



MTConnect[®] Standard

Part 4.0 – Asset Information Model

Version 2.1.0

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

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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 ***client***

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

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

43 ***controlled vocabulary***

44 restricted set of values that may be published for an observation.

45 ***data dictionary***

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

47 ***data model***

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

50 ***data set***

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

52 ***data source***

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

54 ***deprecated***

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56 is regarded as being obsolete or superseded.

57 ***deprecation warning***

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

60 ***document***

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

63 ***electric current***

64 rate of flow of electric charge.

65 ***element***

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

67 ***extensible***

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

70 ***force***

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

72 ***heartbeat***

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

76 ***higher level***

77 nested element that is above a lower level element.

78 ***implementation***

79 specific instantiation of the MTConnect Standard.

80 ***information model***

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

83 ***instance***

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

86 ***interaction model***

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

89 ***interface***

90 means by which communication is achieved between independent systems.

91 ***key***

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

93 ***key-value pair***

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

96 ***lower camel case***

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

99 ***lower level***

100 nested element that is below a higher level element.

101 ***lower limit***

102 lower conformance boundary for a variable.

103 ***lower warning***

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

105 ***major***

106 identifier representing a consistent set of functionalities defined by the MTConnect
107 Standard.

108 ***maximum***

109 numeric upper constraint.

110 ***message***

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

112 ***metadata***

113 data that provides information about other data.

114 ***minimum***

115 numeric lower constraint.

116 ***minor***

117 identifier representing a specific set of functionalities defined by the MTConnect
118 Standard.

119 ***nominal***

120 ideal or desired value for a variable.

121 ***organize***

122 act of containing and owning one or more elements.

123 ***organizer***

124 entity that *organizes* one or more elements.

125 ***parameter***

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

128 ***part***

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

132 ***pascal case***

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

135 ***persistence***

136 method for retaining or restoring information.

137 ***probe***

138 instrument commonly used for measuring the physical geometrical characteristics
139 of an object.

140 ***profile***

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

144 ***requester***

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

146 ***reset***

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

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

150 ***responder***

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

152 ***response document***

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

155 ***revision***

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

159 ***schema***

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

162 ***semantic data model***

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

165 ***sensing element***

166 mechanism that provides a signal or measured value.

167 ***sequence number***

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

170 ***specification limit***

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

172 ***spindle***

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

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

175 ***standard***

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

178 ***stereotype***

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

180 ***subtype***

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

182 ***table***

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

- 184 ***table cell***
 185 subdivision of a *table entry* representing a singular value.
- 186 ***table entry***
 187 subdivision of a *table* containing a set of *key-value pairs* representing *table cells*.
- 188 ***top level***
 189 element that represents the most significant physical or logical functions of a piece
 190 of equipment.
- 191 ***type***
 192 classification or categorization of information.
- 193 ***upper limit***
 194 upper conformance boundary for a variable.
- 195 ***upper warning***
 196 upper boundary indicating increased concern and supervision may be required.
- 197 ***version***
 198 unique identifier of the administered item. *Ref ISO/IEC 11179-:2015*

199 2.2 Information Model Terms

- 200 ***Asset Information Model***
 201 *information model* that provides semantic models for *Assets*.
- 202 ***Device Information Model***
 203 *information model* that describes the physical and logical configuration for a piece
 204 of equipment and the data that may be reported by that equipment.
- 205 ***Error Information Model***
 206 *information model* that describes the *response document* returned by an *agent* when
 207 it encounters an error while interpreting a *request* for information from a *client* or
 208 when an *agent* experiences an error while publishing the *response* to a *request* for
 209 information.
- 210 ***MTConnect Information Model***
 211 *information model* that defines the semantics of the MTConnect Standard.

212 ***Observation Information Model***

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

215 **2.3 Protocol Terms**

216 ***asset request***

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

218 ***current request***

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

222 ***data streaming***

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

225 ***MTConnect Request***

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

227 ***MTConnect Response Document***

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

229 ***MTConnectAssets Response Document***

230 *response document* published by an *MTConnect Agent* in response to an *asset re-*
231 *quest*.

232 ***MTConnectDevices Response Document***

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

235 ***MTConnectErrors Response Document***

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

238 ***MTConnectStreams Response Document***

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

241 ***probe request***

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

244 ***protocol***

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

247 ***publish***

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

249 ***publish and subscribe***

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

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

254 ***request***

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

257 ***request and response***

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

260 ***response***

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

262 ***sample request***

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

266 ***streaming data***

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

268 ***subscribe***

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

270 ***transport protocol***

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

273 2.4 HTTP Terms

274 **HTTP Body**

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

277 **HTTP Error Message**

278 response provided by an *agent* indicating that an *HTTP Request* is incorrectly for-
279 matted or identifies that the requested data is not available from the *agent*. *Ref IETF:RFC-*
280 *2616*

281 **HTTP Header**

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

284 **HTTP Header Field**

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

287 **HTTP Message**

288 consist of requests from client to server and responses from server to client. *Ref IETF:RFC-*
289 *2616*

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

292 **HTTP Messaging**

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

294 **HTTP Method**

295 portion of a command in an *HTTP Request* that indicates the desired action to be
296 performed on the identified resource; often referred to as verbs. *Ref IETF:RFC-*
297 *2616*

298 **HTTP Query**

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

301 **HTTP Request**

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

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

307 ***HTTP Request Line***

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

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

313 ***HTTP Request Method***

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

316 ***HTTP Request URI***

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

319 ***HTTP Response***

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

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

324 ***HTTP Server***

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

327 ***HTTP Status Code***

328 3-digit integer result code of the attempt to understand and satisfy the request.
329 *Ref IETF:RFC-2616*

330 ***HTTP Version***

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

332 2.5 XML Terms

333 ***abstract element***

334 element that defines a set of common characteristics that are shared by a group of
335 elements. An abstract entity cannot appear in a document. In a specific implemen-
336 tation, an abstract entity is replaced by a derived element that is itself not an abstract
337 entity. The characteristics for the derived element are inherited from the abstract
338 entity.

339 ***attribute***

340 additional information or property for an *element*.

341 ***child element***

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

344 ***document body***

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

348 ***document header***

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

353 ***element name***

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

356 ***namespace***

357 organizes information into logical groups.

358 ***parent element***

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

361 ***root element***

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

363 ***structural element***

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

366 ***XML Document***

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

368 ***XML Schema***

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

370 **2.6 MTConnect Terms**

371 ***Asset***

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

373 Note 1 to entry: An *Asset* relies upon an *Device* to provide observations
 374 and information about itself and the *Device* revises the information to
 375 reflect changes to the *Asset* during their interaction. Examples of *Assets*
 376 are cutting tools, Part Information, Manufacturing Processes, Fixtures,
 377 and Files.

378 Note 2 to entry: A singular `assetId`, *Asset* uniquely identifies an
 379 *Asset* throughout its lifecycle and is used to track and relate the *Asset* to
 380 other *Devices* and entities.

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

384 ***Component***

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

386 ***Composition***

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

388 ***Configuration***

389 configuration for a *Component*

390 ***DataItem***

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

392 ***Device***

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

394 ***MTConnect Agent***

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

396 ***MTConnect Document***

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

398 ***MTConnect Event***

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

400 ***MTConnect Interface***

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

402 ***Observation***

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

404 **2.7 Acronyms**

405 ***2D***

406 *two-dimensional*

407 ***3D***

408 *three-dimensional*

409 ***AI***

410 *artificial intelligence*

411 ***ALM***

412 *application lifecycle management*

413 ***AMT***

414 *The Association for Manufacturing Technology*

415 ***ANSI***

416 *American National Standards Institute*

417	<i>AP</i>	
418		Application Protocol
419	<i>API</i>	
420		application programming interface
421	<i>ASME</i>	
422		American Society of Mechanical Engineers
423	<i>ASTM</i>	
424		American Society for Testing and Materials
425	<i>AWS</i>	
426		American Welding Society
427	<i>BDD</i>	
428		block definition diagram
429	<i>BOM</i>	
430		bill of materials
431	<i>BST</i>	
432		Board on Standardization and Testing
433	<i>C&R</i>	
434		cause and remedy
435	<i>CA</i>	
436		certificate authority
437	<i>CAD</i>	
438		computer-aided design
439	<i>CAE</i>	
440		computer-aided engineering
441	<i>CAI</i>	
442		computer-aided inspection
443	<i>CAM</i>	
444		computer-aided manufacturing

445	CAx	
446		computer-aided technologies
447	CDATA	
448		Character Data
449	CFD	
450		computational fluid dynamics
451	CM	
452		configuration management
453	CMS	
454		coordinate-measurement system
455	CNC	
456		Computer Numerical Controller
457	CNRI	
458		Corporation for National Research Initiatives
459	CPM	
460		Core Product Model
461	CPM2	
462		Revised Core Product Model
463	CPSC	
464		Consumer Product Safety Commission
465	cUAV	
466		configurable unmanned aerial vehicle
467	DARPA	
468		Defense Advanced Research Projects Agency
469	DER	
470		designated-engineering representative
471	DFM	
472		design for manufacturing

473	<i>DLA</i>	
474		Defense Logistics Agency
475	<i>DMC</i>	
476		digital manufacturing certificate
477	<i>DMSC</i>	
478		Dimensional Metrology Standards Consortium
479	<i>DNS</i>	
480		Domain Name System
481	<i>DoD</i>	
482		U.S. Department of Defense
483	<i>DOI</i>	
484		Distributed Object Identifier
485	<i>DRM</i>	
486		digital rights management
487	<i>ECR</i>	
488		engineering change request
489	<i>ERP</i>	
490		enterprise resource planning
491	<i>FAA</i>	
492		Federal Aviation Administration
493	<i>FAIR</i>	
494		first article inspection reporting
495	<i>FDA</i>	
496		Food and Drug Administration
497	<i>FEA</i>	
498		finite-element analysis
499	<i>GD&T</i>	
500		geometric dimensions and tolerances

501	<i>GID</i>
502	global identifier
503	<i>HMI</i>
504	Human Machine Interface
505	<i>HTML</i>
506	Hypertext Markup Language
507	<i>HTTP</i>
508	Hypertext Transfer Protocol
509	<i>HTTPS</i>
510	Hypertext Transfer Protocol over Secure Sockets Layer
511	<i>I/O</i>
512	in-out
513	<i>ID</i>
514	identifier
515	<i>IEEE</i>
516	Institute of Electrical and Electronics Engineers
517	<i>IIoT</i>
518	industrial internet of things
519	<i>INCOSE</i>
520	International Council on Systems Engineering
521	<i>IP</i>
522	intellectual property
523	<i>ISO</i>
524	International Standards Organization
525	<i>ISS</i>
526	International Space Station
527	<i>ISV</i>
528	Independent Software Vendor

529	<i>IT</i>	
530		information technology
531	<i>ITU-T</i>	
532		Telecommunication Standardization Sector of the International Telecommunication
533		Union
534	<i>JSON</i>	
535		JavaScript Object Notation
536	<i>JT</i>	
537		Jupiter Tessellation
538	<i>LHS</i>	
539		Lifecycle Handler System
540	<i>LIFT</i>	
541		Lifecycle Information Framework and Technology
542	<i>LOI</i>	
543		Lifecycle Object Identifier
544	<i>MAC</i>	
545		media access control
546	<i>MADE</i>	
547		Manufacturing Automation and Design Engineering
548	<i>MBD</i>	
549		model-based definition
550	<i>MBE</i>	
551		Model-Based Enterprise
552	<i>MBI</i>	
553		model-based inspection
554	<i>MBM</i>	
555		model-based manufacturing

556	<i>MBSD</i>	
557		model-based standards development
558	<i>MBSE</i>	
559		model-based systems engineering
560	<i>MEDALS</i>	
561		Military Engineering Data Asset Locator System
562	<i>MES</i>	
563		manufacturing execution system
564	<i>MOI</i>	
565		manufacturing object identifier
566	<i>MOM</i>	
567		Message Orienged Middleware
568	<i>MQTT</i>	
569		Message Queuing Telemetry Transport
570	<i>MTC</i>	
571		Manufacturing Technology Centre
572	<i>NASA</i>	
573		National Aeronautics and Space Administration
574	<i>NC</i>	
575		numerical control
576	<i>NIST</i>	
577		National Institute of Standards and Technology
578	<i>NMTOKEN</i>	
579		Name Token
580	<i>NNMI</i>	
581		National Network of Manufacturing Innovation
582	<i>NSF</i>	
583		National Science Foundation

584	<i>NTSC</i>
585	National Transportation Safety Board
586	<i>OASIS</i>
587	Organization for the Advancement of Structured Information Standards
588	<i>ODI</i>
589	Open Data Institute
590	<i>OEM</i>
591	original equipment manufacturer
592	<i>OOI</i>
593	Ocean Observatories Initiative
594	<i>OPC</i>
595	OLE for Process Control
596	<i>OSLC</i>
597	Open Services for Lifecycle Collaboration
598	<i>OSTP</i>
599	Office of Science and Technology Policy
600	<i>OT</i>
601	operational technology
602	<i>OWL</i>
603	Ontology Web Language
604	<i>PDF</i>
605	Portable Document Format
606	<i>PDM</i>
607	product-data management
608	<i>PDQ</i>
609	product-data quality
610	<i>PHM</i>
611	prognosis and health monitoring

612	<i>PI</i>	
613		principal investigator
614	<i>PLC</i>	
615		Programmable Logic Controller
616	<i>PLCS</i>	
617		Product Life Cycle Support
618	<i>PLM</i>	
619		product lifecycle management
620	<i>PLOT</i>	
621		product lifecycle of trust
622	<i>PMI</i>	
623		product and manufacturing information
624	<i>PMS</i>	
625		Production Management System
626	<i>PRC</i>	
627		Product Representation Compact
628	<i>PSI</i>	
629		Physical Science Informatics
630	<i>PTAB</i>	
631		Primary Trustworthy Digital Repository Authorization Body Ltd.
632	<i>QIF</i>	
633		Quality Information Framework
634	<i>QMS</i>	
635		quality management system
636	<i>QName</i>	
637		Qualified Name
638	<i>RDF</i>	
639		Resource Description Framework

640	<i>REST</i>
641	Representational State Transfer
642	<i>RII</i>
643	receiving and incoming inspection
644	<i>S/MIME</i>
645	Secure/Multipurpose Internet Mail Extensions
646	<i>SaaS</i>
647	software-as-a-service
648	<i>SAML</i>
649	Security Assertion Markup Language
650	<i>SC</i>
651	Standards Committee
652	<i>SCADA</i>
653	Supervisory Control And Data Acquisition
654	<i>SDO</i>
655	Standards Development Organization
656	<i>SFTP</i>
657	Secure File Transfer Protocol
658	<i>SKOS</i>
659	Simple Knowledge Organization System
660	<i>SLH</i>
661	system lifecycle handler
662	<i>SLR</i>
663	systematic literature review
664	<i>SME</i>
665	small-to-medium enterprise
666	<i>SMOPAC</i>
667	Smart Manufacturing Operations Planning and Control

668	<i>SMS Test Bed</i>
669	Smart Manufacturing Systems Test Bed
670	<i>SOA</i>
671	service-oriented architecture
672	<i>SPMM</i>
673	semantic-based product metamodel
674	<i>SSL</i>
675	Secure Sockets Layer
676	<i>STEP</i>
677	Standard for the Exchange of Product Model Data
678	<i>STEP AP242</i>
679	Standard for the Exchange of Product Model Data Application Protocol 242
680	<i>STL</i>
681	Stereolithography
682	<i>SysML</i>
683	Systems Modeling Language
684	<i>TCP/IP</i>
685	Transmission Control Protocol/Internet Protocol
686	<i>TDP</i>
687	technical data package
688	<i>TLS</i>
689	Transport Layer Security
690	<i>TSM</i>
691	Total System Model
692	<i>UA</i>
693	Unified Architecture
694	<i>UAL</i>
695	Unified Architecture Language

696	<i>UML</i>	
697		Unified Modeling Language
698	<i>URI</i>	
699		Uniform Resource Identifier
700	<i>URL</i>	
701		Uniform Resource Locator
702	<i>URN</i>	
703		Uniform Resource Name
704	<i>UTC</i>	
705		Coordinated Universal Time
706	<i>UUID</i>	
707		Universally Unique Identifier
708	<i>V&V</i>	
709		verification and validation
710	<i>W3C</i>	
711		World Wide Web Consortium
712	<i>WSN</i>	
713		Wirth Syntax Notation
714	<i>WWW</i>	
715		World Wide Web
716	<i>X.509-PKI</i>	
717		Public Key Infrastructure
718	<i>X.509-PMI</i>	
719		Privilege Management Infrastructure
720	<i>XML</i>	
721		Extensible Markup Language
722	<i>XPath</i>	
723		XML Path Language
724	<i>XSD</i>	
725		XML Schema Definitions

726 2.8 MTConnect References

- 727 [MTConnect Part 1.0] *MTConnect Standard Part 1.0 - Fundamentals*. Version 2.0.
- 728 [MTConnect Part 2.0] *MTConnect Standard: Part 2.0 - Device Information Model*. Ver-
729 sion 2.0.
- 730 [MTConnect Part 3.0] *MTConnect Standard: Part 3.0 - Observation Information Model*.
731 Version 2.0.
- 732 [MTConnect Part 4.0] *MTConnect Standard: Part 4.0 - Asset Information Model*. Ver-
733 sion 2.0.

734

735 3 Asset Information Model

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

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

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

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

760 3.1 Asset

761 abstract *Asset*.

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

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

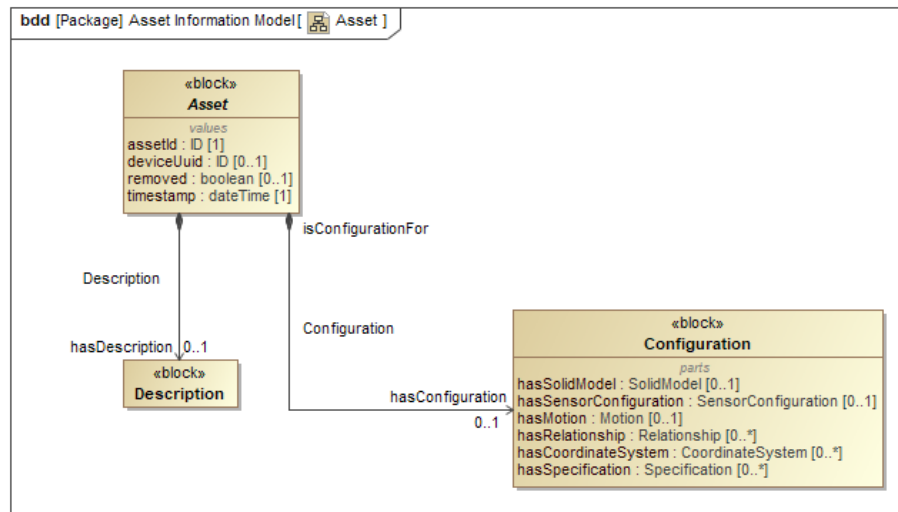


Figure 1: Asset

3.1.1 Value Properties of Asset

Table 1 lists the Value Properties of Asset.

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

Table 1: Value Properties of Asset

Descriptions for Value Properties of Asset:

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

- 778 • timestamp
- 779 time the Asset data was last modified.

780 3.1.2 Part Properties of Asset

781 Table 2 lists the Part Properties of Asset.

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

Table 2: Part Properties of Asset

782 Descriptions for Part Properties of Asset:

- 783 • Description
- 784 descriptive content.
- 785 This can contain configuration information and manufacturer specific details.
- 786 • Configuration
- 787 technical information about an entity describing its physical layout, functional characteristics, and relationships with other entities.
- 788 See Configuration in *MTConnect Standard: Part 2.0 - Device Information Model*.
- 789
- 790

791 4 Cutting Tool Asset Information Model

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

800 MTConnect Standard will adopt the ISO 13399 structure when formulating the vocabulary
 801 for Cutting Tool geometries and structure to be represented in the `CuttingToolArchetype`.
 802 The nominal values provided in the `CuttingToolLifeCycle` section are only con-
 803 cerned with two aspects of the Cutting Tool; the Cutting Tool and the cutting item. The
 804 tool item, Adaptive Item, and Assembly Item will only be covered in the `Cutting-`
 805 `ToolDefinition` section of this document since this section contains the full ISO
 806 13399 information about a Cutting Tool.



Figure 2: Cutting Tool Parts

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

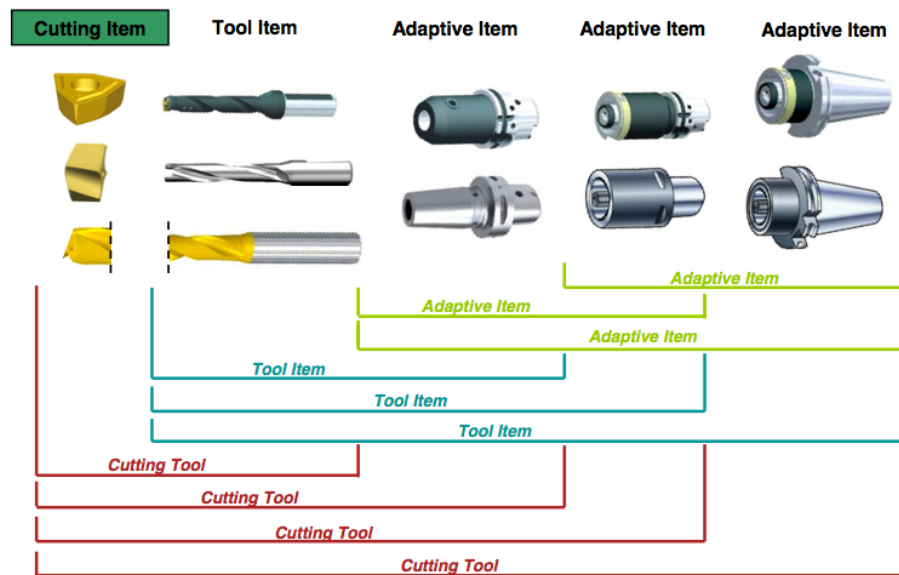


Figure 3: Cutting Tool Composition

Figure 3 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 4 and Figure 5 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

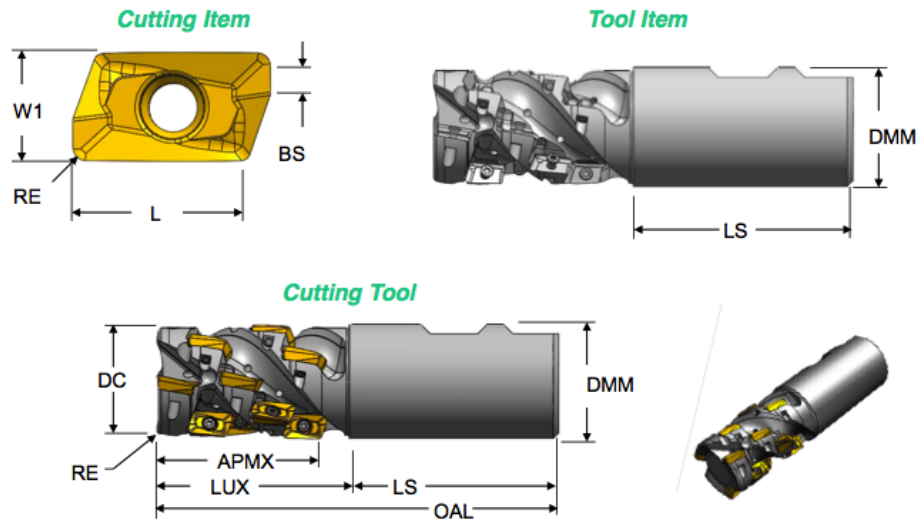


Figure 4: Cutting Tool, Tool Item, and Cutting Item

830 4.1 Cutting Tool

831 This section provides semantic information for the `CuttingTool` and `CuttingToolArchetype`
832 models.

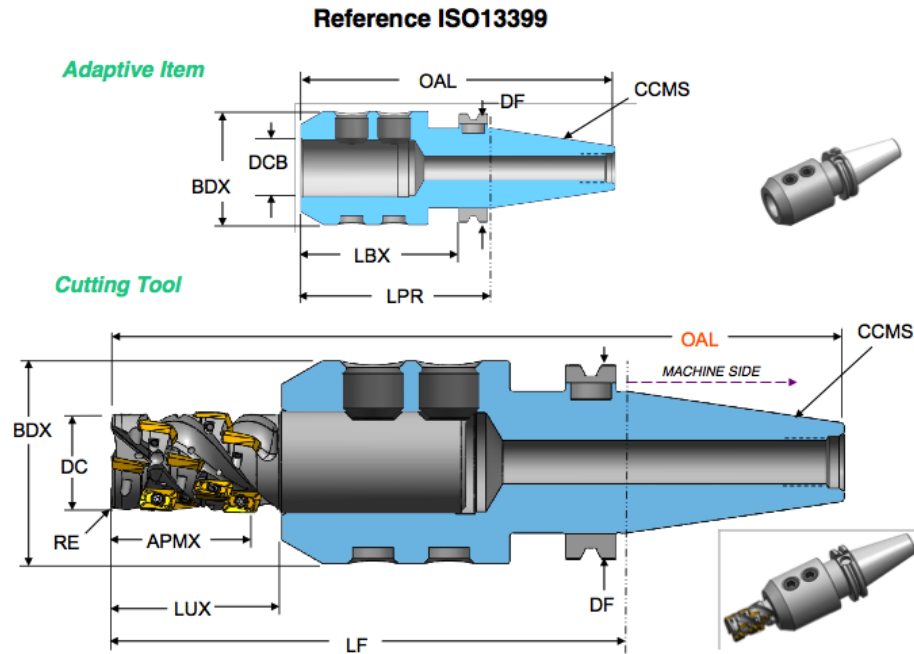
833 Note: See *Section B.2 - CuttingTool Schema Diagrams* for XML schema.

834 4.1.1 CuttingTool

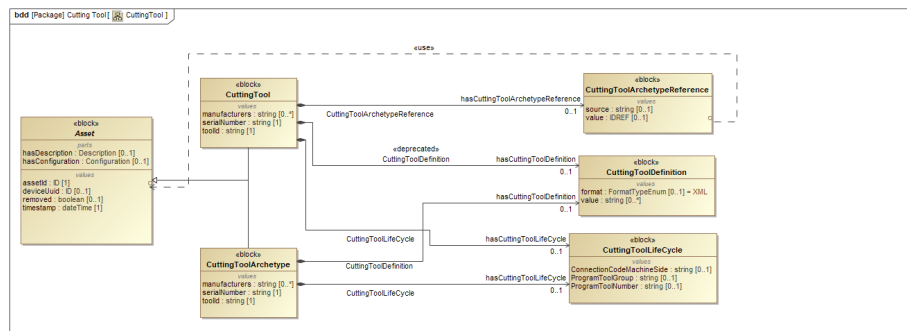
835 Asset that physically removes the material from the workpiece by shear deformation.

836 4.1.1.1 Value Properties of CuttingTool

837 Table 3 lists the Value Properties of `CuttingTool`.

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

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

Table 3: Value Properties of CuttingTool**Figure 6: CuttingTool**

838 Descriptions for Value Properties of CuttingTool:

- 839 • manufacturers
- 840 manufacturers of the cutting tool.
- 841 This will reference the tool item and adaptive items specifically. The cutting items
- 842 manufacturers' will be a property of CuttingItem.

843 Note: In XML, the representation **MUST** be a comma(,) delimited list of

844 manufacturer names. See *Section B.2 - CuttingTool Schema Diagrams*.

- 845 • serialNumber
- 846 unique identifier for this assembly.
- 847 • toolId
- 848 identifier for a class of cutting tools.

849 4.1.1.2 Part Properties of CuttingTool

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

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

Table 4: Part Properties of CuttingTool

851 Descriptions for Part Properties of CuttingTool:

- 852 • CuttingToolLifeCycle
- 853 data regarding the application or use of the tool.
- 854 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
- 855 and statistical process control applications. Life cycle data will not remain static,
- 856 but will change periodically when a tool is used or measured.
- 857 See *Section 4.2.1 - CuttingToolLifeCycle*.
- 858 • CuttingToolArchetypeReference
- 859 reference information about the `assetId` and/or the URL of the data source of
- 860 CuttingToolArchetype.

- 861 • <<deprecated>> `CuttingToolDefinition`
- 862 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO*
- 863 *13399*.
- 864 **DEPRECATED** in *Version 1.3.0* for `CuttingTool`.

865 4.1.2 CuttingToolArchetype

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

868 4.1.2.1 Value Properties of CuttingToolArchetype

869 Table 5 lists the Value Properties of `CuttingToolArchetype`.

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

Table 5: Value Properties of `CuttingToolArchetype`

870 Descriptions for Value Properties of `CuttingToolArchetype`:

- 871 • `manufacturers`
- 872 manufacturers of the cutting tool.
- 873 This will reference the tool item and adaptive items specifically. The cutting items
- 874 manufacturers' will be a property of `CuttingItem`.

875 Note: In XML, the representation will be a comma(,) delimited list of
876 manufacturer names. See *Section B.2 - CuttingTool Schema Diagrams*.

- 877 • `serialNumber`
- 878 unique identifier for this assembly.
- 879 • `toolId`
- 880 identifier for a class of cutting tools.

881 4.1.2.2 Part Properties of CuttingToolArchetype

882 Table 6 lists the Part Properties of CuttingToolArchetype.

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

Table 6: Part Properties of CuttingToolArchetype

883 Descriptions for Part Properties of CuttingToolArchetype:

- 884 • <<deprecated>> CuttingToolDefinition
 - 885 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO*
 - 886 *13399.*
 - 887 **DEPRECATED** in *Version 2.1.0* for CuttingToolArchetype.
- 888 • CuttingToolLifeCycle
 - 889 data regarding the application or use of the tool.
 - 890 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
 - 891 and statistical process control applications. Life cycle data will not remain static,
 - 892 but will change periodically when a tool is used or measured.
 - 893 See *Section 4.2.1 - CuttingToolLifeCycle.*

894 4.1.3 CuttingToolArchetypeReference

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

897 The value of `CuttingToolArchetypeReference` **MUST** be IDREF. See *Section 8.1.10*
898 - *IDREF*.

899 4.1.3.1 Value Properties of CuttingToolArchetypeReference

900 Table 7 lists the Value Properties of CuttingToolArchetypeReference.

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

Table 7: Value Properties of CuttingToolArchetypeReference

901 Descriptions for Value Properties of CuttingToolArchetypeReference:

- 902 • source
- 903 Uniform Resource Locator (URL) of the CuttingToolArchetype *information*
- 904 *model*.

905 4.1.4 <<deprecated>>CuttingToolDefinition

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

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

908 4.1.4.1 Value Properties of CuttingToolDefinition

909 Table 8 lists the Value Properties of CuttingToolDefinition.

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

Table 8: Value Properties of CuttingToolDefinition

910 Descriptions for Value Properties of CuttingToolDefinition:

- 911 • format
- 912 identifies the expected representation of the enclosed data.

913 4.2 Cutting Tool Life Cycle

914 This section provides semantic information for the CuttingToolLifeCycle model.

915 Note: See Section B.3 - CuttingToolLifeCycle Schema Diagrams for XML

916 schema.

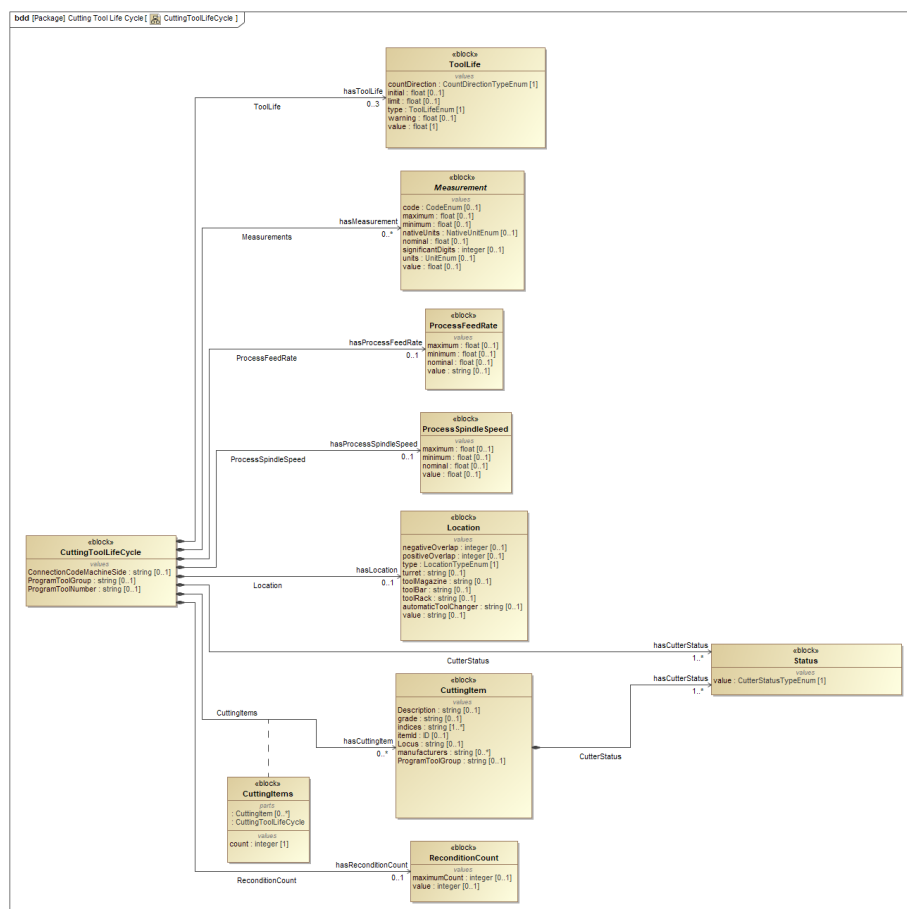


Figure 7: CuttingToolLifeCycle

917 4.2.1 CuttingToolLifeCycle

918 data regarding the application or use of the tool.

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

922 4.2.1.1 Value Properties of CuttingToolLifeCycle

923 *Table 9* lists the Value Properties of `CuttingToolLifeCycle`.

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

Table 9: Value Properties of CuttingToolLifeCycle

924 Descriptions for Value Properties of CuttingToolLifeCycle:

- 925 • ConnectionCodeMachineSide
- 926 identifier for the capability to connect any component of the cutting tool together,
- 927 except Assembly Items, on the machine side. Code: CCMS
- 928 • ProgramToolGroup
- 929 tool group this tool is assigned in the part program.
- 930 • ProgramToolNumber
- 931 number of the tool as referenced in the part program.

932 4.2.1.2 Part Properties of CuttingToolLifeCycle

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

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

Table 10: Part Properties of CuttingToolLifeCycle

934 Descriptions for Part Properties of CuttingToolLifeCycle:

- 935 • ProcessFeedRate
- 936 constrained process feed rate for the tool in mm/s.

937 The value **MAY** contain the nominal process target feed rate if available. If `ProcessFeedRate`
 938 is provided, at least one value of maximum, nominal, or minimum **MUST** be specified.
 939

940 See *Section 4.2.6 - ProcessFeedRate*.

941 • `ToolLife`
 942 cutting tool life as related to the assembly.

943 See *Section 4.2.2 - ToolLife*.

944 • `ProcessSpindleSpeed`
 945 constrained process spindle speed for the tool in revolutions/minute.

946 The value **MAY** contain the nominal process target spindle speed if available. If
 947 `ProcessSpindleSpeed` is provided, at least one value of maximum, nominal, or minimum **MUST** be specified.
 948

949 See *Section 4.2.5 - ProcessSpindleSpeed*.

950 • `Status`
 951 status of the cutting tool.

952 `CutterStatus` provides the status of the assembly and *organize* one or more
 953 `Status` entities. See *Section 4.2.7 - Status*.

954 The following combinations of `Status` entities **MUST NOT** occur for a `Cut-`
 955 `terStatus`:

- 956 – `NEW` **MUST NOT** be used with `USED`, `RECONDITIONED`, or `EXPIRED`.
- 957 – `UNKNOWN` **MUST NOT** be used with any other status.
- 958 – `ALLOCATED` and `UNALLOCATED` **MUST NOT** be used together.
- 959 – `AVAILABLE` and `UNAVAILABLE` **MUST NOT** be used together.
- 960 – If the tool is `EXPIRED`, `BROKEN`, or `NOT_REGISTERED` it **MUST NOT** be
 961 `AVAILABLE`.

962 • `CuttingItem`
 963 part of of the tool that physically removes the material from the workpiece by shear
 964 deformation.

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

967 • `Measurement`
 968 constrained scalar value associated with a cutting tool.

969 `Measurements` groups one or more `Measurement` subtypes. See *Section 4.2.8*
 970 *- Measurement*.

- 971 • `ReconditionCount`
 972 number of times the cutter has been reconditioned.
 973 See *Section 4.2.4 - ReconditionCount*.
- 974 • `Location`
 975 location of the pot or spindle the cutting tool currently resides in.
 976 If `negativeOverlap` or `positiveOverlap` is provided, the tool reserves ad-
 977 ditional locations on either side, otherwise if they are not given, no additional loca-
 978 tions are required for this tool.
 979 If the pot occupies the first or last location, a rollover to the beginning or the end of
 980 the indexable values may occur. For example, if there are 64 pots and the tool is in
 981 pot 64 with a `positiveOverlap` of 1, the first pot **MAY** be occupied as well.
 982 See *Section 4.2.3 - Location* for more detail.

983 4.2.2 ToolLife

984 cutting tool life as related to the assembly.

985 `ToolLife` **MUST** be defined only for the `CuttingToolLifeCycle` of `Cutting-`
 986 `Tool` and **MUST NOT** be defined for the `CuttingToolLifeCycle` of `Cutting-`
 987 `ToolArchetype`.

988 The value of `ToolLife` **MUST** be float.

989 4.2.2.1 Value Properties of ToolLife

990 *Table 11* 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 11: Value Properties of `ToolLife`

991 Descriptions for Value Properties of `ToolLife`:

992 • `countDirection`
 993 indicates if the tool life counts from zero to maximum or maximum to zero.
 994 CountDirectionTypeEnum Enumeration:

995 – DOWN
 996 tool life counts down from the maximum to zero.

997 – UP
 998 tool life counts up from zero to the maximum.

999 • `initial`
 1000 initial life of the tool when it is new.

1001 • `limit`
 1002 end of life limit for the tool.

1003 • `type`
 1004 type of tool life being accumulated.
 1005 ToolLifeEnum Enumeration:

1006 – MINUTES
 1007 tool life measured in minutes.
 1008 All units for minimum, maximum, and nominal **MUST** be provided in min-
 1009 utes.

1010 – PART_COUNT
 1011 tool life measured in parts.
 1012 All units for minimum, maximum, and nominal **MUST** be provided as the
 1013 number of parts.

1014 – WEAR
 1015 tool life measured in tool wear.
 1016 Wear **MUST** be provided in millimeters as an offset to nominal. All units for
 1017 minimum, maximum, and nominal **MUST** be given as millimeter offsets as
 1018 well. The standard will only consider dimensional wear at this time.

1019 • `warning`
 1020 point at which a tool life warning will be raised.

1021 4.2.3 Location

1022 location of the pot or spindle the cutting tool currently resides in.

1023 If `negativeOverlap` or `positiveOverlap` is provided, the tool reserves additional
1024 locations on either side, otherwise if they are not given, no additional locations are required
1025 for this tool.

1026 If the pot occupies the first or last location, a rollover to the beginning or the end of the
1027 indexable values may occur. For example, if there are 64 pots and the tool is in pot 64 with
1028 a `positiveOverlap` of 1, the first pot **MAY** be occupied as well.

1029 Location **MUST** be defined only for the `CuttingToolLifeCycle` of `Cutting-`
1030 `Tool` and **MUST NOT** be defined for the `CuttingToolLifeCycle` of `Cutting-`
1031 `ToolArchetype`.

1032 The value of `Location` **MUST** be `string`.

1033 4.2.3.1 Value Properties of Location

1034 *Table 12* lists the Value Properties of `Location`.

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

Table 12: Value Properties of `Location`

1035 Descriptions for Value Properties of `Location`:

- 1036 • `negativeOverlap`
1037 number of locations at lower index values from this location.
- 1038 • `positiveOverlap`
1039 number of locations at higher index value from this location.

- 1040 • type
- 1041 type of location being identified.
- 1042 When a POT or STATION type is used, value of Location **MUST** be a numeric
- 1043 value.
- 1044 LocationTypeEnum Enumeration:
- 1045 – CRIB
- 1046 location with regard to a tool crib.
- 1047 – END_EFFECTOR
- 1048 location associated with an end effector.
- 1049 – EXPIRED_POT
- 1050 location for a tool that is no longer usable and is awaiting removal from a tool
- 1051 magazine or turret.
- 1052 – POT
- 1053 number of the pot in the tool handling system.
- 1054 – REMOVAL_POT
- 1055 location for a tool removed from a tool magazine or turret awaiting transfer to
- 1056 a location outside of the piece of equipment.
- 1057 – RETURN_POT
- 1058 location for a tool removed from a *spindle* or turret and awaiting return to a
- 1059 tool magazine.
- 1060 – SPINDLE
- 1061 location associated with a *spindle*.
- 1062 – STAGING_POT
- 1063 location for a tool awaiting transfer to a tool magazine or turret from outside
- 1064 of the piece of equipment.
- 1065 – STATION
- 1066 tool location in a horizontal turning machine.
- 1067 – TRANSFER_POT
- 1068 location for a tool awaiting transfer from a tool magazine to spindle or a turret.
- 1069 • turret
- 1070 turret associated with a tool.
- 1071 • toolMagazine
- 1072 tool magazine associated with a tool.

- 1073 • `toolBar`
- 1074 tool bar associated with a tool.
- 1075 • `toolRack`
- 1076 tool rack associated with a tool.
- 1077 • `automaticToolChanger`
- 1078 automatic tool changer associated with a tool.

1079 4.2.4 ReconditionCount

1080 number of times the cutter has been reconditioned.

1081 ReconditionCount **MUST** be defined only for the CuttingToolLifeCycle of
 1082 CuttingTool and **MUST NOT** be defined for the CuttingToolLifeCycle of
 1083 CuttingToolArchetype.

1084 The value of ReconditionCount **MUST** be integer.

1085 4.2.4.1 Value Properties of ReconditionCount

1086 *Table 13* lists the Value Properties of ReconditionCount.

Value Property name	Value Property type	Multiplicity
<code>maximumCount</code>	<code>integer</code>	0..1

Table 13: Value Properties of ReconditionCount

1087 Descriptions for Value Properties of ReconditionCount:

- 1088 • `maximumCount`
- 1089 maximum number of times the tool may be reconditioned.

1090 4.2.5 ProcessSpindleSpeed

1091 constrained process spindle speed for the tool in revolutions/minute.

1092 The value **MAY** contain the nominal process target spindle speed if available. If `ProcessSpindleSpeed` is provided, at least one value of maximum, nominal, or minimum **MUST** be specified.

1095 The value of `ProcessSpindleSpeed` **MUST** be float.

1096 4.2.5.1 Value Properties of `ProcessSpindleSpeed`

1097 *Table 14* lists the Value Properties of `ProcessSpindleSpeed`.

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

Table 14: Value Properties of `ProcessSpindleSpeed`

1098 Descriptions for Value Properties of `ProcessSpindleSpeed`:

- 1099 • maximum
- 1100 upper bound for the tool's target spindle speed.
- 1101 • minimum
- 1102 lower bound for the tools spindle speed.
- 1103 • nominal
- 1104 nominal speed the tool is designed to operate at.

1105 4.2.6 `ProcessFeedRate`

1106 constrained process feed rate for the tool in mm/s.

1107 The value **MAY** contain the nominal process target feed rate if available. If `ProcessFeedRate` is provided, at least one value of maximum, nominal, or minimum **MUST** be specified.

1110 The value of `ProcessFeedRate` **MUST** be string.

1111 4.2.6.1 Value Properties of ProcessFeedRate

1112 *Table 15* lists the Value Properties of ProcessFeedRate.

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

Table 15: Value Properties of ProcessFeedRate

1113 Descriptions for Value Properties of ProcessFeedRate:

- 1114 • maximum
- 1115 upper bound for the tool's process target feedrate.
- 1116 • minimum
- 1117 lower bound for the tool's feedrate.
- 1118 • nominal
- 1119 nominal feedrate the tool is designed to operate at.

1120 4.2.7 Status

1121 status of the cutting tool.

1122 CutterStatusTypeEnum Enumeration:

- 1123 • ALLOCATED
- 1124 tool is has been committed to a piece of equipment for use and is not available for
- 1125 use in any other piece of equipment.
- 1126 • AVAILABLE
- 1127 tool is available for use.
- 1128 If this is not present, the tool is currently not ready to be used.
- 1129 • BROKEN
- 1130 premature tool failure.

- 1131 • EXPIRED
- 1132 tool has reached the end of its useful life.
- 1133 • MEASURED
- 1134 tool has been measured.
- 1135 • NEW
- 1136 new tool that has not been used or first use.
- 1137 Marks the start of the tool history.
- 1138 • NOT_REGISTERED
- 1139 tool cannot be used until it is entered into the system.
- 1140 • RECONDITIONED
- 1141 tool has been reconditioned.
- 1142 • UNALLOCATED
- 1143 tool has not been committed to a process and can be allocated.
- 1144 • UNAVAILABLE
- 1145 tool is unavailable for use in metal removal.
- 1146 • UNKNOWN
- 1147 tool is an indeterminate state. This is the default value.
- 1148 • USED
- 1149 tool is in process and has remaining tool life.

1150 4.2.8 Measurement

- 1151 constrained scalar value associated with a cutting tool.
- 1152 A `Measurement` is specific to the tool management policy at a particular shop. The tool
- 1153 zero reference point or gauge line will be different depending on the particular implemen-
- 1154 tation and will be assumed to be consistent within the shop. MTConnect Standard does
- 1155 not standardize the manufacturing process or the definition of the zero point.
- 1156 The value of `Measurement` **MUST** be float.

1157 4.2.8.1 Value Properties of Measurement

1158 *Table 16* lists the Value Properties of Measurement.

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

Table 16: Value Properties of Measurement

1159 Descriptions for Value Properties of Measurement:

- 1160 • code
- 1161 shop specific code for the measurement.
- 1162 ISO 13399 codes **MAY** be used for these codes as well.
- 1163 See *Section 4.4 - Cutting Tool Measurement Subtypes* and *Section 4.5 - Cutting*
- 1164 *Item Measurement Subtypes* for details on Measurement types and their respec-
- 1165 tive code values.
- 1166 • maximum
- 1167 maximum value for the measurement.
- 1168 • minimum
- 1169 minimum value for the measurement.
- 1170 • nativeUnits
- 1171 units the measurement was originally recorded in. See *MTConnect Standard: Part*
- 1172 *2.0 - Device Information Model* for the complete list of nativeUnits.
- 1173 The value of nativeUnits **MUST** be one of the NativeUnitEnum enumera-
- 1174 tion.
- 1175 • nominal
- 1176 as advertised value for the measurement.
- 1177 • significantDigits
- 1178 number of significant digits in the reported value.

- units
- units for the measurements. See *MTConnect Standard: Part 2.0 - Device Information Model* for the complete list of units.
- The value of `units` **MUST** be one of the `UnitEnum` enumeration.

4.3 Cutting Item

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

MTConnect Standard considers `CuttingItems` as part of the `CuttingTool`. A `CuttingItem` **MUST NOT** exist in MTConnect unless it is attached to a `CuttingTool`. Some of the measurements, such as `FunctionalLength`, **MUST** be made with reference to the entire `CuttingTool` to be meaningful.

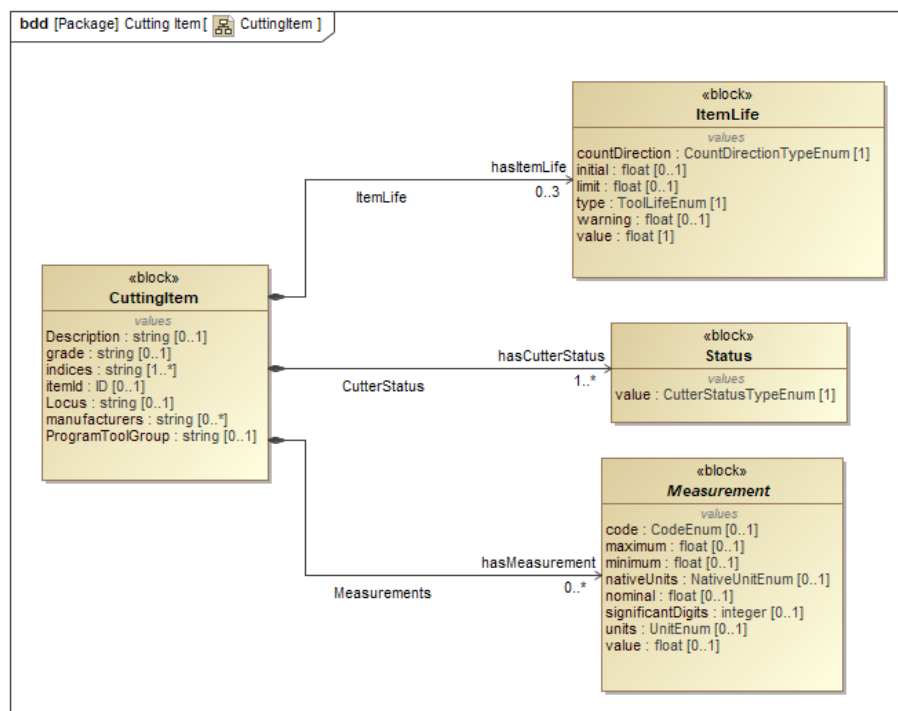


Figure 8: CuttingItem

1194 Note: See *Section B.4 - CuttingItem Schema Diagrams* for XML schema.

1195 4.3.1 CuttingItem

1196 part of the tool that physically removes the material from the workpiece by shear defor-
1197 mation.

1198 4.3.1.1 Value Properties of CuttingItem

1199 *Table 17* lists the Value Properties of `CuttingItem`.

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

Table 17: Value Properties of `CuttingItem`

1200 Descriptions for Value Properties of `CuttingItem`:

- 1201 • Description
- 1202 free-form description of the cutting item.
- 1203 • grade
- 1204 material composition for this cutting item.
- 1205 • indices
- 1206 number or numbers representing the individual cutting item or items on the tool.
- 1207 Indices **SHOULD** start numbering with the inserts or `CuttingItem` furthest from
- 1208 the gauge line and increasing in value as the items get closer to the gauge line. Items
- 1209 at the same distance **MAY** be arbitrarily numbered.

1210 Note: In XML, the representation **MUST** be a single number (“1”) or a
1211 comma separated set of individual elements (“1,2,3,4”), or as an inclusive

- 1212 range of values as in (“1-10”) or any combination of ranges and numbers
 1213 as in “1-4,6-10,22”. There **MUST NOT** be spaces or non-integer values
 1214 in the text representation.
- 1215 • `itemId`
 1216 manufacturer identifier of this cutting item.
 - 1217 • `Locus`
 1218 free form description of the location on the cutting tool.
 1219 For clarity, the words `FLUTE`, `INSERT`, and `CARTRIDGE` **SHOULD** be used to
 1220 assist in noting the location of a `CuttingItem`. `Locus` **MAY** be any free form
 1221 string, but **SHOULD** adhere to the following rules:
 - 1222 – The location numbering **SHOULD** start at the furthest `CuttingItem` and
 1223 work it’s way back to the `CuttingItem` closest to the gauge line.
 - 1224 – Flutes **SHOULD** be identified as such using the word `FLUTE`:. For example:
 1225 `FLUTE: 1, INSERT: 2` - would indicate the first flute and the second furthest
 1226 insert from the end of the tool on that flute.
 - 1227 – Other designations such as `CARTRIDGE` **MAY** be included, but should be
 1228 identified using upper case and followed by a colon (:).
 - 1229 • `manufacturers`
 1230 manufacturers of the cutting item.
 1231 This will reference the tool item and adaptive items specifically. The cutting items
 1232 manufacturers’ will be a property of `CuttingItem`.
- 1233 Note: In XML, the representation **MUST** be a comma(,) delimited list of
 1234 manufacturer names. See *Section B.4 - CuttingItem Schema Diagrams*.
- 1235 • `ProgramToolGroup`
 1236 tool group this item is assigned in the part program.

1237 4.3.1.2 Part Properties of `CuttingItem`

1238 *Table 18* lists the Part Properties of `CuttingItem`.

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

Table 18: Part Properties of CuttingItem

1239 Descriptions for Part Properties of CuttingItem:

1240 • Status

1241 status of the cutting tool.

1242 CutterStatus provides the status of the assembly and *organize* one or more
1243 Status entities. See *Section 4.2.7 - Status*.

1244 The following combinations of Status entities **MUST NOT** occur for a Cut-
1245 terStatus:

1246 – NEW **MUST NOT** be used with USED, RECONDITIONED, or EXPIRED.

1247 – UNKNOWN **MUST NOT** be used with any other status.

1248 – ALLOCATED and UNALLOCATED **MUST NOT** be used together.

1249 – AVAILABLE and UNAVAILABLE **MUST NOT** be used together.

1250 – If the tool is EXPIRED, BROKEN, or NOT_REGISTERED it **MUST NOT** be
1251 AVAILABLE.

1252 CutterStatus **MUST** be defined only for the CuttingToolLifeCycle of
1253 CuttingTool and **MUST NOT** be defined for the CuttingToolLifeCycle
1254 of CuttingToolArchetype.

1255 • ItemLife

1256 life of a CuttingItem.

1257 See *Section 4.3.3 - ItemLife*.

1258 • Measurement

1259 constrained scalar value associated with a cutting tool.

1260 Measurements groups one or more Measurement subtypes. See *Section 4.2.8*
1261 - *Measurement*.

1262 4.3.2 CuttingItems

1263 CuttingItems groups one or more CuttingItem entities. See *Section 4.3.1 - CuttingItem* and *Section 4.3 - Cutting Item* for more detail.

1265 4.3.2.1 Value Properties of CuttingItems

1266 Table 19 lists the Value Properties of CuttingItems.

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 19: Value Properties of CuttingItems

1267 Descriptions for Value Properties of CuttingItems:

- 1268 • count
- 1269 number of CuttingItem organized by CuttingItems.

1270 4.3.3 ItemLife

1271 life of a CuttingItem.

1272 The value of ItemLife **MUST** be float.

1273 4.3.3.1 Value Properties of ItemLife

1274 Table 20 lists the Value Properties of ItemLife.

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

Table 20: Value Properties of ItemLife

1275 Descriptions for Value Properties of ItemLife:

- 1276 • `countDirection`
- 1277 indicates if the item life counts from zero to maximum or maximum to zero.
- 1278 The value of `countDirection` **MUST** be one of the `CountDirectionType-`
- 1279 `Enum` enumeration.
- 1280 • `initial`
- 1281 initial life of the item when it is new.
- 1282 • `limit`
- 1283 end of life limit for this item.
- 1284 • `type`
- 1285 type of item life being accumulated.
- 1286 The value of `type` **MUST** be one of the `ToolLifeEnum` enumeration.
- 1287 • `warning`
- 1288 point at which a item life warning will be raised.

1289 4.4 Cutting Tool Measurement Subtypes

1290 This section lists the `Measurement` subtypes for `CuttingTool`.

1291 These `Measurement` subtypes for `CuttingTool` are specific to the entire assembly
 1292 and **MUST NOT** be used for the `Measurement` pertaining to a `CuttingItem`. Fig-
 1293 ure 9 and Figure 10 will be used to reference the assembly specific `Measurement` sub-
 1294 types.

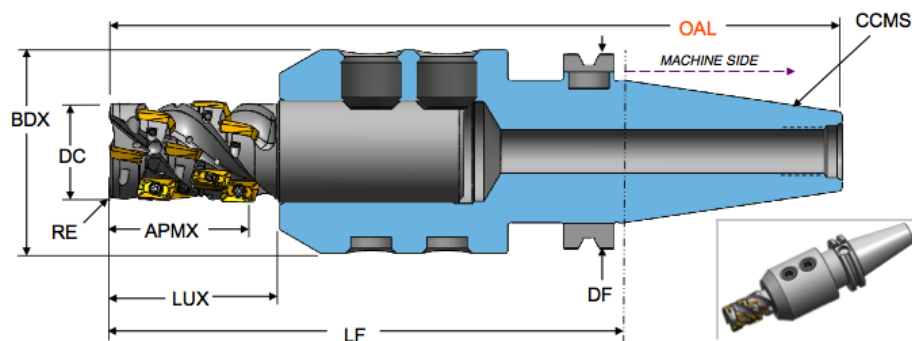


Figure 9: Cutting Tool Measurement 1

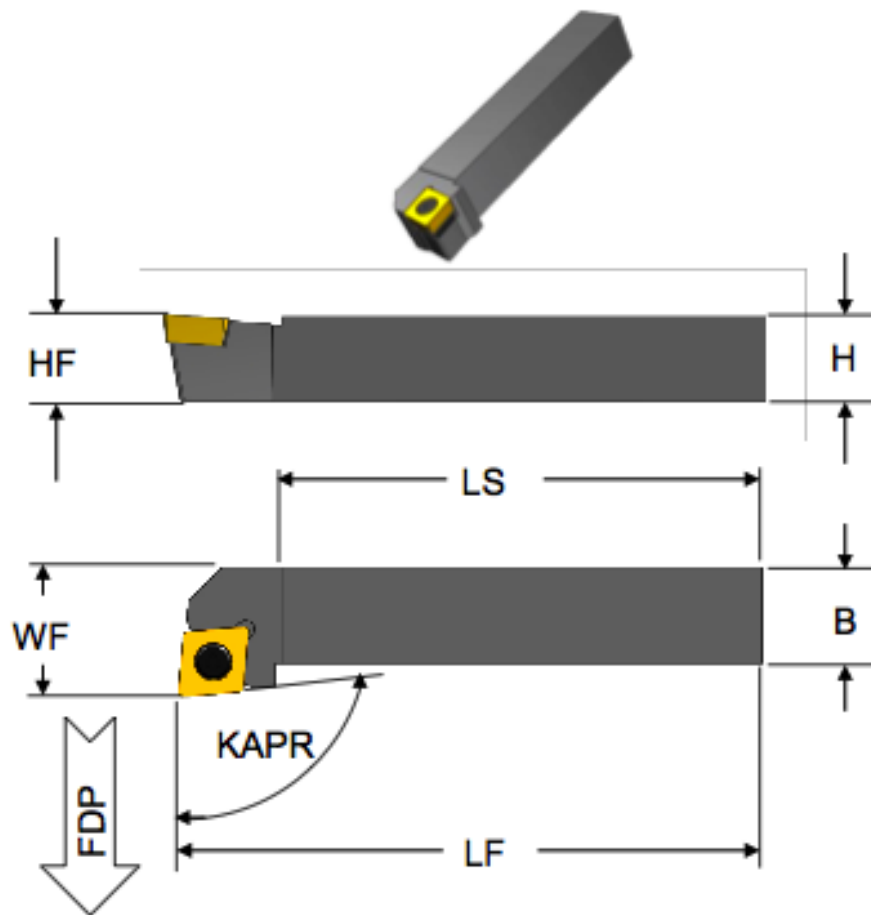


Figure 10: Cutting Tool Measurement 2

1295 4.4.1 BodyDiameterMax

1296 largest diameter of the body of a tool item.

1297 The code of BodyDiameterMax **MUST** be BDX.

1298 The units of BodyDiameterMax **MUST** be MILLIMETER.

1299 4.4.2 BodyLengthMax

1300 distance measured along the X axis from that point of the item closest to the workpiece,
 1301 including the cutting item for a tool item but excluding a protruding locking mechanism
 1302 for an adaptive item, to either the front of the flange on a flanged body or the beginning of

1303 the connection interface feature on the machine side for cylindrical or prismatic shanks.

1304 The code of BodyLengthMax **MUST** be LBX.

1305 The units of BodyLengthMax **MUST** be MILLIMETER.

1306 **4.4.3 DepthOfCutMax**

1307 maximum engagement of the cutting edge or edges with the workpiece measured perpen-
1308 dicular to the feed motion.

1309 The code of DepthOfCutMax **MUST** be APMX.

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

1311 **4.4.4 CuttingDiameterMax**

1312 maximum diameter of a circle on which the defined point Pk of each of the master inserts
1313 is located on a tool item.

1314 The normal of the machined peripheral surface points towards the axis of the cutting tool.

1315 The code of CuttingDiameterMax **MUST** be DC.

1316 The units of CuttingDiameterMax **MUST** be MILLIMETER.

1317 **4.4.5 FlangeDiameterMax**

1318 dimension between two parallel tangents on the outside edge of a flange.

1319 The code of FlangeDiameterMax **MUST** be DF.

1320 The units of FlangeDiameterMax **MUST** be MILLIMETER.

1321 **4.4.6 OverallToolLength**

1322 largest length dimension of the cutting tool including the master insert where applicable.

1323 The code of OverallToolLength **MUST** be OAL.

1324 The units of OverallToolLength **MUST** be MILLIMETER.

1325 4.4.7 ShankDiameter

1326 dimension of the diameter of a cylindrical portion of a tool item or an adaptive item that
1327 can participate in a connection.

1328 The code of ShankDiameter **MUST** be DMM.

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

1330 4.4.8 ShankHeight

1331 dimension of the height of the shank.

1332 The code of ShankHeight **MUST** be H.

1333 The units of ShankHeight **MUST** be MILLIMETER.

1334 4.4.9 ShankLength

1335 dimension of the length of the shank.

1336 The code of ShankLength **MUST** be LS.

1337 The units of ShankLength **MUST** be MILLIMETER.

1338 4.4.10 UsableLengthMax

1339 maximum length of a cutting tool that can be used in a particular cutting operation includ-
1340 ing the non-cutting portions of the tool.

1341 The code of UsableLengthMax **MUST** be LUX.

1342 The units of UsableLengthMax **MUST** be MILLIMETER.

1343 4.4.11 ProtrudingLength

1344 dimension from the yz-plane to the furthest point of the tool item or adaptive item mea-
1345 sured in the -X direction.

1346 The code of ProtrudingLength **MUST** be LPR.

1347 The units of ProtrudingLength **MUST** be MILLIMETER.

1348 4.4.12 FunctionalLength

1349 distance from the gauge plane or from the end of the shank to the furthest point on the
1350 tool, if a gauge plane does not exist, to the cutting reference point determined by the main
1351 function of the tool.

1352 The CuttingTool functional length will be the length of the entire tool, not a single
1353 cutting item. Each CuttingItem can have an independent FunctionalLength rep-
1354 resented in its measurements.

1355 The code of FunctionalLength **MUST** be LF.

1356 The units of FunctionalLength **MUST** be MILLIMETER.

1357 4.4.13 Weight

1358 total weight of the cutting tool in grams.

1359 The force exerted by the mass of the cutting tool.

1360 The code of Weight **MUST** be WT.

1361 The units of Weight **MUST** be GRAM.

1362 4.5 Cutting Item Measurement Subtypes

1363 This section lists the Measurement subtypes for CuttingItem.

1364 These Measurement subtypes for CuttingItem are specific to an individual Cut-

1365 tingItem and **MUST NOT** be used for the Measurement pertaining to an assembly.
 1366 Figures below will be used to for reference for the CuttingItem specific Measure-
 1367 ment types.

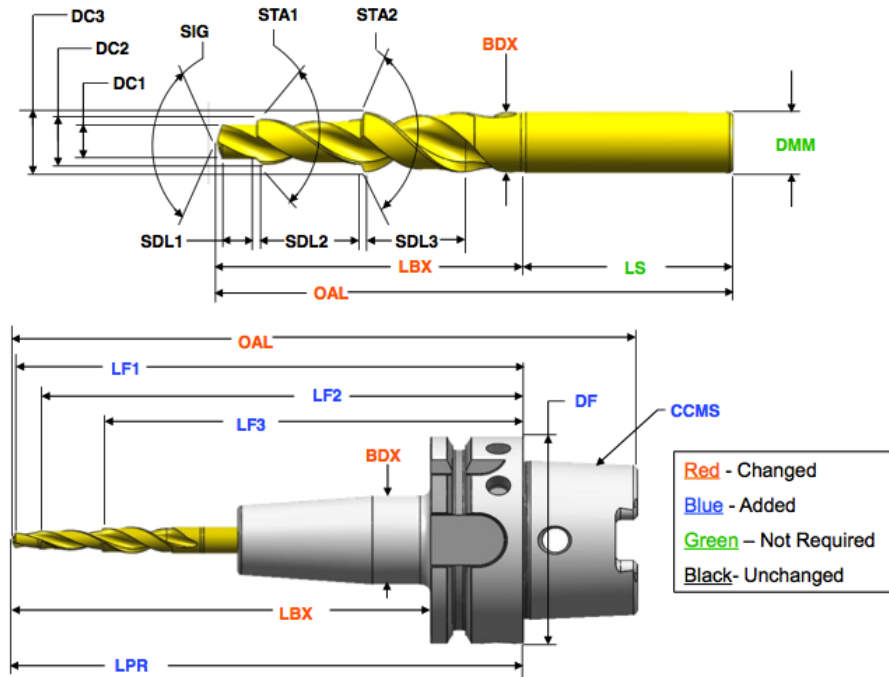


Figure 11: Cutting Tool

1368 4.5.1 FunctionalLength

1369 distance from the gauge plane or from the end of the shank of the cutting tool, if a gauge
 1370 plane does not exist, to the cutting reference point determined by the main function of the
 1371 tool.

1372 This measurement will be with reference to the cutting tool and **MUST NOT** exist without
 1373 a cutting tool.

1374 The code of FunctionalLength **MUST** be LFx.

1375 The units of FunctionalLength **MUST** be MILLIMETER.

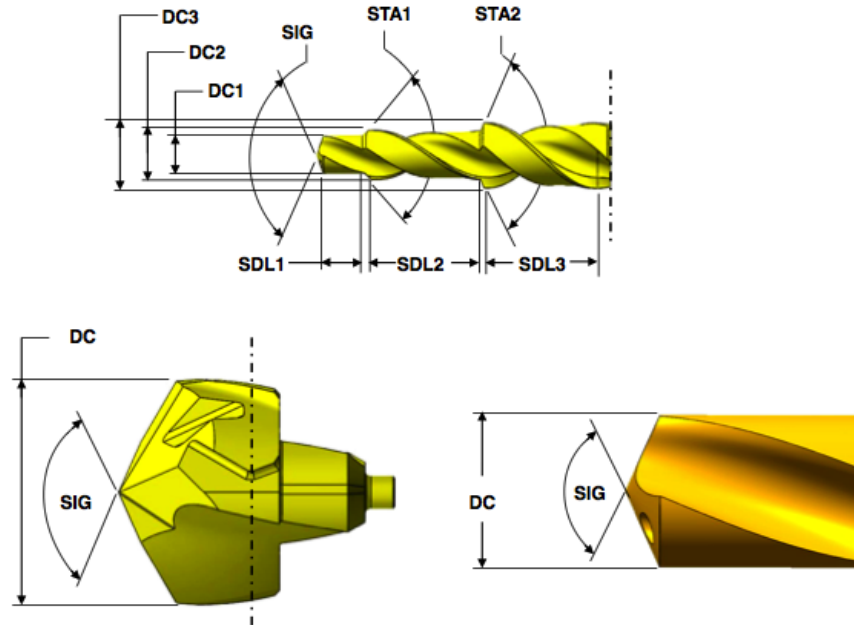


Figure 12: Cutting Item

1376 4.5.2 CuttingReferencePoint

1377 theoretical sharp point of the cutting tool from which the major functional dimensions are
1378 taken.

1379 The code of CuttingReferencePoint **MUST** be CRP.

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

1381 4.5.3 CuttingEdgeLength

1382 theoretical length of the cutting edge of a cutting item over sharp corners.

1383 The code of CuttingEdgeLength **MUST** be L.

1384 The units of CuttingEdgeLength **MUST** be MILLIMETER.

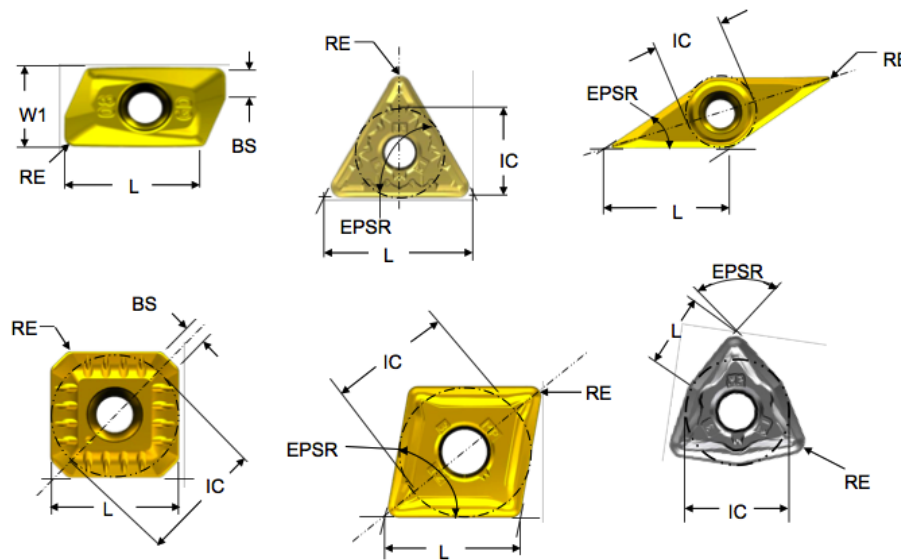


Figure 13: Cutting Item Measurement

1385 4.5.4 DriveAngle

1386 angle between the driving mechanism locator on a tool item and the main cutting edge.

1387 The code of DriveAngle **MUST** be DRVA.

1388 The units of DriveAngle **MUST** be DEGREE.

1389 4.5.5 FlangeDiameter

1390 dimension between two parallel tangents on the outside edge of a flange.

1391 The code of FlangeDiameter **MUST** be DF.

1392 The units of FlangeDiameter **MUST** be MILLIMETER.

1393 4.5.6 FunctionalWidth

1394 distance between the cutting reference point and the rear backing surface of a turning tool
1395 or the axis of a boring bar.

1396 The code of FunctionalWidth **MUST** be WF.

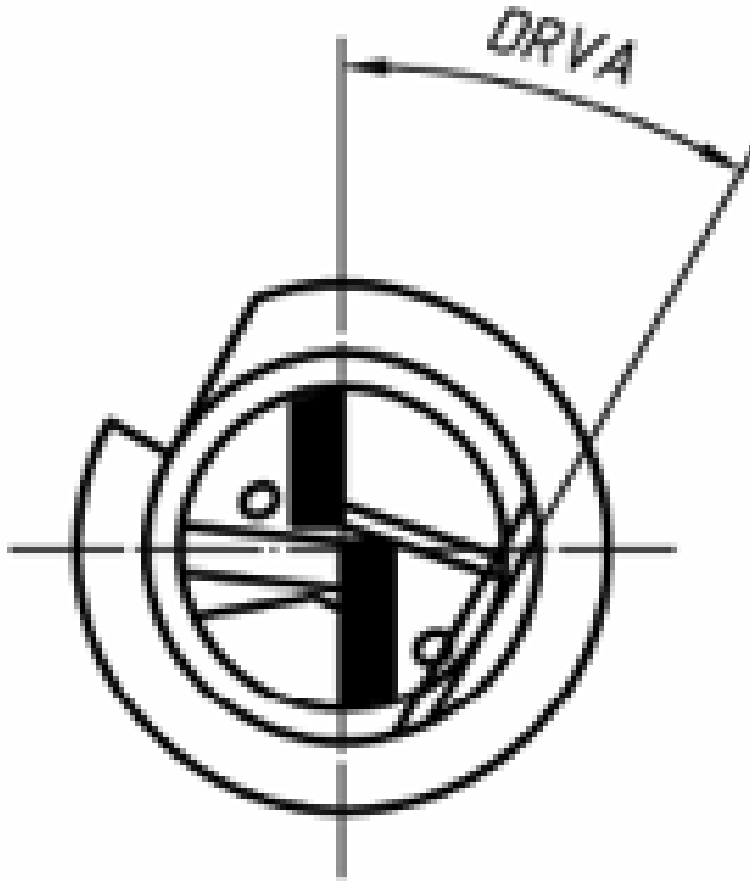


Figure 14: Cutting Item Drive Angle

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

1398 4.5.7 IncribedCircleDiameter

1399 diameter of a circle to which all edges of a equilateral and round regular insert are tangen-
1400 tial.

1401 The code of IncribedCircleDiameter **MUST** be IC.

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

1403 **4.5.8 PointAngle**

1404 angle between the major cutting edge and the same cutting edge rotated by 180 degrees
1405 about the tool axis.

1406 The code of PointAngle **MUST** be SIG.

1407 The units of PointAngle **MUST** be DEGREE.

1408 **4.5.9 ToolCuttingEdgeAngle**

1409 angle between the tool cutting edge plane and the tool feed plane measured in a plane
1410 parallel the xy-plane.

1411 The code of ToolCuttingEdgeAngle **MUST** be KAPR.

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

1413 **4.5.10 ToolLeadAngle**

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

1416 The code of ToolLeadAngle **MUST** be PSIR.

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

1418 **4.5.11 ToolOrientation**

1419 angle of the tool with respect to the workpiece for a given process.

1420 The value is application specific.

1421 The code is N/A for ToolOrientation.

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

1423 **4.5.12 StepDiameterLength**

1424 length of a portion of a stepped tool that is related to a corresponding cutting diameter
1425 measured from the cutting reference point of that cutting diameter to the point on the next
1426 cutting edge at which the diameter starts to change.

1427 The code of StepDiameterLength **MUST** be SDLx.

1428 The units of StepDiameterLength **MUST** be MILLIMETER.

1429 **4.5.13 StepIncludedAngle**

1430 angle between a major edge on a step of a stepped tool and the same cutting edge rotated
1431 180 degrees about its tool axis.

1432 The code of StepIncludedAngle **MUST** be STAx.

1433 The units of StepIncludedAngle **MUST** be DEGREE.

1434 **4.5.14 WiperEdgeLength**

1435 measure of the length of a wiper edge of a cutting item.

1436 The code of WiperEdgeLength **MUST** be BS.

1437 The units of WiperEdgeLength **MUST** be MILLIMETER.

1438 **4.5.15 CuttingDiameter**

1439 diameter of a circle on which the defined point Pk located on this cutting tool.

1440 The normal of the machined peripheral surface points towards the axis of the cutting tool.

1441 The code of CuttingDiameter **MUST** be DCx.

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

1443 4.5.16 CuttingHeight

1444 distance from the basal plane of the tool item to the cutting point.

1445 The code of CuttingHeight **MUST** be HF.

1446 The units of CuttingHeight **MUST** be MILLIMETER.

1447 4.5.17 CornerRadius

1448 nominal radius of a rounded corner measured in the X Y-plane.

1449 The code of CornerRadius **MUST** be RE.

1450 The units of CornerRadius **MUST** be MILLIMETER.

1451 4.5.18 Weight

1452 total weight of the cutting tool in grams.

1453 The force exerted by the mass of the cutting tool.

1454 The code of Weight **MUST** be WT.

1455 The units of Weight **MUST** be GRAM.

1456 4.5.19 ChamferFlatLength

1457 flat length of a chamfer.

1458 The code of ChamferFlatLength **MUST** be BCH.

1459 The units of ChamferFlatLength **MUST** be MILLIMETER.

1460 4.5.20 ChamferWidth

1461 width of the chamfer.

1462 The code of ChamferWidth **MUST** be CHW.

1463 The units of ChamferWidth **MUST** be MILLIMETER.

1464 4.5.21 InsertWidth

1465 W1 is used for the insert width when an inscribed circle diameter is not practical.

1466 The code of InsertWidth **MUST** be W1.

1467 The units of InsertWidth **MUST** be MILLIMETER.

1468 **5 Files Asset Information Model**

1469 Manufacturing processes require various documents, programs, setup sheets, and digital
 1470 media available at the device for a given process. The `File` and `FileArchetype` As-
 1471 sets provide a mechanism to communicate specific “Files” that are relevant to a process
 1472 where the media is located on a server and represented by a Universal Resource Locator
 1473 (URL).

1474 The `FileArchetype` contains metadata common to all `File` Assets for a certain
 1475 purpose. The `File` Asset references the file specific to a given device or set of devices.
 1476 The `File` Asset does not hold the contents of the file, it contains a reference to the
 1477 location (URL) used to access the information. The metadata associated with the `File`
 1478 provides semantic information about the representation (mime-type) and the application
 1479 associated with the `File`. The application of the file is an extensible controlled vocabulary
 1480 with common manufacturing uses provided.

1481 **5.1 Files**

1482 This section provides semantic information for the `File` model.

1483 Note: See *Section B.7 - File Schema Diagrams* for XML schema.

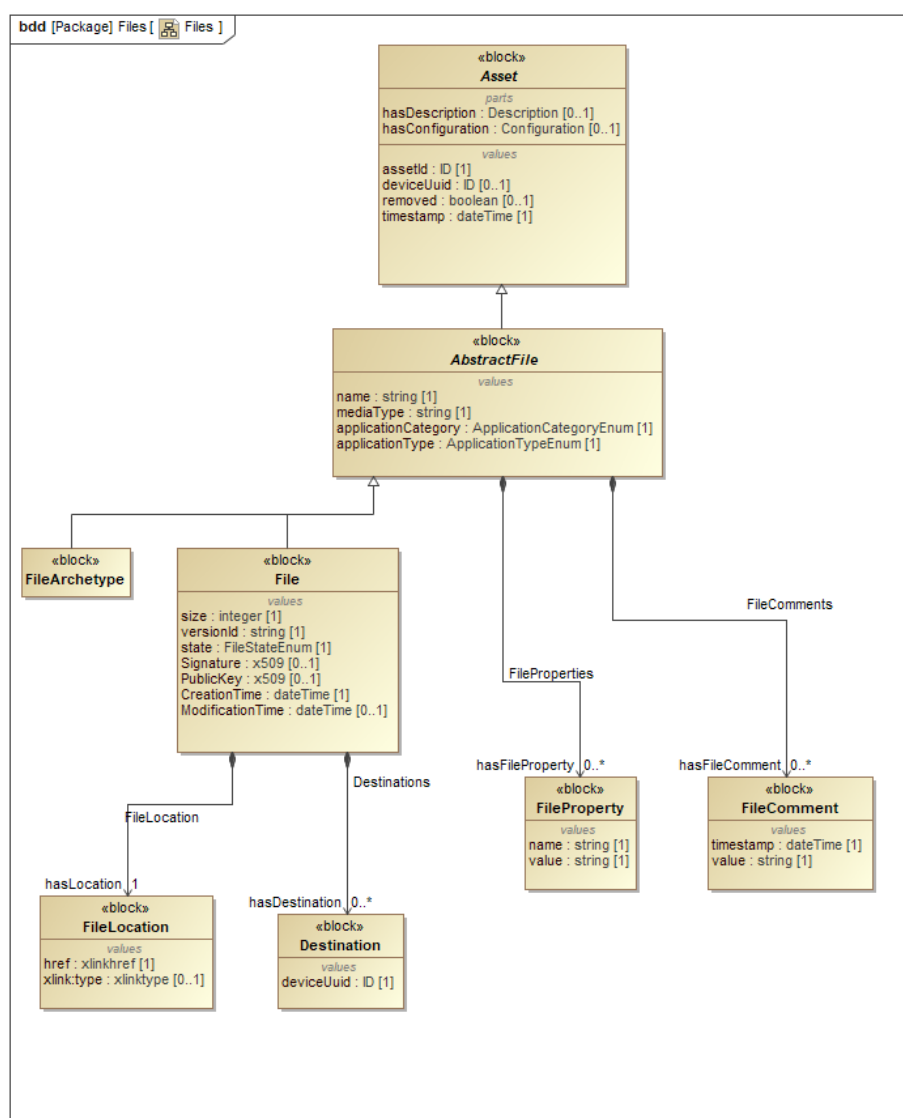
1484 **5.1.1 AbstractFile**

1485 `abstract Asset` that contains the common properties of the `File` and `FileArchetype`
 1486 types.

1487 **5.1.1.1 Value Properties of AbstractFile**

1488 *Table 21* lists the Value Properties of `AbstractFile`.

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

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

1489 Descriptions for Value Properties of AbstractFile:

- 1490 • name
- 1491 name of the file.
- 1492 • mediaType
- 1493 mime type of the file.
- 1494 • applicationCategory
- 1495 category of application that will use this file.
- 1496 ApplicationCategoryEnum Enumeration:
- 1497 – ASSEMBLY
- 1498 files regarding the fully assembled product.
- 1499 – DEVICE
- 1500 device related files.
- 1501 – HANDLING
- 1502 files relating to the handling of material.
- 1503 – INSPECTION
- 1504 files related to the quality inspection.
- 1505 – MAINTENANCE
- 1506 files relating to equipment maintenance.
- 1507 – PART
- 1508 files relating to a part.
- 1509 – PROCESS
- 1510 files related to the manufacturing process.
- 1511 – SETUP
- 1512 files related to the setup of a process.
- 1513 • applicationType
- 1514 type of application that will use this file.
- 1515 ApplicationTypeEnum Enumeration:
- 1516 – DATA
- 1517 generic data.
- 1518 – DESIGN
- 1519 computer aided design files or drawings.

- 1520 – DOCUMENTATION
- 1521 documentation regarding a category of file.
- 1522 – INSTRUCTIONS
- 1523 user instructions regarding the execution of a task.
- 1524 – LOG
- 1525 data related to the history of a machine or process.
- 1526 – PRODUCTION_PROGRAM
- 1527 machine instructions to perform a process.

1528 **5.1.1.2 Part Properties of AbstractFile**

1529 *Table 22* lists the Part Properties of AbstractFile.

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

Table 22: Part Properties of AbstractFile

1530 Descriptions for Part Properties of AbstractFile:

- 1531 • FileProperty
- 1532 key-value pair providing additional metadata about a File.
- 1533 FileProperties groups one or more FileProperty entities for a File. See
- 1534 *Section 5.1.4 - FileProperty.*
- 1535 • FileComment
- 1536 remark or interpretation for human interpretation associated with a File or FileArchetype.
- 1537 FileComments groups one or more FileComment entities for a File. See
- 1538 *Section 5.1.5 - FileComment.*

1539 **5.1.2 File**

1540 AbstractFile type that provides information about the File instance and its URL.

1541 **5.1.2.1 Value Properties of File**

1542 *Table 23* lists the Value Properties of File.

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

Table 23: Value Properties of File

1543 Descriptions for Value Properties of File:

- 1544 • size
- 1545 size of the file in bytes.
- 1546 • versionId
- 1547 version identifier of the file.
- 1548 • state
- 1549 state of the file.
- 1550 FileStateEnum Enumeration:
- 1551 – EXPERIMENTAL
- 1552 used for processes other than production or otherwise defined.
- 1553 – PRODUCTION
- 1554 used for production processes.
- 1555 – REVISION
- 1556 content is modified from PRODUCTION or EXPERIMENTAL.
- 1557 • Signature
- 1558 secure hash of the file.
- 1559 • PublicKey
- 1560 public key used to verify the signature.
- 1561 • CreationTime
- 1562 time the file was created.
- 1563 • ModificationTime
- 1564 time the file was modified.

1565 5.1.2.2 Part Properties of File

1566 *Table 24* lists the Part Properties of File.

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

Table 24: Part Properties of File

1567 Descriptions for Part Properties of File:

- 1568 • FileLocation
- 1569 URL reference to the file location.
- 1570 *See Section 5.1.6 - FileLocation.*
- 1571 • Destination
- 1572 reference to the target Device for this File.
- 1573 Destinations groups one or more Destination entities. *See Section 5.1.7 -*
- 1574 *Destination.*

1575 5.1.3 FileArchetype

1576 AbstractFile type that provides information common to all versions of a file.

1577 5.1.4 FileProperty

1578 key-value pair providing additional metadata about a File.

1579 The value of FileProperty **MUST** be string.

1580 5.1.4.1 Value Properties of FileProperty

1581 *Table 25* lists the Value Properties of FileProperty.

Value Property name	Value Property type	Multiplicity
name	string	1

Table 25: Value Properties of FileProperty

1582 Descriptions for Value Properties of FileProperty:

- 1583 • name
- 1584 name of the FileProperty.

1585 5.1.5 FileComment

1586 remark or interpretation for human interpretation associated with a File or FileArchetype.

1587 The value of FileComment **MUST** be string.

1588 5.1.5.1 Value Properties of FileComment

1589 Table 26 lists the Value Properties of FileComment.

Value Property name	Value Property type	Multiplicity
timestamp	datetime	1

Table 26: Value Properties of FileComment

1590 Descriptions for Value Properties of FileComment:

- 1591 • timestamp
- 1592 time the comment was made.

1593 5.1.6 FileLocation

1594 URL reference to the file location.

1595 5.1.6.1 Value Properties of FileLocation

1596 Table 27 lists the Value Properties of FileLocation.

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

Table 27: Value Properties of FileLocation

1597 Descriptions for Value Properties of FileLocation:

- 1598 • href
- 1599 URL reference to the file.
- 1600 href is of type xlink:href from the W3C XLink specification.
- 1601 • xlink:type
- 1602 type of href for the xlink href type.
- 1603 **MUST** be locator referring to a URL .

1604 5.1.7 Destination

1605 reference to the target Device for this File.

1606 5.1.7.1 Value Properties of Destination

1607 Table 28 lists the Value Properties of Destination.

Value Property name	Value Property type	Multiplicity
deviceUuid	ID	1

Table 28: Value Properties of Destination

1608 Descriptions for Value Properties of Destination:

- 1609 • deviceUuid
- 1610 uuid of the target device or application.

1611 **6 Raw Material Asset Information Model**

1612 Raw material represents the source of material for immediate use and sources of material
1613 that may or may not be used during the manufacturing process.

1614 The `RawMaterial Asset` holds the references to the content stored in the actual `Raw-`
1615 `Material` container or derived about the `RawMaterial` by the system during opera-
1616 tion.

1617 **6.1 Raw Material**

1618 This section provides semantic information for the `RawMaterial` model.

1619 Note: See *Section B.8 - RawMaterial Schema Diagrams* for XML schema.

1620 **6.1.1 RawMaterial**

1621 `Asset` that represents raw material.

1622 **6.1.1.1 Value Properties of RawMaterial**

1623 *Table 29* lists the Value Properties of `RawMaterial`.

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

Table 29: Value Properties of RawMaterial

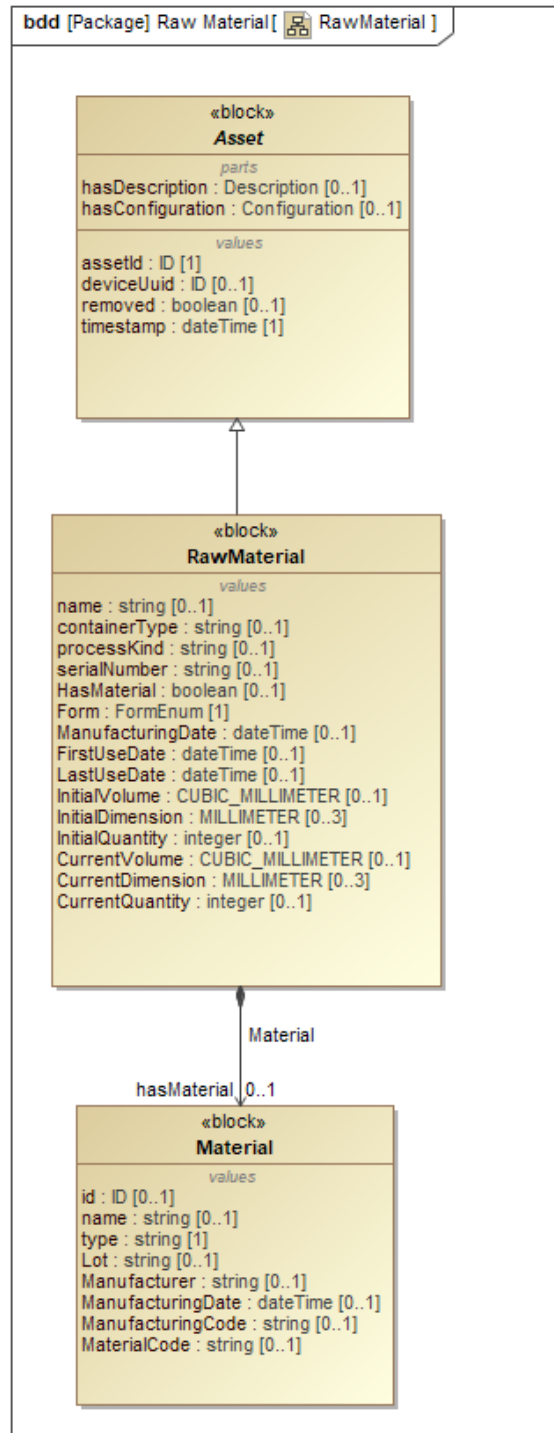


Figure 16: RawMaterial

1624 Descriptions for Value Properties of RawMaterial:

- 1625 • name
- 1626 name of the raw material.
- 1627 Examples: Container1 and AcrylicContainer.
- 1628 • containerType
- 1629 type of container holding the raw material.
- 1630 Examples: Pallet, Canister, Cartridge, Tank, Bin, Roll, and Spool.
- 1631 • processKind
- 1632 ISO process type supported by this raw material.
- 1633 Examples include: VAT_POLYMERIZATION, BINDER_JETTING, MATERIAL_EXTRUSION,
- 1634 MATERIAL_JETTING, SHEET_LAMINATION, POWDER_BED_FUSION and DI-
- 1635 RECTED_ENERGY_DEPOSITION.
- 1636 • serialNumber
- 1637 serial number of the raw material.
- 1638 • HasMaterial
- 1639 Material has existing usable volume.
- 1640 • Form
- 1641 form of the raw material.
- 1642 FormEnum Enumeration:
- 1643 – BAR
- 1644 – BLOCK
- 1645 – CASTING
- 1646 – FILAMENT
- 1647 – GAS
- 1648 – GEL
- 1649 – LIQUID
- 1650 – POWDER
- 1651 – SHEET
- 1652 • ManufacturingDate
- 1653 date the raw material was created.

- 1654 • FirstUseDate
- 1655 date raw material was first used.
- 1656 • LastUseDate
- 1657 date raw material was last used.
- 1658 • InitialVolume
- 1659 amount of material initially placed in raw material when manufactured.
- 1660 • InitialDimension
- 1661 dimension of material initially placed in raw material when manufactured.
- 1662 • InitialQuantity
- 1663 quantity of material initially placed in raw material when manufactured.
- 1664 • CurrentVolume
- 1665 amount of material currently in raw material.
- 1666 • CurrentDimension
- 1667 dimension of material currently in raw material.
- 1668 • CurrentQuantity
- 1669 quantity of material currently in raw material.

1670 **6.1.1.2 Part Properties of RawMaterial**

1671 *Table 30* lists the Part Properties of RawMaterial.

Part Property name	Multiplicity
Material	0..1

Table 30: Part Properties of RawMaterial

1672 Descriptions for Part Properties of RawMaterial:

- 1673 • Material
- 1674 material used as the RawMaterial.
- 1675 See *Section 6.1.2 - Material*.

1676 6.1.2 Material

1677 material used as the RawMaterial.

1678 6.1.2.1 Value Properties of Material

1679 *Table 31* lists the Value Properties of Material.

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

Table 31: Value Properties of Material

1680 Descriptions for Value Properties of Material:

- 1681 • id
- 1682 unique identifier for the material.
- 1683 • name
- 1684 name of the material.
- 1685 Examples: ULTM9085, ABS, 4140.
- 1686 • type
- 1687 type of material.
- 1688 Examples: Metal, Polymer, Wood, 4140, Recycled, Prestine and Used.
- 1689 • Lot
- 1690 manufacturer's lot code of the material.
- 1691 • Manufacturer
- 1692 name of the material manufacturer.

- 1693 • ManufacturingDate
- 1694 manufacturing date of the material from the material manufacturer.
- 1695 • ManufacturingCode
- 1696 lot code of the raw feed stock for the material, from the feed stock manufacturer.
- 1697 • MaterialCode
- 1698 American Society for Testing and Materials (ASTM) standard code that the material
- 1699 complies with.

1700 7 QIF Asset Information Model

1701 The Quality Information Framework (QIF) is an American National Standards Institute
 1702 (ANSI) accredited standard developed by the Digital Metrology Standards Consortium
 1703 (DMSC) standards development organization. The DMSC is an A-liaison to the Interna-
 1704 tional Standards Organization (ISO) Technical Committee (TC) 184. QIF addresses the
 1705 needs of the metrology community to have a semantic information model for the exchange
 1706 of metrology data throughout the verification lifecycle from product design to execution,
 1707 analysis, and reporting.

1708 The MTConnect QIF *Asset Information Model* provides a wrapper around a QIF document
 1709 (i.e., a dataset conforming to the QIF Information model) in its native XML representation.
 1710 The MTConnect standard does not alter or extend the QIF standard and regards the QIF
 1711 standard as a passthrough.

1712 Information about the QIF standards is at the following location: <https://qifstandards.org>

1713 7.1 QIF

1714 This section provides semantic information for the `QIFDocumentWrapper` model.

1715 Note: See *Section B.9 - QIFDocumentWrapper Schema Diagrams* for XML
 1716 schema.

1717 7.1.1 QIFDocument

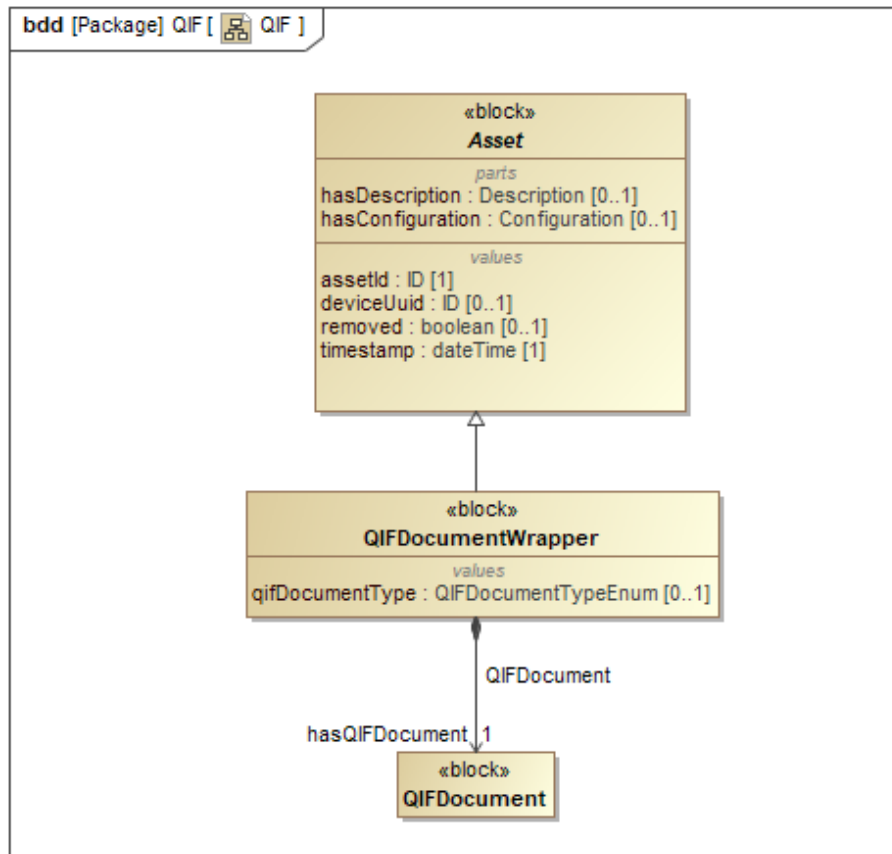
1718 QIF Document as given by the QIF standard.

1719 7.1.2 QIFDocumentWrapper

1720 Asset that carries the QIF Document.

1721 7.1.2.1 Value Properties of QIFDocumentWrapper

1722 *Table 32* lists the Value Properties of `QIFDocumentWrapper`.

**Figure 17: QIFDocumentWrapper**

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

Table 32: Value Properties of QIFDocumentWrapper

1723 Descriptions for Value Properties of QIFDocumentWrapper:

- 1724 • qifDocumentType
 1725 contained QIF Document type as defined in the QIF Standard.

1726 QIFDocumentTypeEnum Enumeration:

- 1727 – MEASUREMENT_RESOURCE
 1728 – PLAN
 1729 – PRODUCT
 1730 – RESULTS

- 1731 – RULES
- 1732 – STATISTICS

1733 **7.1.2.2 Part Properties of QIFDocumentWrapper**

1734 *Table 33* lists the Part Properties of QIFDocumentWrapper.

Part Property name	Multiplicity
QIFDocument	1

Table 33: Part Properties of QIFDocumentWrapper

1735 Descriptions for Part Properties of QIFDocumentWrapper:

- 1736 • QIFDocument
- 1737 QIF Document as given by the QIF standard.

1738 8 Profile

1739 MTConnect Profile is a *profile* that extends the Systems Modeling Language (SysML)
 1740 metamodel for the MTConnect domain using additional data types and *stereotypes*.

1741 8.1 DataTypes

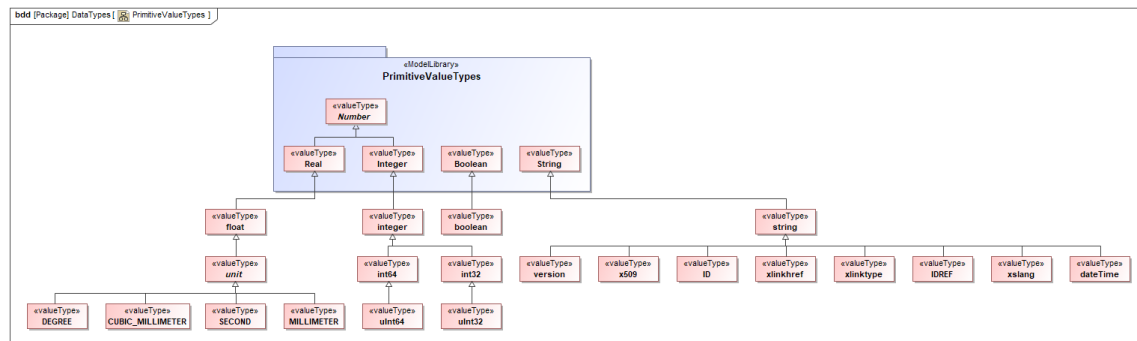


Figure 18: DataTypes

1742 8.1.1 boolean

1743 primitive type.

1744 8.1.2 ID

1745 string that represents an identifier (ID).

1746 8.1.3 string

1747 primitive type.

1748 8.1.4 float

1749 primitive type.

1750 8.1.5 datetime

1751 string that represents timestamp in ISO 8601 format.

1752 8.1.6 integer

1753 primitive type.

1754 8.1.7 xlinktype

1755 string that represents the type of an XLink element. See [https://www.w3.org/TR/](https://www.w3.org/TR/xlink11/)
1756 [xlink11/](https://www.w3.org/TR/xlink11/).

1757 8.1.8 xslang

1758 string that represents a language tag. See [http://www.ietf.org/rfc/rfc4646.](http://www.ietf.org/rfc/rfc4646.txt)
1759 [txt](http://www.ietf.org/rfc/rfc4646.txt).

1760 8.1.9 SECOND

1761 float that represents time in seconds.

1762 8.1.10 IDREF

1763 string that represents a reference to an ID.

1764 8.1.11 xlinkhref

1765 string that represents the locator attribute of an XLink element. See [https://www.w3.](https://www.w3.org/TR/xlink11/)
1766 [org/TR/xlink11/](https://www.w3.org/TR/xlink11/).

1767 8.1.12 x509

1768 string that represents an `x509` data block. *Ref ISO/IEC 9594-8:2020.*

1769 8.1.13 int32

1770 32-bit integer.

1771 8.1.14 int64

1772 64-bit integer.

1773 8.1.15 version

1774 series of four numeric values, separated by a decimal point, representing a *major*, *minor*,
1775 and *revision* number of the MTConnect Standard and the revision number of a specific
1776 *schema*.

1777 8.1.16 uint32

1778 32-bit unsigned integer.

1779 8.1.17 uint64

1780 64-bit unsigned integer.

1781 8.2 Stereotypes

1782 8.2.1 organizer

1783 element that *organizes* other elements of a type.

1784 8.2.2 deprecated

1785 element that has been deprecated.

1786 8.2.3 extensible

1787 enumeration that can be extended.

1788 8.2.4 informative

1789 element that is descriptive and non-normative.

1790 8.2.5 valueType

1791 extends SysML <<ValueType>> to include `Class` as a value type.

1792 8.2.6 normative

1793 element that has been added to the standard.

1794 8.2.7 observes

1795 association in which a *Component* makes *Observations* about an observable *DataItem*.

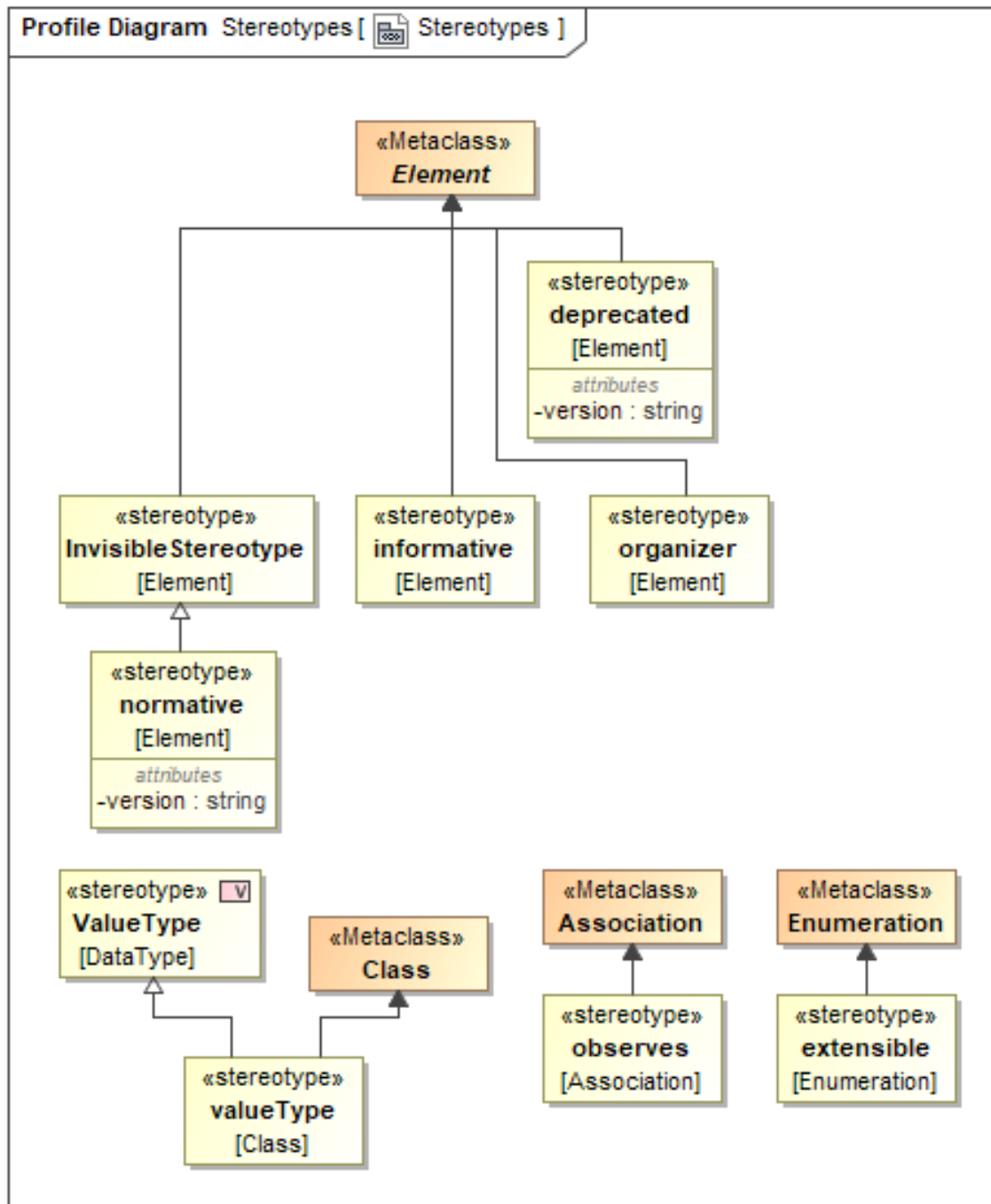


Figure 19: Stereotypes

1796 Appendices

1797 A Bibliography

- 1798 Engineering Industries Association. EIA Standard - EIA-274-D, Interchangeable Variable,
1799 Block Data Format for Positioning, Contouring, and Contouring/Positioning Numerically
1800 Controlled Machines. Washington, D.C. 1979.
- 1801 ISO TC 184/SC4/WG3 N1089. ISO/DIS 10303-238: Industrial automation systems and
1802 integration Product data representation and exchange Part 238: Application Protocols: Ap-
1803 plication interpreted model for computerized numerical controllers. Geneva, Switzerland,
1804 2004.
- 1805 International Organization for Standardization. ISO 14649: Industrial automation sys-
1806 tems and integration – Physical device control – Data model for computerized numerical
1807 controllers – Part 10: General process data. Geneva, Switzerland, 2004.
- 1808 International Organization for Standardization. ISO 14649: Industrial automation sys-
1809 tems and integration – Physical device control – Data model for computerized numerical
1810 controllers – Part 11: Process data for milling. Geneva, Switzerland, 2000.
- 1811 International Organization for Standardization. ISO 6983/1 – Numerical Control of ma-
1812 chines – Program format and definition of address words – Part 1: Data format for posi-
1813 tioning, line and contouring control systems. Geneva, Switzerland, 1982.
- 1814 Electronic Industries Association. ANSI/EIA-494-B-1992, 32 Bit Binary CL (BCL) and
1815 7 Bit ASCII CL (ACL) Exchange Input Format for Numerically Controlled Machines.
1816 Washington, D.C. 1992.
- 1817 National Aerospace Standard. Uniform Cutting Tests - NAS Series: Metal Cutting Equip-
1818 ment Specifications. Washington, D.C. 1969.
- 1819 International Organization for Standardization. ISO 10303-11: 1994, Industrial automa-
1820 tion systems and integration Product data representation and exchange Part 11: Descrip-
1821 tion methods: The EXPRESS language reference manual. Geneva, Switzerland, 1994.
- 1822 International Organization for Standardization. ISO 10303-21: 1996, Industrial automa-
1823 tion systems and integration – Product data representation and exchange – Part 21: Imple-
1824 mentation methods: Clear text encoding of the exchange structure. Geneva, Switzerland,
1825 1996.
- 1826 H.L. Horton, F.D. Jones, and E. Oberg. Machinery's Handbook. Industrial Press, Inc.

- 1827 New York, 1984.
- 1828 International Organization for Standardization. ISO 841-2001: Industrial automation sys-
1829 tems and integration - Numerical control of machines - Coordinate systems and motion
1830 nomenclature. Geneva, Switzerland, 2001.
- 1831 ASME B5.57: Methods for Performance Evaluation of Computer Numerically Controlled
1832 Lathes and Turning Centers, 1998.
- 1833 ASME/ANSI B5.54: Methods for Performance Evaluation of Computer Numerically Con-
1834 trolled Machining Centers. 2005.
- 1835 OPC Foundation. OPC Unified Architecture Specification, Part 1: Concepts Version 1.00.
1836 July 28, 2006.
- 1837 IEEE STD 1451.0-2007, Standard for a Smart Transducer Interface for Sensors and Ac-
1838 tuators – Common Functions, Communication Protocols, and Transducer Electronic Data
1839 Sheet (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The In-
1840 stitute of Electrical and Electronics Engineers, Inc., New York, N.Y. 10016, SH99684,
1841 October 5, 2007.
- 1842 IEEE STD 1451.4-1994, Standard for a Smart Transducer Interface for Sensors and Ac-
1843 tuators – Mixed-Mode Communication Protocols and Transducer Electronic Data Sheet
1844 (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The Institute of
1845 Electrical and Electronics Engineers, Inc., New York, N.Y. 10016, SH95225, December
1846 15, 2004.

1847 **B XML Schema Diagrams**

1848 See XML schemas for the MTConnect standard here: <https://schemas.mtconnect.org/>.
1849

1850 **B.1 Assets Schema Diagrams**

1851 See `Asset` element in `MTConnectAssets` schema.

1852 See `Description` element in `MTConnectAssets` schema.

1853 **B.2 CuttingTool Schema Diagrams**

1854 See `CuttingTool` element in `MTConnectAssets` schema.

1855 See `CuttingToolDefinition` element in `MTConnectAssets` schema.

1856 See `CuttingToolArchetypeReference` element in `MTConnectAssets` schema.

1857 **B.3 CuttingToolLifeCycle Schema Diagrams**

1858 See `CuttingToolLifeCycle` element in `MTConnectAssets` schema.

1859 See `CutterStatus` element in `MTConnectAssets` schema.

1860 See `Location` element in `MTConnectAssets` schema.

1861 See `Measurement` element in `MTConnectAssets` schema.

1862 See `ProcessFeedRate` element in `MTConnectAssets` schema.

1863 See `ProcessSpindleSpeed` element in `MTConnectAssets` schema.

1864 See `ReconditionCount` element in `MTConnectAssets` schema.

1865 See `ToolLife` element in `MTConnectAssets` schema.

1866 B.4 CuttingItem Schema Diagrams

1867 See CuttingItems element in MTConnectAssets schema.

1868 See CuttingItem element in MTConnectAssets schema.

1869 See ItemLife element in MTConnectAssets schema.

1870 B.5 ISO 13399 Diagrams

1871 B.5.1 Measurement Diagrams

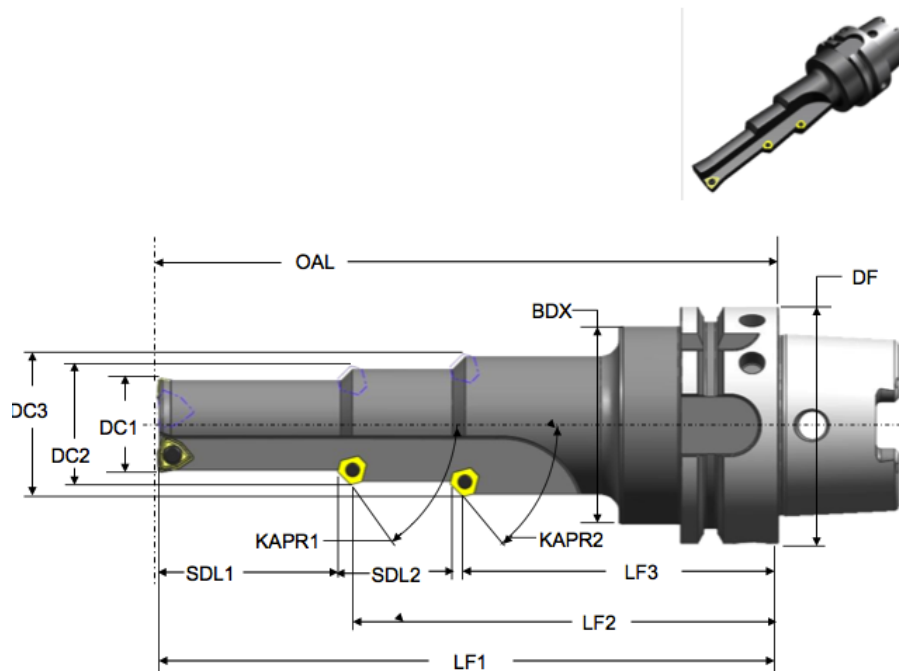


Figure 20: Cutting Tool Measurement 3

1872 B.6 Cutting Tool Examples

1873 B.6.1 Shell Mill

Example 1: Example for Indexable Insert Measurements

1874 1 <?xml version="1.0" encoding="UTF-8"?>

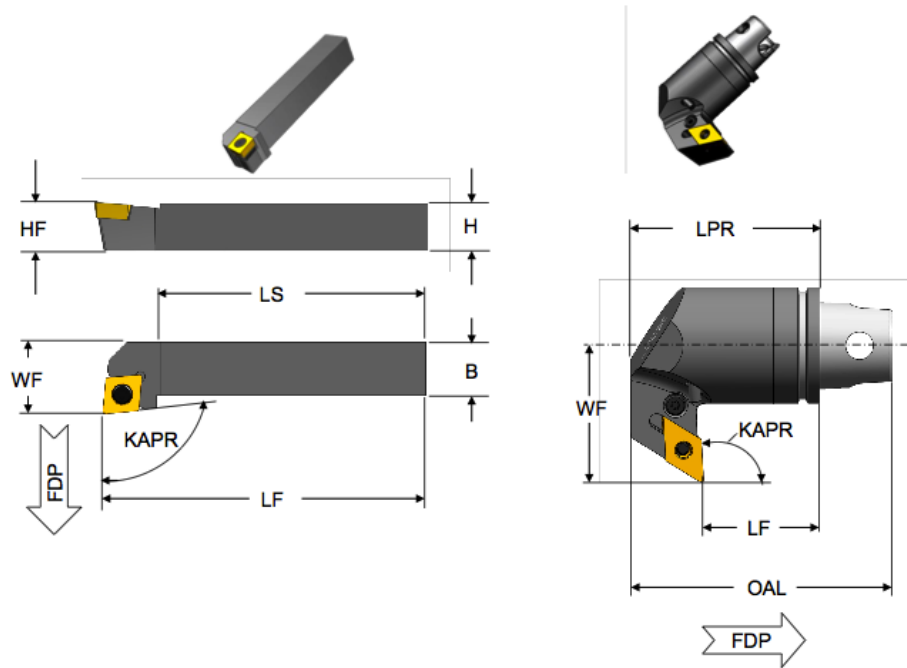
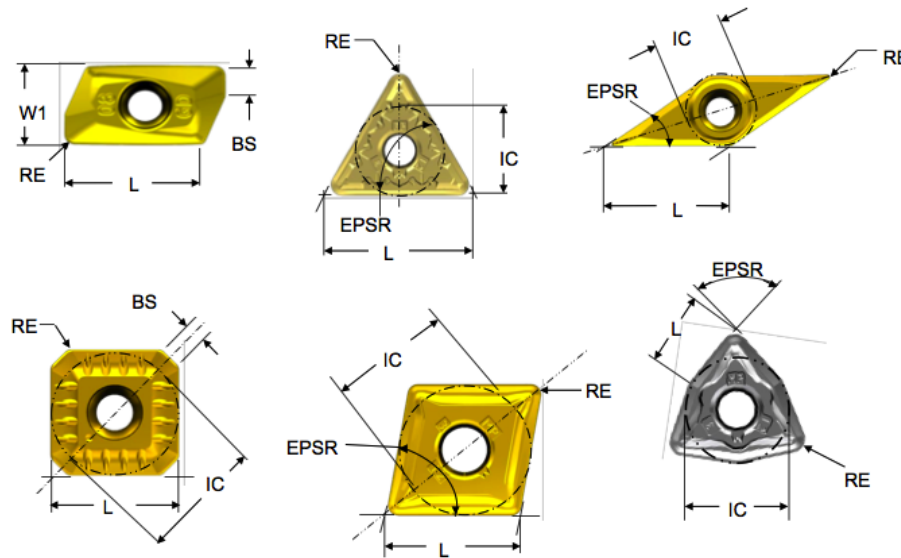


Figure 21: Cutting Tool Measurement 4

```

1875 2 <MTConnectAssets
1876 3 xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1877 4 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1878 5 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1879 6 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1880 7 http://mtconnect.org/schemas/MTConnectAssets\textunderscore 1.2.xsd"
1881 >
1882 8   <<Header_creationTime="2011-05-11T13:55:22"
1883 9   <<assetBufferSize="1024"<_sender="localhost"
1884 10  <<assetCount="2"<_version="1.2"<_instanceId="1234"/>
1885 11  <<Assets>
1886 12  <<CuttingTool_serialNumber="1"<_toolId="KSSP300R4SD43L240"
1887 13  <<timestamp="2011-05-11T13:55:22"<_assetId="KSSP300R4SD43L240.1"
1888 14  <<manufacturers="KMT,Parlec">
1889 15  <<<CuttingToolLifeCycle>
1890 16  <<<CutterStatus><Status>NEW</Status></CutterStatus>
1891 17  <<<ProcessSpindleSpeed_maximum="13300"
1892 18  <<<nominal="605">10000</ProcessSpindleSpeed>
1893 19  <<<ProcessFeedRate
1894 20  <<<nominal="9.22">9.22</ProcessSpindleSpeed>
1895 21  <<<ConnectionCodeMachineSide>CV50
1896 22  <<</ConnectionCodeMachineSide>
1897 23  <<<Measurements>
1898 24  <<<<<BodyDiameterMax_code="BDX">73.25
1899 25  <<<</BodyDiameterMax>
1900 26  <<<<OverallToolLength_nominal="222.25"

```


**Figure 22: Cutting Tool Measurement 5**

```

1901 27  minimum="221.996" _maximum="222.504"
1902 28  code="OAL">222.25</OverallToolLength>
1903 29  <UsableLengthMax_code="LUX" _nominal="82.55">82.55
1904 30  </UsableLengthMax>
1905 31  <CuttingDiameterMax_code="DC" _nominal="76.2"
1906 32  _maximum="76.213" _minimum="76.187">76.2
1907 33  </CuttingDiameterMax>
1908 34  <BodyLengthMax_code="LF" _nominal="120.65"
1909 35  _maximum="120.904" _minimum="120.404">120.65
1910 36  </BodyLengthMax>
1911 37  <DepthOfCutMax_code="APMX"
1912 38  _nominal="60.96">60.95</DepthOfCutMax>
1913 39  <FlangeDiameterMax_code="DF"
1914 40  _nominal="98.425">98.425</FlangeDiameterMax>
1915 41  </Measurements>
1916 42  <CuttingItems_count="24">
1917 43  <CuttingItem_indices="1-24" _itemId="SDET43PDER8GB"
1918 44  _manufacturers="KMT" _grade="KC725M">
1919 45  <Measurements>
1920 46  <CuttingEdgeLength_code="L" _nominal="12.7"
1921 47  _minimum="12.675" _maximum="12.725">12.7
1922 48  </CuttingEdgeLength>
1923 49  <WiperEdgeLength_code="BS" _nominal=
1924 50  "2.56">2.56</WiperEdgeLength>
1925 51  <IncrinedCircleDiameter_code="IC"
1926 52  _nominal="12.7">12.7
1927 53  </IncrinedCircleDiameter>
1928 54  <CornerRadius_code="RE" _nominal="0.8">
1929 55  0.8</CornerRadius>

```

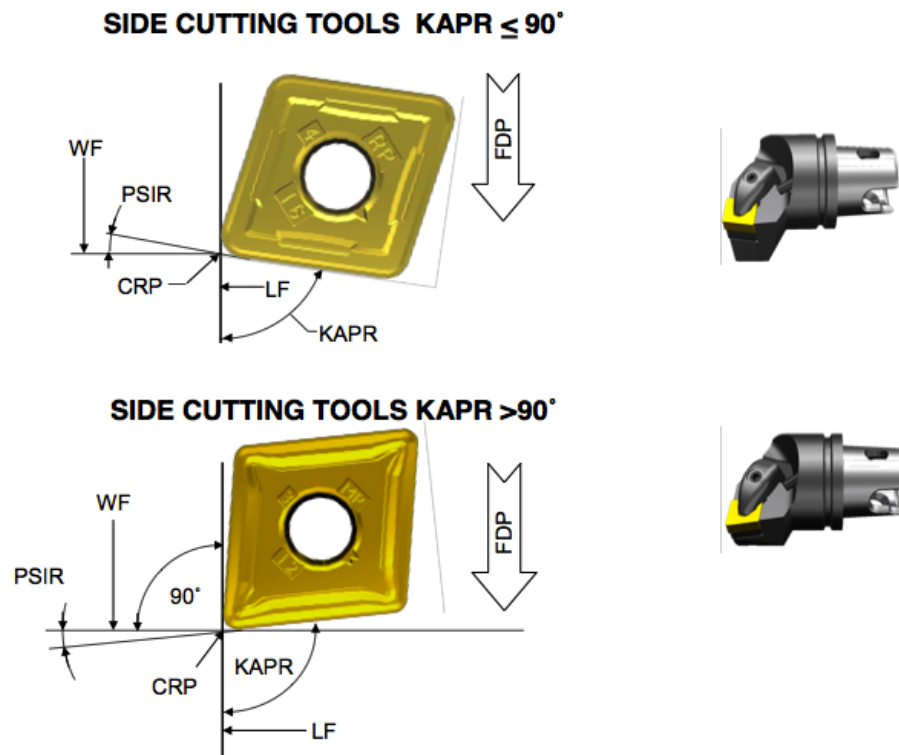


Figure 23: Cutting Tool Measurement 6

```

1930 56 <<<<<<</Measurements>
1931 57 <<<<<<</CuttingItem>
1932 58 <<<<<<</CuttingItems>
1933 59 <<<<<<</CuttingToolLifeCycle>
1934 60 <<<<<<</CuttingTool>
1935 61 <<<<<<</Assets>
1936 62 <<<<<<</MTConnectAssets>

```

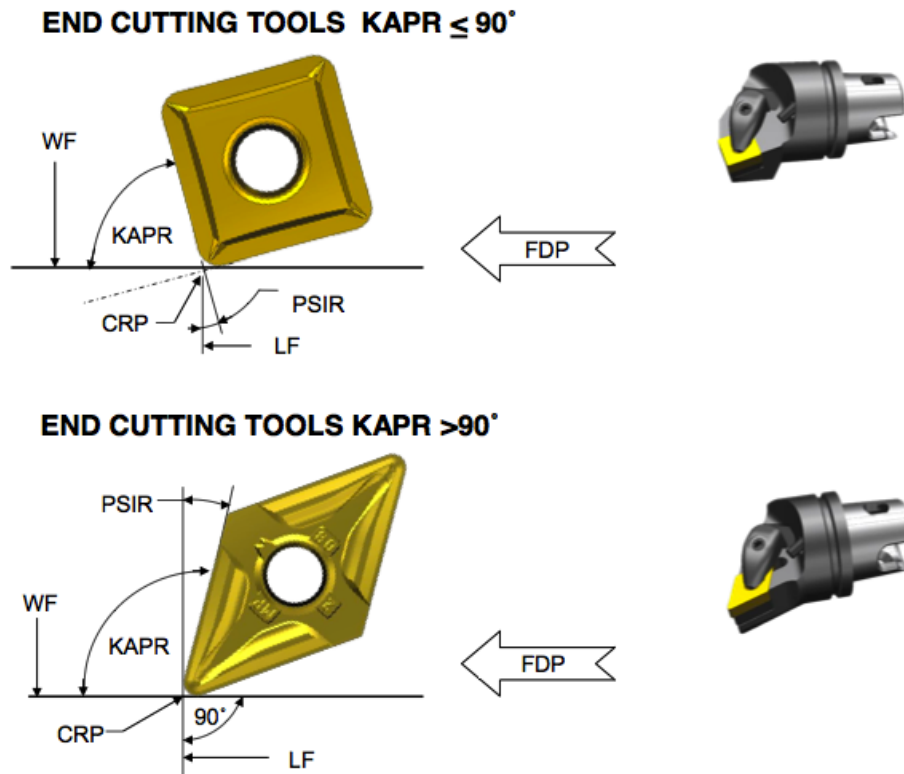


Figure 24: Cutting Tool Measurement 7

1937 B.6.2 Step Drill

Example 2: Example for Step Mill Side View

```

1938 1 <?xml version="1.0" encoding="UTF-8"?>
1939 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1940 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1941 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1942 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1943 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
1944 7 >
1945 8 <Header creationTime="2011-05-
1946 9 11T13:55:22" assetBufferSize="1024"
1947 10 sender="localhost" assetCount="2" version="1.2" instanceId="1234"
1948 11 />
1949 12 <Assets>
1950 13 <CuttingTool serialNumber="1_" toolId="B732A08500HP"
1951 14 timestamp="2011-05-11T13:55:22" assetId="B732A08500HP_"
1952 15 manufacturers="KMT,Parlec">
1953 16 <Description>
1954 17 Step Drill - KMT, B732A08500HP Grade KC7315
1955 Adapter - Parlec, C50-M12SF300-6
1956 </Description>

```

BCH = CHAMFER FLAT LENGTH
CHW = CHAMFER WIDTH

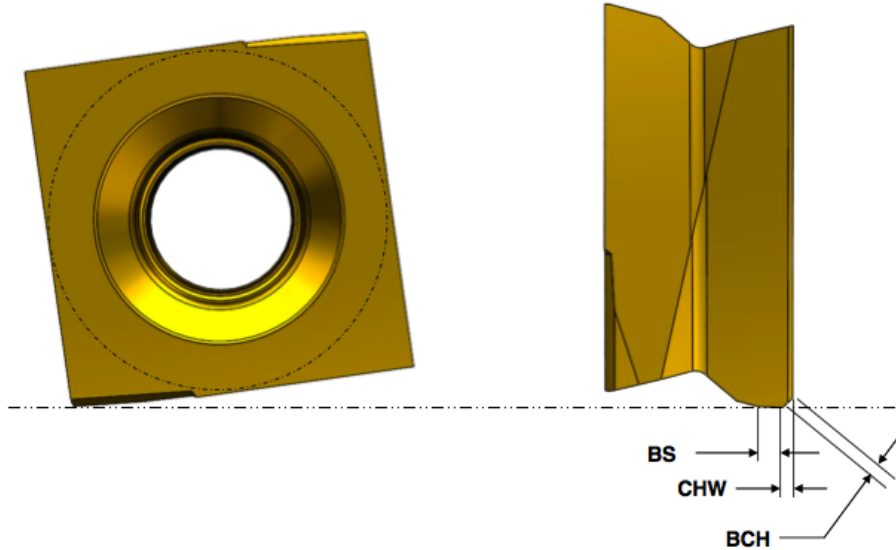


Figure 25: Cutting Tool Measurement 8

```

1957 18      <CuttingToolLifeCycle>
1958 19      <CutterStatus><Status>NEW</Status></CutterStatus>
1959 20      <ProcessSpindleSpeed nominal="5893">5893</
1960      ProcessSpindleSpeed>
1961 21      <ProcessFeedRate nominal="2.5">2.5</ProcessFeedRate>
1962 22      <ConnectionCodeMachineSide>CV50 Taper</
1963      ConnectionCodeMachineSide>
1964 23      <Measurements>
1965 24      <BodyDiameterMax code="BDX">31.8</BodyDiameterMax>
1966 25      <BodyLengthMax code="LBX" nominal="120.825" maximum="
1967      126.325"
1968 26      minimum="115.325">120.825</BodyLengthMax>
1969 27      <ProtrudingLength code="LPR" nominal="155.75" maximum="
1970      161.25"
1971 28      minimum="150.26">155.75</ProtrudingLength>
1972 29      <FlangeDiameterMax code="DF"
1973 30      nominal="98.425">98.425</FlangeDiameterMax>
1974 31      <OverallToolLength nominal="257.35" minimum="251.85"
1975 32      maximum="262.85" code="OAL">257.35</OverallToolLength>
1976 33      </Measurements>
1977 34      <CuttingItems count="2">
1978 35      <CuttingItem indices="1" manufacturers="KMT" grade="KC7315
1979      ">>
1980 36      <Measurements>

```

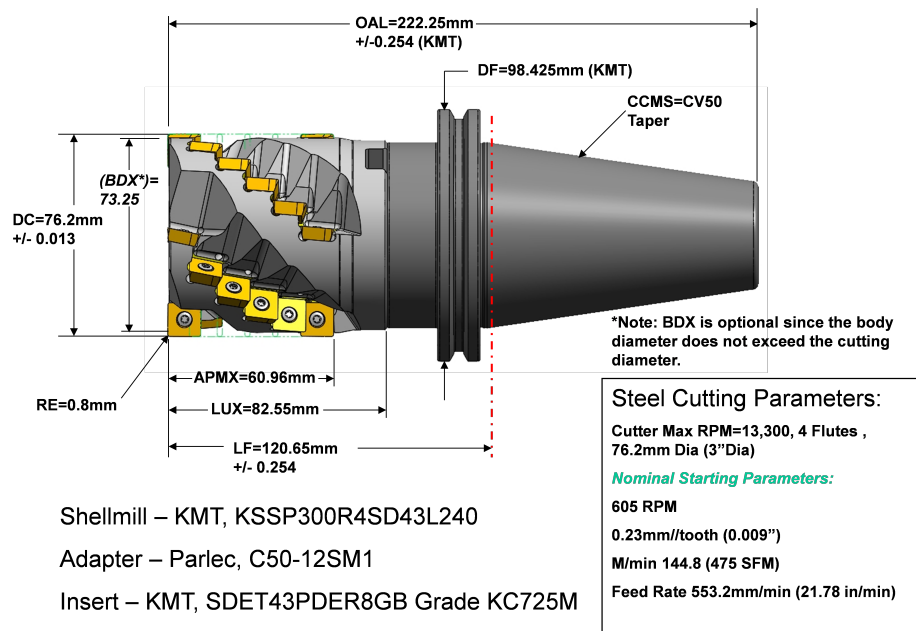


Figure 26: Shell Mill Side View

```

1981 37      <CuttingDiameter code="DC1" nominal="8.5" maximum="
1982      8.521"
1983 38      minimum="8.506">8.5135</CuttingDiameter>
1984 39      <StepIncludedAngle code="STA1" nominal="90" maximum="
1985      91"
1986 40      minimum="89">90</StepIncludedAngle>
1987 41      <Functionallength code="LF1" nominal="154.286"
1988 42      minimum="148.786"
1989 43      maximum="159.786">154.286</Functionallength>
1990 44      <StepDiameterLength code="SDL1"
1991 45      nominal="9">9</StepDiameterLength>
1992 46      <PointAngle code="SIG" nominal="135" minimum="133"
1993 47      maximum="137">135</PointAngle>
1994 48      </Measurements>
1995 49      </CuttingItem>
1996 50      <CuttingItem indices="2" manufacturers="KMT" grade="KC7315
1997      ">>
1998 51      <Measurements>
1999 52      <CuttingDiameter code="DC2" nominal="12" maximum="
2000      12.011"
2001 53      minimum="12">12</CuttingDiameter>
2002 54      <Functionallength code="LF2" nominal="122.493"
2003 55      maximum="127.993"
2004 56      minimum="116.993">122.493</Functionallength>
2005 57      <StepDiameterLength code="SDL2"
2006 58      nominal="9">9</StepDiameterLength>
2007 59      </Measurements>

```

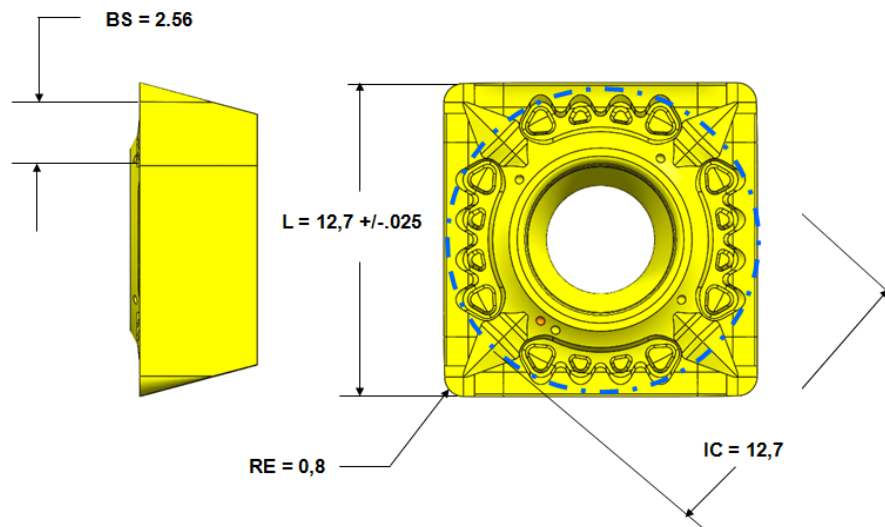
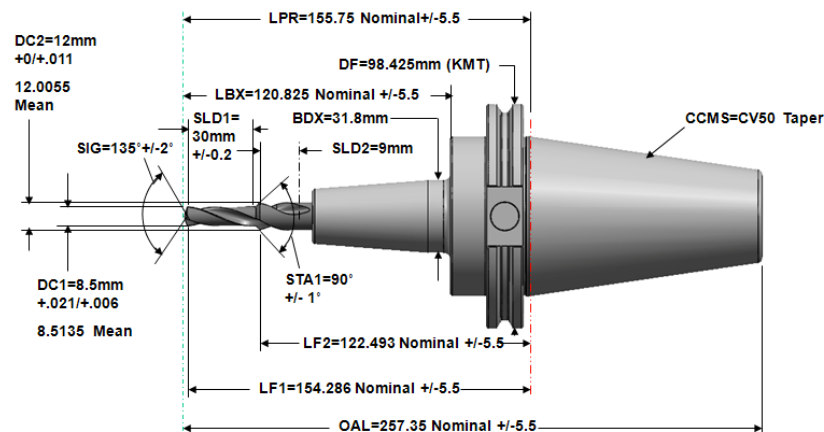


Figure 27: Indexable Insert Measurements

```

2008 60      </CuttingItem>
2009 61      </CuttingItems>
2010 62      </CuttingToolLifeCycle>
2011 63      </CuttingTool>
2012 64      </Assets>
2013 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 28: Step Mill Side View

2014 B.6.3 Shell Mill with Individual Loci

Example 3: Example for Shell Mill with Explicate Loci

```

2015 1 <?xml version="1.0" encoding="UTF-8"?>
2016 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2017 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2018 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2019 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2020 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2021 >
2022 7 <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
2023 8 sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2024 />
2025 9 <Assets>
2026 10 <CuttingTool serialNumber="1" toolId="KSSP300R4SD43L240"
2027 11 timestamp="2011-05-11T13:55:22" assetId="KSSP300R4SD43L240.1"
2028 12 manufacturers="KMT,Parlec">
2029 13 <Description>Keyway: 55 degrees</Description>
2030 14 <CuttingToolLifeCycle>
2031 15 <CutterStatus><Status>NEW</Status></CutterStatus>
2032 16 <Measurements>
2033 17 <UsableLengthMax code="LUX"
2034 18 nominal="82.55">82.55</UsableLengthMax>
2035 19 <CuttingDiameterMax code="DC" nominal="76.2" maximum="
2036 20 76.213"
2037 20 minimum="76.187">76.2</CuttingDiameterMax>

```

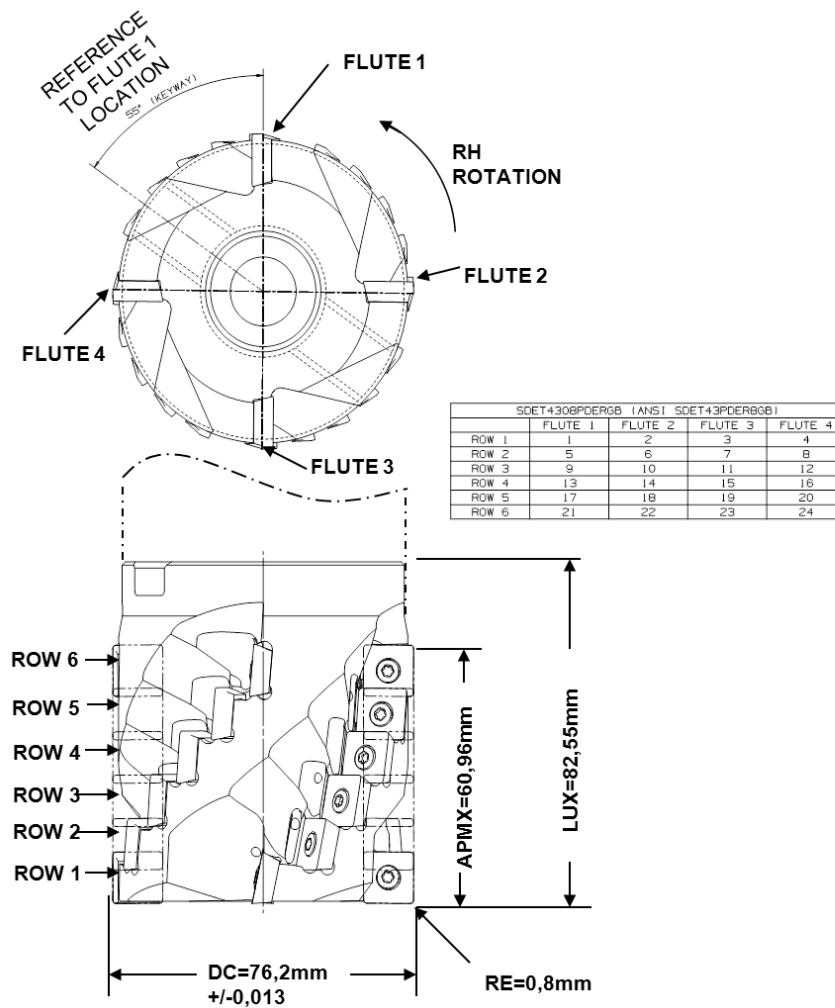


Figure 29: Shell Mill with Explicate Loci

```

2038 21      <DepthOfCutMax code="APMX" nominal="60.96">60.95</
2039          DepthOfCutMax>
2040 22      </Measurements>
2041 23      <CuttingItems count="24">
2042 24          <CuttingItem indices="1" itemId="SDET43PDER8GB"
2043 25              manufacturers="KMT">
2044 26              <Locus>FLUTE: 1, ROW: 1</Locus>
2045 27              <Measurements>
2046 28                  <DriveAngle code="DRVA" nominal="55">55</DriveAngle>
2047 29              </Measurements>
2048 30          </CuttingItem>
2049 31          <CuttingItem indices="2-24" itemId="SDET43PDER8GB"
2050 32              manufacturers="KMT">
2051 33              <Locus>FLUTE: 2-4, ROW: 1; FLUTE: 1-4, ROW 2-6</Locus>
2052 34          </CuttingItem>

```



```
2053 35      </CuttingItems>
2054 36      </CuttingToolLifeCycle>
2055 37      </CuttingTool>
2056 38      </Assets>
2057 39 </MTConnectAssets>
```

2058 B.6.4 Drill with Individual Loci

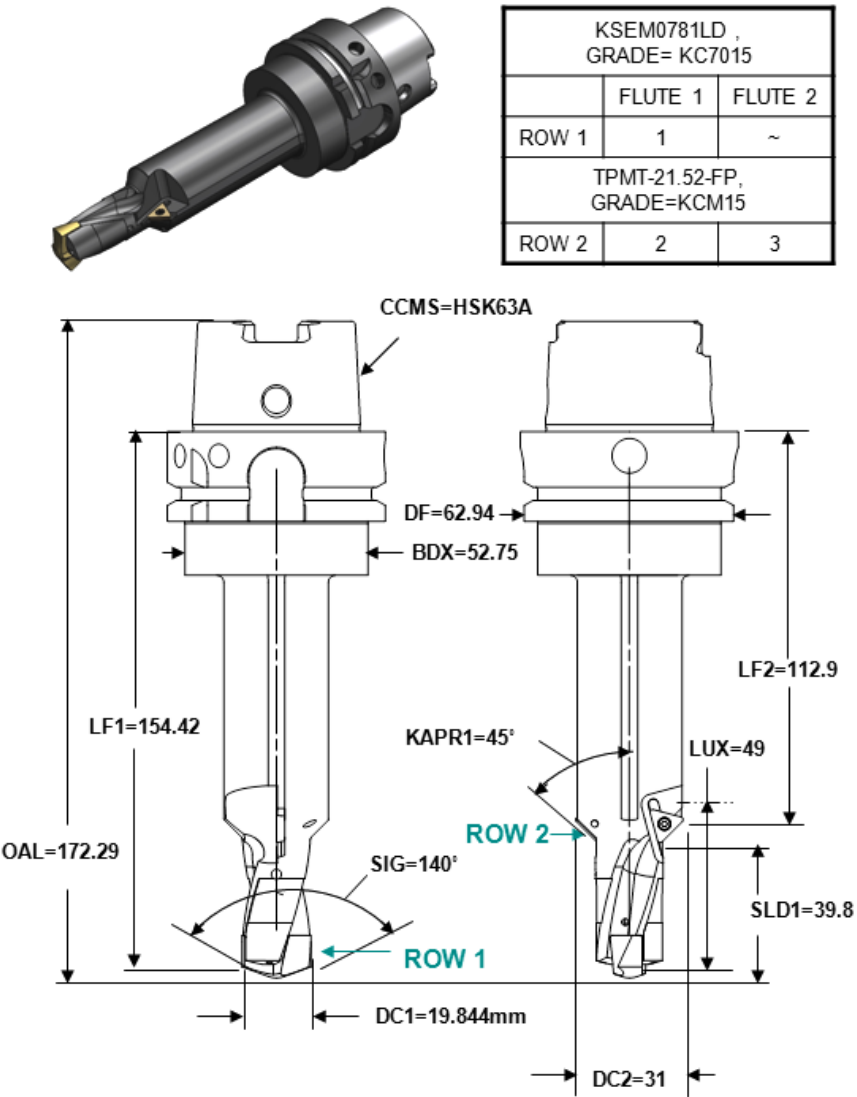


Figure 30: Step Drill with Explicate Loci

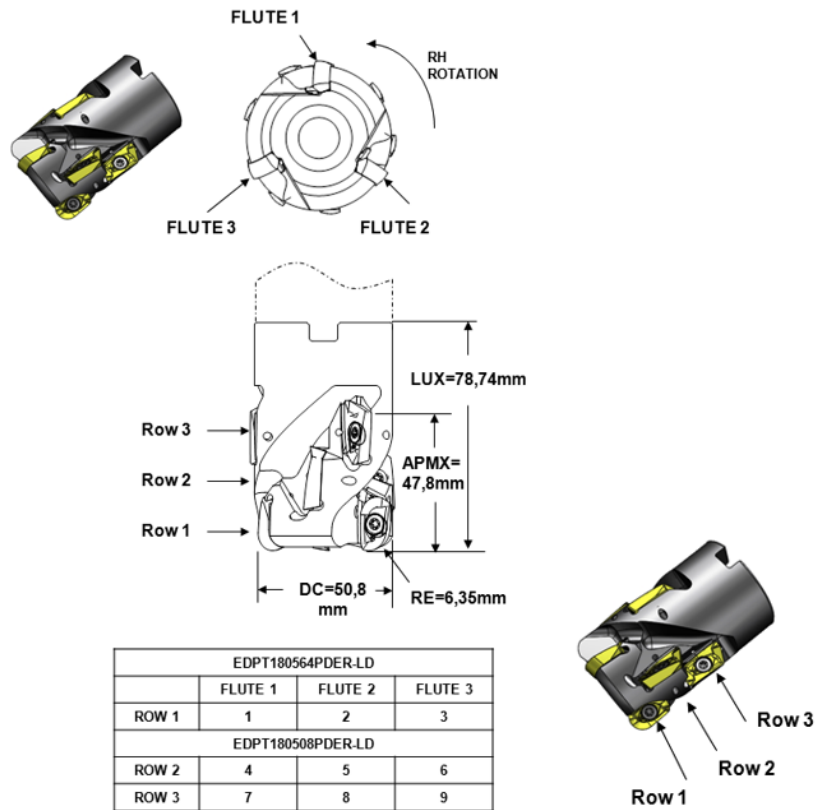
Example 4: Example for Step Drill with Explicate Loci

```
2059 1 <?xml version="1.0" encoding="UTF-8"?>
2060 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2061 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2062 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2063 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2064 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2065 7 >
2066 7 <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
```

```

2067 8   sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2068    />
2069 9   <Assets>
2070 10   <CuttingTool serialNumber="1" toolId="KSEM0781LD"
2071 11   timestamp="2011-05-11T13:55:22" assetId="KSEM0781LD.1"
2072   manufacturers="KMT">
2073 12   <CuttingToolLifeCycle>
2074 13   <CutterStatus><Status>NEW</Status></CutterStatus>
2075 14   <ConnectionCodeMachineSide>HSK63A</ConnectionCodeMachineSide
2076   >
2077 15   <Measurements>
2078 16   <BodyDiameterMax code="BDX">52.75</BodyDiameterMax>
2079 17   <OverallToolLength nominal="172.29"
2080 18   code="OAL">172.29</OverallToolLength>
2081 19   <UsableLengthMax code="LUX" nominal="49">49</
2082   UsableLengthMax>
2083 20   <FlangeDiameterMax code="DF"
2084 21   nominal="62.94">62.94</FlangeDiameterMax>
2085 22   </Measurements>
2086 23   <CuttingItems count="3">
2087 24   <CuttingItem indices="1" itemId="KSEM0781LD" manufacturers
2088   ="KMT"
2089 25   grade="KC7015">
2090 26   <Locus>FLUTE: 1, ROW: 1</Locus>
2091 27   <Measurements>
2092 28   <FunctionalLength code="LF1" nominal="154.42">154.42</
2093   FunctionalLength>
2094 29   <CuttingDiameter code="DC1" nominal="19.844">19.844</
2095   CuttingDiameter>
2096 30   <PointAngle code="SIG" nominal="140">140</PointAngle>
2097 31   <ToolCuttingEdgeAngle code="KAPR1" nominal="45">45</
2098   ToolCuttingEdgeAngle>
2099 32   <StepDiameterLength code="SLD1" nominal="39.8">39.8</
2100   StepDiameterLength>
2101 33   </Measurements>
2102 34   </CuttingItem>
2103 35   <CuttingItem indices="2-3" itemId="TPMT-21.52-FP"
2104 36   manufacturers="KMT" grade="KCM15">
2105 37   <Locus>FLUTE: 1-2, ROW: 2</Locus>
2106 38   <Measurements>
2107 39   <FunctionalLength code="LF2" nominal="112.9">112.9</
2108   FunctionalLength>
2109 40   <CuttingDiameter code="DC2" nominal="31">31</
2110   CuttingDiameter>
2111 41   </Measurements>
2112 42   </CuttingItem>
2113 43   </CuttingItems>
2114 44   </CuttingToolLifeCycle>
2115 45   </CuttingTool>
2116 46   </Assets>
2117 47   </MTConnectAssets>

```

2118 **B.6.5 Shell Mill with Different Inserts on First Row****Figure 31:** Shell Mill with Different Inserts on First Row**Example 5:** Example for Shell Mill with Different Inserts on First Row

```

2119 1 <?xml version="1.0" encoding="UTF-8"?>
2120 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2121 3 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2122 4 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2123 5 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2124 6 http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2125 >
2126 7 <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
2127 8 sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2128 />
2129 9 <Assets>
2130 10 <CuttingTool serialNumber="1" toolId="XXX" timestamp="2011-05-11
2131 T13:55:22"
2132 11 assetId="XXX.1" manufacturers="KMT">
2133 12 <CuttingToolLifeCycle>
2134 13 <CutterStatus><Status>NEW</Status></CutterStatus>
2135 14 <Measurements>

```

```

2136 15      <DepthOfCutMax code="APMX" nominal="47.8">47.8</
2137      DepthOfCutMax>
2138 16      <CuttingDiameterMax code="DC"
2139 17      nominal="50.8">50.8</CuttingDiameterMax>
2140 18      <UsableLengthMax code="LUX"
2141 19      nominal="78.74">78.74</UsableLengthMax>
2142 20      </Measurements>
2143 21      <CuttingItems count="9">
2144 22      <CuttingItem indices="1-3" itemId="EDPT180564PDER-LD"
2145 23      manufacturers="KMT">
2146 24      <Locus>FLUTE: 1-3, ROW: 1</Locus>
2147 25      <Measurements>
2148 26      <CornerRadius code="RE" nominal="6.25">6.35</
2149      CornerRadius>
2150 27      </Measurements>
2151 28      </CuttingItem>
2152 29      <CuttingItem indices="4-9" itemId="EDPT180508PDER-LD"
2153 30      manufacturers="KMT">
2154 31      <Locus>FLANGE: 1-4, ROW: 2-3</Locus>
2155 32      </CuttingItem>
2156 33      </CuttingItems>
2157 34      </CuttingToolLifeCycle>
2158 35      </CuttingTool>
2159 36      </Assets>
2160 37      </MTConnectAssets>

```

2161 B.7 File Schema Diagrams

2162 See File element in MTConnectAssets schema.

2163 B.8 RawMaterial Schema Diagrams

2164 See RawMaterial element in MTConnectAssets schema.

2165 B.9 QIFDocumentWrapper Schema Diagrams

2166 See QIFDocumentWrapper element in MTConnectAssets schema.