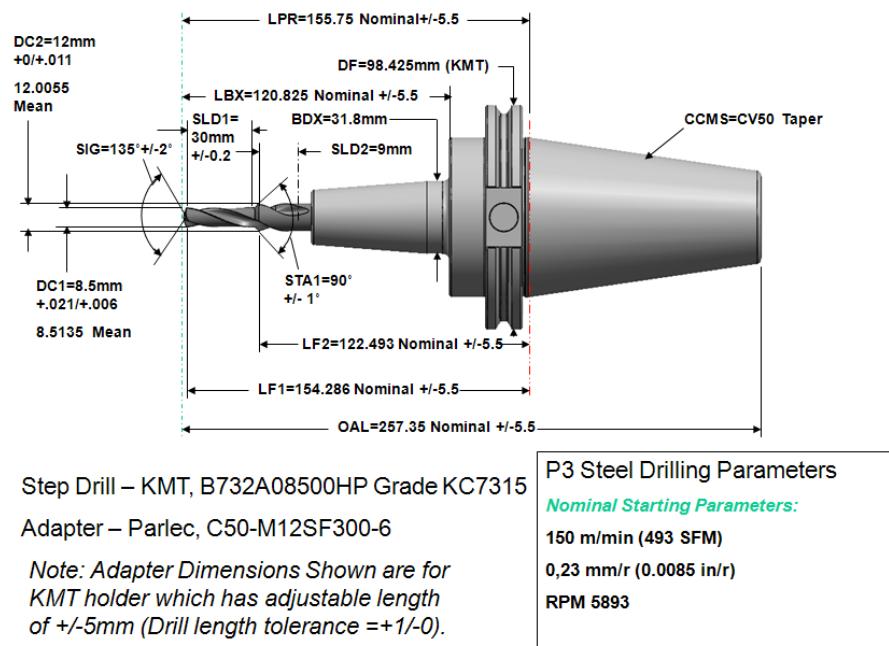


Figure 44: Step Mill Side View

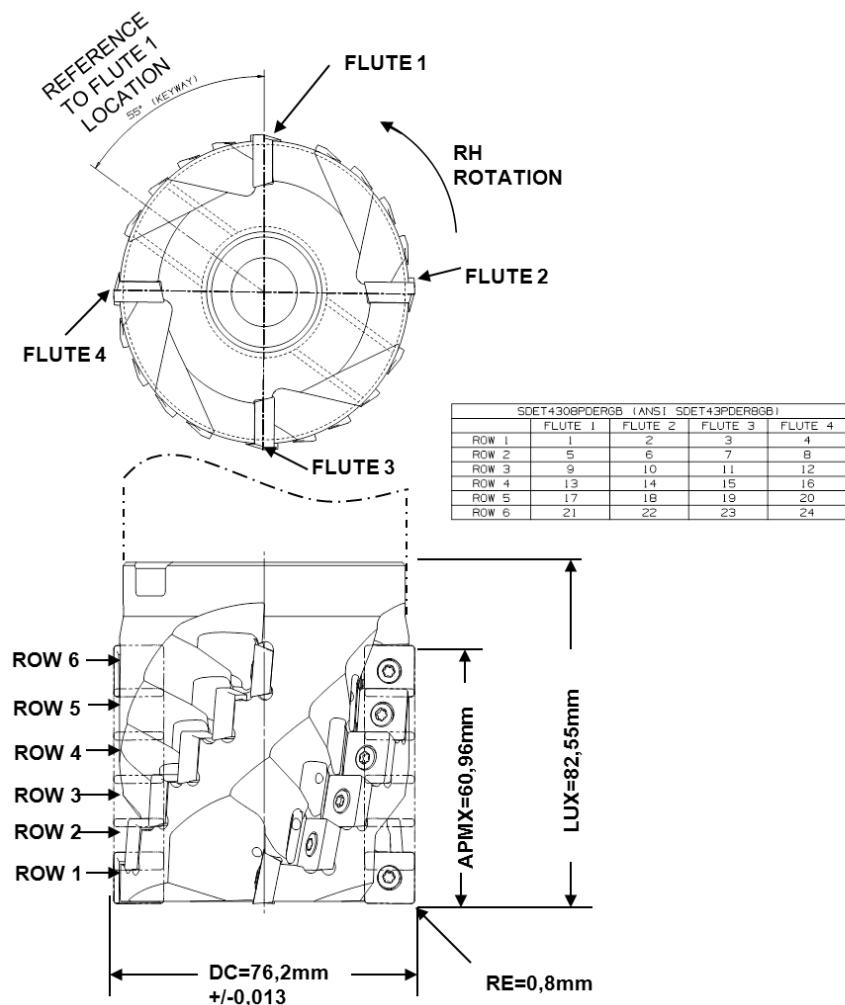


Figure 45: Shell Mill with Explicate Loci

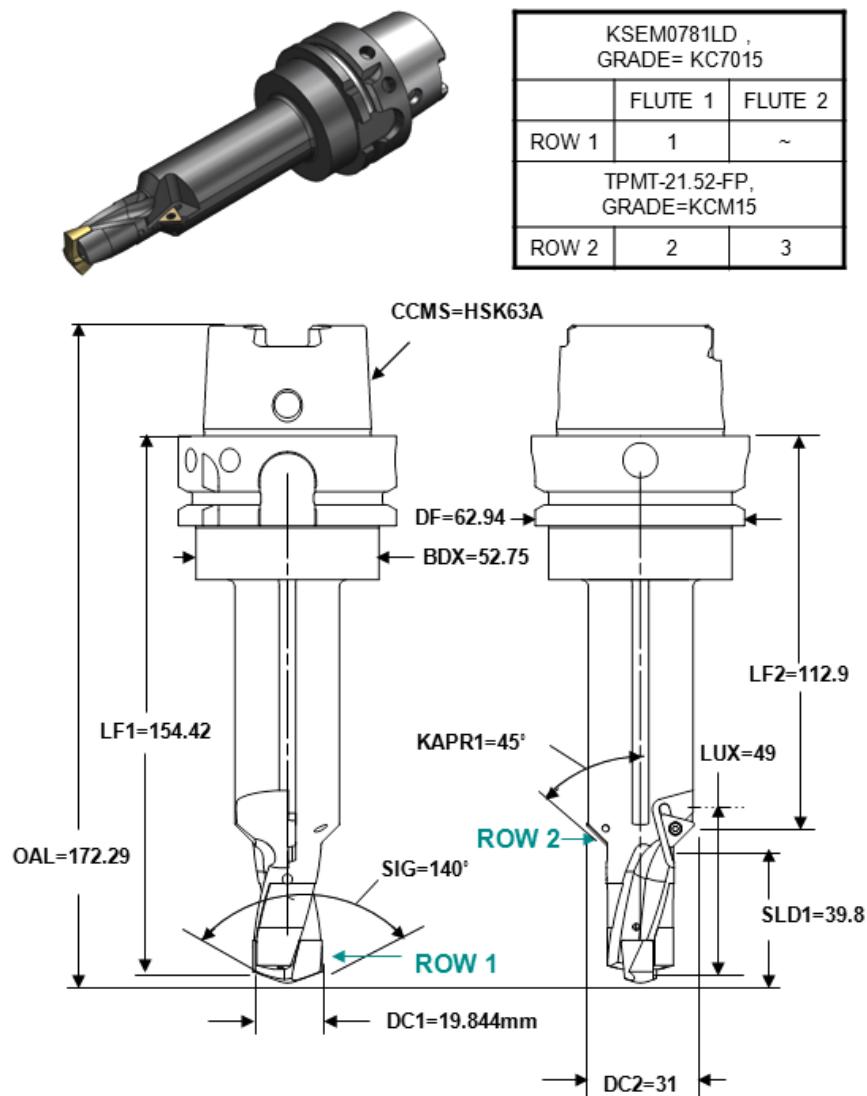


Figure 46: Step Drill with Explicate Loci

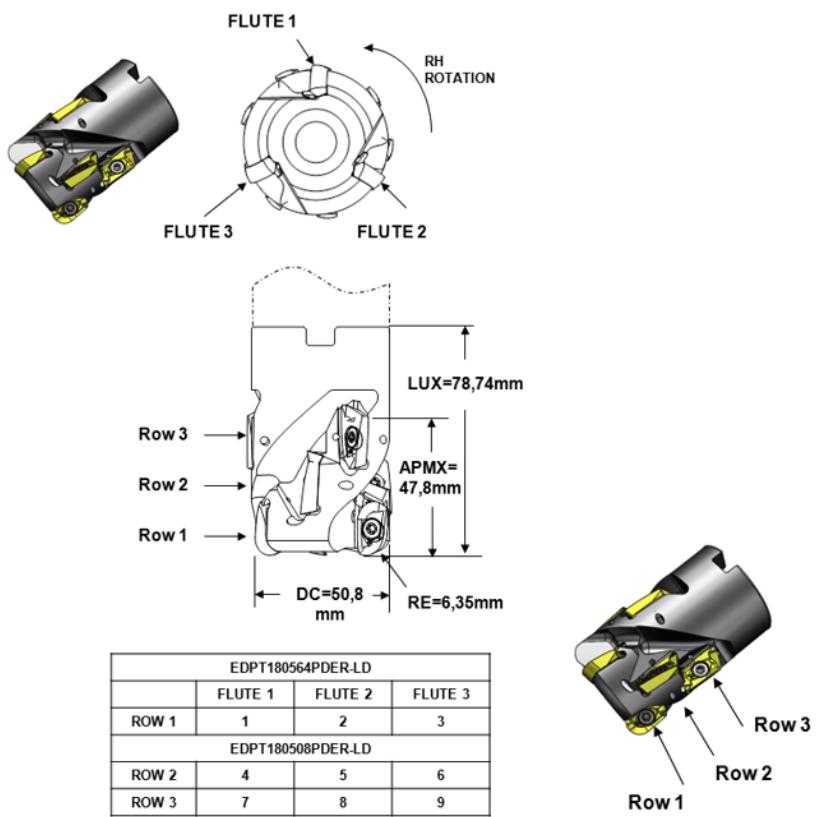
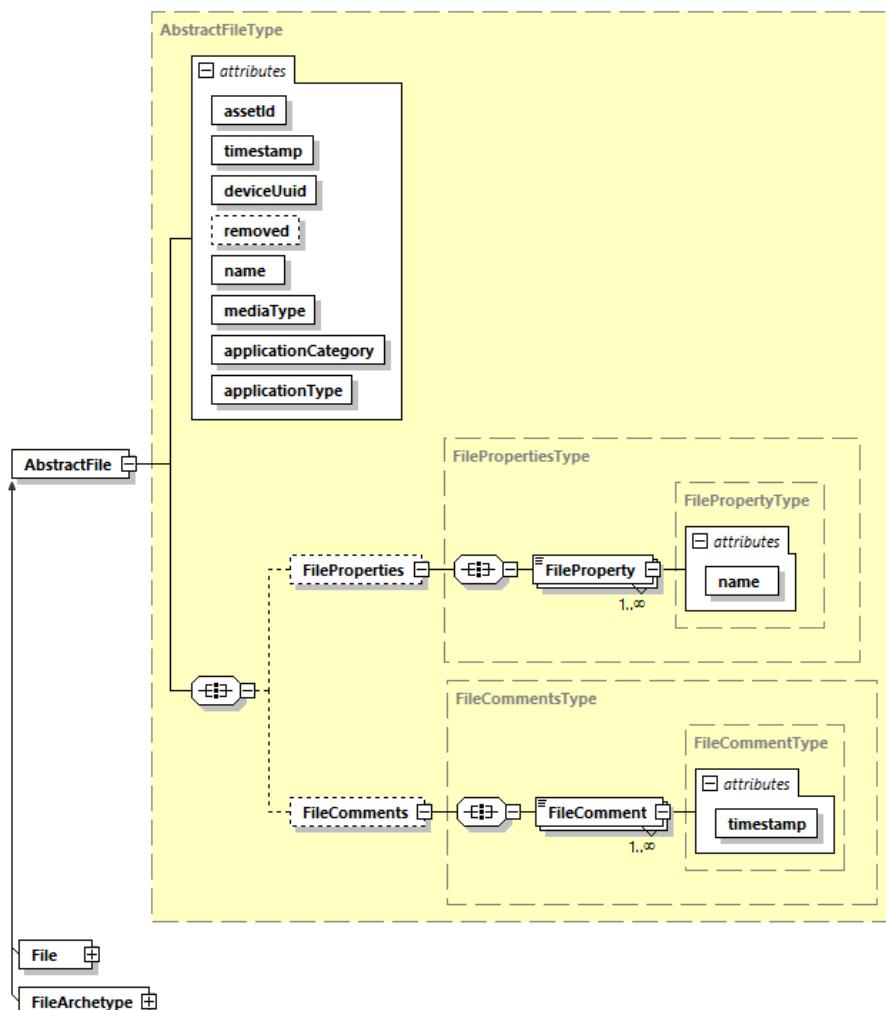
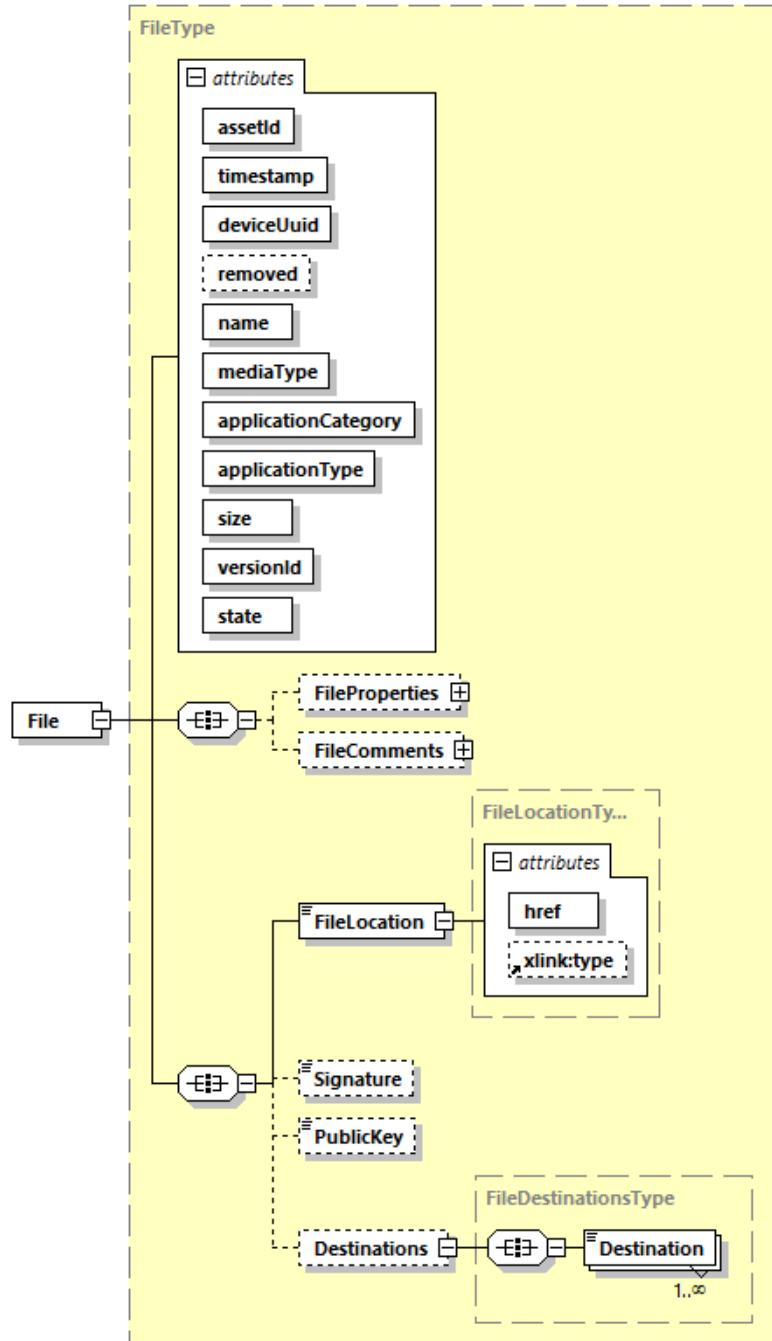


Figure 47: Shell Mill with Different Inserts on First Row

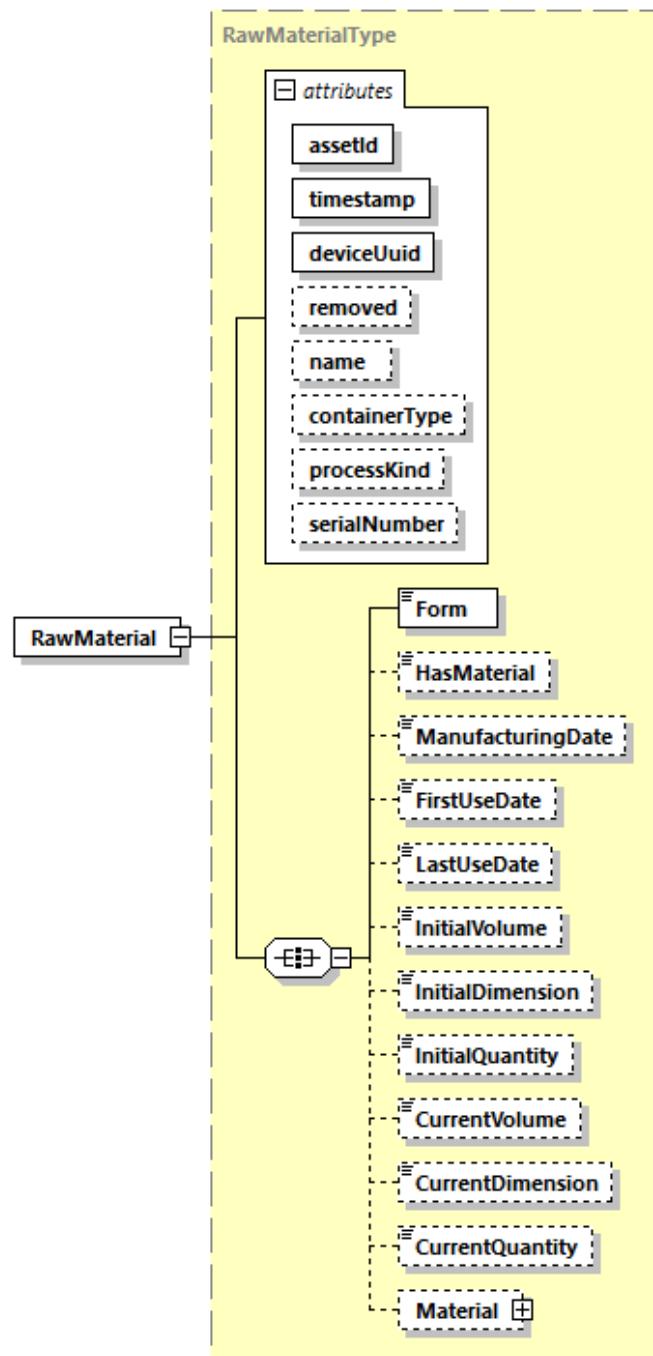
**Figure 48:** AbstractFile Schema



Generated by XMLSpy

www.altova.com

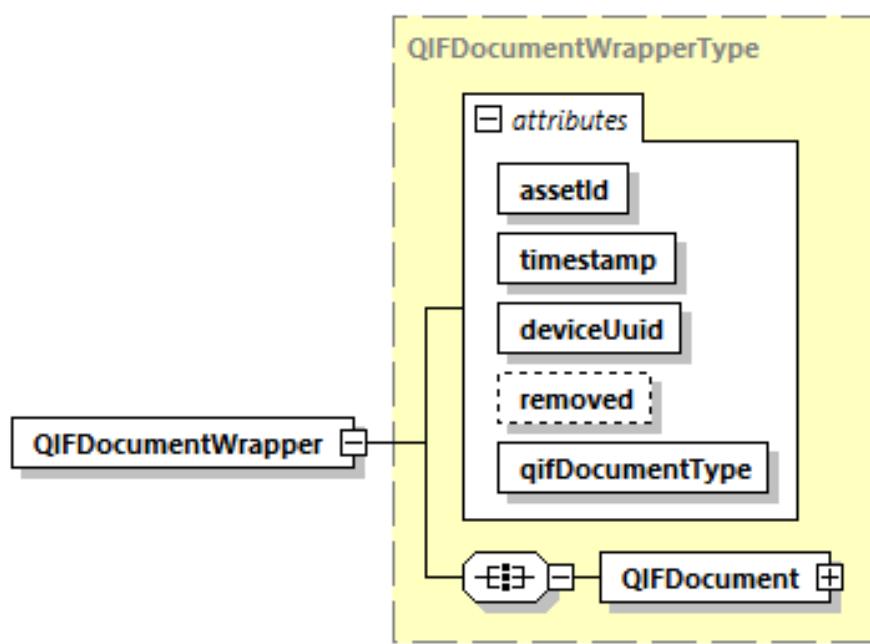
Figure 49: File Schema



Generated by XMLSpy

www.altova.com

Figure 50: RawMaterial Schema



Generated by XMLSpy

www.altova.com

Figure 51: QIFDocumentWrapper Schema