



MTConnect[®] Standard

Part 4.0 – Asset Information Model

Version 2.5.0

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

Table of Contents

1	Purpose of This Document	2
2	Terminology and Conventions	3
2.1	General Terms	3
2.2	Information Model Terms	10
2.3	Protocol Terms	11
2.4	HTTP Terms	13
2.5	XML Terms	15
2.6	MTConnect Terms	16
2.7	Acronyms	17
2.8	MTConnect References	29
3	Asset Information Model	30
3.1	Asset	30
3.1.1	Value Properties of Asset	31
3.1.2	Part Properties of Asset	32
3.2	PhysicalAsset	33
3.2.1	Part Properties of PhysicalAsset	34
4	Cutting Tool Asset Information Model	35
4.1	Cutting Tool	37
4.1.1	CuttingTool	37
4.1.2	CuttingToolArchetype	39
4.1.3	CuttingToolArchetypeReference	41
4.1.4	CuttingToolDefinition	41
4.2	Cutting Tool Life Cycle	42
4.2.1	CuttingToolLifeCycle	42
4.2.2	ToolLife	46
4.2.3	Location	47
4.2.4	ReconditionCount	50
4.2.5	ProcessSpindleSpeed	50
4.2.6	ProcessFeedRate	51
4.2.7	Status	52
4.2.8	ToolingMeasurement	53
4.3	Cutting Item	54
4.3.1	CuttingItem	55
4.3.2	CuttingItems	57
4.3.3	ItemLife	58
4.4	Cutting Tool Measurement Subtypes	59
4.4.1	BodyDiameterMax	59
4.4.2	BodyLengthMax	60

4.4.3	DepthOfCutMax	61
4.4.4	CuttingDiameterMax	61
4.4.5	FlangeDiameterMax	61
4.4.6	OverallToolLength	61
4.4.7	ShankDiameter	62
4.4.8	ShankHeight	62
4.4.9	ShankLength	62
4.4.10	UsableLengthMax	62
4.4.11	ProtrudingLength	63
4.4.12	FunctionalLength	63
4.4.13	Weight	63
4.5	Cutting Item Measurement Subtypes	63
4.5.1	FunctionalLength	64
4.5.2	CuttingReferencePoint	65
4.5.3	CuttingEdgeLength	65
4.5.4	DriveAngle	66
4.5.5	FlangeDiameter	66
4.5.6	FunctionalWidth	66
4.5.7	IncribedCircleDiameter	67
4.5.8	PointAngle	68
4.5.9	ToolCuttingEdgeAngle	68
4.5.10	ToolLeadAngle	68
4.5.11	ToolOrientation	68
4.5.12	StepDiameterLength	69
4.5.13	StepIncludedAngle	69
4.5.14	WiperEdgeLength	69
4.5.15	CuttingDiameter	69
4.5.16	CuttingHeight	70
4.5.17	CornerRadius	70
4.5.18	Weight	70
4.5.19	ChamferFlatLength	70
4.5.20	ChamferWidth	70
4.5.21	InsertWidth	71
5	Files Asset Information Model	72
5.1	Files	72
5.1.1	AbstractFile	72
5.1.2	File	75
5.1.3	FileArchetype	77
5.1.4	FileProperty	77
5.1.5	FileComment	78
5.1.6	FileLocation	78

5.1.7	Destination	79
6	Raw Material Asset Information Model	80
6.1	Raw Material	80
6.1.1	RawMaterial	80
6.1.2	Material	85
7	QIF Asset Information Model	87
7.1	QIF	87
7.1.1	QIFDocument	87
7.1.2	QIFDocumentWrapper	87
8	Component Configuration Parameters Asset Information Model	90
8.1	Component Configuration Parameters	90
8.1.1	ComponentConfigurationParameters	91
8.1.2	ParameterSet	91
8.1.3	Parameter	92
9	Fixture Asset Information Model	94
9.1	Fixture	94
9.1.1	Fixture	94
10	Pallet Asset Information Model	95
10.1	Pallet	95
10.1.1	Pallet	95
11	Profile	96
11.1	DataTypes	96
11.1.1	boolean	96
11.1.2	ID	96
11.1.3	string	96
11.1.4	float	96
11.1.5	datetime	97
11.1.6	integer	97
11.1.7	xlinktype	97
11.1.8	xslang	97
11.1.9	SECOND	97
11.1.10	xlinkhref	97
11.1.11	x509	97
11.1.12	int32	98
11.1.13	int64	98
11.1.14	version	98
11.1.15	uint32	98

11.1.16	uint64	98
11.1.17	binary	98
11.1.18	double	98
11.1.19	Array	99
11.1.20	<<hasFormatSpecificRepresentation>>float3d . . .	99
11.1.21	UUID	99
11.1.22	METER	99
11.2	Stereotypes	99
11.2.1	organizer	99
11.2.2	deprecated	99
11.2.3	extensible	99
11.2.4	informative	100
11.2.5	normative	100
11.2.6	observes	100
11.2.7	satisfiedBy	101
11.2.8	hasFormatSpecificRepresentation	101
11.2.9	valueType	101
11.2.10	isArray	101
11.2.11	MTConnectRequirementSpecification	101
Appendices		102
A	Bibliography	102
B	XML Schema Diagrams	104
B.1	Assets Schema Diagrams	104
B.2	CuttingTool Schema Diagrams	104
B.3	CuttingToolLifeCycle Schema Diagrams	104
B.4	CuttingItem Schema Diagrams	105
B.5	ISO 13399 Diagrams	105
B.6	Cutting Tool Examples	105
B.7	File Schema Diagrams	119
B.8	RawMaterial Schema Diagrams	119
B.9	QIFDocumentWrapper Schema Diagrams	119

Table of Figures

Figure 1: Asset	31
Figure 2: Asset	33
Figure 3: Cutting Tool Parts	35
Figure 4: Cutting Tool Composition	36
Figure 5: Cutting Tool, Tool Item, and Cutting Item	37
Figure 6: Cutting Tool, Tool Item, and Cutting Item 2	38
Figure 7: CuttingTool	38
Figure 8: CuttingToolLifeCycle	43
Figure 9: CuttingItem	54
Figure 10:Cutting Tool Measurement 1	59
Figure 11:Cutting Tool Measurement 2	60
Figure 12:Cutting Tool	64
Figure 13:Cutting Item	65
Figure 14:Cutting Item Measurement	66
Figure 15:Cutting Item Drive Angle	67
Figure 16:Files	73
Figure 17:RawMaterial	82
Figure 18:QIFDocumentWrapper	88
Figure 19:ComponentConfigurationParameters	90
Figure 20:Fixture	94
Figure 21:Pallet	95
Figure 22:DataTypes	96
Figure 23:Stereotypes	100
Figure 24:Cutting Tool Measurement 3	105
Figure 25:Cutting Tool Measurement 4	106
Figure 26:Cutting Tool Measurement 5	107
Figure 27:Cutting Tool Measurement 6	108
Figure 28:Cutting Tool Measurement 7	109
Figure 29:Cutting Tool Measurement 8	110
Figure 30:Shell Mill Side View	111
Figure 31:Indexable Insert Measurements	112
Figure 32:Step Mill Side View	113
Figure 33:Shell Mill with Explicate Loci	114
Figure 34:Step Drill with Explicate Loci	116
Figure 35:Shell Mill with Different Inserts on First Row	118

List of Tables

Table 1: Value Properties of Asset	32
Table 2: Part Properties of Asset	32
Table 3: Part Properties of PhysicalAsset	34
Table 4: Value Properties of CuttingTool	38
Table 5: Part Properties of CuttingTool	39
Table 6: Value Properties of CuttingToolArchetype	40
Table 7: Part Properties of CuttingToolArchetype	40
Table 8: Value Properties of CuttingToolArchetypeReference	41
Table 9: Value Properties of CuttingToolDefinition	41
Table 10: Value Properties of CuttingToolLifeCycle	43
Table 11: Part Properties of CuttingToolLifeCycle	44
Table 12: Value Properties of ToolLife	46
Table 13: Value Properties of Location	48
Table 14: Value Properties of ReconditionCount	50
Table 15: Value Properties of ProcessSpindleSpeed	51
Table 16: Value Properties of ProcessFeedRate	51
Table 17: Value Properties of ToolingMeasurement	53
Table 18: Value Properties of CuttingItem	55
Table 19: Part Properties of CuttingItem	56
Table 20: Value Properties of CuttingItems	58
Table 21: Value Properties of ItemLife	58
Table 22: Value Properties of AbstractFile	73
Table 23: Part Properties of AbstractFile	75
Table 24: Value Properties of File	76
Table 25: Part Properties of File	77
Table 26: Value Properties of FileProperty	78
Table 27: Value Properties of FileComment	78
Table 28: Value Properties of FileLocation	79
Table 29: Value Properties of Destination	79
Table 30: Value Properties of RawMaterial	81
Table 31: Part Properties of RawMaterial	84
Table 32: Value Properties of Material	85
Table 33: Value Properties of QIFDocumentWrapper	88
Table 34: Part Properties of QIFDocumentWrapper	89
Table 35: Part Properties of ComponentConfigurationParameters	91
Table 36: Value Properties of ParameterSet	91
Table 37: Part Properties of ParameterSet	92
Table 38: Value Properties of Parameter	92

1 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 General Terms

14 ***adapter***

15 optional piece of hardware or software that transforms information provided by a
16 piece of equipment into a form that can be received by an *agent*.

17 ***agent***

18 software that collects data published from one or more piece(s) of equipment, or-
19 ganizes that data in a structured manner, and responds to requests for data from
20 client software systems by providing a structured response in the form of a *response*
21 *document* that is constructed using the *semantic data model* of a Standard.

22 ***alarm limit***

23 limit used to trigger warning or alarm indicators.

24 ***application***

25 software or a program that is specific to the solution of an application problem.
26 *Ref ISO/IEC 20944-1:2013*

27 ***archetype***

28 *archetype* provides the requirements, constraints, and common properties for a type
29 of *Asset*.

30 ***asset buffer***

31 *buffer* for *Assets*.

32 ***attachment***

33 connection by which one thing is associated with another.

34 ***buffer***

35 section of an *agent* that provides storage for information published from pieces of
36 equipment.

37 ***cartesian coordinate system***

38 3D orthogonal coordinate system [(ISO/IEC 19794-5:2011en).

39 ***characteristic***

40 control placed on an element of a *feature* such as its size, location, or form, which
41 may be a specification limit, a nominal with tolerance, or some other numerical or
42 non-numerical control. *Ref QIF 3.0 3.4.29. Ref AS9102-B.*

43 ***client***

44 *application* that sends *request* for information to an *agent*.

45 Note: Examples include software applications or a function that imple-
46 ments the *request* portion of an *interface interaction model*.

47 ***combined standard uncertainty***

48 *standard uncertainty* of the result of a measurement when that result is obtained
49 from the values of a number of other quantities, equal to the positive square root of a
50 sum of terms, the terms being the variances or covariances of these other quantities
51 weighted according to how the measurement result varies with changes in these
52 quantities. *Ref JCGM 100:2008 2.3.4*

53 ***condition activation***

54 state transition from Normal to either Warning or Fault.

55 ***controlled vocabulary***

56 restricted set of values for a given property.

57 ***data dictionary***

58 listing of standardized terms and definitions used in *MTConnect Information Model*.

59 ***data model***

60 organizes elements of data and standardizes how they relate to one another and to
61 the properties of real-world entities.

62 ***data set***

63 *key-value pairs* where each entry is uniquely identified by the *key*.

64 ***data source***

65 piece of equipment that can produce data that is published to an *agent*.

66 ***deprecated***

67 indication that specific content in an *MTConnect Document* is currently usable but
68 is regarded as being obsolete or superseded.

69 ***deprecation warning***

70 indication that specific content in an *MTConnect Document* may be changed to *dep-*
71 *recated* in a future release of the standard.

72 ***document***

73 piece of written, printed, or electronic matter that provides information or evidence
74 that serves as an official record.

75 ***electric current***

76 rate of flow of electric charge.

77 ***element***

78 constituent part or a basic unit of identifiable and definable data.

79 ***extensible***

80 ability for an implementer to extend *MTConnect Information Model* by adding con-
81 tent not currently addressed in the MTConnect Standard.

82 ***feature***

83 topological entity(ies) or design requirements related to a geometric model. *Ref QIF*
84 *3.0-3.4.59*

85 ***force***

86 push or pull on a mass which results in an acceleration.

87 ***heartbeat***

88 function that indicates to a *client* that the communications connection to an *agent* is
89 still viable during times when there is no new data available to report often referred
90 to as a “keep alive” message.

91 ***higher level***

92 nested element that is above a lower level element.

93 ***implementation***

94 specific instantiation of the MTConnect Standard.

95 ***information model***

96 rules, relationships, and terminology that are used to define how information is struc-
97 tured.

98 ***instance***

99 describes a set of *streaming data* in an *agent*. Each time an *agent* is restarted with
100 an empty *buffer*, data placed in the *buffer* represents a new *instance* of the *agent*.

101 ***interaction model***

102 model that defines how information is exchanged across an *interface* to enable in-
103 teractions between independent systems.

104 ***interface***

105 means by which communication is achieved between independent systems.

106 ***key***

107 unique identifier in a *key-value pair* association.

108 ***key-value pair***

109 association between an identifier referred to as the *key* and a value which taken
110 together create a *key-value pair*.

111 ***location***

112 place or named space associated with an object or that can be occupied by an object.

113 ***lower camel case***

114 first word is lowercase and the remaining words are capitalized and all spaces be-
115 tween words are removed.

116 ***lower level***

117 nested element that is below a higher level element.

118 ***lower limit***

119 lower conformance boundary for a variable.

120 ***lower warning***

121 lower boundary indicating increased concern and supervision may be required.

122 ***major***

123 identifier representing a consistent set of functionalities defined by the MTConnect
124 Standard.

125 ***maximum***

126 numeric upper constraint.

127 ***message***

128 communication in writing, in speech, or by signals.

129 ***metadata***

130 data that provides information about other data.

131 ***minimum***

132 numeric lower constraint.

133 ***minor***

134 identifier representing a specific set of functionalities defined by the MTConnect
135 Standard.

136 ***nominal***

137 ideal or desired value for a variable.

138 ***organize***

139 act of containing and owning one or more elements.

140 ***organizer***

141 entity that *organizes* one or more elements.

142 ***parameter***

143 variable that must be given a value during the execution of a program or a commu-
144 nications command.

145 ***part***

146 discrete item that has both defined and measurable physical characteristics including
147 mass, material, and features, and is created by applying one or more manufacturing
148 process steps to a workpiece

149 ***pascal case***

150 first letter of each word is capitalized and the remaining letters are in lowercase. All
151 space is removed between letters

152 ***patch***

153 supplemental identifier representing only organizational or editorial changes to a
154 *minor* version document with no changes in the functionality described in that doc-
155 ument.

156 ***persistence***

157 method for retaining or restoring information.

158 ***position***

159 *location* that is represented by a point in space relative to a reference.

160 ***probe***

161 instrument commonly used for measuring the physical geometrical characteristics
162 of an object.

163 ***profile***

164 extends a reference metamodel (such as Unified Modeling Language (UML)) by
165 allowing to adapt or customize the metamodel with constructs that are specific to a
166 particular domain, platform, or a software development method.

167 ***requester***

168 entity that initiates a *request* for information in a communications exchange.

169 ***reset***

170 act of reverting back the accumulated value or statistic to their initial value.

171 Note: An *Observation* with a *data set* representation removes all *key-*
172 *value pairs*, setting the *data set* to an empty set.

173 ***responder***

174 entity that responds to a *request* for information in a communications exchange.

175 ***response document***

176 electronic *document* published by an *MTConnect Agent* in response to a *probe re-*
177 *quest*, *current request*, *sample request* or *asset request*.

178 ***schema***

179 definition of the structure, rules, and vocabularies used to define the information
180 published in an electronic document.

181 ***semantic data model***

182 methodology for defining the structure and meaning for data in a specific logical
183 way that can be interpreted by a software system.

184 ***sensing element***

185 mechanism that provides a signal or measured value.

186 ***sequence number***

187 primary key identifier used to manage and locate a specific piece of *streaming data*
188 in an *agent*.

189 ***specification limit***

190 limit defining a range of values designating acceptable performance for a variable.

191 ***spindle***

192 mechanism that provides rotational capabilities to a piece of equipment.

193 Note: Typically used for either work holding, materials or cutting tools.

194 ***standard***

195 *document* established by consensus that provides rules, guidelines, or characteristics
196 for activities or their results.. *Ref ISO/IEC Guide 2:2004*

197 ***standard uncertainty***

198 *uncertainty* of the result of a measurement expressed as a standard deviation. *Ref JCGM*
199 *100:2008 2.3.1*

200 ***stereotype***

201 defines how an existing UML metaclass may be extended as part of a *profile*.

202 ***subtype***

203 secondary or subordinate type of categorization or classification of information.

204 ***table***

205 two dimensional set of values given by a set of *key-value pairs table entries*.

206 ***table cell***

207 subdivision of a *table entry* representing a singular value.

208 ***table entry***

209 subdivision of a *table* containing a set of *key-value pairs* representing *table cells*.

210 ***top level***

211 element that represents the most significant physical or logical functions of a piece
212 of equipment.

213 ***type***

214 classification or categorization of information.

215 ***uncertainty***

216 uncertainty (of measurement) parameter, associated with the result of a measure-
 217 ment, that characterizes the dispersion of the values that could reasonably be at-
 218 tributed to the measurand. *Ref JCGM 100:2008 2.2.3*

219 Note: Use of the term uncertainty refers to uncertainty of measurement.

220 ***upper limit***

221 upper conformance boundary for a variable.

222 ***upper warning***

223 upper boundary indicating increased concern and supervision may be required.

224 ***version***

225 unique identifier of the administered item. *Ref ISO/IEC 11179-:2015*

226 **2.2 Information Model Terms**

227 ***Asset Information Model***

228 *information model* that provides semantic models for *Assets*.

229 ***Device Information Model***

230 *information model* that describes the physical and logical configuration for a piece
 231 of equipment and the data that may be reported by that equipment.

232 ***Error Information Model***

233 *information model* that describes the *response document* returned by an *agent* when
 234 it encounters an error while interpreting a *request* for information from a *client* or
 235 when an *agent* experiences an error while publishing the *response* to a *request* for
 236 information.

237 ***MTConnect Information Model***

238 *information model* that defines the semantics of the MTConnect Standard.

239 ***Observation Information Model***

240 *information model* that describes the *streaming data* reported by a piece of equip-
 241 ment.

242 2.3 Protocol Terms

243 ***asset request***

244 *HTTP Request* to the *agent* regarding *Assets*.

245 ***current request***

246 *request* to an *agent* to produce an *MTConnectStreams Response Document* contain-
 247 ing the *Observation Information Model* for a snapshot of the latest observations at
 248 the moment of the *request* or at a given *sequence number*.

249 ***data streaming***

250 method for an *agent* to provide a continuous stream of information in response to a
 251 single *request* from a *client*.

252 ***MTConnect Request***

253 *request* for information issued from a *client* to an *MTConnect Agent*.

254 ***MTConnect Response Document***

255 *response document* published by an *MTConnect Agent*.

256 ***MTConnectAssets Response Document***

257 *response document* published by an *MTConnect Agent* in response to an *asset re-*
 258 *quest*.

259 ***MTConnectDevices Response Document***

260 *response document* published by an *MTConnect Agent* in response to a *probe re-*
 261 *quest*.

262 ***MTConnectErrors Response Document***

263 *response document* published by an *MTConnect Agent* whenever it encounters an
 264 error while interpreting an *MTConnect Request*.

265 ***MTConnectStreams Response Document***

266 *response document* published by an *MTConnect Agent* in response to a *current re-*
 267 *quest* or a *sample request*.

268 ***probe request***

269 *request* to an *agent* to produce an *MTConnectDevices Response Document* contain-
 270 ing the *Device Information Model*.

271 ***protocol***

272 set of rules that allow two or more entities to transmit information from one to the
273 other.

274 ***publish***

275 sending of messages in a *publish and subscribe* pattern.

276 ***publish and subscribe***

277 asynchronous communication method in which messages are exchanged between
278 applications without knowing the identity of the sender or recipient.

279 Note: In the MTConnect Standard, a communications messaging pattern
280 that may be used to publish *streaming data* from an *agent*.

281 ***request***

282 communications method where a *client* transmits a message to an *agent*. That mes-
283 sage instructs the *agent* to respond with specific information.

284 ***request and response***

285 communications pattern that supports the transfer of information between an *agent*
286 and a *client*.

287 ***response***

288 response *interface* which responds to a *request*.

289 ***sample request***

290 *request* to an *agent* to produce an *MTConnectStreams Response Document* contain-
291 ing the *Observation Information Model* for a set of timestamped observations made
292 by *Components*.

293 ***streaming data***

294 observations published by a piece of equipment defined by the equipment metadata.

295 ***subscribe***

296 receiving messages in a *publish and subscribe* pattern.

297 ***transport protocol***

298 set of capabilities that provide the rules and procedures used to transport information
299 between an *agent* and a client software application through a physical connection.

300 2.4 HTTP Terms

301 **HTTP Body**

302 data bytes transmitted in an HTTP transaction message immediately following the
303 headers. *Ref IETF:RFC-2616*

304 **HTTP Error Message**

305 response provided by an *agent* indicating that an *HTTP Request* is incorrectly for-
306 matted or identifies that the requested data is not available from the *agent*. *Ref IETF:RFC-*
307 *2616*

308 **HTTP Header**

309 header of either an *HTTP Request* from a *client* or an *HTTP Response* from an *agent*.
310 *Ref IETF:RFC-2616*

311 **HTTP Header Field**

312 components of the header section of request and response messages in an HTTP
313 transaction. *Ref IETF:RFC-2616*

314 **HTTP Message**

315 consist of requests from client to server and responses from server to client. *Ref IETF:RFC-*
316 *2616*

317 Note: In MTConnect Standard, it describes the information that is ex-
318 changed between an *agent* and a *client*.

319 **HTTP Messaging**

320 *interface* for information exchange functionality. *Ref IETF:RFC-2616*

321 **HTTP Method**

322 portion of a command in an *HTTP Request* that indicates the desired action to be
323 performed on the identified resource; often referred to as verbs. *Ref IETF:RFC-*
324 *2616*

325 **HTTP Query**

326 portion of a request for information that more precisely defines the specific informa-
327 tion to be published in response to the request. *Ref IETF:RFC-2616*

328 **HTTP Request**

329 request message from a client to a server includes, within the first line of that mes-
330 sage, the method to be applied to the resource, the identifier of the resource, and the
331 protocol version in use. *Ref IETF:RFC-2616*

332 Note: In MTConnect Standard, a request issued by a *client* to an *agent*
333 requesting information defined in the *HTTP Request Line*.

334 ***HTTP Request Line***

335 begins with a method token, followed by the Request-URI and the protocol version,
336 and ending with CRLF. A CRLF is allowed in the definition of TEXT only as part
337 of a header field continuation. *Ref IETF:RFC-2616*

338 Note: the first line of an *HTTP Request* describing a specific *response*
339 *document* to be published by an *agent*.

340 ***HTTP Request Method***

341 indicates the method to be performed on the resource identified by the Request-URI.
342 *Ref IETF:RFC-2616*

343 ***HTTP Request URI***

344 Uniform Resource Identifier that identifies the resource upon which to apply the
345 request. *Ref IETF:RFC-2616*

346 ***HTTP Response***

347 after receiving and interpreting a request message, a server responds with an HTTP
348 response message. *Ref IETF:RFC-2616*

349 Note: In MTConnect Standard, the information published from an *agent*
350 in reply to an *HTTP Request*.

351 ***HTTP Server***

352 server that accepts *HTTP Request* from *client* and publishes *HTTP Response* as a
353 reply to those *HTTP Request*. *Ref IETF:RFC-2616*

354 ***HTTP Status Code***

355 3-digit integer result code of the attempt to understand and satisfy the request.
356 *Ref IETF:RFC-2616*

357 ***HTTP Version***

358 version of the HTTP protocol. *Ref IETF:RFC-2616*

359 2.5 XML Terms

360 ***abstract element***

361 element that defines a set of common characteristics that are shared by a group of
362 elements. An abstract entity cannot appear in a document. In a specific implemen-
363 tation, an abstract entity is replaced by a derived element that is itself not an abstract
364 entity. The characteristics for the derived element are inherited from the abstract
365 entity.

366 ***attribute***

367 additional information or property for an *element*.

368 ***child element***

369 *element* of a data modeling structure that illustrates the relationship between itself
370 and the higher-level *parent element* within which it is contained.

371 ***document body***

372 portion of the content of an *MTConnect Response Document* that is defined by the
373 relative *MTConnect Information Model*. The *document body* contains the *structural*
374 *elements* and *Observations* or *DataItems* reported in a *response document*.

375 ***document header***

376 portion of the content of an *MTConnect Response Document* that provides infor-
377 mation from an *agent* defining version information, storage capacity, protocol, and
378 other information associated with the management of the data stored in or retrieved
379 from the *agent*.

380 ***element name***

381 descriptive identifier contained in both the `start-tag` and `end-tag` of an XML
382 element that provides the name of the element.

383 ***namespace***

384 organizes information into logical groups.

385 ***parent element***

386 *element* of a data modeling structure that illustrates the relationship between itself
387 and the lower-level *child element*.

388 ***root element***

389 first *structural element* provided in a *response document* encoded using XML.

390 ***structural element***

391 *element* that organizes information that represents the physical and logical parts and
392 sub-parts of a piece of equipment.

393 ***XML Document***

394 structured text file encoded using Extensible Markup Language (XML).

395 ***XML Schema***

396 *schema* defining a specific document encoded in XML.

397 **2.6 MTConnect Terms**

398 ***Asset***

399 asset that is used by the manufacturing process to perform tasks.

400 Note 1 to entry: An *Asset* relies upon an *Device* to provide observations
401 and information about itself and the *Device* revises the information to
402 reflect changes to the *Asset* during their interaction. Examples of *Assets*
403 are cutting tools, Part Information, Manufacturing Processes, Fixtures,
404 and Files.

405 Note 2 to entry: A singular `assetId` uniquely identifies an *Asset* through-
406 out its lifecycle and is used to track and relate the *Asset* to other *Devices*
407 and entities.

408 Note 3 to entry: *Assets* are temporally associated with a device and can
409 be removed from the device without damage or alteration to its primary
410 functions.

411 ***Component***

412 engineered system part of a *Device* composed of zero or more *Components*

413 ***Composition***

414 *Component* belonging to a *Component* and not composed of any *Components*.

415 ***Configuration***

416 configuration for a *Component*

417 ***DataItem***

418 observable observed by a *Component* that may make *Observations*

419 ***Device***

420 *Component* not belonging to any *Component* that may have assets

421 ***MTConnect Agent***

422 *agent* for the *MTConnect Information Model*.

423 ***MTConnect Document***

424 *document* that represents a Part(s) of the MTConnect Standard.

425 ***MTConnect Event***

426 observation of either a state or discrete value of the *Component*.

427 ***MTConnect Interface***

428 *interaction model* for interoperability between pieces of equipment.

429 ***Observation***

430 observation that provides telemetry data for a *DataItem*.

431 **2.7 Acronyms**

432 ***2D***

433 two-dimensional

434 ***3D***

435 three-dimensional

436 ***AI***

437 artificial intelligence

438 ***ALM***

439 application lifecycle management

440 ***AMT***

441 The Association for Manufacturing Technology

442 ***ANSI***

443 American National Standards Institute

444	<i>AP</i>	
445		Application Protocol
446	<i>API</i>	
447		application programming interface
448	<i>ASME</i>	
449		American Society of Mechanical Engineers
450	<i>ASTM</i>	
451		American Society for Testing and Materials
452	<i>AWS</i>	
453		American Welding Society
454	<i>BDD</i>	
455		block definition diagram
456	<i>BOM</i>	
457		bill of materials
458	<i>BST</i>	
459		Board on Standardization and Testing
460	<i>C&R</i>	
461		cause and remedy
462	<i>CA</i>	
463		certificate authority
464	<i>CAD</i>	
465		computer-aided design
466	<i>CAE</i>	
467		computer-aided engineering
468	<i>CAI</i>	
469		computer-aided inspection
470	<i>CAM</i>	
471		computer-aided manufacturing

472	CAx
473	computer-aided technologies
474	CDATA
475	Character Data
476	CFD
477	computational fluid dynamics
478	CM
479	configuration management
480	CMS
481	coordinate-measurement system
482	CNC
483	Computer Numerical Controller
484	CNRI
485	Corporation for National Research Initiatives
486	CPM
487	Core Product Model
488	CPM2
489	Revised Core Product Model
490	CPSC
491	Consumer Product Safety Commission
492	cUAV
493	configurable unmanned aerial vehicle
494	DARPA
495	Defense Advanced Research Projects Agency
496	DER
497	designated-engineering representative
498	DFM
499	design for manufacturing

500	<i>DLA</i>	
501		Defense Logistics Agency
502	<i>DMC</i>	
503		digital manufacturing certificate
504	<i>DMSC</i>	
505		Dimensional Metrology Standards Consortium
506	<i>DNS</i>	
507		Domain Name System
508	<i>DoD</i>	
509		U.S. Department of Defense
510	<i>DOI</i>	
511		Distributed Object Identifier
512	<i>DRM</i>	
513		digital rights management
514	<i>ECR</i>	
515		engineering change request
516	<i>ERP</i>	
517		enterprise resource planning
518	<i>FAA</i>	
519		Federal Aviation Administration
520	<i>FAIR</i>	
521		first article inspection reporting
522	<i>FDA</i>	
523		Food and Drug Administration
524	<i>FEA</i>	
525		finite-element analysis
526	<i>GD&T</i>	
527		geometric dimensions and tolerances

528	<i>GID</i>	
529		global identifier
530	<i>HMI</i>	
531		Human Machine Interface
532	<i>HTML</i>	
533		Hypertext Markup Language
534	<i>HTTP</i>	
535		Hypertext Transfer Protocol
536	<i>HTTPS</i>	
537		Hypertext Transfer Protocol over Secure Sockets Layer
538	<i>I/O</i>	
539		in-out
540	<i>ID</i>	
541		identifier
542	<i>IEEE</i>	
543		Institute of Electrical and Electronics Engineers
544	<i>IIoT</i>	
545		industrial internet of things
546	<i>INCOSE</i>	
547		International Council on Systems Engineering
548	<i>IP</i>	
549		intellectual property
550	<i>ISO</i>	
551		International Standards Organization
552	<i>ISS</i>	
553		International Space Station
554	<i>ISV</i>	
555		Independent Software Vendor

556	<i>IT</i>	
557		information technology
558	<i>ITU-T</i>	
559		Telecommunication Standardization Sector of the International Telecommunication
560		Union
561	<i>JSON</i>	
562		JavaScript Object Notation
563	<i>JT</i>	
564		Jupiter Tessellation
565	<i>LHS</i>	
566		Lifecycle Handler System
567	<i>LIFT</i>	
568		Lifecycle Information Framework and Technology
569	<i>LOI</i>	
570		Lifecycle Object Identifier
571	<i>MAC</i>	
572		media access control
573	<i>MADE</i>	
574		Manufacturing Automation and Design Engineering
575	<i>MBD</i>	
576		model-based definition
577	<i>MBE</i>	
578		Model-Based Enterprise
579	<i>MBI</i>	
580		model-based inspection
581	<i>MBM</i>	
582		model-based manufacturing

583	<i>MBSD</i>
584	model-based standards development
585	<i>MBSE</i>
586	model-based systems engineering
587	<i>MEDALS</i>
588	Military Engineering Data Asset Locator System
589	<i>MES</i>
590	manufacturing execution system
591	<i>MOI</i>
592	manufacturing object identifier
593	<i>MOM</i>
594	Message Orienged Middleware
595	<i>MQTT</i>
596	Message Queuing Telemetry Transport
597	<i>MTC</i>
598	Manufacturing Technology Centre
599	<i>NASA</i>
600	National Aeronautics and Space Administration
601	<i>NC</i>
602	numerical control
603	<i>NIST</i>
604	National Institute of Standards and Technology
605	<i>NMTOKEN</i>
606	Name Token
607	<i>NNMI</i>
608	National Network of Manufacturing Innovation
609	<i>NSF</i>
610	National Science Foundation

611	<i>NTSC</i>
612	National Transportation Safety Board
613	<i>OASIS</i>
614	Organization for the Advancement of Structured Information Standards
615	<i>ODI</i>
616	Open Data Institute
617	<i>OEM</i>
618	original equipment manufacturer
619	<i>OOI</i>
620	Ocean Observatories Initiative
621	<i>OPC</i>
622	OLE for Process Control
623	<i>OSLC</i>
624	Open Services for Lifecycle Collaboration
625	<i>OSTP</i>
626	Office of Science and Technology Policy
627	<i>OT</i>
628	operational technology
629	<i>OWL</i>
630	Ontology Web Language
631	<i>PDF</i>
632	Portable Document Format
633	<i>PDM</i>
634	product-data management
635	<i>PDQ</i>
636	product-data quality
637	<i>PHM</i>
638	prognosis and health monitoring

639	<i>PI</i>	
640		principal investigator
641	<i>PLC</i>	
642		Programmable Logic Controller
643	<i>PLCS</i>	
644		Product Life Cycle Support
645	<i>PLM</i>	
646		product lifecycle management
647	<i>PLOT</i>	
648		product lifecycle of trust
649	<i>PMI</i>	
650		product and manufacturing information
651	<i>PMS</i>	
652		Production Management System
653	<i>PRC</i>	
654		Product Representation Compact
655	<i>PSI</i>	
656		Physical Science Informatics
657	<i>PTAB</i>	
658		Primary Trustworthy Digital Repository Authorization Body Ltd.
659	<i>QIF</i>	
660		Quality Information Framework
661	<i>QMS</i>	
662		quality management system
663	<i>QName</i>	
664		Qualified Name
665	<i>RDF</i>	
666		Resource Description Framework

667	<i>REST</i>
668	Representational State Transfer
669	<i>RII</i>
670	receiving and incoming inspection
671	<i>S/MIME</i>
672	Secure/Multipurpose Internet Mail Extensions
673	<i>SaaS</i>
674	software-as-a-service
675	<i>SAML</i>
676	Security Assertion Markup Language
677	<i>SC</i>
678	Standards Committee
679	<i>SCADA</i>
680	Supervisory Control And Data Acquisition
681	<i>SDO</i>
682	Standards Development Organization
683	<i>SFTP</i>
684	Secure File Transfer Protocol
685	<i>SKOS</i>
686	Simple Knowledge Organization System
687	<i>SLH</i>
688	system lifecycle handler
689	<i>SLR</i>
690	systematic literature review
691	<i>SME</i>
692	small-to-medium enterprise
693	<i>SMOPAC</i>
694	Smart Manufacturing Operations Planning and Control

695	<i>SMS Test Bed</i>
696	Smart Manufacturing Systems Test Bed
697	<i>SOA</i>
698	service-oriented architecture
699	<i>SPMM</i>
700	semantic-based product metamodel
701	<i>SSL</i>
702	Secure Sockets Layer
703	<i>STEP</i>
704	Standard for the Exchange of Product Model Data
705	<i>STEP AP242</i>
706	Standard for the Exchange of Product Model Data Application Protocol 242
707	<i>STL</i>
708	Stereolithography
709	<i>SysML</i>
710	Systems Modeling Language
711	<i>TCP/IP</i>
712	Transmission Control Protocol/Internet Protocol
713	<i>TDP</i>
714	technical data package
715	<i>TLS</i>
716	Transport Layer Security
717	<i>TSM</i>
718	Total System Model
719	<i>UA</i>
720	Unified Architecture
721	<i>UAL</i>
722	Unified Architecture Language

723	<i>UML</i>	
724		Unified Modeling Language
725	<i>URI</i>	
726		Uniform Resource Identifier
727	<i>URL</i>	
728		Uniform Resource Locator
729	<i>URN</i>	
730		Uniform Resource Name
731	<i>UTC</i>	
732		Coordinated Universal Time
733	<i>UUID</i>	
734		Universally Unique Identifier
735	<i>V&V</i>	
736		verification and validation
737	<i>W3C</i>	
738		World Wide Web Consortium
739	<i>WSN</i>	
740		Wirth Syntax Notation
741	<i>WWW</i>	
742		World Wide Web
743	<i>X.509-PKI</i>	
744		Public Key Infrastructure
745	<i>X.509-PMI</i>	
746		Privilege Management Infrastructure
747	<i>XML</i>	
748		Extensible Markup Language
749	<i>XPath</i>	
750		XML Path Language
751	<i>XSD</i>	
752		XML Schema Definitions

753 2.8 MTConnect References

- 754 [MTConnect Part 1.0] *MTConnect Standard Part 1.0 - Fundamentals*. Version 2.0.
- 755 [MTConnect Part 2.0] *MTConnect Standard: Part 2.0 - Device Information Model*. Ver-
756 sion 2.0.
- 757 [MTConnect Part 3.0] *MTConnect Standard: Part 3.0 - Observation Information Model*.
758 Version 2.0.
- 759 [MTConnect Part 4.0] *MTConnect Standard: Part 4.0 - Asset Information Model*. Ver-
760 sion 2.0.

761

762 3 Asset Information Model

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

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

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

782 The MTConnect Standard has two data item types to support change notification when an
 783 *Asset* is added, updated or removed. `AssetChanged` states the `assetId` of the *Asset*
 784 that has been added or updated. `AssetRemoved` states the `assetId` of the *Asset* that
 785 has been removed. See *MTConnect Standard: Part 3.0 - Observation Information Model*
 786 for more details.

787 3.1 Asset

788 abstract *Asset*.

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

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

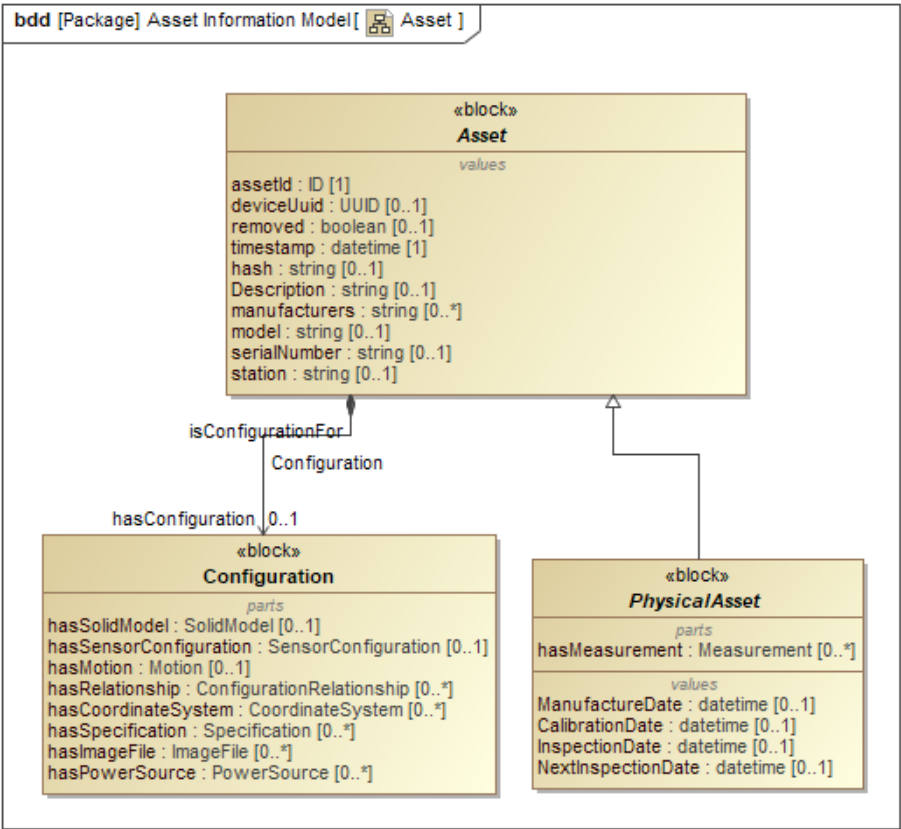


Figure 1: Asset

793 3.1.1 Value Properties of Asset

794 Table 1 lists the Value Properties of Asset.

Value Property name	Value Property type	Multiplicity
assetId	ID	1
deviceUuid	UUID	0..1
removed	boolean	0..1
timestamp	datetime	1
hash	string	0..1

Table 1: Value Properties of Asset

795 Descriptions for Value Properties of Asset:

- 796 • assetId
797 unique identifier for an Asset.
- 798 • deviceUuid
799 associated piece of equipment's Universally Unique Identifier (UUID) that supplied
800 the Asset's data.
801 It references to uuid defined in *MTConnect Standard: Part 2.0 - Device Informa-*
802 *tion Model*.
- 803 • removed
804 indicator that the Asset has been removed from the piece of equipment.
- 805 • timestamp
806 time the Asset data was last modified.
- 807 • hash
808 condensed message digest from a secure one-way hash function. *Ref FIPS PUB*
809 *180-4*

810 3.1.2 Part Properties of Asset

811 Table 2 lists the Part Properties of Asset.

Part Property name	Multiplicity
Configuration	0..1

Table 2: Part Properties of Asset

812 Descriptions for Part Properties of Asset:

- 813
- Configuration
- 814
- technical information about an entity describing its physical layout, functional char-
- 815
- acteristics, and relationships with other entities.
- 816
- See Configuration in *MTConnect Standard: Part 2.0 - Device Information*
- 817
- Model*.

818

3.2 PhysicalAsset

819

abstract physical Asset.

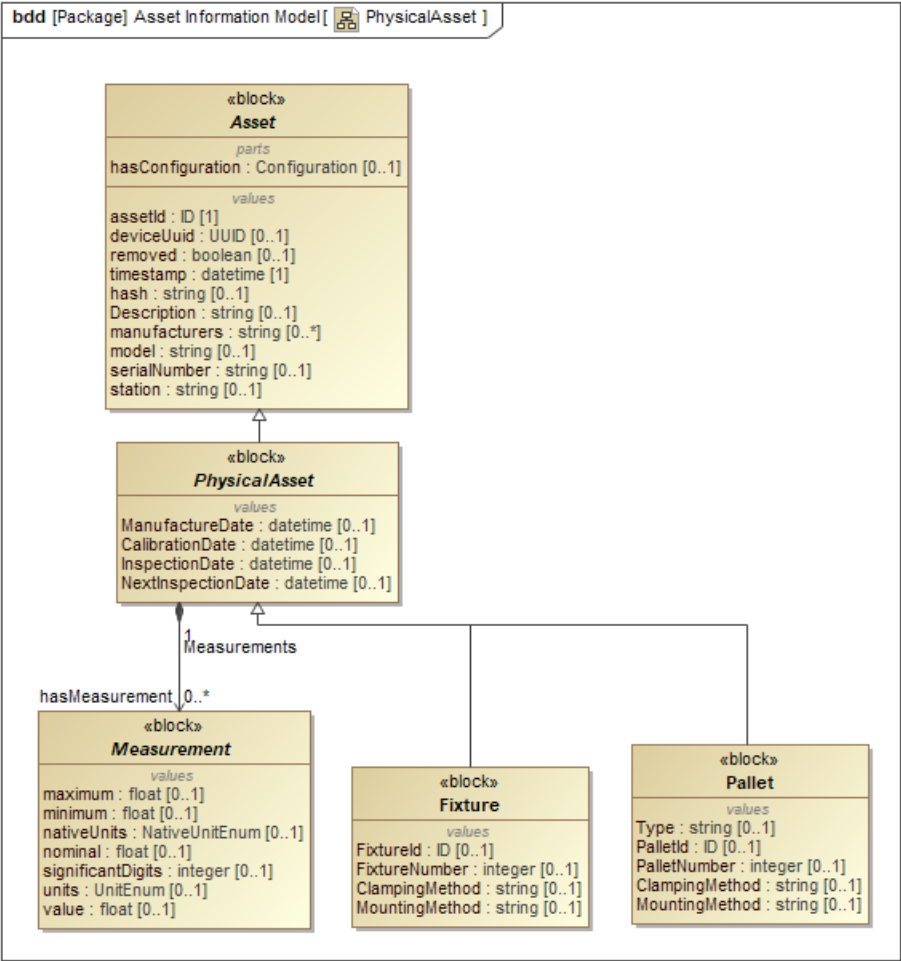


Figure 2: Asset

820 3.2.1 Part Properties of PhysicalAsset

821 *Table 3* lists the Part Properties of `PhysicalAsset`.

Part Property name	Multiplicity
Measurement (organized by <code>Measurements</code>)	0..*

Table 3: Part Properties of `PhysicalAsset`

822 Descriptions for Part Properties of `PhysicalAsset`:

- 823 • Measurement
- 824 constrained scalar value associated with an `Asset`.

825 4 Cutting Tool Asset Information Model

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

834 MTConnect Standard will adopt the ISO 13399 structure when formulating the vocabulary
 835 for Cutting Tool geometries and structure to be represented in the `CuttingToolArchetype`.
 836 The nominal values provided in the `CuttingToolLifeCycle` section are only con-
 837 cerned with two aspects of the Cutting Tool; the Cutting Tool and the cutting item. The
 838 tool item, Adaptive Item, and Assembly Item will only be covered in the `Cutting-`
 839 `ToolDefinition` section of this document since this section contains the full ISO
 840 13399 information about a Cutting Tool.



Figure 3: Cutting Tool Parts

841 The Figure 3 illustrates the parts of a Cutting Tool. The Cutting Tool is the aggregate of all
 842 the components and the cutting item is the part of the tool that removes the material from
 843 the workpiece. These are the primary focus of the MTConnect Standard.

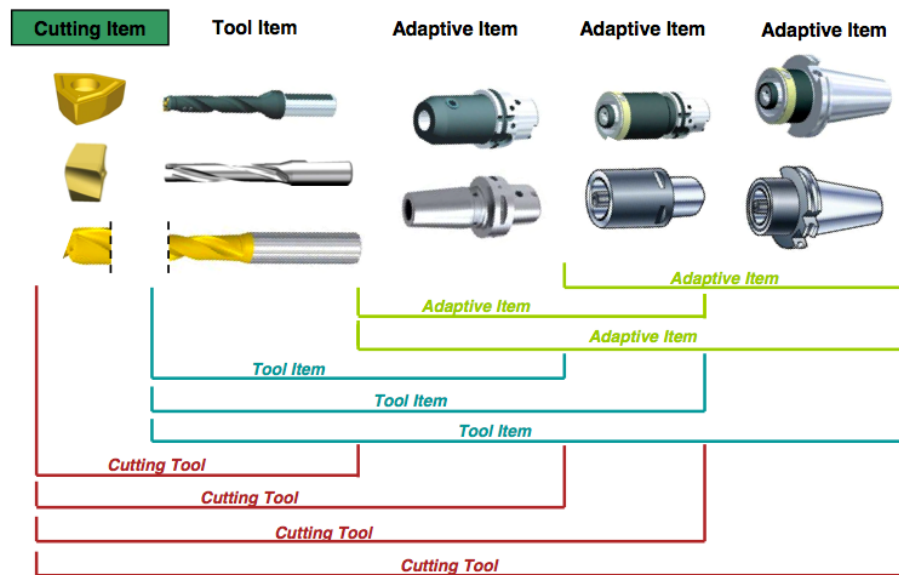


Figure 4: Cutting Tool Composition

Figure 4 provides another view of the composition of a Cutting Tool. The Adaptive Items and tool items will be used for measurements, but will not be modeled as separate entities. When we are referencing the Cutting Tool we are referring to the entirety of the assembly and when we provide data regarding the cutting item we are referencing each individual item as illustrated on the left of the previous diagram.

Figure 5 and Figure 6 further illustrates the components of the Cutting Tool. As we compose the tool item, cutting item, Adaptive Item, we get a Cutting Tool. The tool item, Adaptive Item, and Assembly Item will only be in the `CuttingToolDefinition` section that will contain the full ISO 13399 information. These figures also use the ISO 13399 codes for each of the measurements. These codes will be translated into the MTConnect Standard vocabulary as illustrated below. The measurements will have a maximum, minimum, and nominal value representing the tolerance of allowable values for this dimension.

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

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

Reference ISO13399

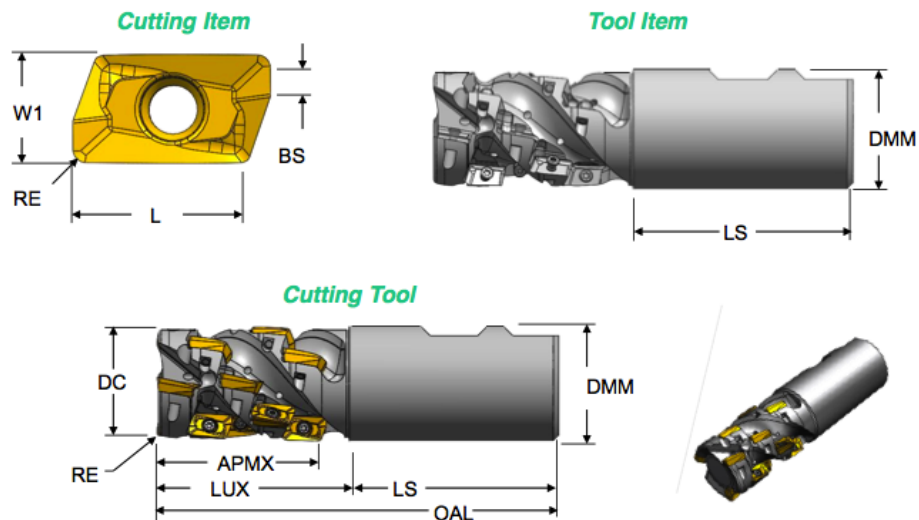


Figure 5: Cutting Tool, Tool Item, and Cutting Item

864 4.1 Cutting Tool

865 This section provides semantic information for the `CuttingTool` and `CuttingToolArchetype`
866 models.

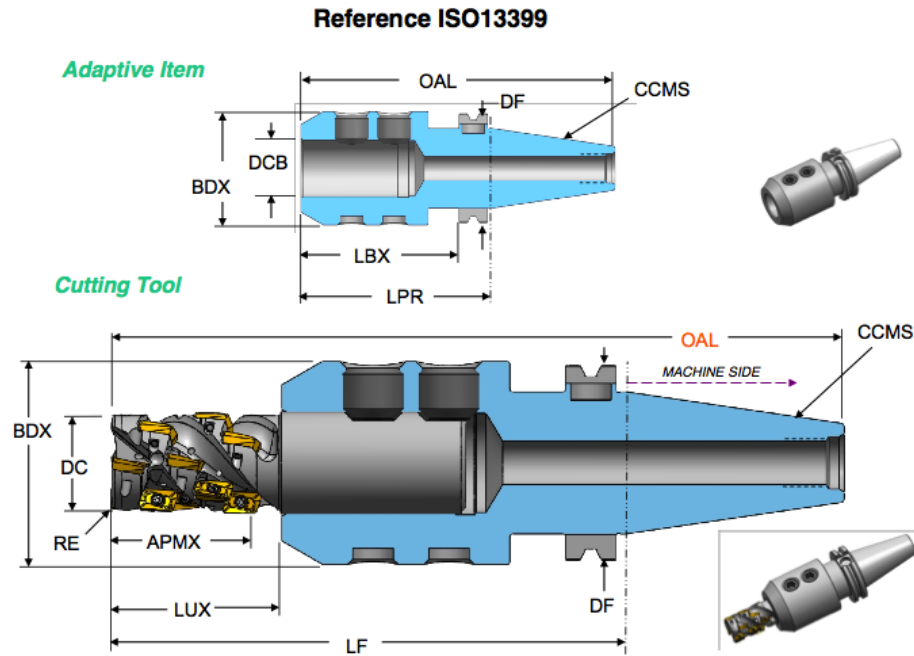
867 Note: See *Section B.2 - CuttingTool Schema Diagrams* for XML schema.

868 4.1.1 CuttingTool

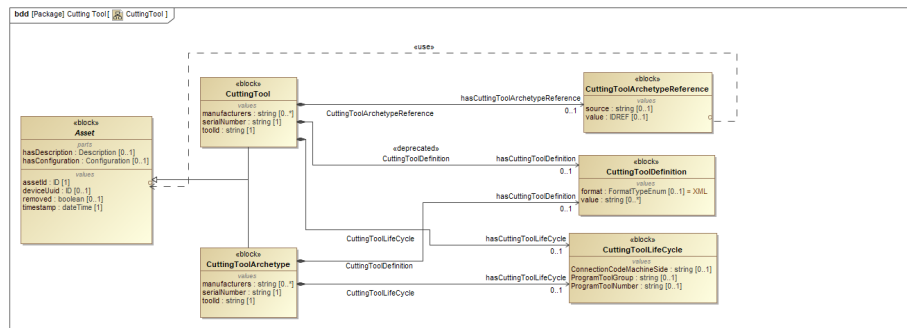
869 Asset that physically removes the material from the workpiece by shear deformation.

870 4.1.1.1 Value Properties of CuttingTool

871 Table 4 lists the Value Properties of `CuttingTool`.

**Figure 6:** Cutting Tool, Tool Item, and Cutting Item 2

Value Property name	Value Property type	Multiplicity
serialNumber	string	1
toolId	string	1

Table 4: Value Properties of CuttingTool**Figure 7:** CuttingTool

872 Descriptions for Value Properties of `CuttingTool`:

- 873 • `toolId`
- 874 identifier for a class of cutting tools.

875 4.1.1.2 Part Properties of `CuttingTool`

876 *Table 5* lists the Part Properties of `CuttingTool`.

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

Table 5: Part Properties of `CuttingTool`

877 Descriptions for Part Properties of `CuttingTool`:

- 878 • `CuttingToolLifeCycle`
- 879 data regarding the application or use of the tool.
- 880 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
- 881 and statistical process control applications. Life cycle data will not remain static,
- 882 but will change periodically when a tool is used or measured.
- 883 See *Section 4.2.1 - CuttingToolLifeCycle*.
- 884 • `CuttingToolArchetypeReference`
- 885 reference information about the `assetId` and/or the URL of the data source of
- 886 `CuttingToolArchetype`.
- 887 • `CuttingToolDefinition`
- 888 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO*
- 889 *13399*.
- 890 **DEPRECATED** in *Version 1.3.0* for `CuttingTool`.

891 4.1.2 `CuttingToolArchetype`

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

894 4.1.2.1 Value Properties of CuttingToolArchetype

895 *Table 6* lists the Value Properties of CuttingToolArchetype.

Value Property name	Value Property type	Multiplicity
serialNumber	string	1
toolId	string	1

Table 6: Value Properties of CuttingToolArchetype

896 Descriptions for Value Properties of CuttingToolArchetype:

- 897 • toolId
- 898 identifier for a class of cutting tools.

899 4.1.2.2 Part Properties of CuttingToolArchetype

900 *Table 7* lists the Part Properties of CuttingToolArchetype.

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

Table 7: Part Properties of CuttingToolArchetype

901 Descriptions for Part Properties of CuttingToolArchetype:

- 902 • CuttingToolDefinition
- 903 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO*
- 904 *13399.*
- 905 **DEPRECATED** in *Version 2.1.0* for CuttingToolArchetype.
- 906 • CuttingToolLifeCycle
- 907 data regarding the application or use of the tool.
- 908 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
- 909 and statistical process control applications. Life cycle data will not remain static,
- 910 but will change periodically when a tool is used or measured.
- 911 See *Section 4.2.1 - CuttingToolLifeCycle.*

912 4.1.3 CuttingToolArchetypeReference

913 reference information about the `assetId` and/or the URL of the data source of Cut-
914 `tingToolArchetype`.

915 The value of `CuttingToolArchetypeReference` **MUST** be ID. See *Section 11.1.2*
916 - *ID*.

917 4.1.3.1 Value Properties of CuttingToolArchetypeReference

918 *Table 8* lists the Value Properties of `CuttingToolArchetypeReference`.

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

Table 8: Value Properties of `CuttingToolArchetypeReference`

919 Descriptions for Value Properties of `CuttingToolArchetypeReference`:

- 920 • `source`
921 Uniform Resource Locator (URL) of the `CuttingToolArchetype` *information*
922 *model*.

923 4.1.4 CuttingToolDefinition

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

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

926 4.1.4.1 Value Properties of CuttingToolDefinition

927 *Table 9* lists the Value Properties of `CuttingToolDefinition`.

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

Table 9: Value Properties of `CuttingToolDefinition`

928 Descriptions for Value Properties of `CuttingToolDefinition`:

- 929 • `format`
- 930 identifies the expected representation of the enclosed data.
- 931 `FormatTypeEnum` Enumeration:
- 932 – `EXPRESS`
- 933 document will conform to the ISO 10303 Part 21 standard.
- 934 – `TEXT`
- 935 document will be a text representation of the tool data.
- 936 – `UNDEFINED`
- 937 document will be provided in an undefined format.
- 938 – `XML`
- 939 default value for the definition. The content will be an XML document.

940 4.2 Cutting Tool Life Cycle

941 This section provides semantic information for the `CuttingToolLifeCycle` model.

942 Note: See *Section B.3 - CuttingToolLifeCycle Schema Diagrams* for XML
 943 schema.

944 4.2.1 CuttingToolLifeCycle

945 data regarding the application or use of the tool.

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

949 4.2.1.1 Value Properties of CuttingToolLifeCycle

950 *Table 10* lists the Value Properties of `CuttingToolLifeCycle`.

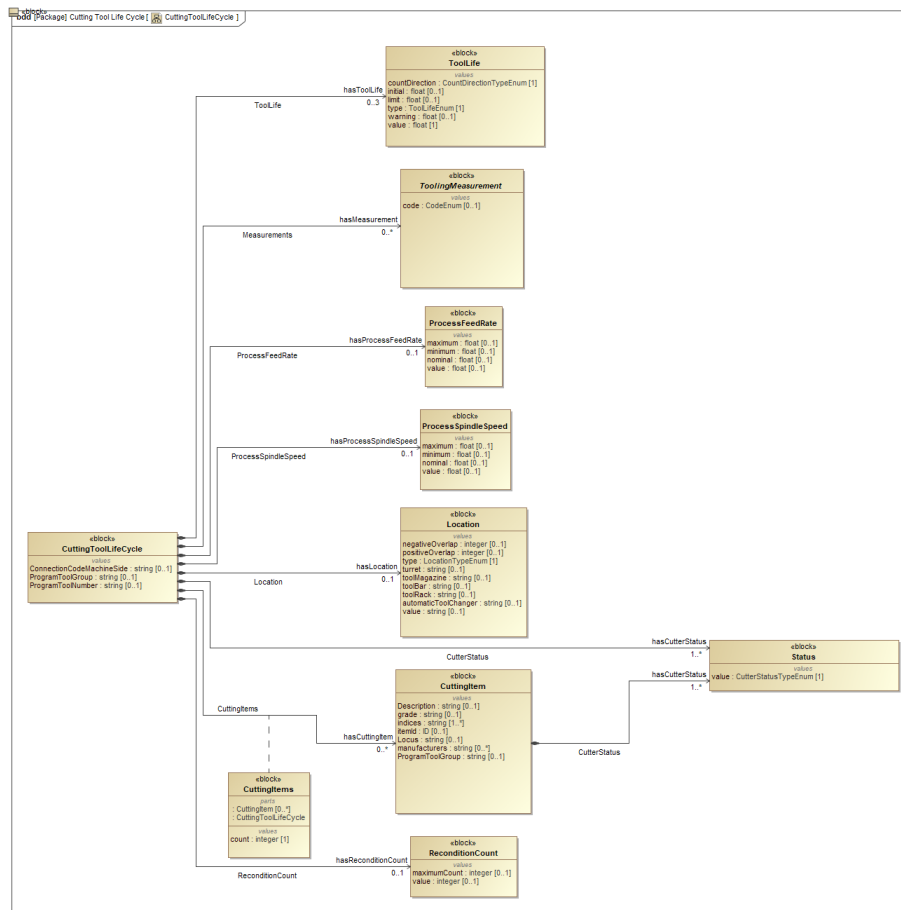


Figure 8: CuttingToolLifeCycle

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

Table 10: Value Properties of CuttingToolLifeCycle

951 Descriptions for Value Properties of CuttingToolLifeCycle:

- 952 • ConnectionCodeMachineSide
953 identifier for the capability to connect any component of the cutting tool together,
954 except Assembly Items, on the machine side. Code: CCMS
- 955 • ProgramToolGroup
956 tool group this tool is assigned in the part program.
- 957 • ProgramToolNumber
958 number of the tool as referenced in the part program.

959 4.2.1.2 Part Properties of CuttingToolLifeCycle

960 *Table 11* 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..*
ToolingMeasurement (organized by Measurements)	0..*
ReconditionCount	0..1
Location	0..1

Table 11: Part Properties of CuttingToolLifeCycle

961 Descriptions for Part Properties of CuttingToolLifeCycle:

- 962 • ProcessFeedRate
963 constrained process feed rate for the tool in mm/s.
964 The value **MAY** contain the nominal process target feed rate if available. If Pro-
965 cessFeedRate is provided, at least one value of maximum, nominal, or min-
966 imum **MUST** be specified.
967 See *Section 4.2.6 - ProcessFeedRate*.
- 968 • ToolLife
969 cutting tool life as related to the assembly.
970 See *Section 4.2.2 - ToolLife*.

- 971 • `ProcessSpindleSpeed`
 972 constrained process spindle speed for the tool in revolutions/minute.
 973 The value **MAY** contain the nominal process target spindle speed if available. If
 974 `ProcessSpindleSpeed` is provided, at least one value of maximum, nomi-
 975 nal, or minimum **MUST** be specified.
 976 See *Section 4.2.5 - ProcessSpindleSpeed*.
- 977 • `Status`
 978 status of the cutting tool.
 979 `CutterStatus` provides the status of the assembly and *organize* one or more
 980 `Status` entities. See *Section 4.2.7 - Status*.
 981 The following combinations of `Status` entities **MUST NOT** occur for a `Cut-`
 982 `terStatus`:
- 983 – `NEW` **MUST NOT** be used with `USED`, `RECONDITIONED`, or `EXPIRED`.
 - 984 – `UNKNOWN` **MUST NOT** be used with any other status.
 - 985 – `ALLOCATED` and `UNALLOCATED` **MUST NOT** be used together.
 - 986 – `AVAILABLE` and `UNAVAILABLE` **MUST NOT** be used together.
 - 987 – If the tool is `EXPIRED`, `BROKEN`, or `NOT_REGISTERED` it **MUST NOT** be
 988 `AVAILABLE`.
- 989 • `CuttingItem`
 990 part of of the tool that physically removes the material from the workpiece by shear
 991 deformation.
 992 `CuttingItems` groups one or more `CuttingItem` entities. See *Section 4.3.1 -*
 993 *CuttingItem* and *Section 4.3 - Cutting Item* for more detail.
- 994 • `ToolingMeasurement`
 995 constrained scalar value associated with a cutting tool.
 996 `Measurements` groups one or more `Measurement` subtypes. See *Section 4.4 -*
 997 *Cutting Tool Measurement Subtypes*.
- 998 • `ReconditionCount`
 999 number of times the cutter has been reconditioned.
 1000 See *Section 4.2.4 - ReconditionCount*.

- 1001 • Location
- 1002 location of the pot or spindle the cutting tool currently resides in.
- 1003 If `negativeOverlap` or `positiveOverlap` is provided, the tool reserves ad-
- 1004 ditional locations on either side, otherwise if they are not given, no additional loca-
- 1005 tions are required for this tool.
- 1006 If the pot occupies the first or last location, a rollover to the beginning or the end of
- 1007 the indexable values may occur. For example, if there are 64 pots and the tool is in
- 1008 pot 64 with a `positiveOverlap` of 1, the first pot **MAY** be occupied as well.
- 1009 See *Section 4.2.3 - Location* for more detail.

1010 4.2.2 ToolLife

- 1011 cutting tool life as related to the assembly.
- 1012 ToolLife **MUST** be defined only for the `CuttingToolLifeCycle` of `Cutting-`
- 1013 Tool and **MUST NOT** be defined for the `CuttingToolLifeCycle` of `Cutting-`
- 1014 ToolArchetype.
- 1015 The value of ToolLife **MUST** be float.

1016 4.2.2.1 Value Properties of ToolLife

- 1017 Table 12 lists the Value Properties of ToolLife.

Value Property name	Value Property type	Multiplicity
<code>countDirection</code>	<code>CountDirectionTypeEnum</code>	1
<code>initial</code>	float	0..1
<code>limit</code>	float	0..1
<code>type</code>	<code>ToolLifeEnum</code>	1
<code>warning</code>	float	0..1

Table 12: Value Properties of ToolLife

- 1018 Descriptions for Value Properties of ToolLife:

- 1019 • `countDirection`
- 1020 indicates if the tool life counts from zero to maximum or maximum to zero.
- 1021 `CountDirectionTypeEnum` Enumeration:

- 1022 – DOWN
- 1023 tool life counts down from the maximum to zero.
- 1024 – UP
- 1025 tool life counts up from zero to the maximum.
- 1026 • initial
- 1027 initial life of the tool when it is new.
- 1028 • limit
- 1029 end of life limit for the tool.
- 1030 • type
- 1031 type of tool life being accumulated.
- 1032 ToolLifeEnum Enumeration:
- 1033 – MINUTES
- 1034 tool life measured in minutes.
- 1035 All units for minimum, maximum, and nominal **MUST** be provided in min-
- 1036 utes.
- 1037 – PART_COUNT
- 1038 tool life measured in parts.
- 1039 All units for minimum, maximum, and nominal **MUST** be provided as the
- 1040 number of parts.
- 1041 – WEAR
- 1042 tool life measured in tool wear.
- 1043 Wear **MUST** be provided in millimeters as an offset to nominal. All units for
- 1044 minimum, maximum, and nominal **MUST** be given as millimeter offsets as
- 1045 well. The standard will only consider dimensional wear at this time.
- 1046 • warning
- 1047 point at which a tool life warning will be raised.

1048 4.2.3 Location

- 1049 location of the pot or spindle the cutting tool currently resides in.
- 1050 If `negativeOverlap` or `positiveOverlap` is provided, the tool reserves additional
- 1051 locations on either side, otherwise if they are not given, no additional locations are required
- 1052 for this tool.

1053 If the pot occupies the first or last location, a rollover to the beginning or the end of the
 1054 indexable values may occur. For example, if there are 64 pots and the tool is in pot 64 with
 1055 a `positiveOverlap` of 1, the first pot **MAY** be occupied as well.

1056 Location **MUST** be defined only for the `CuttingToolLifeCycle` of `Cutting-`
 1057 `Tool` and **MUST NOT** be defined for the `CuttingToolLifeCycle` of `Cutting-`
 1058 `ToolArchetype`.

1059 The value of `Location` **MUST** be string.

1060 4.2.3.1 Value Properties of Location

1061 *Table 13* lists the Value Properties of `Location`.

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

Table 13: Value Properties of Location

1062 Descriptions for Value Properties of `Location`:

- 1063 • `negativeOverlap`
 1064 number of locations at lower index values from this location.
- 1065 • `positiveOverlap`
 1066 number of locations at higher index value from this location.
- 1067 • `type`
 1068 type of location being identified.
 1069 When a `POT` or `STATION` type is used, value **MUST** be a numeric value.
- 1070 `LocationTypeEnum` Enumeration:
 1071 – `CRIB`
 1072 location with regard to a tool crib.

- 1073 – END_EFFECTOR
- 1074 location associated with an end effector.
- 1075 – EXPIRED_POT
- 1076 location for a tool that is no longer usable and is awaiting removal from a tool
- 1077 magazine or turret.
- 1078 – POT
- 1079 number of the pot in the tool handling system.
- 1080 – REMOVAL_POT
- 1081 location for a tool removed from a tool magazine or turret awaiting transfer to
- 1082 a location outside of the piece of equipment.
- 1083 – RETURN_POT
- 1084 location for a tool removed from a *spindle* or turret and awaiting return to a
- 1085 tool magazine.
- 1086 – SPINDLE
- 1087 location associated with a *spindle*.
- 1088 – STAGING_POT
- 1089 location for a tool awaiting transfer to a tool magazine or turret from outside
- 1090 of the piece of equipment.
- 1091 – STATION
- 1092 tool location in a horizontal turning machine.
- 1093 – TRANSFER_POT
- 1094 location for a tool awaiting transfer from a tool magazine to spindle or a turret.

- 1095 • turret
- 1096 turret associated with a tool.

- 1097 • toolMagazine
- 1098 tool magazine associated with a tool.

- 1099 • toolBar
- 1100 tool bar associated with a tool.

- 1101 • toolRack
- 1102 tool rack associated with a tool.

- 1103 • automaticToolChanger
- 1104 automatic tool changer associated with a tool.

1105 4.2.4 ReconditionCount

1106 number of times the cutter has been reconditioned.

1107 The value of ReconditionCount **MUST** be integer.

1108 4.2.4.1 Value Properties of ReconditionCount

1109 *Table 14* lists the Value Properties of ReconditionCount.

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

Table 14: Value Properties of ReconditionCount

1110 Descriptions for Value Properties of ReconditionCount:

1111 • maximumCount

1112 maximum number of times the tool may be reconditioned.

1113 4.2.5 ProcessSpindleSpeed

1114 constrained process spindle speed for the tool in revolutions/minute.

1115 The value **MAY** contain the nominal process target spindle speed if available. If Pro-
 1116 cessSpindleSpeed is provided, at least one value of maximum, nominal, or min-
 1117 imum **MUST** be specified.

1118 The value of ProcessSpindleSpeed **MUST** be float.

1119 4.2.5.1 Value Properties of ProcessSpindleSpeed

1120 *Table 15* 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 15: Value Properties of ProcessSpindleSpeed

1121 Descriptions for Value Properties of ProcessSpindleSpeed:

- 1122 • maximum
- 1123 upper bound for the tool's target spindle speed.
- 1124 • minimum
- 1125 lower bound for the tools spindle speed.
- 1126 • nominal
- 1127 nominal speed the tool is designed to operate at.

1128 4.2.6 ProcessFeedRate

1129 constrained process feed rate for the tool in mm/s.

1130 The value **MAY** contain the nominal process target feed rate if available. If Process-
 1131 FeedRate is provided, at least one value of maximum, nominal, or minimum **MUST**
 1132 be specified.

1133 The value of ProcessFeedRate **MUST** be float.

1134 4.2.6.1 Value Properties of ProcessFeedRate

1135 *Table 16* 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 16: Value Properties of ProcessFeedRate

1136 Descriptions for Value Properties of ProcessFeedRate:

- 1137 • maximum
- 1138 upper bound for the tool's process target feedrate.
- 1139 • minimum
- 1140 lower bound for the tool's feedrate.
- 1141 • nominal
- 1142 nominal feedrate the tool is designed to operate at.

1143 4.2.7 Status

1144 status of the cutting tool.

1145 CutterStatusTypeEnum Enumeration:

- 1146 • ALLOCATED
- 1147 tool is has been committed to a piece of equipment for use and is not available for
- 1148 use in any other piece of equipment.
- 1149 • AVAILABLE
- 1150 tool is available for use.
- 1151 If this is not present, the tool is currently not ready to be used.
- 1152 • BROKEN
- 1153 premature tool failure.
- 1154 • EXPIRED
- 1155 tool has reached the end of its useful life.
- 1156 • MEASURED
- 1157 tool has been measured.
- 1158 • NEW
- 1159 new tool that has not been used or first use.
- 1160 Marks the start of the tool history.
- 1161 • NOT_REGISTERED
- 1162 tool cannot be used until it is entered into the system.

- 1163 • RECONDITIONED
- 1164 tool has been reconditioned.
- 1165 • UNALLOCATED
- 1166 tool has not been committed to a process and can be allocated.
- 1167 • UNAVAILABLE
- 1168 tool is unavailable for use in metal removal.
- 1169 • UNKNOWN
- 1170 tool is an indeterminate state. This is the default value.
- 1171 • USED
- 1172 tool is in process and has remaining tool life.

1173 4.2.8 ToolingMeasurement

1174 constrained scalar value associated with a cutting tool.

1175 A `Measurement` is specific to the tool management policy at a particular shop. The tool
 1176 zero reference point or gauge line will be different depending on the particular implemen-
 1177 tation and will be assumed to be consistent within the shop. MTConnect Standard does
 1178 not standardize the manufacturing process or the definition of the zero point.

1179 4.2.8.1 Value Properties of ToolingMeasurement

1180 *Table 17* lists the Value Properties of `ToolingMeasurement`.

Value Property name	Value Property type	Multiplicity
code	CodeEnum	0..1

Table 17: Value Properties of `ToolingMeasurement`

1181 Descriptions for Value Properties of `ToolingMeasurement`:

- 1182 • code
- 1183 shop specific code for the measurement.
- 1184 ISO 13399 codes **MAY** be used for these codes as well.

1185 See *Section 4.4 - Cutting Tool Measurement Subtypes* and *Section 4.5 - Cutting*
 1186 *Item Measurement Subtypes* for details on Measurement types and their respec-
 1187 tive code values.

1188 4.3 Cutting Item

1189 A CuttingItem is the portion of the tool that physically removes the material from the
 1190 workpiece by shear deformation. The cutting item can be either a single piece of mate-
 1191 rial attached to the CuttingTool or it can be one or more separate pieces of material
 1192 attached to the CuttingTool using a permanent or removable attachment. A Cuttin-
 1193 gItem can be comprised of one or more cutting edges. Cutting items include: replaceable
 1194 inserts, brazed tips and the cutting portions of solid CuttingTools.

1195 MTConnect Standard considers CuttingItems as part of the CuttingTool. A Cut-
 1196 tingItems **MUST NOT** exist in MTConnect unless it is attached to a CuttingTool.
 1197 Some of the measurements, such as FunctionalLength, **MUST** be made with refer-
 1198 ence to the entire CuttingTool to be meaningful.

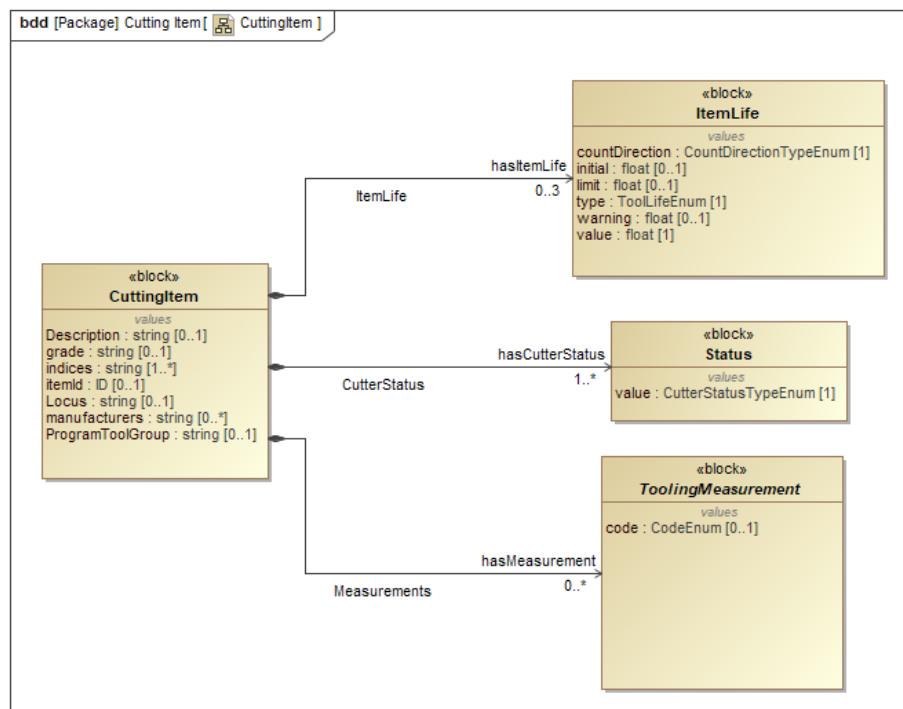


Figure 9: CuttingItem

1199 Note: See *Section B.4 - CuttingItem Schema Diagrams* for XML schema.

1200 4.3.1 CuttingItem

1201 part of the tool that physically removes the material from the workpiece by shear defor-
1202 mation.

1203 4.3.1.1 Value Properties of CuttingItem

1204 *Table 18* 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 18: Value Properties of CuttingItem

1205 Descriptions for Value Properties of CuttingItem:

- 1206 • Description
- 1207 free-form description of the cutting item.
- 1208 • grade
- 1209 material composition for this cutting item.
- 1210 • indices
- 1211 number or numbers representing the individual cutting item or items on the tool.
- 1212 Indices **SHOULD** start numbering with the inserts or CuttingItem furthest from
- 1213 the gauge line and increasing in value as the items get closer to the gauge line. Items
- 1214 at the same distance **MAY** be arbitrarily numbered.

1215 Note: In XML, the representation **MUST** be a single number (“1”) or a
1216 comma separated set of individual elements (“1,2,3,4”), or as a inclusive
1217 range of values as in (“1-10”) or any combination of ranges and numbers
1218 as in “1-4,6-10,22”. There **MUST NOT** be spaces or non-integer values
1219 in the text representation.

- 1220 • `itemId`
 1221 manufacturer identifier of this cutting item.
- 1222 • `Locus`
 1223 free form description of the location on the cutting tool.
 1224 For clarity, the words `FLUTE`, `INSERT`, and `CARTRIDGE` **SHOULD** be used to
 1225 assist in noting the location of a `CuttingItem`. `Locus` **MAY** be any free form
 1226 string, but **SHOULD** adhere to the following rules:
- 1227 – The location numbering **SHOULD** start at the furthest `CuttingItem` and
 1228 work it's way back to the `CuttingItem` closest to the gauge line.
 - 1229 – Flutes **SHOULD** be identified as such using the word `FLUTE`:. For example:
 1230 `FLUTE: 1`, `INSERT: 2` - would indicate the first flute and the second furthest
 1231 insert from the end of the tool on that flute.
 - 1232 – Other designations such as `CARTRIDGE` **MAY** be included, but should be
 1233 identified using upper case and followed by a colon (:).
- 1234 • `manufacturers`
 1235 manufacturers of the cutting item.
 1236 This will reference the tool item and adaptive items specifically. The cutting items
 1237 manufacturers' will be a property of `CuttingItem`.
- 1238 Note: In XML, the representation **MUST** be a comma(,) delimited list of
 1239 manufacturer names. See *Section B.4 - CuttingItem Schema Diagrams*.
- 1240 • `ProgramToolGroup`
 1241 tool group this item is assigned in the part program.

1242 **4.3.1.2 Part Properties of CuttingItem**

1243 *Table 19* lists the Part Properties of `CuttingItem`.

Part Property name	Multiplicity
Status (organized by <code>CutterStatus</code>)	1..*
<code>ItemLife</code>	0..3
ToolingMeasurement (organized by <code>Measurements</code>)	0..*

Table 19: Part Properties of `CuttingItem`

1244 Descriptions for Part Properties of `CuttingItem`:

- 1245 • Status
- 1246 status of the cutting tool.
- 1247 CutterStatus provides the status of the assembly and *organize* one or more
- 1248 Status entities. See *Section 4.2.7 - Status*.
- 1249 The following combinations of Status entities **MUST NOT** occur for a Cut-
- 1250 terStatus:
- 1251 – NEW **MUST NOT** be used with USED, RECONDITIONED, or EXPIRED.
 - 1252 – UNKNOWN **MUST NOT** be used with any other status.
 - 1253 – ALLOCATED and UNALLOCATED **MUST NOT** be used together.
 - 1254 – AVAILABLE and UNAVAILABLE **MUST NOT** be used together.
 - 1255 – If the tool is EXPIRED, BROKEN, or NOT_REGISTERED it **MUST NOT** be
 - 1256 AVAILABLE.
- 1257 CutterStatus **MUST** be defined only for the CuttingToolLifeCycle of
- 1258 CuttingTool and **MUST NOT** be defined for the CuttingToolLifeCycle
- 1259 of CuttingToolArchetype.
- 1260 • ItemLife
- 1261 life of a CuttingItem.
- 1262 See *Section 4.3.3 - ItemLife*.
- 1263 • ToolingMeasurement
- 1264 constrained scalar value associated with a cutting tool.
- 1265 Measurements groups one or more Measurement subtypes. See *Section 4.5 -*
- 1266 *Cutting Item Measurement Subtypes*.

1267 4.3.2 CuttingItems

1268 CuttingItems groups one or more CuttingItem entities. See *Section 4.3.1 - Cut-*

1269 *tingItem* and *Section 4.3 - Cutting Item* for more detail.

1270 4.3.2.1 Value Properties of CuttingItems

1271 *Table 20* lists the Value Properties of CuttingItems.

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 20: Value Properties of CuttingItems

1272 Descriptions for Value Properties of CuttingItems:

- 1273 • count

1274 number of CuttingItem organized by CuttingItems.

1275 4.3.3 ItemLife

1276 life of a CuttingItem.

1277 The value of ItemLife **MUST** be float.

1278 4.3.3.1 Value Properties of ItemLife

1279 *Table 21* 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 21: Value Properties of ItemLife

1280 Descriptions for Value Properties of ItemLife:

- 1281 • countDirection

1282 indicates if the item life counts from zero to maximum or maximum to zero.

1283 The value of countDirection **MUST** be one of the CountDirectionType-
1284 Enum enumeration.

- 1285 • initial

1286 initial life of the item when it is new.

- 1287 • limit
- 1288 end of life limit for this item.
- 1289 • type
- 1290 type of item life being accumulated.
- 1291 The value of type **MUST** be one of the ToolLifeEnum enumeration.
- 1292 • warning
- 1293 point at which a item life warning will be raised.

1294 4.4 Cutting Tool Measurement Subtypes

1295 This section lists the Measurement subtypes for CuttingTool.

1296 These Measurement subtypes for CuttingTool are specific to the entire assembly
 1297 and **MUST NOT** be used for the Measurement pertaining to a CuttingItem. Fig-
 1298 ure 10 and Figure 11 will be used to reference the assembly specific Measurement
 1299 subtypes.

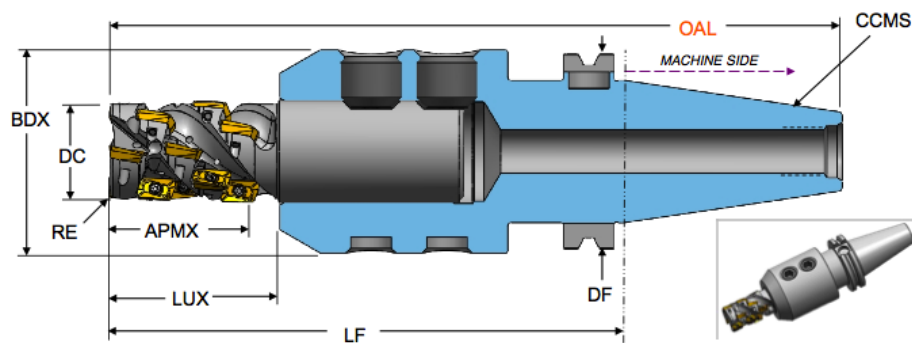


Figure 10: Cutting Tool Measurement 1

1300 4.4.1 BodyDiameterMax

- 1301 largest diameter of the body of a tool item.
- 1302 The code of BodyDiameterMax **MUST** be BDX.
- 1303 The units of BodyDiameterMax **MUST** be MILLIMETER.

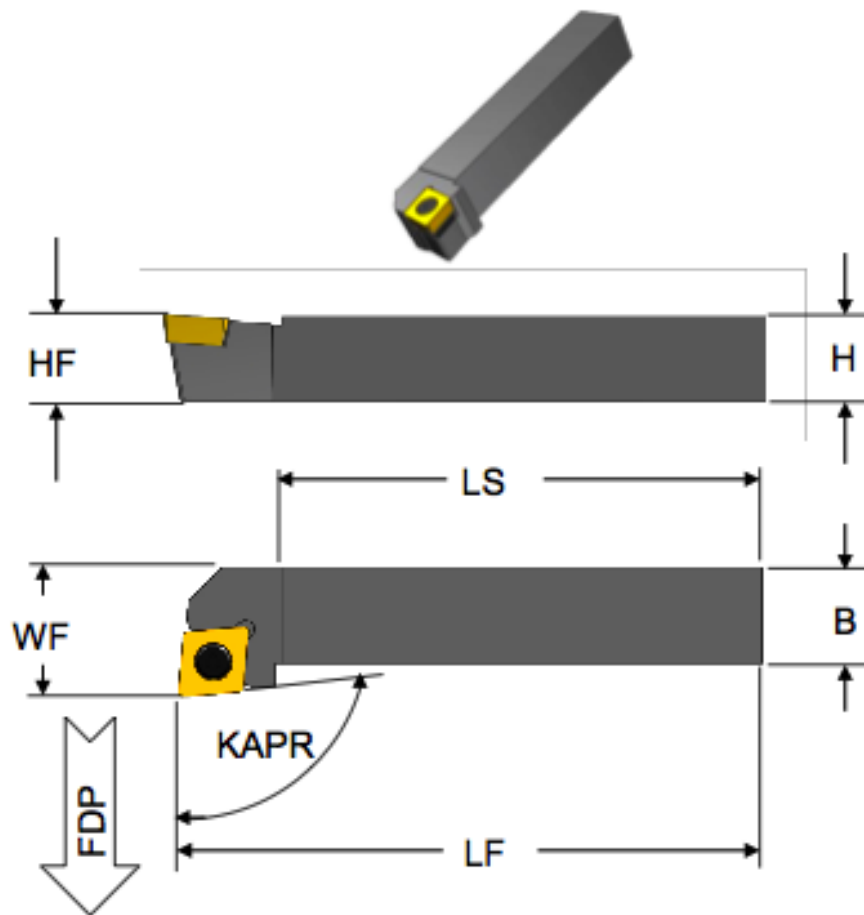


Figure 11: Cutting Tool Measurement 2

1304 4.4.2 BodyLengthMax

1305 distance measured along the X axis from that point of the item closest to the workpiece,
 1306 including the cutting item for a tool item but excluding a protruding locking mechanism
 1307 for an adaptive item, to either the front of the flange on a flanged body or the beginning of
 1308 the connection interface feature on the machine side for cylindrical or prismatic shanks.

1309 The code of BodyLengthMax **MUST** be LBX.

1310 The units of BodyLengthMax **MUST** be MILLIMETER.

1311 **4.4.3 DepthOfCutMax**

1312 maximum engagement of the cutting edge or edges with the workpiece measured perpen-
1313 dicular to the feed motion.

1314 The code of DepthOfCutMax **MUST** be APMX.

1315 The units of DepthOfCutMax **MUST** be MILLIMETER.

1316 **4.4.4 CuttingDiameterMax**

1317 maximum diameter of a circle on which the defined point Pk of each of the master inserts
1318 is located on a tool item.

1319 The normal of the machined peripheral surface points towards the axis of the cutting tool.

1320 The code of CuttingDiameterMax **MUST** be DC.

1321 The units of CuttingDiameterMax **MUST** be MILLIMETER.

1322 **4.4.5 FlangeDiameterMax**

1323 dimension between two parallel tangents on the outside edge of a flange.

1324 The code of FlangeDiameterMax **MUST** be DF.

1325 The units of FlangeDiameterMax **MUST** be MILLIMETER.

1326 **4.4.6 OverallToolLength**

1327 largest length dimension of the cutting tool including the master insert where applicable.

1328 The code of OverallToolLength **MUST** be OAL.

1329 The units of OverallToolLength **MUST** be MILLIMETER.

1330 **4.4.7 ShankDiameter**

1331 dimension of the diameter of a cylindrical portion of a tool item or an adaptive item that
1332 can participate in a connection.

1333 The code of `ShankDiameter` **MUST** be DMM.

1334 The units of `ShankDiameter` **MUST** be MILLIMETER.

1335 **4.4.8 ShankHeight**

1336 dimension of the height of the shank.

1337 The code of `ShankHeight` **MUST** be H.

1338 The units of `ShankHeight` **MUST** be MILLIMETER.

1339 **4.4.9 ShankLength**

1340 dimension of the length of the shank.

1341 The code of `ShankLength` **MUST** be LS.

1342 The units of `ShankLength` **MUST** be MILLIMETER.

1343 **4.4.10 UsableLengthMax**

1344 maximum length of a cutting tool that can be used in a particular cutting operation includ-
1345 ing the non-cutting portions of the tool.

1346 The code of `UsableLengthMax` **MUST** be LUX.

1347 The units of `UsableLengthMax` **MUST** be MILLIMETER.

1348 **4.4.11 ProtrudingLength**

1349 dimension from the yz-plane to the furthest point of the tool item or adaptive item mea-
1350 sured in the -X direction.

1351 The code of `ProtrudingLength` **MUST** be `LPR`.

1352 The units of `ProtrudingLength` **MUST** be `MILLIMETER`.

1353 **4.4.12 FunctionalLength**

1354 distance from the gauge plane or from the end of the shank to the furthest point on the
1355 tool, if a gauge plane does not exist, to the cutting reference point determined by the main
1356 function of the tool.

1357 The `CuttingTool` functional length will be the length of the entire tool, not a single
1358 cutting item. Each `CuttingItem` can have an independent `FunctionalLength` rep-
1359 resented in its measurements.

1360 The code of `FunctionalLength` **MUST** be `LF`.

1361 The units of `FunctionalLength` **MUST** be `MILLIMETER`.

1362 **4.4.13 Weight**

1363 total weight of the cutting tool in grams.

1364 The force exerted by the mass of the cutting tool.

1365 The code of `Weight` **MUST** be `WT`.

1366 The units of `Weight` **MUST** be `GRAM`.

1367 **4.5 Cutting Item Measurement Subtypes**

1368 This section lists the `Measurement` subtypes for `CuttingItem`.

1369 These `Measurement` subtypes for `CuttingItem` are specific to an individual Cut-

1370 tingItem and **MUST NOT** be used for the Measurement pertaining to an assembly.
 1371 Figures below will be used to for reference for the CuttingItem specific Measure-
 1372 ment types.

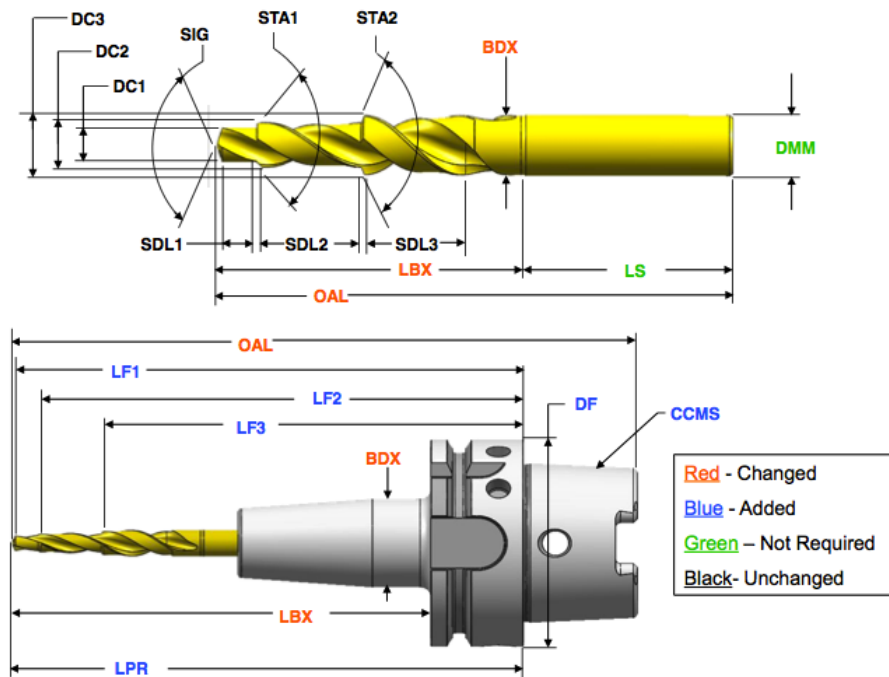


Figure 12: Cutting Tool

1373 4.5.1 FunctionalLength

1374 distance from the gauge plane or from the end of the shank of the cutting tool, if a gauge
 1375 plane does not exist, to the cutting reference point determined by the main function of the
 1376 tool.

1377 This measurement will be with reference to the cutting tool and **MUST NOT** exist without
 1378 a cutting tool.

1379 The code of FunctionalLength **MUST** be LFx.

1380 The units of FunctionalLength **MUST** be MILLIMETER.

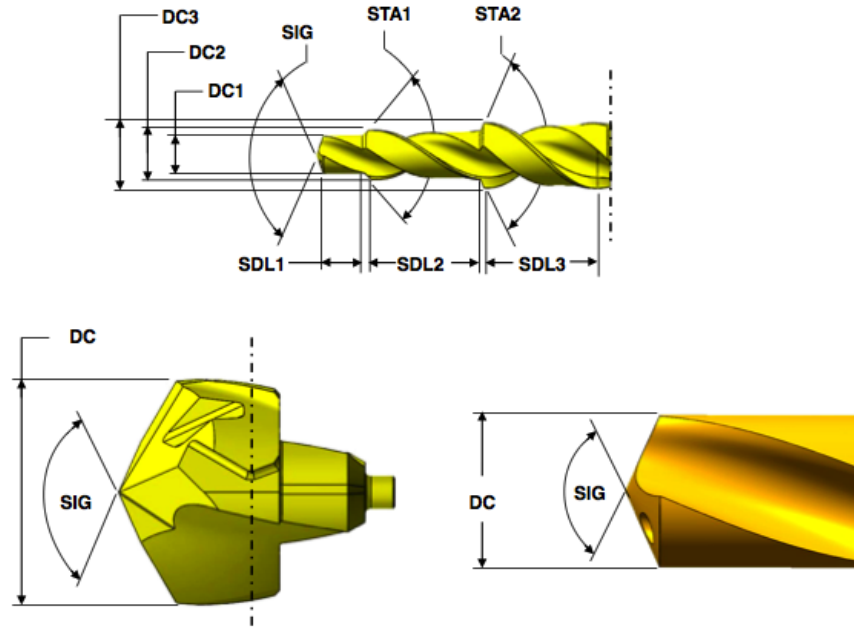


Figure 13: Cutting Item

1381 4.5.2 CuttingReferencePoint

1382 theoretical sharp point of the cutting tool from which the major functional dimensions are
1383 taken.

1384 The code of CuttingReferencePoint **MUST** be CRP.

1385 The units of CuttingReferencePoint **MUST** be MILLIMETER.

1386 4.5.3 CuttingEdgeLength

1387 theoretical length of the cutting edge of a cutting item over sharp corners.

1388 The code of CuttingEdgeLength **MUST** be L.

1389 The units of CuttingEdgeLength **MUST** be MILLIMETER.

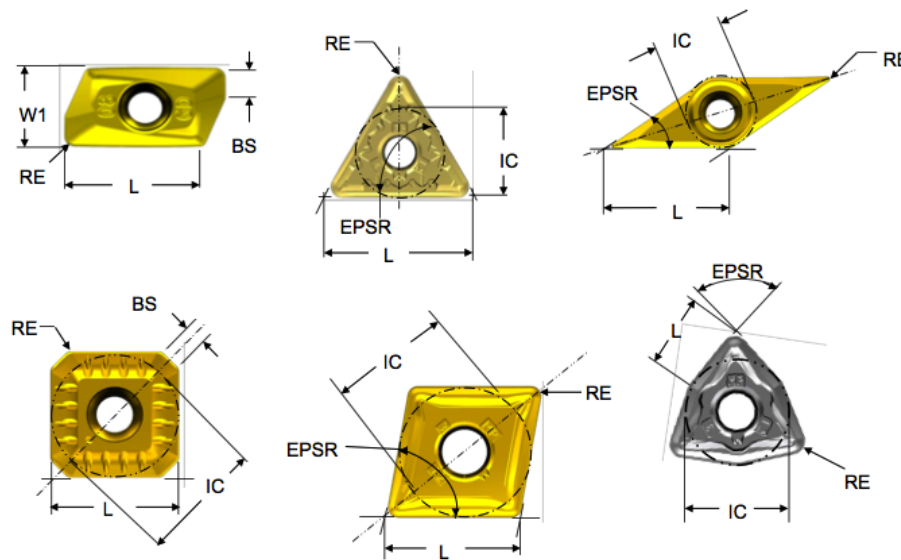


Figure 14: Cutting Item Measurement

1390 4.5.4 DriveAngle

1391 angle between the driving mechanism locator on a tool item and the main cutting edge.

1392 The code of DriveAngle **MUST** be DRVA.

1393 The units of DriveAngle **MUST** be DEGREE.

1394 4.5.5 FlangeDiameter

1395 dimension between two parallel tangents on the outside edge of a flange.

1396 The code of FlangeDiameter **MUST** be DF.

1397 The units of FlangeDiameter **MUST** be MILLIMETER.

1398 4.5.6 FunctionalWidth

1399 distance between the cutting reference point and the rear backing surface of a turning tool
1400 or the axis of a boring bar.

1401 The code of FunctionalWidth **MUST** be WF.

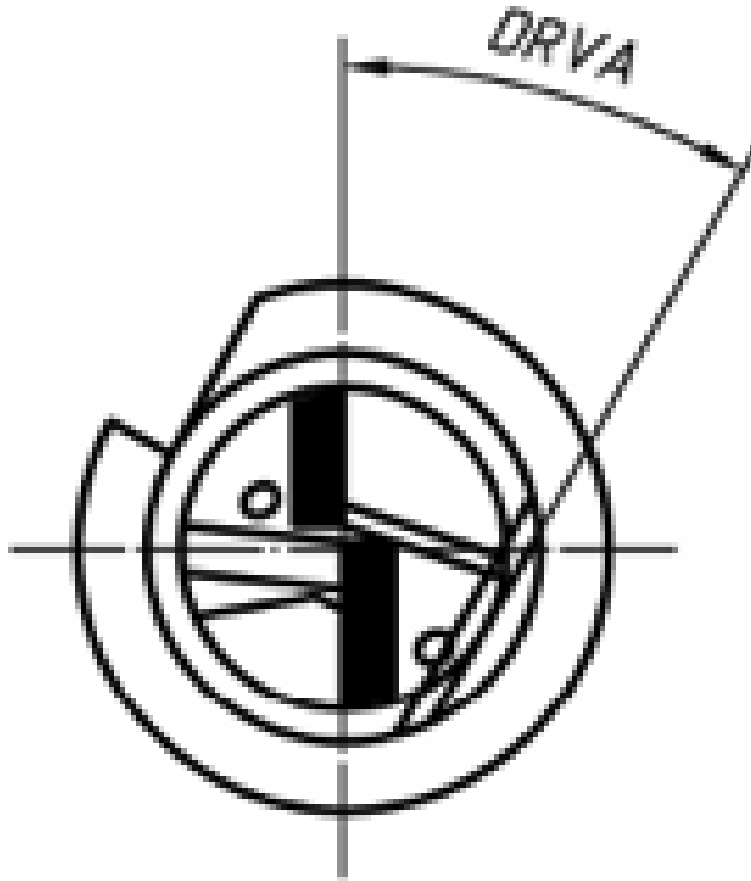


Figure 15: Cutting Item Drive Angle

1402 The units of FunctionalWidth **MUST** be MILLIMETER.

1403 4.5.7 IncrinedCircleDiameter

1404 diameter of a circle to which all edges of a equilateral and round regular insert are tangen-
1405 tial.

1406 The code of IncrinedCircleDiameter **MUST** be IC.

1407 The units of IncrinedCircleDiameter **MUST** be MILLIMETER.

1408 **4.5.8 PointAngle**

1409 angle between the major cutting edge and the same cutting edge rotated by 180 degrees
1410 about the tool axis.

1411 The code of PointAngle **MUST** be SIG.

1412 The units of PointAngle **MUST** be DEGREE.

1413 **4.5.9 ToolCuttingEdgeAngle**

1414 angle between the tool cutting edge plane and the tool feed plane measured in a plane
1415 parallel the xy-plane.

1416 The code of ToolCuttingEdgeAngle **MUST** be KAPR.

1417 The units of ToolCuttingEdgeAngle **MUST** be DEGREE.

1418 **4.5.10 ToolLeadAngle**

1419 angle between the tool cutting edge plane and a plane perpendicular to the tool feed plane
1420 measured in a plane parallel the xy-plane.

1421 The code of ToolLeadAngle **MUST** be PSIR.

1422 The units of ToolLeadAngle **MUST** be DEGREE.

1423 **4.5.11 ToolOrientation**

1424 angle of the tool with respect to the workpiece for a given process.

1425 The value is application specific.

1426 The code is N/A for ToolOrientation.

1427 The units of ToolOrientation **MUST** be DEGREE.

1428 **4.5.12 StepDiameterLength**

1429 length of a portion of a stepped tool that is related to a corresponding cutting diameter
1430 measured from the cutting reference point of that cutting diameter to the point on the next
1431 cutting edge at which the diameter starts to change.

1432 The code of StepDiameterLength **MUST** be SDLx.

1433 The units of StepDiameterLength **MUST** be MILLIMETER.

1434 **4.5.13 StepIncludedAngle**

1435 angle between a major edge on a step of a stepped tool and the same cutting edge rotated
1436 180 degrees about its tool axis.

1437 The code of StepIncludedAngle **MUST** be STAx.

1438 The units of StepIncludedAngle **MUST** be DEGREE.

1439 **4.5.14 WiperEdgeLength**

1440 measure of the length of a wiper edge of a cutting item.

1441 The code of WiperEdgeLength **MUST** be BS.

1442 The units of WiperEdgeLength **MUST** be MILLIMETER.

1443 **4.5.15 CuttingDiameter**

1444 diameter of a circle on which the defined point Pk located on this cutting tool.

1445 The normal of the machined peripheral surface points towards the axis of the cutting tool.

1446 The code of CuttingDiameter **MUST** be DCx.

1447 The units of CuttingDiameter **MUST** be MILLIMETER.

1448 4.5.16 CuttingHeight

1449 distance from the basal plane of the tool item to the cutting point.

1450 The code of CuttingHeight **MUST** be HF.

1451 The units of CuttingHeight **MUST** be MILLIMETER.

1452 4.5.17 CornerRadius

1453 nominal radius of a rounded corner measured in the X Y-plane.

1454 The code of CornerRadius **MUST** be RE.

1455 The units of CornerRadius **MUST** be MILLIMETER.

1456 4.5.18 Weight

1457 total weight of the cutting tool in grams.

1458 The force exerted by the mass of the cutting tool.

1459 The code of Weight **MUST** be WT.

1460 The units of Weight **MUST** be GRAM.

1461 4.5.19 ChamferFlatLength

1462 flat length of a chamfer.

1463 The code of ChamferFlatLength **MUST** be BCH.

1464 The units of ChamferFlatLength **MUST** be MILLIMETER.

1465 4.5.20 ChamferWidth

1466 width of the chamfer.

1467 The code of ChamferWidth **MUST** be CHW.

1468 The units of ChamferWidth **MUST** be MILLIMETER.

1469 4.5.21 InsertWidth

1470 W1 is used for the insert width when an inscribed circle diameter is not practical.

1471 The code of InsertWidth **MUST** be W1.

1472 The units of InsertWidth **MUST** be MILLIMETER.

1473 5 Files Asset Information Model

1474 Manufacturing processes require various documents, programs, setup sheets, and digital
 1475 media available at the device for a given process. The `File` and `FileArchetype` As-
 1476 sets provide a mechanism to communicate specific “Files” that are relevant to a process
 1477 where the media is located on a server and represented by a Universal Resource Locator
 1478 (URL).

1479 The `FileArchetype` contains metadata common to all `File` Assets for a certain
 1480 purpose. The `File` Asset references the file specific to a given device or set of devices.
 1481 The `File` Asset does not hold the contents of the file, it contains a reference to the
 1482 location (URL) used to access the information. The metadata associated with the `File`
 1483 provides semantic information about the representation (mime-type) and the application
 1484 associated with the `File`. The application of the file is an extensible controlled vocabulary
 1485 with common manufacturing uses provided.

1486 5.1 Files

1487 This section provides semantic information for the `File` model.

1488 Note: See *Section B.7 - File Schema Diagrams* for XML schema.

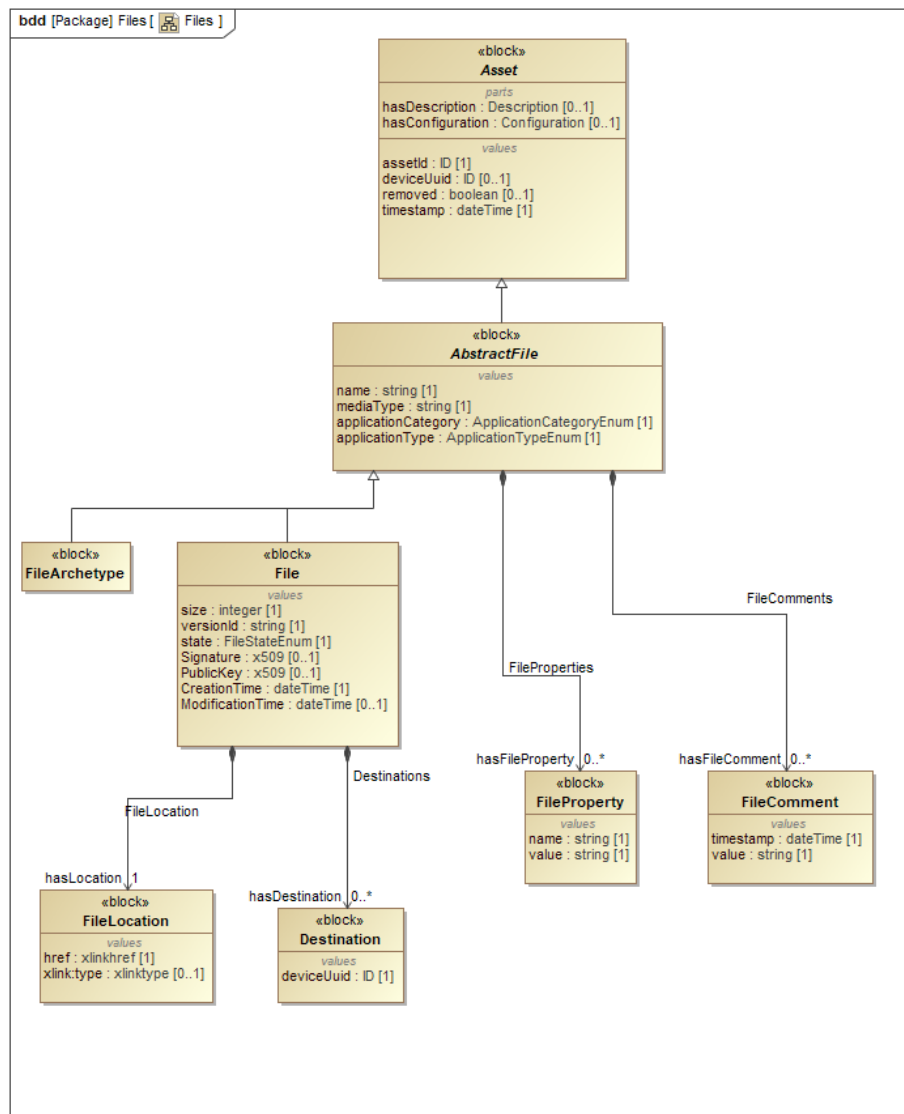
1489 5.1.1 AbstractFile

1490 abstract Asset that contains the common properties of the `File` and `FileArchetype`
 1491 types.

1492 5.1.1.1 Value Properties of AbstractFile

1493 Table 22 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 22: Value Properties of AbstractFile**Figure 16:** Files

1494 Descriptions for Value Properties of AbstractFile:

- 1495 • name
- 1496 name of the file.
- 1497 • mediaType
- 1498 mime type of the file.
- 1499 • applicationCategory
- 1500 category of application that will use this file.
- 1501 ApplicationCategoryEnum Enumeration:
- 1502 – ASSEMBLY
- 1503 files regarding the fully assembled product.
- 1504 – DEVICE
- 1505 device related files.
- 1506 – HANDLING
- 1507 files relating to the handling of material.
- 1508 – INSPECTION
- 1509 files related to the quality inspection.
- 1510 – MAINTENANCE
- 1511 files relating to equipment maintenance.
- 1512 – PART
- 1513 files relating to a part.
- 1514 – PROCESS
- 1515 files related to the manufacturing process.
- 1516 – SETUP
- 1517 files related to the setup of a process.
- 1518 • applicationType
- 1519 type of application that will use this file.
- 1520 ApplicationTypeEnum Enumeration:
- 1521 – DATA
- 1522 generic data.
- 1523 – DESIGN
- 1524 computer aided design files or drawings.

- 1525 – DOCUMENTATION
- 1526 documentation regarding a category of file.
- 1527 – INSTRUCTIONS
- 1528 user instructions regarding the execution of a task.
- 1529 – LOG
- 1530 data related to the history of a machine or process.
- 1531 – PRODUCTION_PROGRAM
- 1532 machine instructions to perform a process.

1533 **5.1.1.2 Part Properties of AbstractFile**

1534 *Table 23* lists the Part Properties of AbstractFile.

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

Table 23: Part Properties of AbstractFile

1535 Descriptions for Part Properties of AbstractFile:

- 1536 • FileProperty
- 1537 key-value pair providing additional metadata about a File.
- 1538 FileProperties groups one or more FileProperty entities for a File. See
- 1539 *Section 5.1.4 - FileProperty.*
- 1540 • FileComment
- 1541 remark or interpretation for human interpretation associated with a File or FileArchetype.
- 1542 FileComments groups one or more FileComment entities for a File. See
- 1543 *Section 5.1.5 - FileComment.*

1544 **5.1.2 File**

1545 AbstractFile type that provides information about the File instance and its URL.

1546 **5.1.2.1 Value Properties of File**

1547 *Table 24* 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 24: Value Properties of File

1548 Descriptions for Value Properties of File:

- 1549 • size
- 1550 size of the file in bytes.
- 1551 • versionId
- 1552 version identifier of the file.
- 1553 • state
- 1554 state of the file.
- 1555 FileStateEnum Enumeration:
- 1556 – EXPERIMENTAL
- 1557 used for processes other than production or otherwise defined.
- 1558 – PRODUCTION
- 1559 used for production processes.
- 1560 – REVISION
- 1561 content is modified from PRODUCTION or EXPERIMENTAL.
- 1562 • Signature
- 1563 secure hash of the file.
- 1564 • PublicKey
- 1565 public key used to verify the signature.
- 1566 • CreationTime
- 1567 time the file was created.
- 1568 • ModificationTime
- 1569 time the file was modified.

1570 5.1.2.2 Part Properties of File

1571 *Table 25* lists the Part Properties of File.

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

Table 25: Part Properties of File

1572 Descriptions for Part Properties of File:

- 1573 • FileLocation
- 1574 URL reference to the file location.
- 1575 *See Section 5.1.6 - FileLocation.*
- 1576 • Destination
- 1577 reference to the target Device for this File.
- 1578 Destinations groups one or more Destination entities. *See Section 5.1.7 -*
- 1579 *Destination.*

1580 5.1.3 FileArchetype

1581 AbstractFile type that provides information common to all versions of a file.

1582 5.1.4 FileProperty

1583 key-value pair providing additional metadata about a File.

1584 The value of FileProperty **MUST** be string.

1585 5.1.4.1 Value Properties of FileProperty

1586 *Table 26* lists the Value Properties of FileProperty.

Value Property name	Value Property type	Multiplicity
name	string	1

Table 26: Value Properties of FileProperty

1587 Descriptions for Value Properties of FileProperty:

- 1588 • name
- 1589 name of the FileProperty.

1590 5.1.5 FileComment

1591 remark or interpretation for human interpretation associated with a File or FileArchetype.

1592 The value of FileComment **MUST** be string.

1593 5.1.5.1 Value Properties of FileComment

1594 Table 27 lists the Value Properties of FileComment.

Value Property name	Value Property type	Multiplicity
timestamp	datetime	1

Table 27: Value Properties of FileComment

1595 Descriptions for Value Properties of FileComment:

- 1596 • timestamp
- 1597 time the comment was made.

1598 5.1.6 FileLocation

1599 URL reference to the file location.

1600 5.1.6.1 Value Properties of FileLocation

1601 Table 28 lists the Value Properties of FileLocation.

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

Table 28: Value Properties of FileLocation

1602 Descriptions for Value Properties of FileLocation:

- 1603 • href
- 1604 URL reference to the file.
- 1605 href is of type xlink:href from the W3C XLink specification.
- 1606 • xlink:type
- 1607 type of href for the xlink href type.
- 1608 **MUST** be locator referring to a URL .

1609 5.1.7 Destination

1610 reference to the target Device for this File.

1611 5.1.7.1 Value Properties of Destination

1612 Table 29 lists the Value Properties of Destination.

Value Property name	Value Property type	Multiplicity
deviceUuid	UUID	1

Table 29: Value Properties of Destination

1613 Descriptions for Value Properties of Destination:

- 1614 • deviceUuid
- 1615 uuid of the target device or application.

1616 **6 Raw Material Asset Information Model**

1617 Raw material represents the source of material for immediate use and sources of material
1618 that may or may not be used during the manufacturing process.

1619 The `RawMaterialAsset` holds the references to the content stored in the actual `Raw-`
1620 `Material` container or derived about the `RawMaterial` by the system during opera-
1621 tion.

1622 **6.1 Raw Material**

1623 This section provides semantic information for the `RawMaterial` model.

1624 Note: See *Section B.8 - RawMaterial Schema Diagrams* for XML schema.

1625 **6.1.1 RawMaterial**

1626 `Asset` that represents raw material.

1627 **6.1.1.1 Value Properties of RawMaterial**

1628 *Table 30* 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 30: Value Properties of RawMaterial

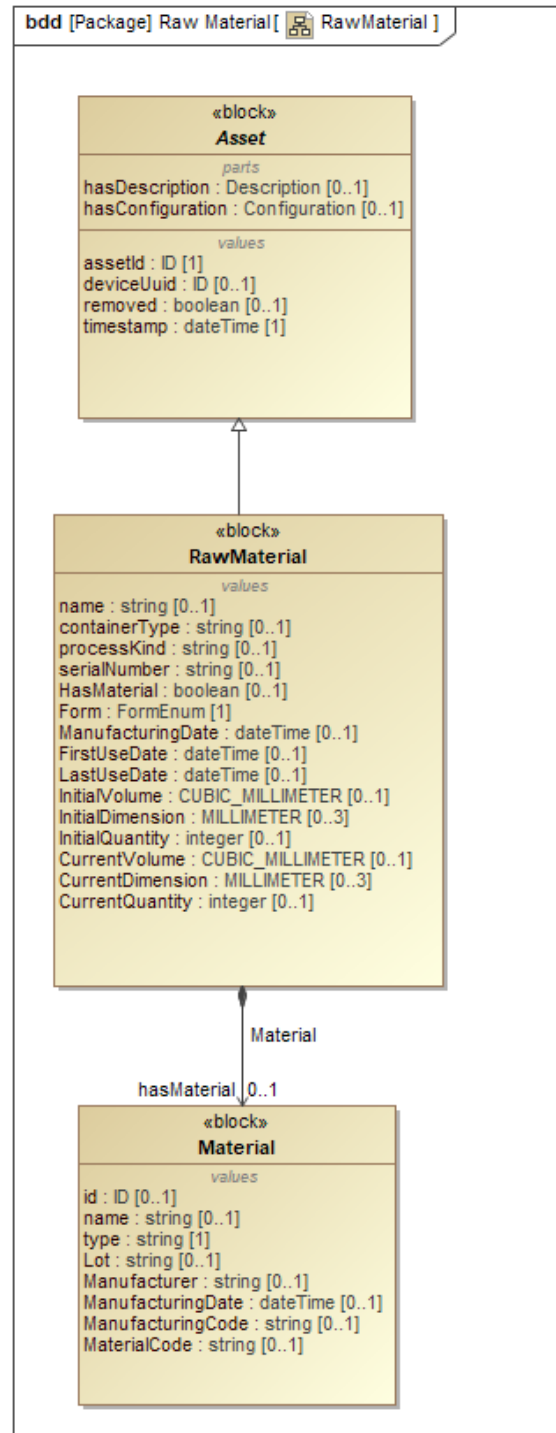


Figure 17: RawMaterial

1629 Descriptions for Value Properties of RawMaterial:

- 1630 • name
- 1631 name of the raw material.
- 1632 Examples: Container1 and AcrylicContainer.
- 1633 • containerType
- 1634 type of container holding the raw material.
- 1635 Examples: Pallet, Canister, Cartridge, Tank, Bin, Roll, and Spool.
- 1636 • processKind
- 1637 ISO process type supported by this raw material.
- 1638 Examples include: VAT_POLYMERIZATION, BINDER_JETTING, MATERIAL_EXTRUSION,
- 1639 MATERIAL_JETTING, SHEET_LAMINATION, POWDER_BED_FUSION and DI-
- 1640 RECTED_ENERGY_DEPOSITION.
- 1641 • serialNumber
- 1642 serial number of the raw material.
- 1643 • HasMaterial
- 1644 Material has existing usable volume.
- 1645 • Form
- 1646 form of the raw material.
- 1647 FormEnum Enumeration:
- 1648 – BAR
- 1649 – BLOCK
- 1650 – CASTING
- 1651 – FILAMENT
- 1652 – GAS
- 1653 – GEL
- 1654 – LIQUID
- 1655 – POWDER
- 1656 – SHEET
- 1657 • ManufacturingDate
- 1658 date the raw material was created.

- 1659 • FirstUseDate
- 1660 date raw material was first used.
- 1661 • LastUseDate
- 1662 date raw material was last used.
- 1663 • InitialVolume
- 1664 amount of material initially placed in raw material when manufactured.
- 1665 • InitialDimension
- 1666 dimension of material initially placed in raw material when manufactured.
- 1667 • InitialQuantity
- 1668 quantity of material initially placed in raw material when manufactured.
- 1669 • CurrentVolume
- 1670 amount of material currently in raw material.
- 1671 • CurrentDimension
- 1672 dimension of material currently in raw material.
- 1673 • CurrentQuantity
- 1674 quantity of material currently in raw material.

1675 **6.1.1.2 Part Properties of RawMaterial**

1676 *Table 31* lists the Part Properties of RawMaterial.

Part Property name	Multiplicity
Material	0..1

Table 31: Part Properties of RawMaterial

1677 Descriptions for Part Properties of RawMaterial:

- 1678 • Material
- 1679 material used as the RawMaterial.
- 1680 See *Section 6.1.2 - Material*.

1681 6.1.2 Material

1682 material used as the RawMaterial.

1683 6.1.2.1 Value Properties of Material

1684 Table 32 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 32: Value Properties of Material

1685 Descriptions for Value Properties of Material:

- 1686 • id
- 1687 unique identifier for the material.
- 1688 • name
- 1689 name of the material.
- 1690 Examples: ULTM9085, ABS, 4140.
- 1691 • type
- 1692 type of material.
- 1693 Examples: Metal, Polymer, Wood, 4140, Recycled, Prestine and Used.
- 1694 • Lot
- 1695 manufacturer's lot code of the material.
- 1696 • Manufacturer
- 1697 name of the material manufacturer.

- 1698 • ManufacturingDate
- 1699 manufacturing date of the material from the material manufacturer.
- 1700 • ManufacturingCode
- 1701 lot code of the raw feed stock for the material, from the feed stock manufacturer.
- 1702 • MaterialCode
- 1703 American Society for Testing and Materials (ASTM) standard code that the material
- 1704 complies with.

1705 7 QIF Asset Information Model

1706 The Quality Information Framework (QIF) is an American National Standards Institute
 1707 (ANSI) accredited standard developed by the Digital Metrology Standards Consortium
 1708 (DMSC) standards development organization. The DMSC is an A-liaison to the Interna-
 1709 tional Standards Organization (ISO) Technical Committee (TC) 184. QIF addresses the
 1710 needs of the metrology community to have a semantic information model for the exchange
 1711 of metrology data throughout the verification lifecycle from product design to execution,
 1712 analysis, and reporting.

1713 The MTConnect QIF *Asset Information Model* provides a wrapper around a QIF document
 1714 (i.e., a dataset conforming to the QIF Information model) in its native XML representation.
 1715 The MTConnect standard does not alter or extend the QIF standard and regards the QIF
 1716 standard as a passthrough.

1717 Information about the QIF standards is at the following location: <https://qifstandards.org>

1718 7.1 QIF

1719 This section provides semantic information for the `QIFDocumentWrapper` model.

1720 Note: See *Section B.9 - QIFDocumentWrapper Schema Diagrams* for XML
 1721 schema.

1722 7.1.1 QIFDocument

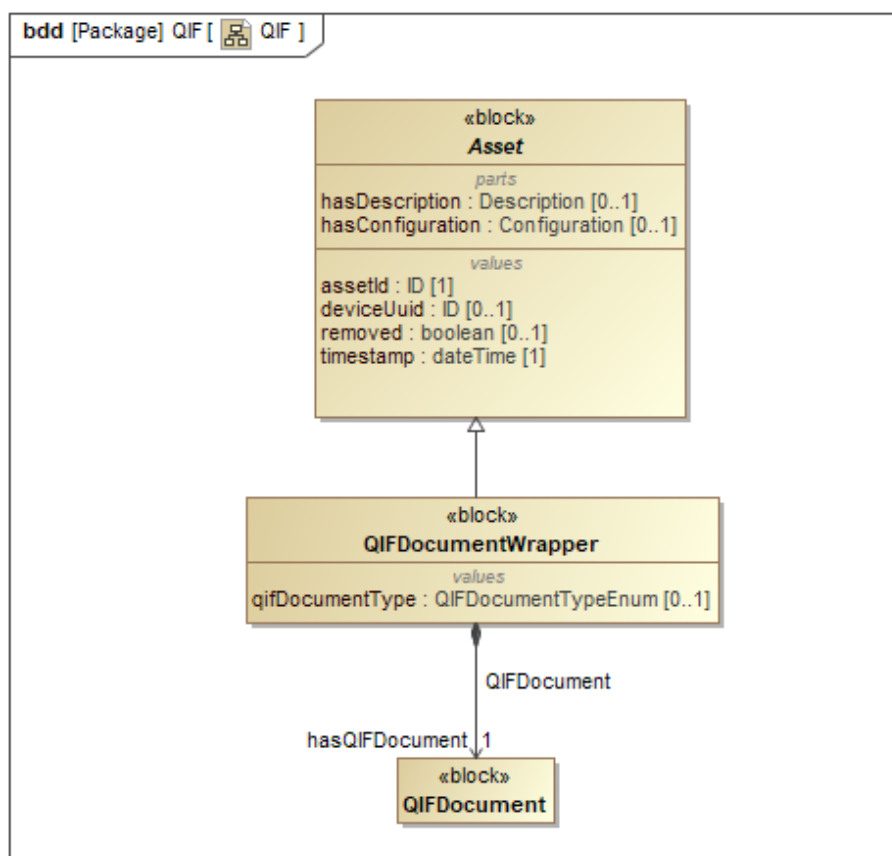
1723 QIF Document as given by the QIF standard.

1724 7.1.2 QIFDocumentWrapper

1725 Asset that carries the QIF Document.

1726 7.1.2.1 Value Properties of QIFDocumentWrapper

1727 *Table 33* lists the Value Properties of `QIFDocumentWrapper`.

**Figure 18: QIFDocumentWrapper**

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

Table 33: Value Properties of QIFDocumentWrapper

1728 Descriptions for Value Properties of QIFDocumentWrapper:

- 1729 • qifDocumentType
- 1730 contained QIF Document type as defined in the QIF Standard.

1731 QIFDocumentTypeEnum Enumeration:

- 1732 – MEASUREMENT_RESOURCE
- 1733 – PLAN
- 1734 – PRODUCT
- 1735 – RESULTS

- 1736 – RULES
- 1737 – STATISTICS

1738 **7.1.2.2 Part Properties of QIFDocumentWrapper**

1739 *Table 34* lists the Part Properties of QIFDocumentWrapper.

Part Property name	Multiplicity
QIFDocument	1

Table 34: Part Properties of QIFDocumentWrapper

1740 Descriptions for Part Properties of QIFDocumentWrapper:

- 1741 • QIFDocument
- 1742 QIF Document as given by the QIF standard.

1743 8 Component Configuration Parameters Asset Informa- 1744 tion Model

1745 8.1 Component Configuration Parameters

1746 This section provides semantic information for the ComponentConfigurationPa-
1747 rameters model.

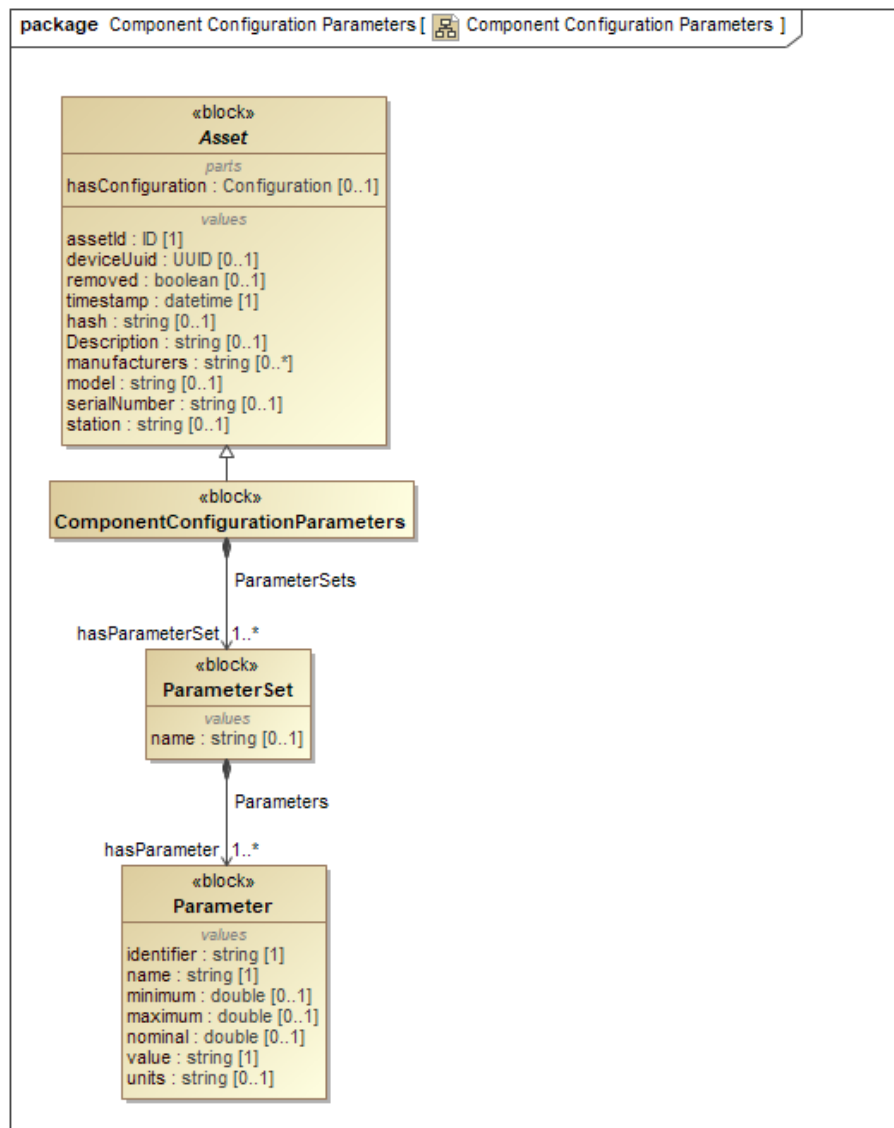


Figure 19: ComponentConfigurationParameters

1748 8.1.1 ComponentConfigurationParameters

1749 set of ParameterSets that govern the functionality of the related Component.

1750 8.1.1.1 Part Properties of ComponentConfigurationParameters

1751 Table 35 lists the Part Properties of ComponentConfigurationParameters.

Part Property name	Multiplicity
ParameterSet (organized by ParameterSets)	1..*

Table 35: Part Properties of ComponentConfigurationParameters

1752 Descriptions for Part Properties of ComponentConfigurationParameters:

- 1753 • ParameterSet
- 1754 set of Parameters.
- 1755 ParameterSets groups one or more ParameterSet entities. See *Section 8.1.2*
- 1756 - *ParameterSet*.

1757 8.1.2 ParameterSet

1758 set of Parameters.

1759 8.1.2.1 Value Properties of ParameterSet

1760 Table 36 lists the Value Properties of ParameterSet.

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

Table 36: Value Properties of ParameterSet

1761 Descriptions for Value Properties of ParameterSet:

- 1762 • name
- 1763 name of the parameter set if more than one exists.

1764 8.1.2.2 Part Properties of ParameterSet

1765 *Table 37* lists the Part Properties of `ParameterSet`.

Part Property name	Multiplicity
Parameter (organized by <code>Parameters</code>)	1..*

Table 37: Part Properties of `ParameterSet`

1766 Descriptions for Part Properties of `ParameterSet`:

- 1767 • `Parameter`
- 1768 property that determines the characteristic or behavior of an entity.
- 1769 `Parameters` groups one or more `Parameter` entities. See *Section 8.1.3 - Pa-*
- 1770 *rameter*.

1771 8.1.3 Parameter

1772 property that determines the characteristic or behavior of an entity.

1773 The value of `Parameter` **MUST** be `string`.

1774 8.1.3.1 Value Properties of Parameter

1775 *Table 38* lists the Value Properties of `Parameter`.

Value Property name	Value Property type	Multiplicity
<code>identifier</code>	<code>string</code>	1
<code>name</code>	<code>string</code>	1
<code>minimum</code>	<code>double</code>	0..1
<code>maximum</code>	<code>double</code>	0..1
<code>nominal</code>	<code>double</code>	0..1
<code>units</code>	<code>string</code>	0..1

Table 38: Value Properties of `Parameter`

1776 Descriptions for Value Properties of `Parameter`:

- 1777 • `identifier`
- 1778 internal identifier, register, or address.

- 1779 • name
- 1780 descriptive name.
- 1781 • minimum
- 1782 minimal allowed value.
- 1783 • maximum
- 1784 maximum allowed value.
- 1785 • nominal
- 1786 nominal value.
- 1787 • units
- 1788 engineering units.
- 1789 units **SHOULD** be SI or MTConnect Units.

1790 9 Fixture Asset Information Model

1791 9.1 Fixture

1792 This section provides semantic information for the `Fixture` model.

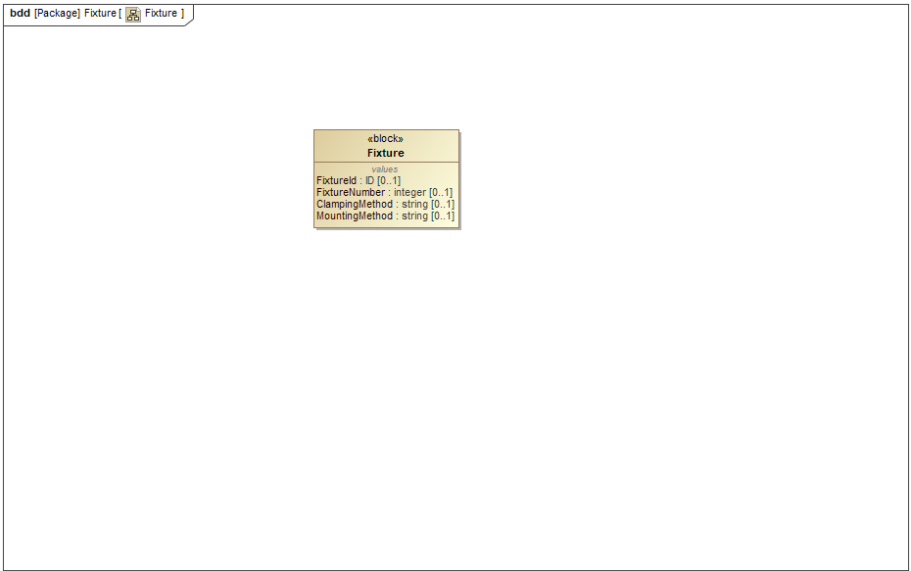


Figure 20: Fixture

1793 9.1.1 Fixture

1794 identifier of the `Pallet`.

1795 10 Pallet Asset Information Model

1796 10.1 Pallet

1797 This section provides semantic information for the `Pallet` model.

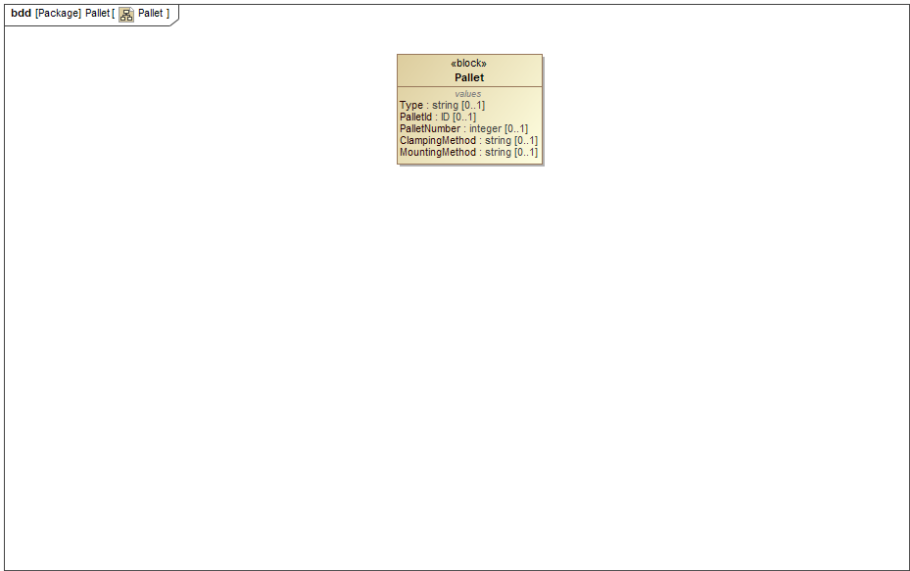


Figure 21: Pallet

1798 10.1.1 Pallet

1799 `PhysicalAsset` that has a portable platform for handling, storing, or moving materials,
1800 parts, blanks etc.

1801 11 Profile

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

1804 11.1 DataTypes

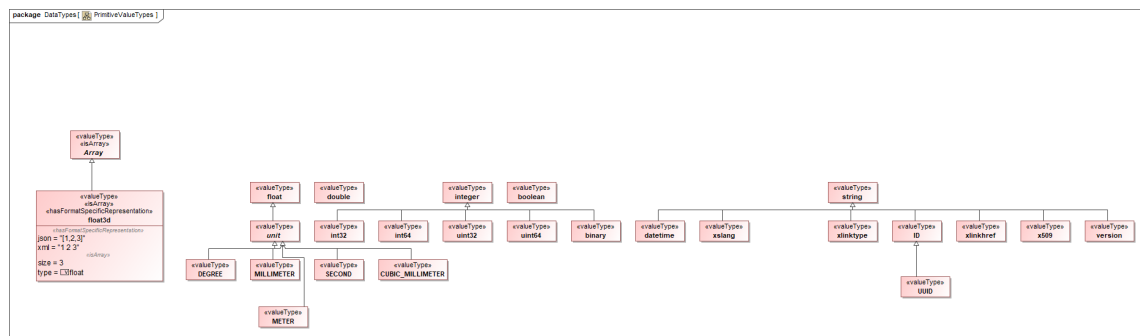


Figure 22: DataTypes

1805 11.1.1 boolean

1806 primitive type.

1807 **11.1.2 ID**

1808 string that represents an identifier (ID).

1809 11.1.3 string

```
1810 primitive type.
```

1811 11.1.4 float

1812 primitive type.

1813 11.1.5 datetime

1814 string that represents timestamp in ISO 8601 format.

1815 11.1.6 integer

1816 primitive type.

1817 11.1.7 xlinktype

1818 string that represents the type of an XLink element. See <https://www.w3.org/TR/xlink11/>.

1820 11.1.8 xslang

1821 string that represents a language tag. See <http://www.ietf.org/rfc/rfc4646.txt>.

1823 11.1.9 SECOND

1824 float that represents time in seconds.

1825 11.1.10 xlinkhref

1826 string that represents the locator attribute of an XLink element. See <https://www.w3.org/TR/xlink11/>.

1828 11.1.11 x509

1829 string that represents an x509 data block. *Ref ISO/IEC 9594-8:2020.*

1830 11.1.12 int32

1831 32-bit integer.

1832 11.1.13 int64

1833 64-bit integer.

1834 11.1.14 version

1835 series of three numeric values, separated by a decimal point, representing a *major*, *minor*,
1836 and *patch* number of the MTConnect Standard.

1837 11.1.15 uint32

1838 32-bit unsigned integer.

1839 11.1.16 uint64

1840 64-bit unsigned integer.

1841 11.1.17 binary

1842 base-2 numeral system or binary numeral system represented by two digits: “0” and “1”.

1843 11.1.18 double

1844 primitive type.

1845 11.1.19 Array

1846 array.

1847 11.1.20 <<hasFormatSpecificRepresentation>>float3d

1848 array of size 3 and datatype float.

1849 11.1.21 UUID

1850 Universally Unique Identifier. *Ref IETF:RFC-4122*

1851 11.1.22 METER

1852 float that represents measurement in meter.

1853 11.2 Stereotypes

1854 11.2.1 organizer

1855 element that *organizes* other elements of a type.

1856 11.2.2 deprecated

1857 element that has been deprecated.

1858 11.2.3 extensible

1859 enumeration that can be extended.

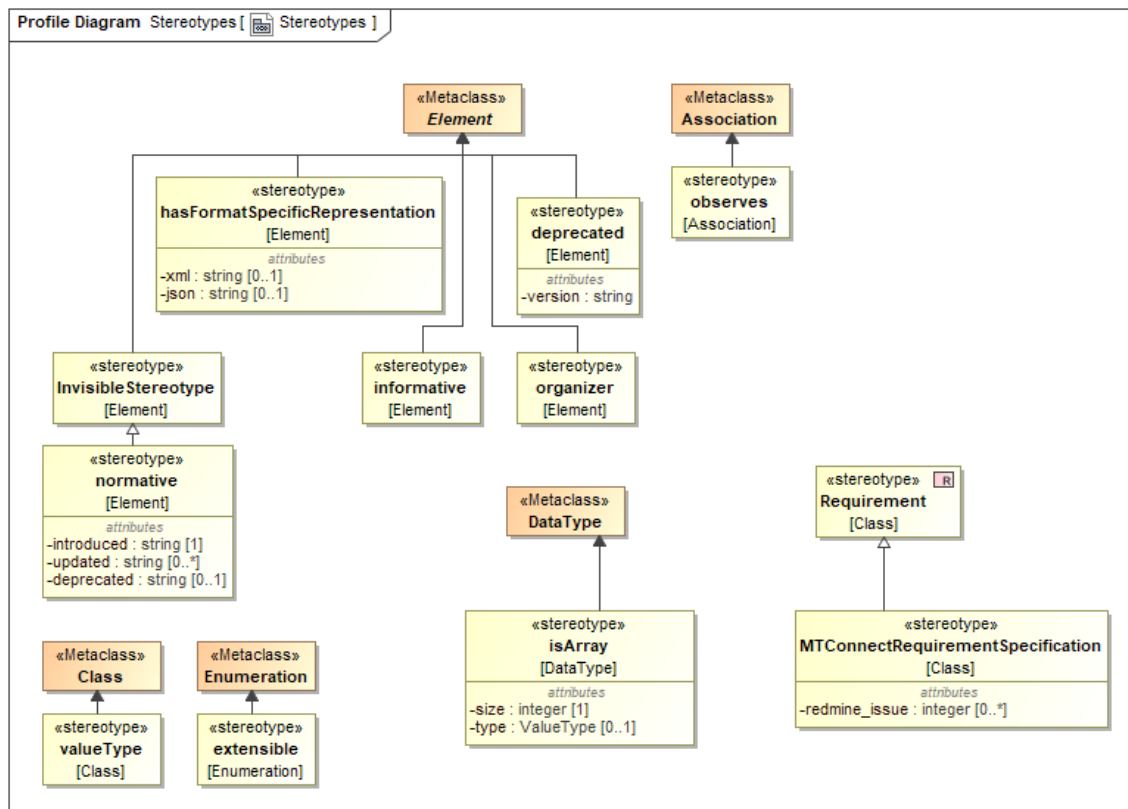


Figure 23: Stereotypes

1860 11.2.4 informative

1861 element that is descriptive and non-normative.

1862 11.2.5 normative

1863 element that has been added to the standard.

1864 11.2.6 observes

1865 association in which a *Component* makes *Observations* about an observable *DataItem*.

1866 11.2.7 satisfiedBy

1867 11.2.8 hasFormatSpecificRepresentation

1868 element that has format specific representation that might be different from the element's
1869 SysML representation.

1870 11.2.9 valueType

1871 extends `Class` to be used as a SysML `<<ValueType>>`.

1872 11.2.10 isArray

1873 datatype that is an array.

1874 11.2.11 MTConnectRequirementSpecification

1875 MTConnect Requirement.

1876 Appendices

1877 A Bibliography

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1879 Block Data Format for Positioning, Contouring, and Contouring/Positioning Numerically
1880 Controlled Machines. Washington, D.C. 1979.
- 1881 ISO TC 184/SC4/WG3 N1089. ISO/DIS 10303-238: Industrial automation systems and
1882 integration Product data representation and exchange Part 238: Application Protocols: Ap-
1883 plication interpreted model for computerized numerical controllers. Geneva, Switzerland,
1884 2004.
- 1885 International Organization for Standardization. ISO 14649: Industrial automation sys-
1886 tems and integration – Physical device control – Data model for computerized numerical
1887 controllers – Part 10: General process data. Geneva, Switzerland, 2004.
- 1888 International Organization for Standardization. ISO 14649: Industrial automation sys-
1889 tems and integration – Physical device control – Data model for computerized numerical
1890 controllers – Part 11: Process data for milling. Geneva, Switzerland, 2000.
- 1891 International Organization for Standardization. ISO 6983/1 – Numerical Control of ma-
1892 chines – Program format and definition of address words – Part 1: Data format for posi-
1893 tioning, line and contouring control systems. Geneva, Switzerland, 1982.
- 1894 Electronic Industries Association. ANSI/EIA-494-B-1992, 32 Bit Binary CL (BCL) and
1895 7 Bit ASCII CL (ACL) Exchange Input Format for Numerically Controlled Machines.
1896 Washington, D.C. 1992.
- 1897 National Aerospace Standard. Uniform Cutting Tests - NAS Series: Metal Cutting Equip-
1898 ment Specifications. Washington, D.C. 1969.
- 1899 International Organization for Standardization. ISO 10303-11: 1994, Industrial automa-
1900 tion systems and integration Product data representation and exchange Part 11: Descrip-
1901 tion methods: The EXPRESS language reference manual. Geneva, Switzerland, 1994.
- 1902 International Organization for Standardization. ISO 10303-21: 1996, Industrial automa-
1903 tion systems and integration – Product data representation and exchange – Part 21: Imple-
1904 mentation methods: Clear text encoding of the exchange structure. Geneva, Switzerland,
1905 1996.
- 1906 H.L. Horton, F.D. Jones, and E. Oberg. Machinery's Handbook. Industrial Press, Inc.

- 1907 New York, 1984.
- 1908 International Organization for Standardization. ISO 841-2001: Industrial automation sys-
1909 tems and integration - Numerical control of machines - Coordinate systems and motion
1910 nomenclature. Geneva, Switzerland, 2001.
- 1911 ASME B5.57: Methods for Performance Evaluation of Computer Numerically Controlled
1912 Lathes and Turning Centers, 1998.
- 1913 ASME/ANSI B5.54: Methods for Performance Evaluation of Computer Numerically Con-
1914 trolled Machining Centers. 2005.
- 1915 OPC Foundation. OPC Unified Architecture Specification, Part 1: Concepts Version 1.00.
1916 July 28, 2006.
- 1917 IEEE STD 1451.0-2007, Standard for a Smart Transducer Interface for Sensors and Ac-
1918 tuators – Common Functions, Communication Protocols, and Transducer Electronic Data
1919 Sheet (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The In-
1920 stitute of Electrical and Electronics Engineers, Inc., New York, N.Y. 10016, SH99684,
1921 October 5, 2007.
- 1922 IEEE STD 1451.4-1994, Standard for a Smart Transducer Interface for Sensors and Ac-
1923 tuators – Mixed-Mode Communication Protocols and Transducer Electronic Data Sheet
1924 (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The Institute of
1925 Electrical and Electronics Engineers, Inc., New York, N.Y. 10016, SH95225, December
1926 15, 2004.

1927 **B XML Schema Diagrams**

1928 See XML schemas for the MTConnect standard here: <https://schemas.mtconnect.org/>.
1929

1930 **B.1 Assets Schema Diagrams**

1931 See Asset element in MTConnectAssets schema.

1932 See Description element in MTConnectAssets schema.

1933 **B.2 CuttingTool Schema Diagrams**

1934 See CuttingTool element in MTConnectAssets schema.

1935 See CuttingToolDefinition element in MTConnectAssets schema.

1936 See CuttingToolArchetypeReference element in MTConnectAssets schema.

1937 **B.3 CuttingToolLifeCycle Schema Diagrams**

1938 See CuttingToolLifeCycle element in MTConnectAssets schema.

1939 See CutterStatus element in MTConnectAssets schema.

1940 See Location element in MTConnectAssets schema.

1941 See Measurement element in MTConnectAssets schema.

1942 See ProcessFeedRate element in MTConnectAssets schema.

1943 See ProcessSpindleSpeed element in MTConnectAssets schema.

1944 See ReconditionCount element in MTConnectAssets schema.

1945 See ToolLife element in MTConnectAssets schema.

1946 B.4 CuttingItem Schema Diagrams

1947 See CuttingItems element in MTConnectAssets schema.

1948 See CuttingItem element in MTConnectAssets schema.

1949 See ItemLife element in MTConnectAssets schema.

1950 B.5 ISO 13399 Diagrams

1951 B.5.1 Measurement Diagrams

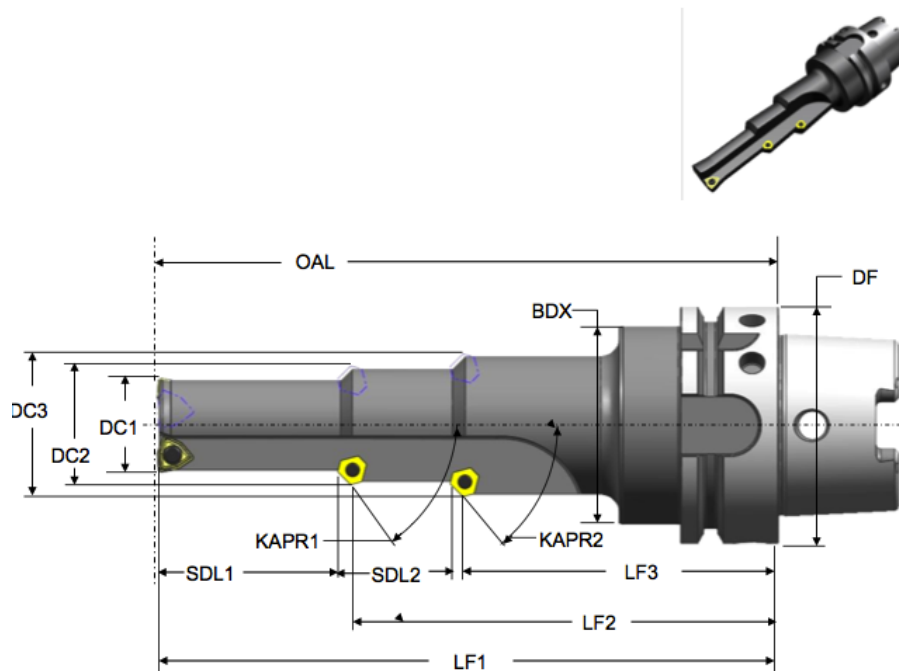


Figure 24: Cutting Tool Measurement 3

1952 B.6 Cutting Tool Examples

1953 B.6.1 Shell Mill

Example 1: Example for Indexable Insert Measurements

1954 1 <?xml version="1.0" encoding="UTF-8"?>

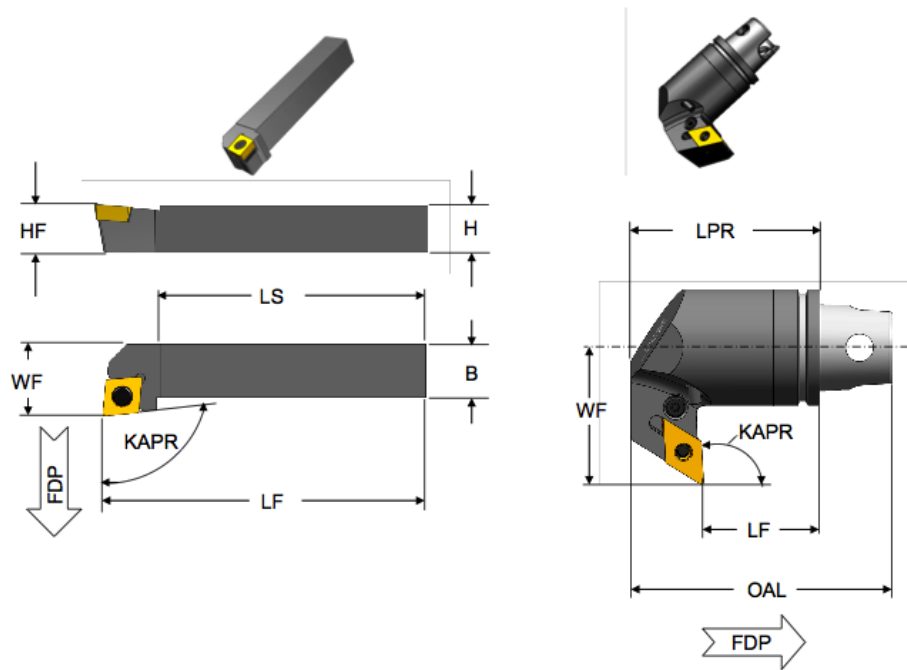


Figure 25: Cutting Tool Measurement 4

```

1955 2 <MTConnectAssets
1956 3 xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1957 4 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1958 5 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1959 6 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1960 7 http://mtconnect.org/schemas/MTConnectAssets\textunderscore 1.2.xsd"
1961 >
1962 8 <<Header_creationTime="2011-05-11T13:55:22"
1963 9 <<assetBufferSize="1024"<_sender="localhost"
1964 10 <<assetCount="2"<_version="1.2"<_instanceId="1234"/>
1965 11 <<Assets>
1966 12 <<CuttingTool_serialNumber="1"<_toolId="KSSP300R4SD43L240"
1967 13 <<timestamp="2011-05-11T13:55:22"<_assetId="KSSP300R4SD43L240.1"
1968 14 <<manufacturers="KMT,Parlec">
1969 15 <<<CuttingToolLifeCycle>
1970 16 <<<CutterStatus><Status>NEW</Status></CutterStatus>
1971 17 <<<ProcessSpindleSpeed_maximum="13300"
1972 18 <<<nominal="605">10000</ProcessSpindleSpeed>
1973 19 <<<ProcessFeedRate
1974 20 <<<nominal="9.22">9.22</ProcessSpindleSpeed>
1975 21 <<<ConnectionCodeMachineSide>CV50
1976 22 <<</ConnectionCodeMachineSide>
1977 23 <<<Measurements>
1978 24 <<<<<BodyDiameterMax_code="BDX">73.25
1979 25 <<<</BodyDiameterMax>
1980 26 <<<<OverallToolLength_nominal="222.25"

```

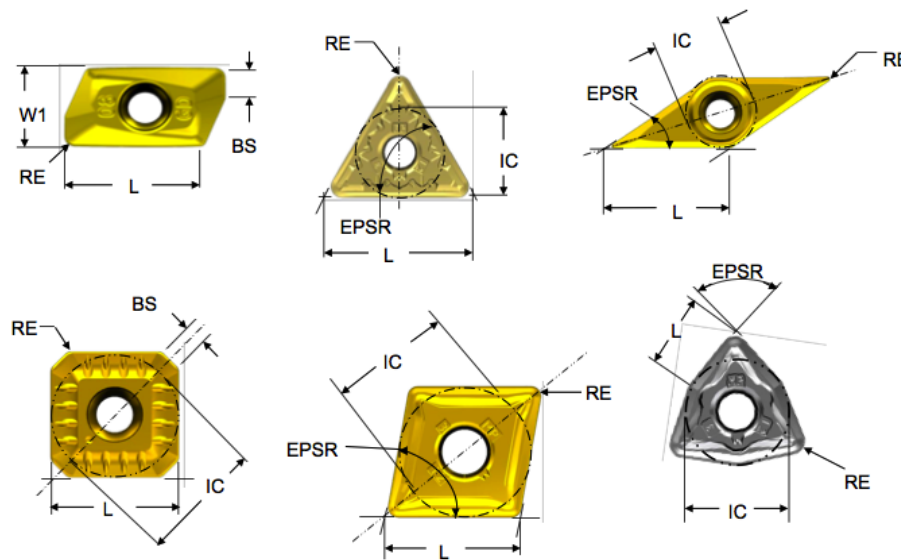


Figure 26: Cutting Tool Measurement 5

```

1981 27  <minimum="221.996">_maximum="222.504"
1982 28  <code="OAL">222.25</OverallToolLength>
1983 29  <UsableLengthMax_code="LUX"_nominal="82.55">82.55
1984 30  </UsableLengthMax>
1985 31  <CuttingDiameterMax_code="DC"_nominal="76.2"
1986 32  <maximum="76.213">_minimum="76.187">76.2
1987 33  </CuttingDiameterMax>
1988 34  <BodyLengthMax_code="LF"_nominal="120.65"
1989 35  <maximum="120.904">_minimum="120.404">120.65
1990 36  </BodyLengthMax>
1991 37  <DepthOfCutMax_code="APMX"
1992 38  <nominal="60.96">60.95</DepthOfCutMax>
1993 39  <FlangeDiameterMax_code="DF"
1994 40  <nominal="98.425">98.425</FlangeDiameterMax>
1995 41  </Measurements>
1996 42  <CuttingItems_count="24">
1997 43  <CuttingItem_indices="1-24"_itemId="SDET43PDER8GB"
1998 44  <manufacturers="KMT"_grade="KC725M">
1999 45  <Measurements>
2000 46  <CuttingEdgeLength_code="L"_nominal="12.7"
2001 47  <minimum="12.675">_maximum="12.725">12.7
2002 48  </CuttingEdgeLength>
2003 49  <WiperEdgeLength_code="BS"_nominal=
2004 50  <"2.56">2.56</WiperEdgeLength>
2005 51  <IncribedCircleDiameter_code="IC"
2006 52  <nominal="12.7">12.7
2007 53  </IncribedCircleDiameter>
2008 54  <CornerRadius_code="RE"_nominal="0.8">
2009 55  <0.8</CornerRadius>

```

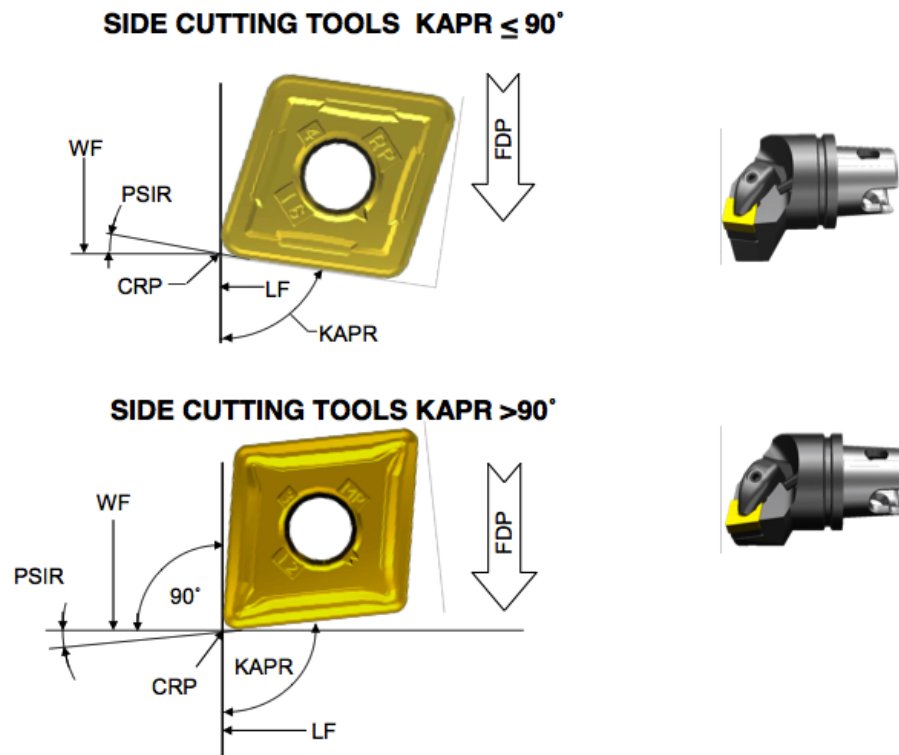


Figure 27: Cutting Tool Measurement 6

```

2010 56 <<<<<<</Measurements>
2011 57 <<<<<<</CuttingItem>
2012 58 <<<<<<</CuttingItems>
2013 59 <<<<<<</CuttingToolLifeCycle>
2014 60 <<<<<<</CuttingTool>
2015 61 <<<<<<</Assets>
2016 62 <<<<<<</MTConnectAssets>

```

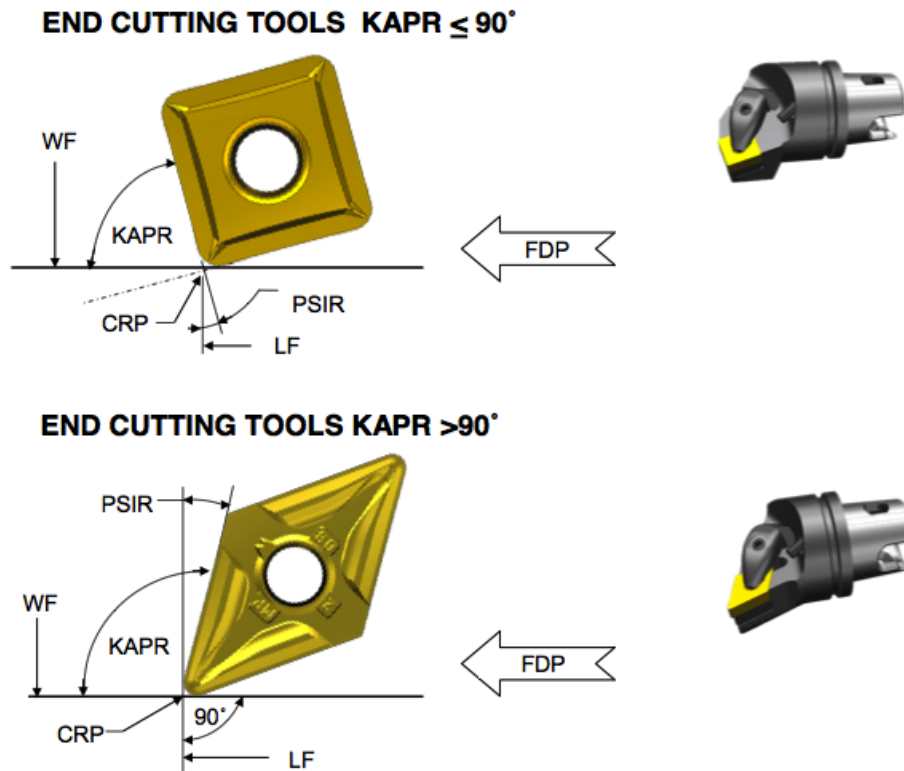


Figure 28: Cutting Tool Measurement 7

2017 B.6.2 Step Drill

Example 2: Example for Step Mill Side View

```

2018 1 <?xml version="1.0" encoding="UTF-8"?>
2019 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2020 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2021 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2022 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2023 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2024 7 >
2025 8 <Header creationTime="2011-05-
2026 9 11T13:55:22" assetBufferSize="1024"
2027 10 sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2028 11 />
2029 12 <Assets>
2030 13 <CuttingTool serialNumber="1_" toolId="B732A08500HP"
2031 14 timestamp="2011-05-11T13:55:22" assetId="B732A08500HP_"
2032 15 manufacturers="KMT,Parlec">
2033 16 <Description>
2034 17 Step Drill - KMT, B732A08500HP Grade KC7315
2035 18 Adapter - Parlec, C50-M12SF300-6
2036 19 </Description>

```

BCH = CHAMFER FLAT LENGTH
 CHW = CHAMFER WIDTH

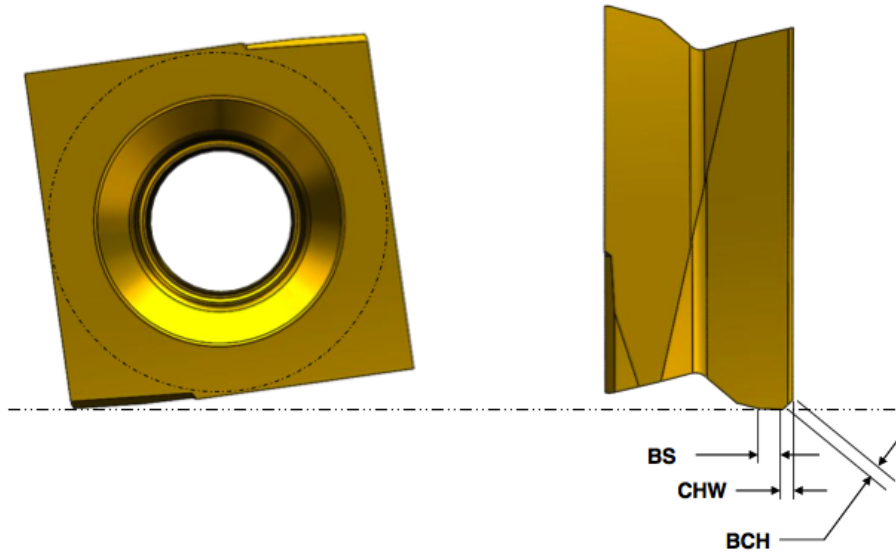


Figure 29: Cutting Tool Measurement 8

```

2037 18      <CuttingToolLifeCycle>
2038 19      <CutterStatus><Status>NEW</Status></CutterStatus>
2039 20      <ProcessSpindleSpeed nominal="5893">5893</
2040 ProcessSpindleSpeed>
2041 21      <ProcessFeedRate nominal="2.5">2.5</ProcessFeedRate>
2042 22      <ConnectionCodeMachineSide>CV50 Taper</
2043 ConnectionCodeMachineSide>
2044 23      <Measurements>
2045 24      <BodyDiameterMax code="BDX">31.8</BodyDiameterMax>
2046 25      <BodyLengthMax code="LBX" nominal="120.825" maximum="
2047 126.325"
2048 26 minimum="115.325">120.825</BodyLengthMax>
2049 27      <ProtrudingLength code="LPR" nominal="155.75" maximum="
2050 161.25"
2051 28 minimum="150.26">155.75</ProtrudingLength>
2052 29      <FlangeDiameterMax code="DF"
2053 30 nominal="98.425">98.425</FlangeDiameterMax>
2054 31      <OverallToolLength nominal="257.35" minimum="251.85"
2055 32 maximum="262.85" code="OAL">257.35</OverallToolLength>
2056 33      </Measurements>
2057 34      <CuttingItems count="2">
2058 35      <CuttingItem indices="1" manufacturers="KMT" grade="KC7315
2059 36      ">>
2060      <Measurements>

```

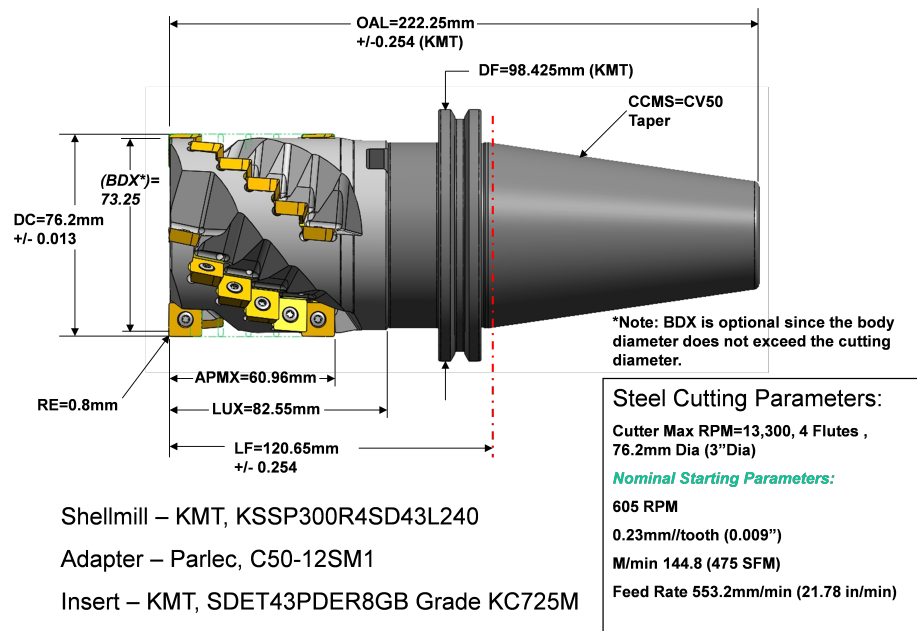


Figure 30: Shell Mill Side View

```

2061 37      <CuttingDiameter code="DC1" nominal="8.5" maximum="
2062      8.521"
2063 38      minimum="8.506">8.5135</CuttingDiameter>
2064 39      <StepIncludedAngle code="STA1" nominal="90" maximum="
2065      91"
2066 40      minimum="89">90</StepIncludedAngle>
2067 41      <Functionallength code="LF1" nominal="154.286"
2068 42      minimum="148.786"
2069 43      maximum="159.786">154.286</Functionallength>
2070 44      <StepDiameterLength code="SDL1"
2071 45      nominal="9">9</StepDiameterLength>
2072 46      <PointAngle code="SIG" nominal="135" minimum="133"
2073 47      maximum="137">135</PointAngle>
2074 48      </Measurements>
2075 49      </CuttingItem>
2076 50      <CuttingItem indices="2" manufacturers="KMT" grade="KC7315
2077      ">>
2078 51      <Measurements>
2079 52      <CuttingDiameter code="DC2" nominal="12" maximum="
2080      12.011"
2081 53      minimum="12">12</CuttingDiameter>
2082 54      <Functionallength code="LF2" nominal="122.493"
2083 55      maximum="127.993"
2084 56      minimum="116.993">122.493</Functionallength>
2085 57      <StepDiameterLength code="SDL2"
2086 58      nominal="9">9</StepDiameterLength>
2087 59      </Measurements>

```

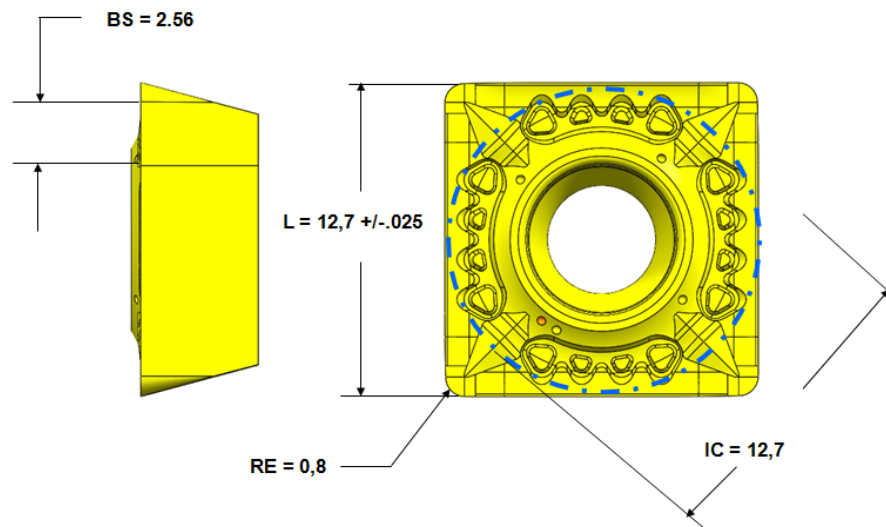
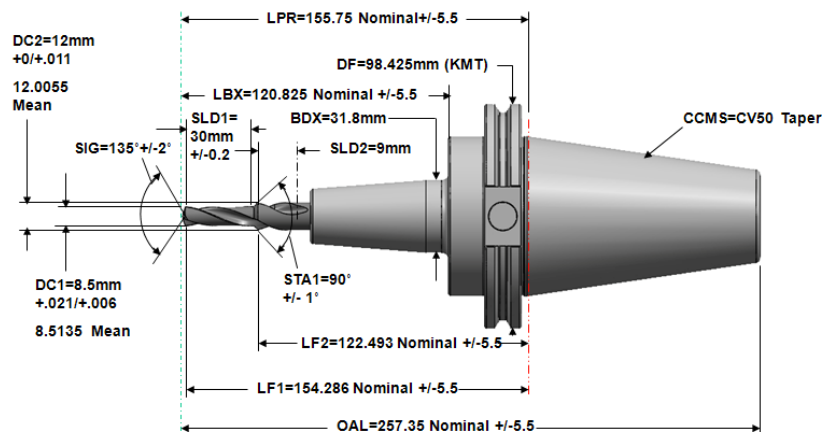


Figure 31: Indexable Insert Measurements

```

2088 60      </CuttingItem>
2089 61      </CuttingItems>
2090 62      </CuttingToolLifeCycle>
2091 63      </CuttingTool>
2092 64      </Assets>
2093 65      </MTConnectAssets>

```



Step Drill – KMT, B732A08500HP Grade KC7315

Adapter – Parlec, C50-M12SF300-6

Note: Adapter Dimensions Shown are for KMT holder which has adjustable length of +/-5mm (Drill length tolerance = +1/-0).

P3 Steel Drilling Parameters

Nominal Starting Parameters:

150 m/min (493 SFM)

0,23 mm/r (0.0085 in/r)

RPM 5893

Figure 32: Step Mill Side View

2094 B.6.3 Shell Mill with Individual Loci

Example 3: Example for Shell Mill with Explicate Loci

```

2095 1 <?xml version="1.0" encoding="UTF-8"?>
2096 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2097 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2098 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2099 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2100 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2101 >
2102 7 <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
2103 8 sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2104 />
2105 9 <Assets>
2106 10 <CuttingTool serialNumber="1" toolId="KSSP300R4SD43L240"
2107 11 timestamp="2011-05-11T13:55:22" assetId="KSSP300R4SD43L240.1"
2108 12 manufacturers="KMT,Parlec">
2109 13 <Description>Keyway: 55 degrees</Description>
2110 14 <CuttingToolLifeCycle>
2111 15 <CutterStatus><Status>NEW</Status></CutterStatus>
2112 16 <Measurements>
2113 17 <UsableLengthMax code="LUX"
2114 18 nominal="82.55">82.55</UsableLengthMax>
2115 19 <CuttingDiameterMax code="DC" nominal="76.2" maximum="
2116 20 76.213"
2117 20 minimum="76.187">76.2</CuttingDiameterMax>

```

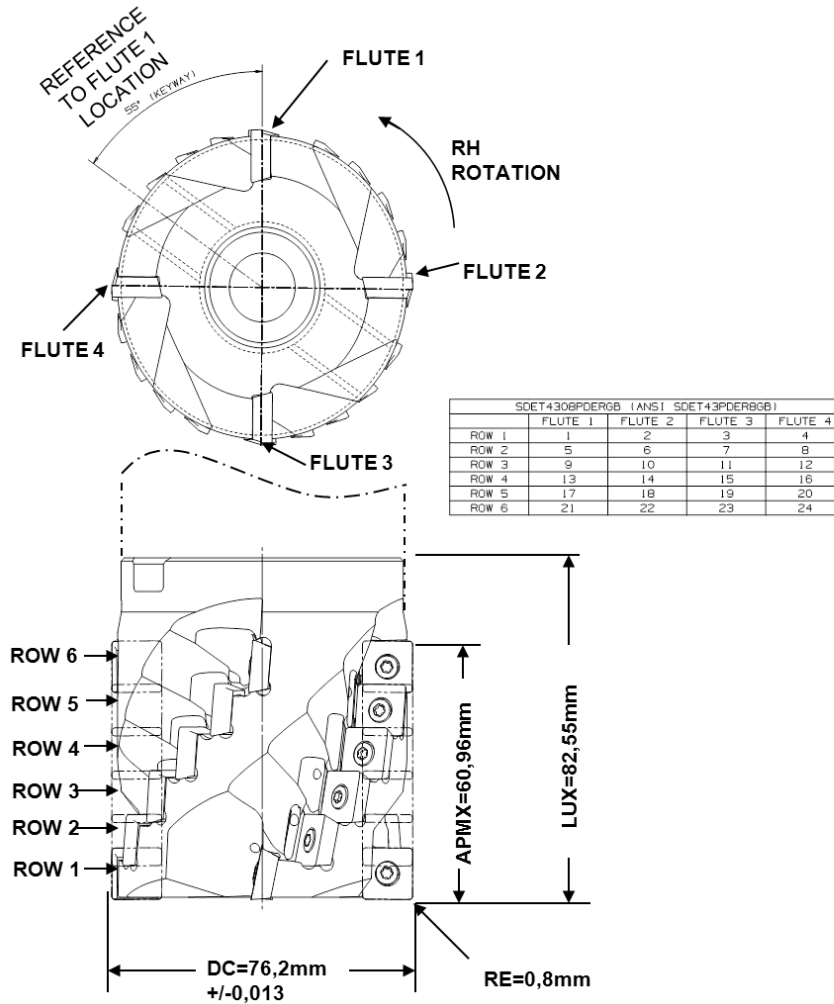


Figure 33: Shell Mill with Explicate Loci

```

2118 21      <DepthOfCutMax code="APMX" nominal="60.96">60.95</
2119          DepthOfCutMax>
2120 22      </Measurements>
2121 23      <CuttingItems count="24">
2122 24          <CuttingItem indices="1" itemId="SDET43PDER8GB"
2123 25              manufacturers="KMT">
2124 26              <Locus>FLUTE: 1, ROW: 1</Locus>
2125 27              <Measurements>
2126 28                  <DriveAngle code="DRVA" nominal="55">55</DriveAngle>
2127 29              </Measurements>
2128 30          </CuttingItem>
2129 31          <CuttingItem indices="2-24" itemId="SDET43PDER8GB"
2130 32              manufacturers="KMT">
2131 33              <Locus>FLUTE: 2-4, ROW: 1; FLUTE: 1-4, ROW 2-6</Locus>
2132 34          </CuttingItem>

```

```
2133 35         </CuttingItems>
2134 36     </CuttingToolLifeCycle>
2135 37 </CuttingTool>
2136 38 </Assets>
2137 39 </MTConnectAssets>
```

2138 B.6.4 Drill with Individual Loci

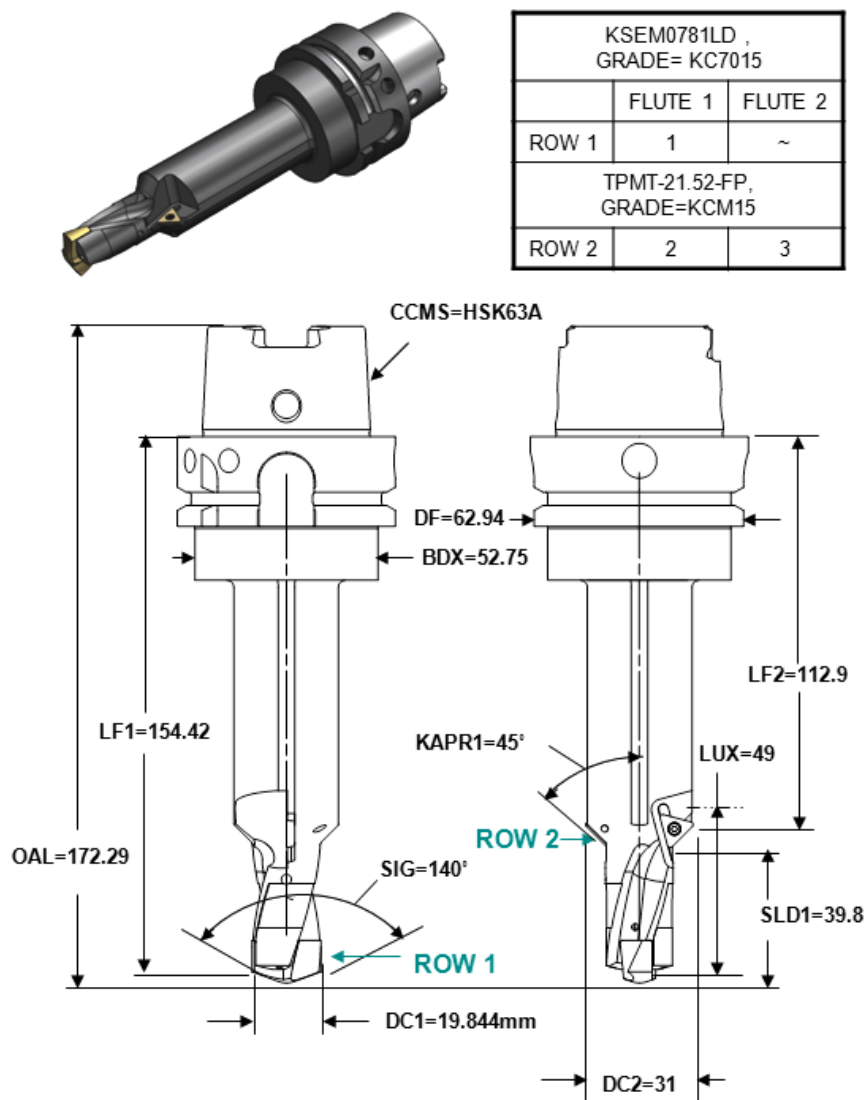


Figure 34: Step Drill with Explicate Loci

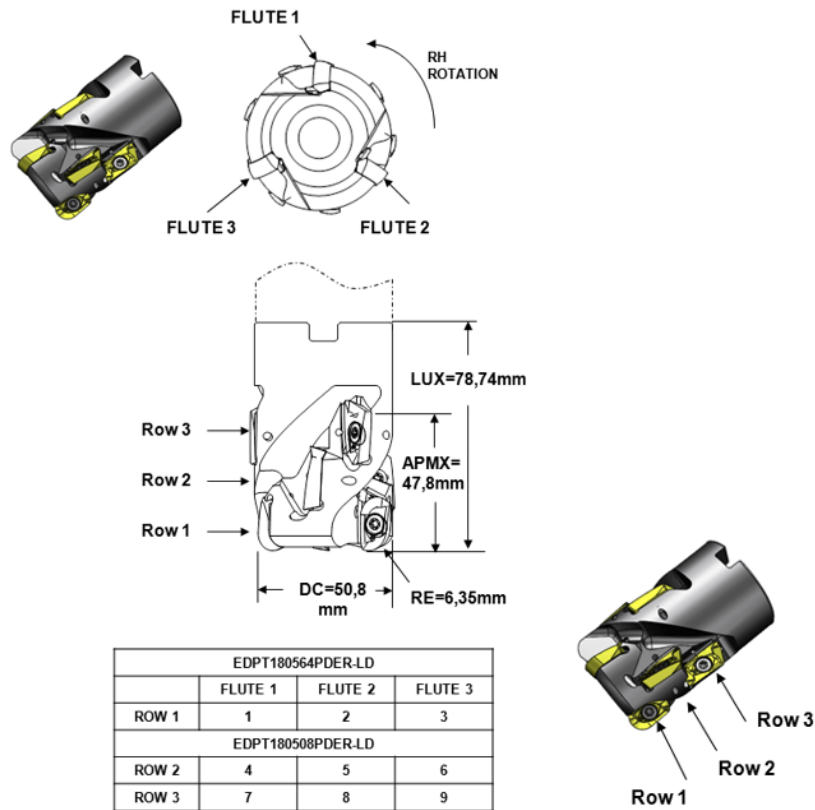
Example 4: Example for Step Drill with Explicate Loci

```
2139 1 <?xml version="1.0" encoding="UTF-8"?>
2140 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2141 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2142 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2143 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2144 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2145 7 >
2146 7 <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
```

```

2147 8   sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2148    />
2149 9   <Assets>
2150 10   <CuttingTool serialNumber="1" toolId="KSEM0781LD"
2151 11   timestamp="2011-05-11T13:55:22" assetId="KSEM0781LD.1"
2152   manufacturers="KMT">
2153 12   <CuttingToolLifeCycle>
2154 13   <CutterStatus><Status>NEW</Status></CutterStatus>
2155 14   <ConnectionCodeMachineSide>HSK63A</ConnectionCodeMachineSide
2156 15   >
2157 16   <Measurements>
2158 17   <BodyDiameterMax code="BDX">52.75</BodyDiameterMax>
2159 18   <OverallToolLength nominal="172.29"
2160 19   code="OAL">172.29</OverallToolLength>
2161 20   <UsableLengthMax code="LUX" nominal="49">49</
2162 21   UsableLengthMax>
2163 22   <FlangeDiameterMax code="DF"
2164 23   nominal="62.94">62.94</FlangeDiameterMax>
2165 24   </Measurements>
2166 25   <CuttingItems count="3">
2167 26   <CuttingItem indices="1" itemId="KSEM0781LD" manufacturers
2168 27   ="KMT"
2169 28   grade="KC7015">
2170 29   <Locus>FLUTE: 1, ROW: 1</Locus>
2171 30   <Measurements>
2172 31   <FunctionallLength code="LF1" nominal="154.42">154.42</
2173 32   FunctionallLength>
2174 33   <CuttingDiameter code="DC1" nominal="19.844">19.844</
2175 34   CuttingDiameter>
2176 35   <PointAngle code="SIG" nominal="140">140</PointAngle>
2177 36   <ToolCuttingEdgeAngle code="KAPR1" nominal="45">45</
2178 37   ToolCuttingEdgeAngle>
2179 38   <StepDiameterLength code="SLD1" nominal="39.8">39.8</
2180 39   StepDiameterLength>
2181 40   </Measurements>
2182 41   </CuttingItem>
2183 42   <CuttingItem indices="2-3" itemId="TPMT-21.52-FP"
2184 43   manufacturers="KMT" grade="KCM15">
2185 44   <Locus>FLUTE: 1-2, ROW: 2</Locus>
2186 45   <Measurements>
2187 46   <FunctionallLength code="LF2" nominal="112.9">119.2</
2188 47   FunctionallLength>
2189 48   <CuttingDiameter code="DC2" nominal="31">31</
2190 49   CuttingDiameter>
2191 50   </Measurements>
2192 51   </CuttingItem>
2193 52   </CuttingItems>
2194 53   </CuttingToolLifeCycle>
2195 54   </CuttingTool>
2196 55   </Assets>
2197 56   </MTConnectAssets>

```

2198 **B.6.5 Shell Mill with Different Inserts on First Row****Figure 35:** Shell Mill with Different Inserts on First Row**Example 5:** Example for Shell Mill with Different Inserts on First Row

```

2199 1 <?xml version="1.0" encoding="UTF-8"?>
2200 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2201 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2202 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2203 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2204 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2205 7 >
2206 8 <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
2207 9 sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2208 10 />
2209 11 <Assets>
2210 12 <CuttingTool serialNumber="1" toolId="XXX" timestamp="2011-05-11
2211 13 T13:55:22"
2212 14 assetId="XXX.1" manufacturers="KMT">
2213 15 <CuttingToolLifeCycle>
2214 16 <CutterStatus><Status>NEW</Status></CutterStatus>
2215 17 <Measurements>

```

```

2216 15      <DepthOfCutMax code="APMX" nominal="47.8">47.8</
2217      DepthOfCutMax>
2218 16      <CuttingDiameterMax code="DC"
2219 17      nominal="50.8">50.8</CuttingDiameterMax>
2220 18      <UsableLengthMax code="LUX"
2221 19      nominal="78.74">78.74</UsableLengthMax>
2222 20      </Measurements>
2223 21      <CuttingItems count="9">
2224 22      <CuttingItem indices="1-3" itemId="EDPT180564PDER-LD"
2225 23      manufacturers="KMT">
2226 24      <Locus>FLUTE: 1-3, ROW: 1</Locus>
2227 25      <Measurements>
2228 26      <CornerRadius code="RE" nominal="6.25">6.35</
2229      CornerRadius>
2230 27      </Measurements>
2231 28      </CuttingItem>
2232 29      <CuttingItem indices="4-9" itemId="EDPT180508PDER-LD"
2233 30      manufacturers="KMT">
2234 31      <Locus>FLANGE: 1-4, ROW: 2-3</Locus>
2235 32      </CuttingItem>
2236 33      </CuttingItems>
2237 34      </CuttingToolLifeCycle>
2238 35      </CuttingTool>
2239 36      </Assets>
2240 37      </MTConnectAssets>

```

2241 B.7 File Schema Diagrams

2242 See File element in MTConnectAssets schema.

2243 B.8 RawMaterial Schema Diagrams

2244 See RawMaterial element in MTConnectAssets schema.

2245 B.9 QIFDocumentWrapper Schema Diagrams

2246 See QIFDocumentWrapper element in MTConnectAssets schema.