



MTConnect® Standard

Part 4.0 – Asset Information Model

Version 2.2.0

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

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1 Purpose of This Document

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

10 2 Terminology and Conventions

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

13 2.1 General Terms

14 *adapter*

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

17 *agent*

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

22 *alarm limit*

23 limit used to trigger warning or alarm indicators.

24 *application*

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

27 *archetype*

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

30 *asset buffer*

31 *buffer* for *Assets*.

32 *attachment*

33 connection by which one thing is associated with another.

34 *buffer*

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

37 ***cartesian coordinate system***

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

39 ***characteristic***40 control placed on an element of a *feature* such as its size, location, or form, which
41 may be a specification limit, a nominal with tolerance, or some other numerical or
42 non-numerical control. *Ref QIF 3.0 3.4.29. Ref AS9102-B.*43 ***client***44 *application* that sends *request* for information to an *agent*.45 Note: Examples include software applications or a function that imple-
46 ments the *request* portion of an *interface interaction model*.47 ***combined standard uncertainty***48 *standard uncertainty* of the result of a measurement when that result is obtained
49 from the values of a number of other quantities, equal to the positive square root of a
50 sum of terms, the terms being the variances or covariances of these other quantities
51 weighted according to how the measurement result varies with changes in these
52 quantities. *Ref JCGM 100:2008 2.3.4*53 ***controlled vocabulary***

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

55 ***data dictionary***56 listing of standardized terms and definitions used in *MTConnect Information Model*.57 ***data model***58 organizes elements of data and standardizes how they relate to one another and to
59 the properties of real-world entities.60 ***data set***61 *key-value pairs* where each entry is uniquely identified by the *key*.62 ***data source***63 piece of equipment that can produce data that is published to an *agent*.64 ***deprecated***65 indication that specific content in an *MTConnect Document* is currently usable but
66 is regarded as being obsolete or superseded.

67 ***deprecation warning***

68 indication that specific content in an *MTConnect Document* may be changed to *depre-*
69 *cated* in a future release of the standard.

70 ***document***

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

73 ***electric current***

74 rate of flow of electric charge.

75 ***element***

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

77 ***extensible***

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

80 ***feature***

81 topological entity(ies) or design requirements related to a geometric model. *Ref QIF*
82 *3.0-3.4.59*

83 ***force***

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

85 ***heartbeat***

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

89 ***higher level***

90 nested element that is above a lower level element.

91 ***implementation***

92 specific instantiation of the MTConnect Standard.

93 ***information model***

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

96 ***instance***

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

99 ***interaction model***

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

102 ***interface***

103 means by which communication is achieved between independent systems.

104 ***key***

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

106 ***key-value pair***

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

109 ***location***

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

111 ***lower camel case***

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

114 ***lower level***

115 nested element that is below a higher level element.

116 ***lower limit***

117 lower conformance boundary for a variable.

118 ***lower warning***

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

120 ***major***

121 identifier representing a consistent set of functionalities defined by the MTConnect
 122 Standard.

123 ***maximum***

124 numeric upper constraint.

125 ***message***

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

127 ***metadata***

128 data that provides information about other data.

129 ***minimum***

130 numeric lower constraint.

131 ***minor***

132 identifier representing a specific set of functionalities defined by the MTConnect
133 Standard.

134 ***nominal***

135 ideal or desired value for a variable.

136 ***organize***

137 act of containing and owning one or more elements.

138 ***organizer***

139 entity that *organizes* one or more elements.

140 ***parameter***

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

143 ***part***

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

147 ***pascal case***

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

150 ***persistence***

151 method for retaining or restoring information.

152 ***position***

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

154 ***probe***

155 instrument commonly used for measuring the physical geometrical characteristics
 156 of an object.

157 ***profile***

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

161 ***requester***

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

163 ***reset***

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

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

167 ***responder***

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

169 ***response document***

170 electronic *document* published by an *MTConnect Agent* in response to a *probe request*, *current request*, *sample request* or *asset request*.

172 ***revision***

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

176 ***schema***

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

179 ***semantic data model***

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

182 ***sensing element***

183 mechanism that provides a signal or measured value.

184 ***sequence number***

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

187 ***specification limit***

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

189 ***spindle***

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

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

192 ***standard***

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

195 ***standard uncertainty***

196 *uncertainty* of the result of a measurement expressed as a standard deviation. *Ref JCGM*
 197 *100:2008 2.3.1*

198 ***stereotype***

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

200 ***subtype***

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

202 ***table***

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

204 ***table cell***

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

206 ***table entry***

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

208 ***top level***

209 element that represents the most significant physical or logical functions of a piece
 210 of equipment.

211 ***type***

212 classification or categorization of information.

213 ***uncertainty***

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

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

218 ***upper limit***

219 upper conformance boundary for a variable.

220 ***upper warning***

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

222 ***version***

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

224 2.2 Information Model Terms

225 ***Asset Information Model***

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

227 ***Device Information Model***

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

230 ***Error Information Model***

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

235 ***MTConnect Information Model***

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

237 ***Observation Information Model***

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

240 2.3 Protocol Terms

241 ***asset request***

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

243 ***current request***

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

247 ***data streaming***

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

250 ***MTConnect Request***

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

252 ***MTConnect Response Document***

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

254 ***MTConnectAssets Response Document***

255 *response document* published by an *MTConnect Agent* in response to an *asset re-*
 256 *quest*.

257 ***MTConnectDevices Response Document***

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

260 ***MTConnectErrors Response Document***

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

263 ***MTConnectStreams Response Document***

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

266 ***probe request***

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

269 **protocol**

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

272 **publish**

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

274 **publish and subscribe**

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

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

279 **request**

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

282 **request and response**

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

285 **response**

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

287 **sample request**

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

291 **streaming data**

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

293 **subscribe**

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

295 **transport protocol**

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

298 2.4 HTTP Terms

299 **HTTP Body**

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

302 **HTTP Error Message**

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

306 **HTTP Header**

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

309 **HTTP Header Field**

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

312 **HTTP Message**

313 consist of requests from client to server and responses from server to client. *Ref IETF:RFC-*
 314 *2616*

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

317 **HTTP Messaging**

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

319 **HTTP Method**

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

323 **HTTP Query**

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

326 **HTTP Request**

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

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

332 ***HTTP Request Line***

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

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

338 ***HTTP Request Method***

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

341 ***HTTP Request URI***

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

344 ***HTTP Response***

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

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

349 ***HTTP Server***

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

352 ***HTTP Status Code***

353 3-digit integer result code of the attempt to understand and satisfy the request.
354 *Ref IETF:RFC-2616*

355 ***HTTP Version***

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

357 2.5 XML Terms

358 ***abstract element***

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

364 ***attribute***

365 additional information or property for an *element*.

366 ***child element***

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

369 ***document body***

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

373 ***document header***

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

378 ***element name***

379 descriptive identifier contained in both the *start-tag* and *end-tag* of an XML
 380 *element* that provides the name of the *element*.

381 ***namespace***

382 organizes information into logical groups.

383 ***parent element***

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

386 ***root element***

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

388 ***structural element***

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

391 ***XML Document***

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

393 ***XML Schema***

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

395 2.6 MTConnect Terms

396 ***Asset***

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

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

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

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

409 ***Component***

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

411 ***Composition***

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

413 ***Configuration***

414 configuration for a *Component*

415 ***DataItem***

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

417 **Device**

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

419 **MTConnect Agent**

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

421 **MTConnect Document**

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

423 **MTConnect Event**

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

425 **MTConnect Interface**

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

427 **Observation**

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

429 2.7 Acronyms

430 **2D**

431 two-dimensional

432 **3D**

433 three-dimensional

434 **AI**

435 artificial intelligence

436 **ALM**

437 application lifecycle management

438 **AMT**

439 The Association for Manufacturing Technology

440 **ANSI**

441 American National Standards Institute

442 **AP**

443 Application Protocol

444 **API**

445 application programming interface

446 **ASME**

447 American Society of Mechanical Engineers

448 **ASTM**

449 American Society for Testing and Materials

450 **AWS**

451 American Welding Society

452 **BDD**

453 block definition diagram

454 **BOM**

455 bill of materials

456 **BST**

457 Board on Standardization and Testing

458 **C&R**

459 cause and remedy

460 **CA**

461 certificate authority

462 **CAD**

463 computer-aided design

464 **CAE**

465 computer-aided engineering

466 **CAI**

467 computer-aided inspection

468 **CAM**

469 computer-aided manufacturing

470 **CAx**
471 computer-aided technologies

472 **CDATA**
473 Character Data

474 **CFD**
475 computational fluid dynamics

476 **CM**
477 configuration management

478 **CMS**
479 coordinate-measurement system

480 **CNC**
481 Computer Numerical Controller

482 **CNRI**
483 Corporation for National Research Initiatives

484 **CPM**
485 Core Product Model

486 **CPM2**
487 Revised Core Product Model

488 **CPSC**
489 Consumer Product Safety Commission

490 **cUAV**
491 configurable unmanned aerial vehicle

492 **DARPA**
493 Defense Advanced Research Projects Agency

494 **DER**
495 designated-engineering representative

496 **DFM**
497 design for manufacturing

498 **DLA**

499 Defense Logistics Agency

500 **DMC**

501 digital manufacturing certificate

502 **DMSC**

503 Dimensional Metrology Standards Consortium

504 **DNS**

505 Domain Name System

506 **DoD**

507 U.S. Department of Defense

508 **DOI**

509 Distributed Object Identifier

510 **DRM**

511 digital rights management

512 **ECR**

513 engineering change request

514 **ERP**

515 enterprise resource planning

516 **FAA**

517 Federal Aviation Administration

518 **FAIR**

519 first article inspection reporting

520 **FDA**

521 Food and Drug Administration

522 **FEA**

523 finite-element analysis

524 **GD&T**

525 geometric dimensions and tolerances

526 **GID**

527 global identifier

528 **HMI**

529 Human Machine Interface

530 **HTML**

531 Hypertext Markup Language

532 **HTTP**

533 Hypertext Transfer Protocol

534 **HTTPS**

535 Hypertext Transfer Protocol over Secure Sockets Layer

536 **I/O**

537 in-out

538 **ID**

539 identifier

540 **IEEE**

541 Institute of Electrical and Electronics Engineers

542 **IIoT**

543 industrial internet of things

544 **INCOSE**

545 International Council on Systems Engineering

546 **IP**

547 intellectual property

548 **ISO**

549 International Standards Organization

550 **ISS**

551 International Space Station

552 **ISV**

553 Independent Software Vendor

554 **IT**

555 information technology

556 **ITU-T**

557 Telecommunication Standardization Sector of the International Telecommunication
558 Union

559 **JSON**

560 JavaScript Object Notation

561 **JT**

562 Jupiter Tesselation

563 **LHS**

564 Lifecycle Handler System

565 **LIFT**

566 Lifecycle Information Framework and Technology

567 **LOI**

568 Lifecycle Object Identifier

569 **MAC**

570 media access control

571 **MADE**

572 Manufacturing Automation and Design Engineering

573 **MBD**

574 model-based definition

575 **MBE**

576 Model-Based Enterprise

577 **MBI**

578 model-based inspection

579 **MBM**

580 model-based manufacturing

581 ***MBSD***

582 model-based standards development

583 ***MBSE***

584 model-based systems engineering

585 ***MEDALS***

586 Military Engineering Data Asset Locator System

587 ***MES***

588 manufacturing execution system

589 ***MOI***

590 manufacturing object identifier

591 ***MOM***

592 Message Oriented Middleware

593 ***MQTT***

594 Message Queuing Telemetry Transport

595 ***MTC***

596 Manufacturing Technology Centre

597 ***NASA***

598 National Aeronautics and Space Administration

599 ***NC***

600 numerical control

601 ***NIST***

602 National Institute of Standards and Technology

603 ***NMTOKEN***

604 Name Token

605 ***NNMI***

606 National Network of Manufacturing Innovation

607 ***NSF***

608 National Science Foundation

609 **NTSC**

610 National Transportation Safety Board

611 **OASIS**

612 Organization for the Advancement of Structured Information Standards

613 **ODI**

614 Open Data Institute

615 **OEM**

616 original equipment manufacturer

617 **OOI**

618 Ocean Observatories Initiative

619 **OPC**

620 OLE for Process Control

621 **OSLC**

622 Open Services for Lifecycle Collaboration

623 **OSTP**

624 Office of Science and Technology Policy

625 **OT**

626 operational technology

627 **OWL**

628 Ontology Web Language

629 **PDF**

630 Portable Document Format

631 **PDM**

632 product-data management

633 **PDQ**

634 product-data quality

635 **PHM**

636 prognosis and health monitoring

637 ***PI***

638 principal investigator

639 ***PLC***

640 Programmable Logic Controller

641 ***PLCS***

642 Product Life Cycle Support

643 ***PLM***

644 product lifecycle management

645 ***PLOT***

646 product lifecycle of trust

647 ***PMI***

648 product and manufacturing information

649 ***PMS***

650 Production Management System

651 ***PRC***

652 Product Representation Compact

653 ***PSI***

654 Physical Science Informatics

655 ***PTAB***

656 Primary Trustworthy Digital Repository Authorization Body Ltd.

657 ***QIF***

658 Quality Information Framework

659 ***QMS***

660 quality management system

661 ***QName***

662 Qualified Name

663 ***RDF***

664 Resource Description Framework

665 ***REST***

666 Representational State Transfer

667 ***RII***

668 receiving and incoming inspection

669 ***S/MIME***

670 Secure/Multipurpose Internet Mail Extensions

671 ***SaaS***

672 software-as-a-service

673 ***SAML***

674 Security Assertion Markup Language

675 ***SC***

676 Standards Committee

677 ***SCADA***

678 Supervisory Control And Data Acquisition

679 ***SDO***

680 Standards Development Organization

681 ***SFTP***

682 Secure File Transfer Protocol

683 ***SKOS***

684 Simple Knowledge Organization System

685 ***SLH***

686 system lifecycle handler

687 ***SLR***

688 systematic literature review

689 ***SME***

690 small-to-medium enterprise

691 ***SMOPAC***

692 Smart Manufacturing Operations Planning and Control

693 **SMS Test Bed**

694 Smart Manufacturing Systems Test Bed

695 **SOA**

696 service-oriented architecture

697 **SPMM**

698 semantic-based product metamodel

699 **SSL**

700 Secure Sockets Layer

701 **STEP**

702 Standard for the Exchange of Product Model Data

703 **STEP AP242**

704 Standard for the Exchange of Product Model Data Application Protocol 242

705 **STL**

706 Stereolithography

707 **SysML**

708 Systems Modeling Language

709 **TCP/IP**

710 Transmission Control Protocol/Internet Protocol

711 **TDP**

712 technical data package

713 **TLS**

714 Transport Layer Security

715 **TSM**

716 Total System Model

717 **UA**

718 Unified Architecture

719 **UAL**

720 Unified Architecture Language

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

751 2.8 MTConnect References

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

759

760 3 Asset Information Model

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

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

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

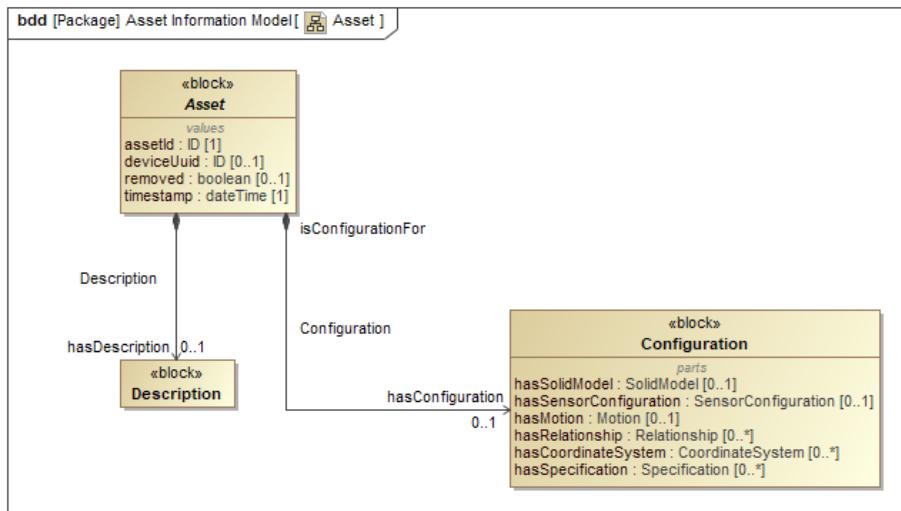
780 The MTConnect Standard has two data item types to support change notification when an
 781 *Asset* is added, updated or removed. AssetChanged states the assetId of the *Asset*
 782 that has been added or updated. AssetRemoved states the assetId of the *Asset* that
 783 has been removed. See *MTConnect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

785 3.1 Asset

786 abstract *Asset*.

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

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

**Figure 1:** Asset

791 3.1.1 Value Properties of Asset

792 *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
hash	string	0..1

Table 1: Value Properties of Asset

793 Descriptions for Value Properties of Asset:

- 794 • assetId
795 unique identifier for an Asset.
- 796 • deviceUuid
797 associated piece of equipment's Universally Unique Identifier (UUID) that supplied
798 the Asset's data.
799 It references to the `uuid` property of the Device defined in *MTConnect Standard: Part 2.0 - Device Information Model*.

801 • removed
 802 indicator that the Asset has been removed from the piece of equipment.
 803 • timestamp
 804 time the Asset data was last modified.
 805 • hash
 806 condensed message digest from a secure one-way hash function. *Ref FIPS PUB*
 807 *180-4*

808 3.1.2 Part Properties of Asset

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

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

Table 2: Part Properties of Asset

810 Descriptions for Part Properties of Asset:

811 • Description
 812 descriptive content.
 813 This can contain configuration information and manufacturer specific details.
 814 • Configuration
 815 technical information about an entity describing its physical layout, functional char-
 816 acteristics, and relationships with other entities.
 817 See Configuration in *MTConnect Standard: Part 2.0 - Device Information*
 818 *Model*.

819 4 Cutting Tool Asset Information Model

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

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



Figure 2: Cutting Tool Parts

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

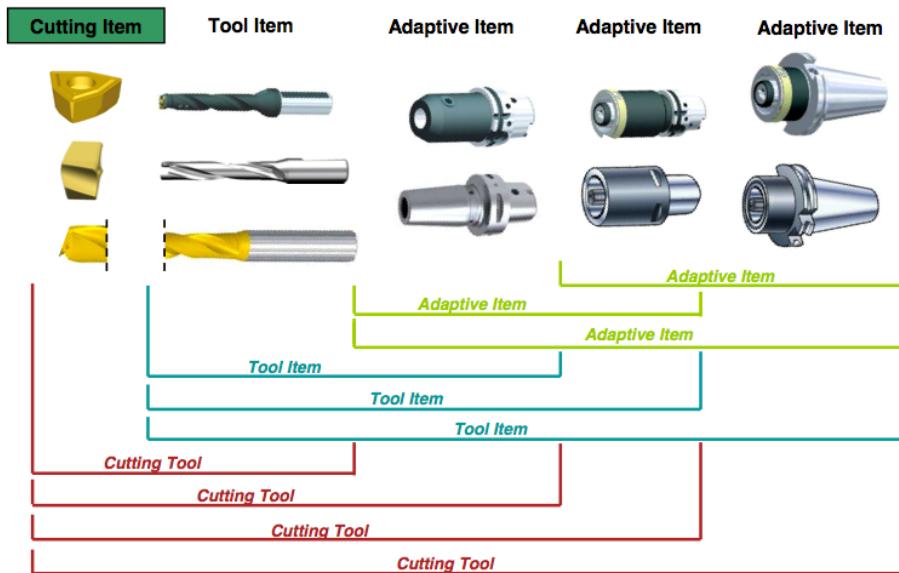


Figure 3: Cutting Tool Composition

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

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

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

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

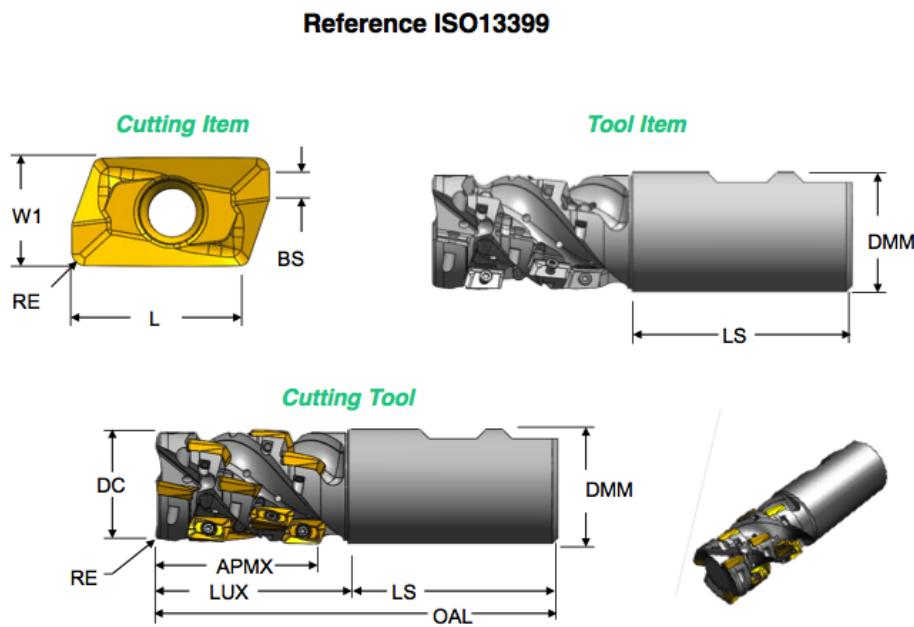


Figure 4: Cutting Tool, Tool Item, and Cutting Item

858 4.1 Cutting Tool

859 This section provides semantic information for the `CuttingTool` and `CuttingToolArchetype`
860 models.

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

862 4.1.1 CuttingTool

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

864 4.1.1.1 Value Properties of CuttingTool

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

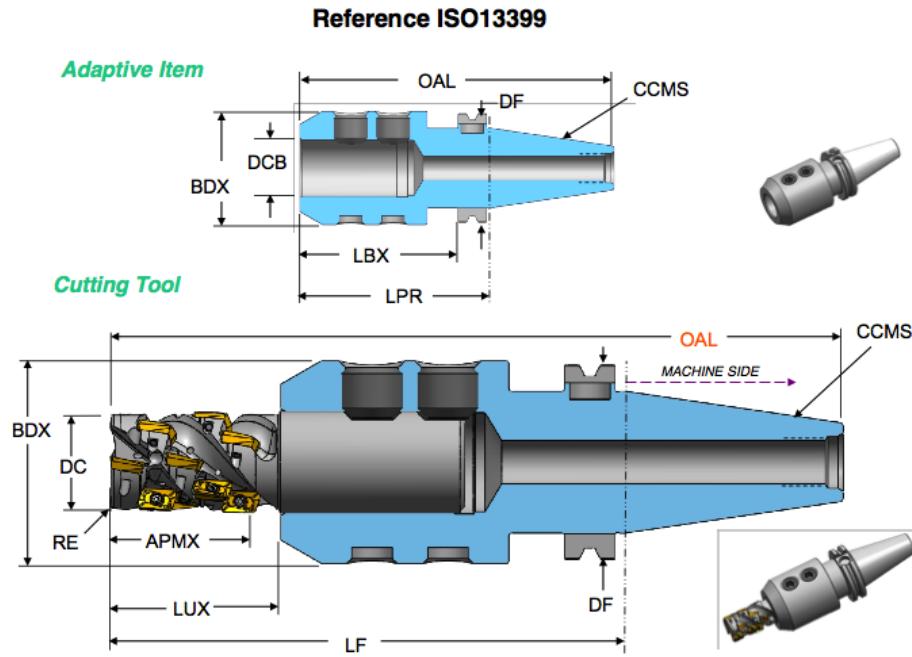


Figure 5: Cutting Tool, Tool Item, and Cutting Item 2

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

Table 3: Value Properties of CuttingTool

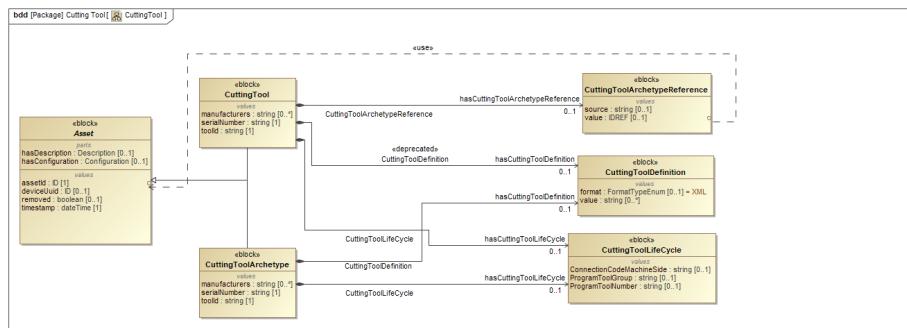


Figure 6: CuttingTool

866 Descriptions for Value Properties of CuttingTool:

867 • manufacturers
 868 manufacturers of the cutting tool.
 869 This will reference the tool item and adaptive items specifically. The cutting items
 870 manufacturers' will be a property of CuttingItem.

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

873 • serialNumber
 874 unique identifier for this assembly.
 875 • toolId
 876 identifier for a class of cutting tools.

877 4.1.1.2 Part Properties of CuttingTool

878 *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

879 Descriptions for Part Properties of CuttingTool:

880 • CuttingToolLifeCycle
 881 data regarding the application or use of the tool.
 882 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
 883 and statistical process control applications. Life cycle data will not remain static,
 884 but will change periodically when a tool is used or measured.
 885 See *Section 4.2.1 - CuttingToolLifeCycle*.
 886 • CuttingToolArchetypeReference
 887 reference information about the assetId and/or the URL of the data source of
 888 CuttingToolArchetype.

- 889 • CuttingToolDefinition
 890 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO*
 891 *13399.*
 892 **DEPRECATED** in *Version 1.3.0* for CuttingTool.

893 4.1.2 CuttingToolArchetype

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

896 4.1.2.1 Value Properties of CuttingToolArchetype

897 *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

898 Descriptions for Value Properties of CuttingToolArchetype:

- 899 • manufacturers
 900 manufacturers of the cutting tool.
 901 This will reference the tool item and adaptive items specifically. The cutting items
 902 manufacturers' will be a property of CuttingItem.

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

- 905 • serialNumber
 906 unique identifier for this assembly.
 907 • toolId
 908 identifier for a class of cutting tools.

909 **4.1.2.2 Part Properties of CuttingToolArchetype**910 *Table 6* lists the Part Properties of CuttingToolArchetype.

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

Table 6: Part Properties of CuttingToolArchetype

911 Descriptions for Part Properties of CuttingToolArchetype:

- 912 • CuttingToolDefinition

913 detailed structure of the cutting tool which is static during its lifecycle. *Ref ISO
914 13399.*915 **DEPRECATED** in Version 2.1.0 for CuttingToolArchetype.

- 916 • CuttingToolLifeCycle

917 data regarding the application or use of the tool.

918 This data is provided by various pieces of equipment (i.e. machine tool, presetter)
919 and statistical process control applications. Life cycle data will not remain static,
920 but will change periodically when a tool is used or measured.921 See *Section 4.2.1 - CuttingToolLifeCycle*.922 **4.1.3 CuttingToolArchetypeReference**923 reference information about the assetId and/or the URL of the data source of Cut-
924 tingToolArchetype.925 The value of CuttingToolArchetypeReference **MUST** be IDREF. See *Section 9.11
926 - IDREF*.927 **4.1.3.1 Value Properties of CuttingToolArchetypeReference**928 *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

929 Descriptions for Value Properties of CuttingToolArchetypeReference:

- 930 • source

931 Uniform Resource Locator (URL) of the CuttingToolArchetype *information*
 932 *model*.

933 4.1.4 CuttingToolDefinition

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

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

936 4.1.4.1 Value Properties of CuttingToolDefinition

937 *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

938 Descriptions for Value Properties of CuttingToolDefinition:

- 939 • format

940 identifies the expected representation of the enclosed data.

941 FormatTypeEnum Enumeration:

- 942 – EXPRESS

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

- 944 – TEXT

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

- 946 - UNDEFINED
 947 document will be provided in an undefined format.
 948 - XML
 949 default value for the definition. The content will be an XML document.

950 4.2 Cutting Tool Life Cycle

951 This section provides semantic information for the CuttingToolLifeCycle model.

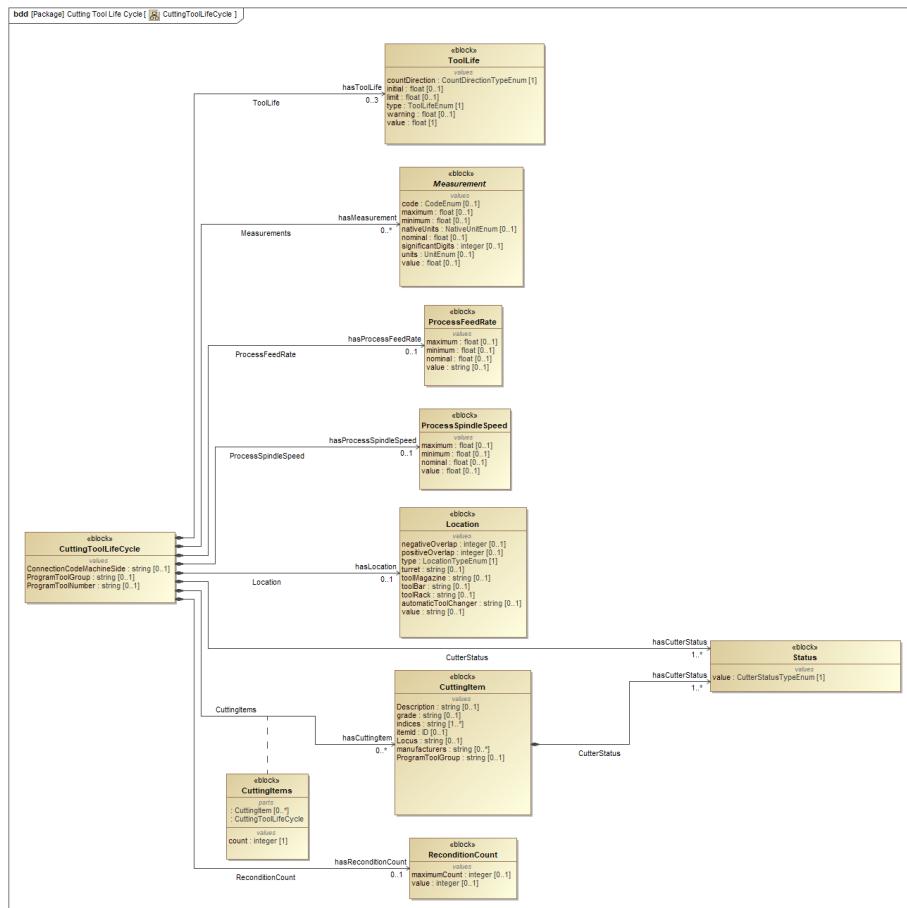


Figure 7: CuttingToolLifeCycle

952 Note: See *Section B.3 - CuttingToolLifeCycle Schema Diagrams* for XML
 953 schema.

954 4.2.1 CuttingToolLifeCycle

955 data regarding the application or use of the tool.

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

959 4.2.1.1 Value Properties of CuttingToolLifeCycle

960 *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

961 Descriptions for Value Properties of CuttingToolLifeCycle:

- 962 • ConnectionCodeMachineSide
 963 identifier for the capability to connect any component of the cutting tool together,
 964 except Assembly Items, on the machine side. Code: CCMS
- 965 • ProgramToolGroup
 966 tool group this tool is assigned in the part program.
- 967 • ProgramToolNumber
 968 number of the tool as referenced in the part program.

969 4.2.1.2 Part Properties of CuttingToolLifeCycle

970 *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

971 Descriptions for Part Properties of CuttingToolLifeCycle:

972 • ProcessFeedRate

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

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

977 See *Section 4.2.6 - ProcessFeedRate*.

978 • ToolLife

979 cutting tool life as related to the assembly.

980 See *Section 4.2.2 - ToolLife*.

981 • ProcessSpindleSpeed

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

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

986 See *Section 4.2.5 - ProcessSpindleSpeed*.

987 • Status

988 status of the cutting tool.

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

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

- 993 – NEW **MUST NOT** be used with USED, RECONDITIONED, or EXPIRED.
 994 – UNKNOWN **MUST NOT** be used with any other status.
 995 – ALLOCATED and UNALLOCATED **MUST NOT** be used together.
 996 – AVAILABLE and UNAVAILABLE **MUST NOT** be used together.
 997 – If the tool is EXPIRED, BROKEN, or NOT_REGISTERED it **MUST NOT** be
 998 AVAILABLE.

999 • CuttingItem

1000 part of the tool that physically removes the material from the workpiece by shear
 1001 deformation.

1002 CuttingItems groups one or more CuttingItem entities. See *Section 4.3.1 -*
 1003 *CuttingItem* and *Section 4.3 - Cutting Item* for more detail.

1004 • Measurement

1005 constrained scalar value associated with a cutting tool.

1006 Measurements groups one or more Measurement subtypes. See *Section 4.2.8*
 1007 *- Measurement*.

1008 • ReconditionCount

1009 number of times the cutter has been reconditioned.

1010 See *Section 4.2.4 - ReconditionCount*.

1011 • Location

1012 location of the pot or spindle the cutting tool currently resides in.

1013 If negativeOverlap or positiveOverlap is provided, the tool reserves ad-
 1014 ditional locations on either side, otherwise if they are not given, no additional loca-
 1015 tions are required for this tool.

1016 If the pot occupies the first or last location, a rollover to the beginning or the end of
 1017 the indexable values may occur. For example, if there are 64 pots and the tool is in
 1018 pot 64 with a positiveOverlap of 1, the first pot **MAY** be occupied as well.

1019 See *Section 4.2.3 - Location* for more detail.

1020 **4.2.2 ToolLife**

1021 cutting tool life as related to the assembly.

1022 ToolLife **MUST** be defined only for the CuttingToolLifeCycle of Cutting-
 1023 Tool and **MUST NOT** be defined for the CuttingToolLifeCycle of Cutting-
 1024 ToolArchetype.

1025 The value of ToolLife **MUST** be float.

1026 **4.2.2.1 Value Properties of ToolLife**

1027 *Table 11* lists the Value Properties of ToolLife.

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

Table 11: Value Properties of ToolLife

1028 Descriptions for Value Properties of ToolLife:

1029 • countDirection

1030 indicates if the tool life counts from zero to maximum or maximum to zero.

1031 CountDirectionTypeEnum Enumeration:

1032 – DOWN

1033 tool life counts down from the maximum to zero.

1034 – UP

1035 tool life counts up from zero to the maximum.

1036 • initial

1037 initial life of the tool when it is new.

1038 • limit

1039 end of life limit for the tool.

1040 • type

1041 type of tool life being accumulated.

1042 ToolLifeEnum Enumeration:

1043 - MINUTES
1044 tool life measured in minutes.
1045 All units for minimum, maximum, and nominal **MUST** be provided in min-
1046 utes.
1047 - PART_COUNT
1048 tool life measured in parts.
1049 All units for minimum, maximum, and nominal **MUST** be provided as the
1050 number of parts.
1051 - WEAR
1052 tool life measured in tool wear.
1053 Wear **MUST** be provided in millimeters as an offset to nominal. All units for
1054 minimum, maximum, and nominal **MUST** be given as millimeter offsets as
1055 well. The standard will only consider dimensional wear at this time.
1056 • warning
1057 point at which a tool life warning will be raised.

1058 4.2.3 Location

1059 location of the pot or spindle the cutting tool currently resides in.
1060 If negativeOverlap or positiveOverlap is provided, the tool reserves additional
1061 locations on either side, otherwise if they are not given, no additional locations are required
1062 for this tool.
1063 If the pot occupies the first or last location, a rollover to the beginning or the end of the
1064 indexable values may occur. For example, if there are 64 pots and the tool is in pot 64 with
1065 a positiveOverlap of 1, the first pot **MAY** be occupied as well.
1066 Location **MUST** be defined only for the CuttingToolLifeCycle of Cutting-
1067 Tool and **MUST NOT** be defined for the CuttingToolLifeCycle of Cutting-
1068 ToolArchetype.
1069 The value of Location **MUST** be string.

1070 4.2.3.1 Value Properties of Location

1071 *Table 12* lists the Value Properties of Location.

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

Table 12: Value Properties of Location

1072 Descriptions for Value Properties of Location:

- 1073 • negativeOverlap
- 1074 number of locations at lower index values from this location.
- 1075 • positiveOverlap
- 1076 number of locations at higher index value from this location.
- 1077 • type
- 1078 type of location being identified.
- 1079 When a POT or STATION type is used, value of Location **MUST** be a numeric value.
- 1080
- 1081 LocationTypeEnum Enumeration:
 - 1082 - CRIB
 - 1083 location with regard to a tool crib.
 - 1084 - END_EFFECTOR
 - 1085 location associated with an end effector.
 - 1086 - EXPIRED_POT
 - 1087 location for a tool that is no longer usable and is awaiting removal from a tool magazine or turret.
 - 1088
 - 1089 - POT
 - 1090 number of the pot in the tool handling system.
 - 1091 - REMOVAL_POT
 - 1092 location for a tool removed from a tool magazine or turret awaiting transfer to a location outside of the piece of equipment.
 - 1093

- 1094 – RETURN_POT
- 1095 location for a tool removed from a *spindle* or turret and awaiting return to a
- 1096 tool magazine.
- 1097 – SPINDLE
- 1098 location associated with a *spindle*.
- 1099 – STAGING_POT
- 1100 location for a tool awaiting transfer to a tool magazine or turret from outside
- 1101 of the piece of equipment.
- 1102 – STATION
- 1103 tool location in a horizontal turning machine.
- 1104 – TRANSFER_POT
- 1105 location for a tool awaiting transfer from a tool magazine to spindle or a turret.
- 1106 • turret
- 1107 turret associated with a tool.
- 1108 • toolMagazine
- 1109 tool magazine associated with a tool.
- 1110 • toolBar
- 1111 tool bar associated with a tool.
- 1112 • toolRack
- 1113 tool rack associated with a tool.
- 1114 • automaticToolChanger
- 1115 automatic tool changer associated with a tool.

1116 4.2.4 ReconditionCount

1117 number of times the cutter has been reconditioned.

1118 ReconditionCount **MUST** be defined only for the CuttingToolLifeCycle of

1119 CuttingTool and **MUST NOT** be defined for the CuttingToolLifeCycle of

1120 CuttingToolArchetype.

1121 The value of ReconditionCount **MUST** be integer.

1122 **4.2.4.1 Value Properties of ReconditionCount**

1123 *Table 13* lists the Value Properties of ReconditionCount.

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

Table 13: Value Properties of ReconditionCount

1124 Descriptions for Value Properties of ReconditionCount:

- 1125 • maximumCount
 1126 maximum number of times the tool may be reconditioned.

1127 **4.2.5 ProcessSpindleSpeed**

1128 constrained process spindle speed for the tool in revolutions/minute.

1129 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.

1132 The value of ProcessSpindleSpeed **MUST** be float.

1133 **4.2.5.1 Value Properties of ProcessSpindleSpeed**

1134 *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

1135 Descriptions for Value Properties of ProcessSpindleSpeed:

- 1136 • maximum
 1137 upper bound for the tool's target spindle speed.

- 1138 • minimum
- 1139 lower bound for the tools spindle speed.
- 1140 • nominal
- 1141 nominal speed the tool is designed to operate at.

1142 4.2.6 ProcessFeedRate

- 1143 constrained process feed rate for the tool in mm/s.
- 1144 The value **MAY** contain the nominal process target feed rate if available. If `Process-`
 1145 `FeedRate` is provided, at least one value of maximum, nominal, or minimum **MUST**
 1146 be specified.
- 1147 The value of `ProcessFeedRate` **MUST** be string.

1148 4.2.6.1 Value Properties of ProcessFeedRate

1149 *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`

1150 Descriptions for Value Properties of `ProcessFeedRate`:

- 1151 • maximum
- 1152 upper bound for the tool's process target feedrate.
- 1153 • minimum
- 1154 lower bound for the tool's feedrate.
- 1155 • nominal
- 1156 nominal feedrate the tool is designed to operate at.

1157 4.2.7 Status

1158 status of the cutting tool.

1159 CutterStatusTypeEnum Enumeration:

- 1160 • ALLOCATED
 - 1161 tool is has been committed to a piece of equipment for use and is not available for
 - 1162 use in any other piece of equipment.
- 1163 • AVAILABLE
 - 1164 tool is available for use.
- 1165 If this is not present, the tool is currently not ready to be used.
- 1166 • BROKEN
 - 1167 premature tool failure.
- 1168 • EXPIRED
 - 1169 tool has reached the end of its useful life.
- 1170 • MEASURED
 - 1171 tool has been measured.
- 1172 • NEW
 - 1173 new tool that has not been used or first use.
 - 1174 Marks the start of the tool history.
- 1175 • NOT_REGISTERED
 - 1176 tool cannot be used until it is entered into the system.
- 1177 • RECONDITIONED
 - 1178 tool has been reconditioned.
- 1179 • UNALLOCATED
 - 1180 tool has not been committed to a process and can be allocated.
- 1181 • UNAVAILABLE
 - 1182 tool is unavailable for use in metal removal.
- 1183 • UNKNOWN
 - 1184 tool is an indeterminate state. This is the default value.

- 1185 • USED
 1186 tool is in process and has remaining tool life.

1187 4.2.8 Measurement

- 1188 constrained scalar value associated with a cutting tool.
 1189 A Measurement is specific to the tool management policy at a particular shop. The tool
 1190 zero reference point or gauge line will be different depending on the particular implemen-
 1191 tation and will be assumed to be consistent within the shop. MTConnect Standard does
 1192 not standardize the manufacturing process or the definition of the zero point.
 1193 The value of Measurement **MUST** be float.

1194 4.2.8.1 Value Properties of Measurement

1195 *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

1196 Descriptions for Value Properties of Measurement:

- 1197 • code
 1198 shop specific code for the measurement.
 1199 ISO 13399 codes **MAY** be used for these codes as well.
 1200 See *Section 4.4 - Cutting Tool Measurement Subtypes* and *Section 4.5 - Cutting*
 1201 *Item Measurement Subtypes* for details on Measurement types and their respec-
 1202 tive code values.

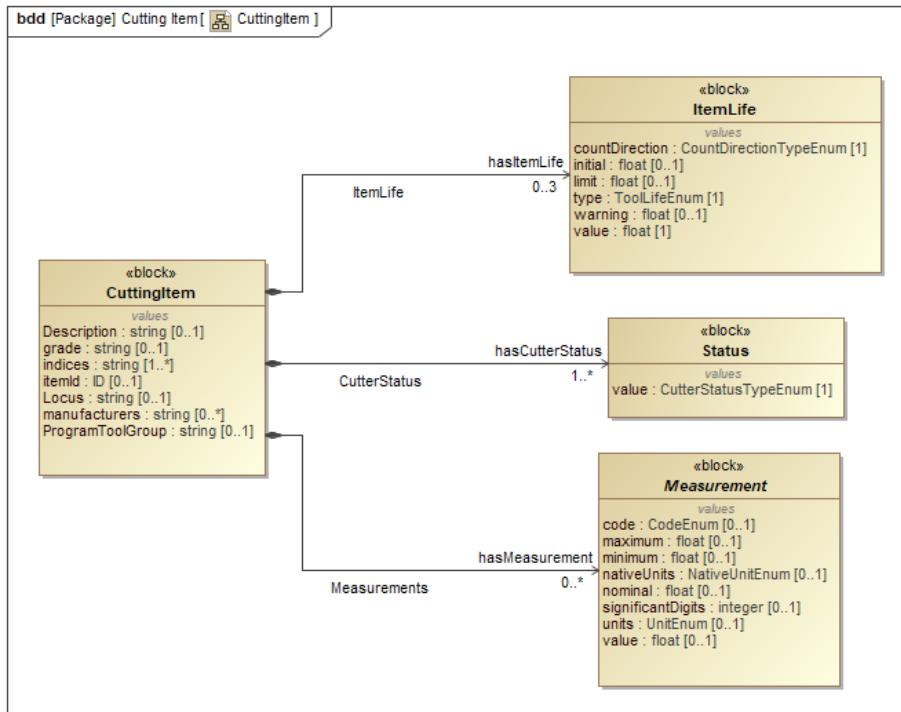
- 1203 • maximum
 1204 maximum value for the measurement.
- 1205 • minimum
 1206 minimum value for the measurement.
- 1207 • nativeUnits
 1208 units the measurement was originally recorded in. See *MTConnect Standard: Part*
 1209 *2.0 - Device Information Model* for the complete list of nativeUnits.
 1210 The value of nativeUnits **MUST** be one of the NativeUnitEnum enumera-
 1211 tion.
- 1212 • nominal
 1213 as advertised value for the measurement.
- 1214 • significantDigits
 1215 number of significant digits in the reported value.
- 1216 • units
 1217 units for the measurements. See *MTConnect Standard: Part 2.0 - Device Informa-*
 1218 *tion Model* for the complete list of units.
 1219 The value of units **MUST** be one of the UnitEnum enumeration.

1220 4.3 Cutting Item

1221 A CuttingItem is the portion of the tool that physically removes the material from the
 1222 workpiece by shear deformation. The cutting item can be either a single piece of mate-
 1223 rial attached to the CuttingTool or it can be one or more separate pieces of material
 1224 attached to the CuttingTool using a permanent or removable attachment. A Cuttin-
 1225 gItem can be comprised of one or more cutting edges. Cutting items include: replaceable
 1226 inserts, brazed tips and the cutting portions of solid CuttingTools.

1227 MTConnect Standard considers CuttingItems as part of the CuttingTool. A Cut-
 1228 tingItems **MUST NOT** exist in MTConnect unless it is attached to a CuttingTool.
 1229 Some of the measurements, such as FunctionalLength, **MUST** be made with refer-
 1230 ence to the entire CuttingTool to be meaningful.

1231 Note: See *Section B.4 - CuttingItem Schema Diagrams* for XML schema.

**Figure 8:** CuttingItem

1232 4.3.1 CuttingItem

1233 part of the tool that physically removes the material from the workpiece by shear deformation.
 1234

1235 4.3.1.1 Value Properties of CuttingItem

1236 *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

1237 Descriptions for Value Properties of CuttingItem:

- 1238 • Description
free-form description of the cutting item.
- 1239
- 1240 • grade
material composition for this cutting item.
- 1241
- 1242 • indices
number or numbers representing the individual cutting item or items on the tool.
- 1243
- 1244 Indices **SHOULD** start numbering with the inserts or CuttingItem furthest from
- 1245 the gauge line and increasing in value as the items get closer to the gauge line. Items
- 1246 at the same distance **MAY** be arbitrarily numbered.

1247 Note: In XML, the representation **MUST** be a single number (“1”) or a
1248 comma separated set of individual elements (“1,2,3,4”), or as a inclusive
1249 range of values as in (“1-10”) or any combination of ranges and numbers
1250 as in “1-4,6-10,22”. There **MUST NOT** be spaces or non-integer values
1251 in the text representation.

- 1252 • itemId
1253 manufacturer identifier of this cutting item.
- 1254
- 1255 • Locus
1256 free form description of the location on the cutting tool.
1257 For clarity, the words FLUTE, INSERT, and CARTRIDGE **SHOULD** be used to
1258 assist in noting the location of a CuttingItem. Locus **MAY** be any free form
string, but **SHOULD** adhere to the following rules:

- 1259 – The location numbering **SHOULD** start at the furthest CuttingItem and
1260 work it’s way back to the CuttingItem closest to the gauge line.
- 1261 – Flutes **SHOULD** be identified as such using the word FLUTE:. For example:
1262 FLUTE: 1, INSERT: 2 - would indicate the first flute and the second furthest
1263 insert from the end of the tool on that flute.
- 1264 – Other designations such as CARTRIDGE **MAY** be included, but should be
1265 identified using upper case and followed by a colon (:).

- 1266 • manufacturers
1267 manufacturers of the cutting item.
1268 This will reference the tool item and adaptive items specifically. The cutting items
1269 manufacturers’ will be a property of CuttingItem.

1270 Note: In XML, the representation **MUST** be a comma(,) delimited list of
 1271 manufacturer names. See *Section B.4 - CuttingItem Schema Diagrams*.

1272 • ProgramToolGroup
 1273 tool group this item is assigned in the part program.

1274 **4.3.1.2 Part Properties of CuttingItem**

1275 *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

1276 Descriptions for Part Properties of CuttingItem:

1277 • Status
 1278 status of the cutting tool.
 1279 CutterStatus provides the status of the assembly and *organize* one or more
 1280 Status entities. See *Section 4.2.7 - Status*.

1281 The following combinations of Status entities **MUST NOT** occur for a Cut-
 1282 terStatus:

- 1283 – NEW **MUST NOT** be used with USED, RECONDITIONED, or EXPIRED.
- 1284 – UNKNOWN **MUST NOT** be used with any other status.
- 1285 – ALLOCATED and UNALLOCATED **MUST NOT** be used together.
- 1286 – AVAILABLE and UNAVAILABLE **MUST NOT** be used together.
- 1287 – If the tool is EXPIRED, BROKEN, or NOT_REGISTERED it **MUST NOT** be
 1288 AVAILABLE.

1289 CutterStatus **MUST** be defined only for the CuttingToolLifeCycle of
 1290 CuttingTool and **MUST NOT** be defined for the CuttingToolLifeCycle
 1291 of CuttingToolArchetype.

1292 • ItemLife
 1293 life of a CuttingItem.
 1294 See *Section 4.3.3 - ItemLife*.

1295 • Measurement
 1296 constrained scalar value associated with a cutting tool.
 1297 Measurements groups one or more Measurement subtypes. See *Section 4.2.8*
 1298 - *Measurement*.

1299 4.3.2 CuttingItems

1300 CuttingItems groups one or more CuttingItem entities. See *Section 4.3.1 - CuttingItem* and *Section 4.3 - Cutting Item* for more detail.

1302 4.3.2.1 Value Properties of CuttingItems

1303 *Table 19* lists the Value Properties of CuttingItems.

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 19: Value Properties of CuttingItems

1304 Descriptions for Value Properties of CuttingItems:

1305 • count
 1306 number of CuttingItem organized by CuttingItems.

1307 4.3.3 ItemLife

1308 life of a CuttingItem.

1309 The value of ItemLife **MUST** be float.

1310 4.3.3.1 Value Properties of ItemLife

1311 *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

1312 Descriptions for Value Properties of ItemLife:

- 1313 • countDirection
- 1314 indicates if the item life counts from zero to maximum or maximum to zero.
- 1315 The value of countDirection **MUST** be one of the CountDirectionTypeEnum enumeration.
- 1316
- 1317 • initial
- 1318 initial life of the item when it is new.
- 1319 • limit
- 1320 end of life limit for this item.
- 1321 • type
- 1322 type of item life being accumulated.
- 1323 The value of type **MUST** be one of the ToolLifeEnum enumeration.
- 1324 • warning
- 1325 point at which a item life warning will be raised.

1326 4.4 Cutting Tool Measurement Subtypes

- 1327 This section lists the Measurement subtypes for CuttingTool.
- 1328 These Measurement subtypes for CuttingTool are specific to the entire assembly
- 1329 and **MUST NOT** be used for the Measurement pertaining to a CuttingItem. Figure
- 1330 9 and Figure 10 will be used to reference the assembly specific Measurement sub-
- 1331 types.

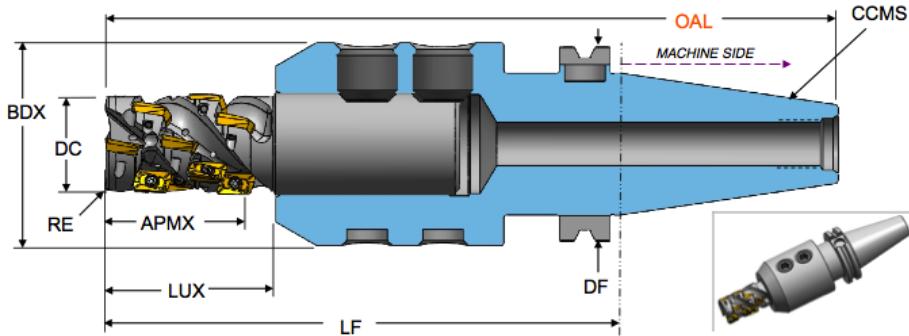


Figure 9: Cutting Tool Measurement 1

1332 4.4.1 BodyDiameterMax

1333 largest diameter of the body of a tool item.

1334 The code of BodyDiameterMax **MUST** be BDX.

1335 The units of BodyDiameterMax **MUST** be MILLIMETER.

1336 4.4.2 BodyLengthMax

1337 distance measured along the X axis from that point of the item closest to the workpiece,
1338 including the cutting item for a tool item but excluding a protruding locking mechanism
1339 for an adaptive item, to either the front of the flange on a flanged body or the beginning of
1340 the connection interface feature on the machine side for cylindrical or prismatic shanks.

1341 The code of BodyLengthMax **MUST** be LBX.

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

1343 4.4.3 DepthOfCutMax

1344 maximum engagement of the cutting edge or edges with the workpiece measured perpendicular to the feed motion.
1345

1346 The code of DepthOfCutMax **MUST** be APMX.

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

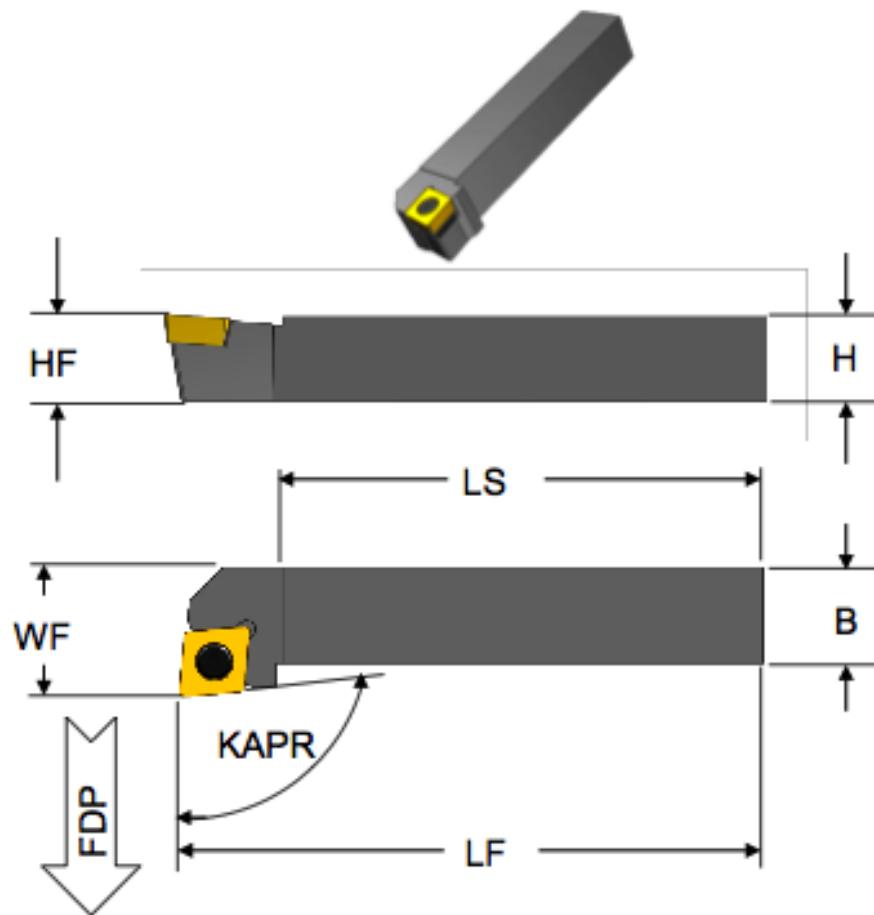


Figure 10: Cutting Tool Measurement 2

1348 4.4.4 CuttingDiameterMax

1349 maximum diameter of a circle on which the defined point Pk of each of the master inserts
1350 is located on a tool item.

1351 The normal of the machined peripheral surface points towards the axis of the cutting tool.

1352 The code of CuttingDiameterMax **MUST** be DC.

1353 The units of CuttingDiameterMax **MUST** be MILLIMETER.

1354 4.4.5 FlangeDiameterMax

1355 dimension between two parallel tangents on the outside edge of a flange.

1356 The code of FlangeDiameterMax **MUST** be DF.

1357 The units of FlangeDiameterMax **MUST** be MILLIMETER.

1358 4.4.6 OverallToolLength

1359 largest length dimension of the cutting tool including the master insert where applicable.

1360 The code of OverallToolLength **MUST** be OAL.

1361 The units of OverallToolLength **MUST** be MILLIMETER.

1362 4.4.7 ShankDiameter

1363 dimension of the diameter of a cylindrical portion of a tool item or an adaptive item that
1364 can participate in a connection.

1365 The code of ShankDiameter **MUST** be DMM.

1366 The units of ShankDiameter **MUST** be MILLIMETER.

1367 4.4.8 ShankHeight

1368 dimension of the height of the shank.

1369 The code of ShankHeight **MUST** be H.

1370 The units of ShankHeight **MUST** be MILLIMETER.

1371 4.4.9 ShankLength

1372 dimension of the length of the shank.

1373 The code of ShankLength **MUST** be LS.

1374 The units of ShankLength **MUST** be MILLIMETER.

1375 4.4.10 UsableLengthMax

1376 maximum length of a cutting tool that can be used in a particular cutting operation includ-
1377 ing the non-cutting portions of the tool.

1378 The code of UsableLengthMax **MUST** be LUX.

1379 The units of UsableLengthMax **MUST** be MILLIMETER.

1380 4.4.11 ProtrudingLength

1381 dimension from the yz-plane to the furthest point of the tool item or adaptive item mea-
1382 sured in the -X direction.

1383 The code of ProtrudingLength **MUST** be LPR.

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

1385 4.4.12 FunctionalLength

1386 distance from the gauge plane or from the end of the shank to the furthest point on the
1387 tool, if a gauge plane does not exist, to the cutting reference point determined by the main
1388 function of the tool.

1389 The CuttingTool functional length will be the length of the entire tool, not a single
1390 cutting item. Each CuttingItem can have an independent FunctionalLength rep-
1391 resented in its measurements.

1392 The code of FunctionalLength **MUST** be LF.

1393 The units of FunctionalLength **MUST** be MILLIMETER.

1394 4.4.13 Weight

1395 total weight of the cutting tool in grams.

1396 The force exerted by the mass of the cutting tool.

1397 The code of Weight **MUST** be WT.

1398 The units of Weight **MUST** be GRAM.

1399 4.5 Cutting Item Measurement Subtypes

1400 This section lists the Measurement subtypes for CuttingItem.

1401 These Measurement subtypes for CuttingItem are specific to an individual CuttingItem and **MUST NOT** be used for the Measurement pertaining to an assembly.
 1402 Figures below will be used to for reference for the CuttingItem specific Measurement types.
 1403

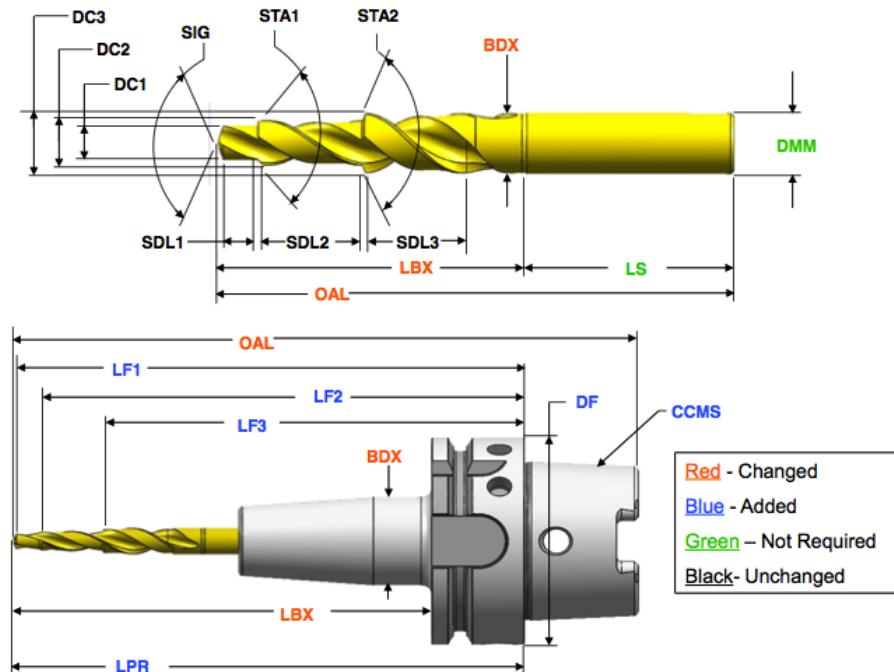


Figure 11: Cutting Tool

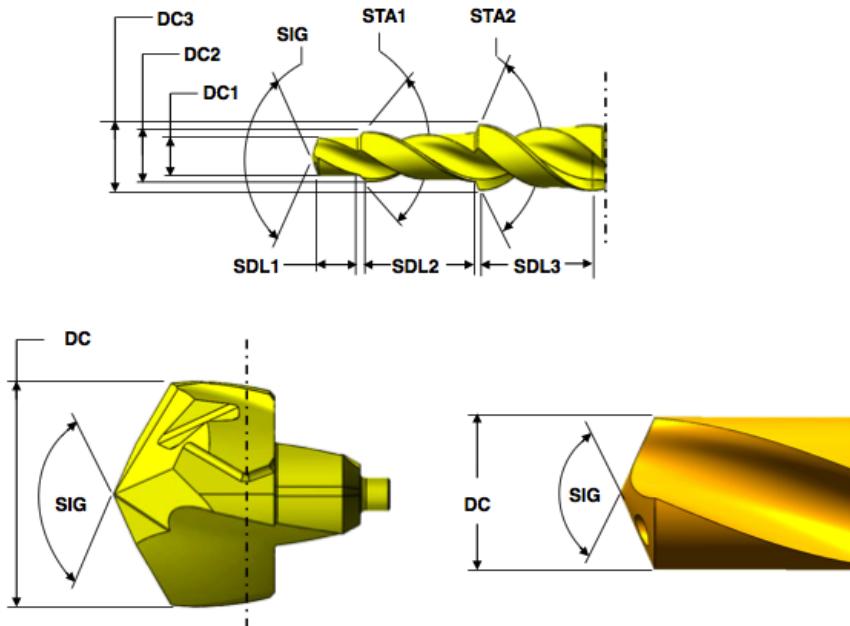


Figure 12: Cutting Item

1405 4.5.1 FunctionalLength

1406 distance from the gauge plane or from the end of the shank of the cutting tool, if a gauge
 1407 plane does not exist, to the cutting reference point determined by the main function of the
 1408 tool.

1409 This measurement will be with reference to the cutting tool and **MUST NOT** exist without
 1410 a cutting tool.

1411 The code of FunctionalLength **MUST** be LFx.

1412 The units of FunctionalLength **MUST** be MILLIMETER.

1413 4.5.2 CuttingReferencePoint

1414 theoretical sharp point of the cutting tool from which the major functional dimensions are
 1415 taken.

1416 The code of CuttingReferencePoint **MUST** be CRP.

1417 The units of CuttingReferencePoint **MUST** be MILLIMETER.

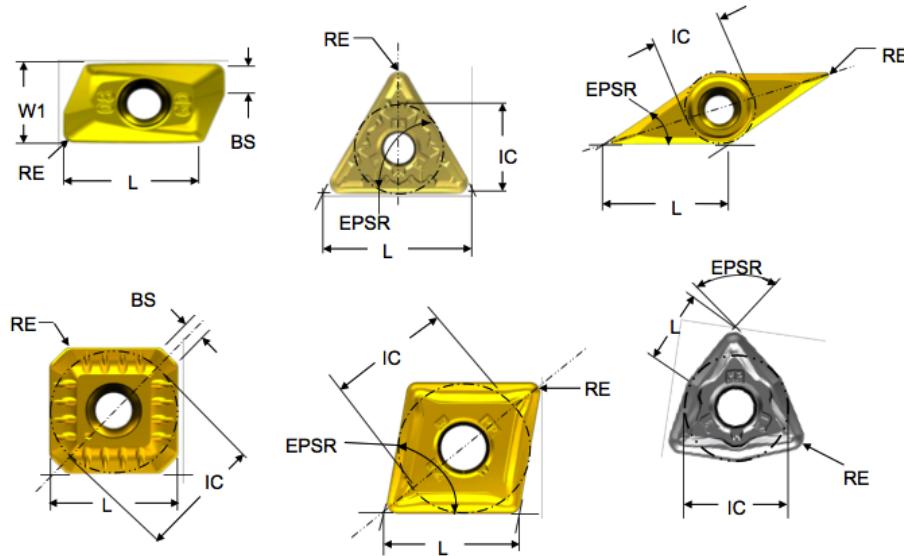


Figure 13: Cutting Item Measurement

1418 4.5.3 CuttingEdgeLength

1419 theoretical length of the cutting edge of a cutting item over sharp corners.

1420 The code of CuttingEdgeLength **MUST** be **L**.

1421 The units of CuttingEdgeLength **MUST** be MILLIMETER.

1422 4.5.4 DriveAngle

1423 angle between the driving mechanism locator on a tool item and the main cutting edge.

1424 The code of DriveAngle **MUST** be **DRVA**.

1425 The units of DriveAngle **MUST** be DEGREE.

1426 4.5.5 FlangeDiameter

1427 dimension between two parallel tangents on the outside edge of a flange.

1428 The code of FlangeDiameter **MUST** be **DF**.

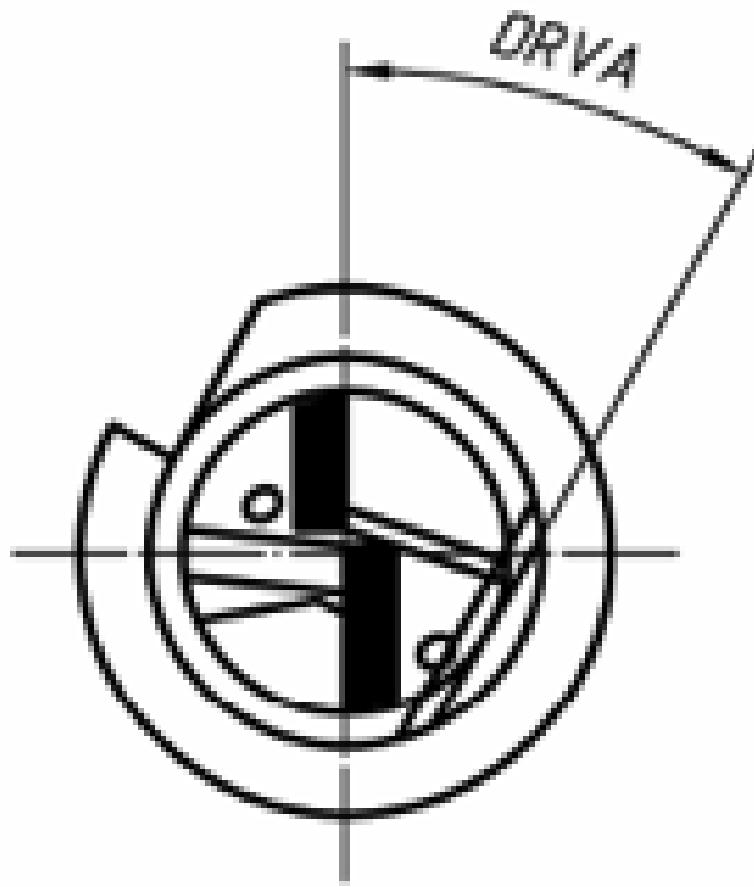


Figure 14: Cutting Item Drive Angle

1429 The units of FlangeDiameter **MUST** be MILLIMETER.

1430 4.5.6 FunctionalWidth

1431 distance between the cutting reference point and the rear backing surface of a turning tool
1432 or the axis of a boring bar.

1433 The code of FunctionalWidth **MUST** be WF.

1434 The units of FunctionalWidth **MUST** be MILLIMETER.

1435 4.5.7 IncribedCircleDiameter

1436 diameter of a circle to which all edges of a equilateral and round regular insert are tangen-
1437 tial.

1438 The code of IncribedCircleDiameter **MUST** be IC.

1439 The units of IncribedCircleDiameter **MUST** be MILLIMETER.

1440 4.5.8 PointAngle

1441 angle between the major cutting edge and the same cutting edge rotated by 180 degrees
1442 about the tool axis.

1443 The code of PointAngle **MUST** be SIG.

1444 The units of PointAngle **MUST** be DEGREE.

1445 4.5.9 ToolCuttingEdgeAngle

1446 angle between the tool cutting edge plane and the tool feed plane measured in a plane
1447 parallel the xy-plane.

1448 The code of ToolCuttingEdgeAngle **MUST** be KAPR.

1449 The units of ToolCuttingEdgeAngle **MUST** be DEGREE.

1450 4.5.10 ToolLeadAngle

1451 angle between the tool cutting edge plane and a plane perpendicular to the tool feed plane
1452 measured in a plane parallel the xy-plane.

1453 The code of ToolLeadAngle **MUST** be PSIR.

1454 The units of ToolLeadAngle **MUST** be DEGREE.

1455 4.5.11 ToolOrientation

1456 angle of the tool with respect to the workpiece for a given process.

1457 The value is application specific.

1458 The code is N/A for ToolOrientation.

1459 The units of ToolOrientation **MUST** be DEGREE.

1460 4.5.12 StepDiameterLength

1461 length of a portion of a stepped tool that is related to a corresponding cutting diameter
1462 measured from the cutting reference point of that cutting diameter to the point on the next
1463 cutting edge at which the diameter starts to change.

1464 The code of StepDiameterLength **MUST** be SDLx.

1465 The units of StepDiameterLength **MUST** be MILLIMETER.

1466 4.5.13 StepIncludedAngle

1467 angle between a major edge on a step of a stepped tool and the same cutting edge rotated
1468 180 degrees about its tool axis.

1469 The code of StepIncludedAngle **MUST** be STAx.

1470 The units of StepIncludedAngle **MUST** be DEGREE.

1471 4.5.14 WiperEdgeLength

1472 measure of the length of a wiper edge of a cutting item.

1473 The code of WiperEdgeLength **MUST** be BS.

1474 The units of WiperEdgeLength **MUST** be MILLIMETER.

1475 4.5.15 CuttingDiameter

- 1476 diameter of a circle on which the defined point Pk located on this cutting tool.
- 1477 The normal of the machined peripheral surface points towards the axis of the cutting tool.
- 1478 The code of CuttingDiameter **MUST** be DCx.
- 1479 The units of CuttingDiameter **MUST** be MILLIMETER.

1480 4.5.16 CuttingHeight

- 1481 distance from the basal plane of the tool item to the cutting point.
- 1482 The code of CuttingHeight **MUST** be HF.
- 1483 The units of CuttingHeight **MUST** be MILLIMETER.

1484 4.5.17 CornerRadius

- 1485 nominal radius of a rounded corner measured in the X Y-plane.
- 1486 The code of CornerRadius **MUST** be RE.
- 1487 The units of CornerRadius **MUST** be MILLIMETER.

1488 4.5.18 Weight

- 1489 total weight of the cutting tool in grams.
- 1490 The force exerted by the mass of the cutting tool.
- 1491 The code of Weight **MUST** be WT.
- 1492 The units of Weight **MUST** be GRAM.

1493 4.5.19 ChamferFlatLength

1494 flat length of a chamfer.

1495 The code of ChamferFlatLength **MUST** be BCH.

1496 The units of ChamferFlatLength **MUST** be MILLIMETER.

1497 4.5.20 ChamferWidth

1498 width of the chamfer.

1499 The code of ChamferWidth **MUST** be CHW.

1500 The units of ChamferWidth **MUST** be MILLIMETER.

1501 4.5.21 InsertWidth

1502 W1 is used for the insert width when an inscribed circle diameter is not practical.

1503 The code of InsertWidth **MUST** be W1.

1504 The units of InsertWidth **MUST** be MILLIMETER.

1505 5 Files Asset Information Model

1506 Manufacturing processes require various documents, programs, setup sheets, and digital
1507 media available at the device for a given process. The File and FileArchetype As-
1508 sets provide a mechanism to communicate specific “Files” that are relevant to a process
1509 where the media is located on a server and represented by a Universal Resource Locator
1510 (URL).

1511 The FileArchetype contains metadata common to all File Assets for a certain
1512 purpose. The File Asset references the file specific to a given device or set of devices.
1513 The File Asset does not hold the contents of the file, it contains a reference to the
1514 location (URL) used to access the information. The metadata associated with the File
1515 provides semantic information about the representation (mime-type) and the application
1516 associated with the File. The application of the file is an extensible controlled vocabulary
1517 with common manufacturing uses provided.

1518 5.1 Files

1519 This section provides semantic information for the File model.

1520 Note: See *Section B.7 - File Schema Diagrams* for XML schema.

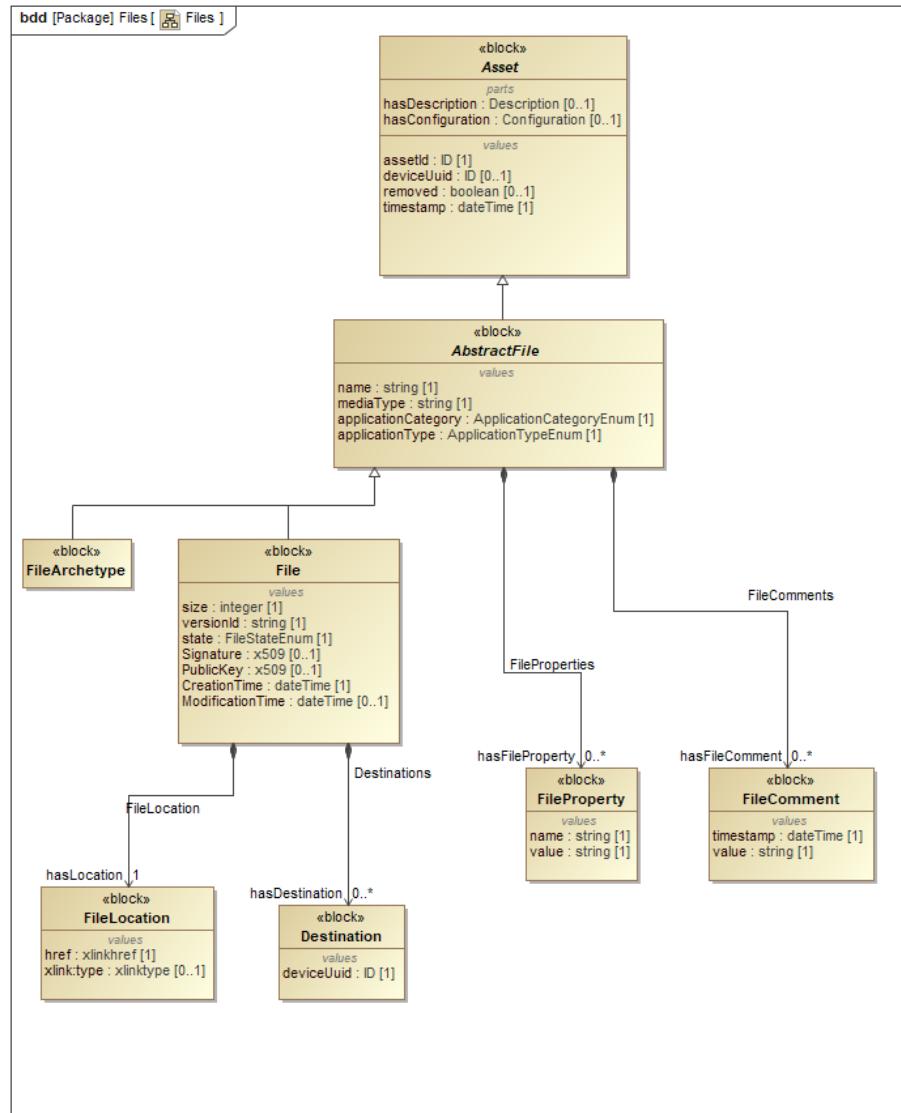
1521 5.1.1 AbstractFile

1522 abstract Asset that contains the common properties of the File and FileArchetype
1523 types.

1524 5.1.1.1 Value Properties of AbstractFile

1525 *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

1526 Descriptions for Value Properties of `AbstractFile`:

- 1527 • `name`
1528 name of the file.
 - 1529 • `mediaType`
1530 mime type of the file.
 - 1531 • `applicationCategory`
1532 category of application that will use this file.
- 1533 `ApplicationCategoryEnum` Enumeration:
- 1534 – `ASSEMBLY`
1535 files regarding the fully assembled product.
 - 1536 – `DEVICE`
1537 device related files.
 - 1538 – `HANDLING`
1539 files relating to the handling of material.
 - 1540 – `INSPECTION`
1541 files related to the quality inspection.
 - 1542 – `MAINTENANCE`
1543 files relating to equipment maintenance.
 - 1544 – `PART`
1545 files relating to a part.
 - 1546 – `PROCESS`
1547 files related to the manufacturing process.
 - 1548 – `SETUP`
1549 files related to the setup of a process.
- 1550 • `applicationType`
1551 type of application that will use this file.
- 1552 `ApplicationTypeEnum` Enumeration:
- 1553 – `DATA`
1554 generic data.
 - 1555 – `DESIGN`
1556 computer aided design files or drawings.

- 1557 - DOCUMENTATION
 1558 documentation regarding a category of file.
 1559 - INSTRUCTIONS
 1560 user instructions regarding the execution of a task.
 1561 - LOG
 1562 data related to the history of a machine or process.
 1563 - PRODUCTION_PROGRAM
 1564 machine instructions to perform a process.

1565 **5.1.1.2 Part Properties of AbstractFile**

1566 *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

1567 Descriptions for Part Properties of AbstractFile:

- 1568 • FileProperty
 1569 key-value pair providing additional metadata about a File.
 1570 FileProperties groups one or more FileProperty entities for a File. See
 1571 *Section 5.1.4 - FileProperty*.
 1572 • FileComment
 1573 remark or interpretation for human interpretation associated with a File or FileArchetype.
 1574 FileComments groups one or more FileComment entities for a File. See
 1575 *Section 5.1.5 - FileComment*.

1576 **5.1.2 File**

1577 AbstractFile type that provides information about the File instance and its URL.

1578 **5.1.2.1 Value Properties of File**

1579 *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

1580 Descriptions for Value Properties of File:

- 1581 • size
size of the file in bytes.
- 1583 • versionId
version identifier of the file.
- 1585 • state
state of the file.
- 1587 FileStateEnum Enumeration:
 - 1588 – EXPERIMENTAL
used for processes other than production or otherwise defined.
 - 1590 – PRODUCTION
used for production processes.
 - 1592 – REVISION
content is modified from PRODUCTION or EXPERIMENTAL.
- 1594 • Signature
secure hash of the file.
- 1596 • PublicKey
public key used to verify the signature.
- 1598 • CreationTime
time the file was created.
- 1600 • ModificationTime
time the file was modified.

1602 **5.1.2.2 Part Properties of File**

1603 *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

1604 Descriptions for Part Properties of File:

1605 • FileLocation

1606 URL reference to the file location.

1607 See *Section 5.1.6 - FileLocation*.

1608 • Destination

1609 reference to the target Device for this File.

1610 Destinations groups one or more Destination entities. See *Section 5.1.7 -*

1611 *Destination*.

1612 **5.1.3 FileArchetype**

1613 AbstractFile type that provides information common to all versions of a file.

1614 **5.1.4 FileProperty**

1615 key-value pair providing additional metadata about a File.

1616 The value of FileProperty **MUST** be string.

1617 **5.1.4.1 Value Properties of FileProperty**

1618 *Table 25* lists the Value Properties of FileProperty.

Value Property name	Value Property type	Multiplicity
name	string	1

Table 25: Value Properties of FileProperty

1619 Descriptions for Value Properties of FileProperty:

1620 • name

1621 name of the FileProperty.

1622 5.1.5 FileComment

1623 remark or interpretation for human interpretation associated with a File or FileArchetype.

1624 The value of FileComment **MUST** be string.

1625 5.1.5.1 Value Properties of FileComment

1626 *Table 26* lists the Value Properties of FileComment.

Value Property name	Value Property type	Multiplicity
timestamp	datetime	1

Table 26: Value Properties of FileComment

1627 Descriptions for Value Properties of FileComment:

1628 • timestamp

1629 time the comment was made.

1630 5.1.6 FileLocation

1631 URL reference to the file location.

1632 5.1.6.1 Value Properties of FileLocation

1633 *Table 27* lists the Value Properties of FileLocation.

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

Table 27: Value Properties of FileLocation

1634 Descriptions for Value Properties of FileLocation:

- 1635 • href
 - 1636 URL reference to the file.
 - 1637 href is of type xlink:href from the W3C XLink specification.
- 1638 • xlink:type
 - 1639 type of href for the xlink href type.
 - 1640 **MUST** be locator referring to a URL .

1641 5.1.7 Destination

1642 reference to the target Device for this File.

1643 5.1.7.1 Value Properties of Destination

1644 *Table 28* lists the Value Properties of Destination.

Value Property name	Value Property type	Multiplicity
deviceUuid	ID	1

Table 28: Value Properties of Destination

1645 Descriptions for Value Properties of Destination:

- 1646 • deviceUuid
 - 1647 uuid of the target device or application.

1648 6 Raw Material Asset Information Model

1649 Raw material represents the source of material for immediate use and sources of material
1650 that may or may not be used during the manufacturing process.

1651 The RawMaterial Asset holds the references to the content stored in the actual Raw-
1652 Material container or derived about the RawMaterial by the system during opera-
1653 tion.

1654 6.1 Raw Material

1655 This section provides semantic information for the RawMaterial model.

1656 Note: See *Section B.8 - RawMaterial Schema Diagrams* for XML schema.

1657 6.1.1 RawMaterial

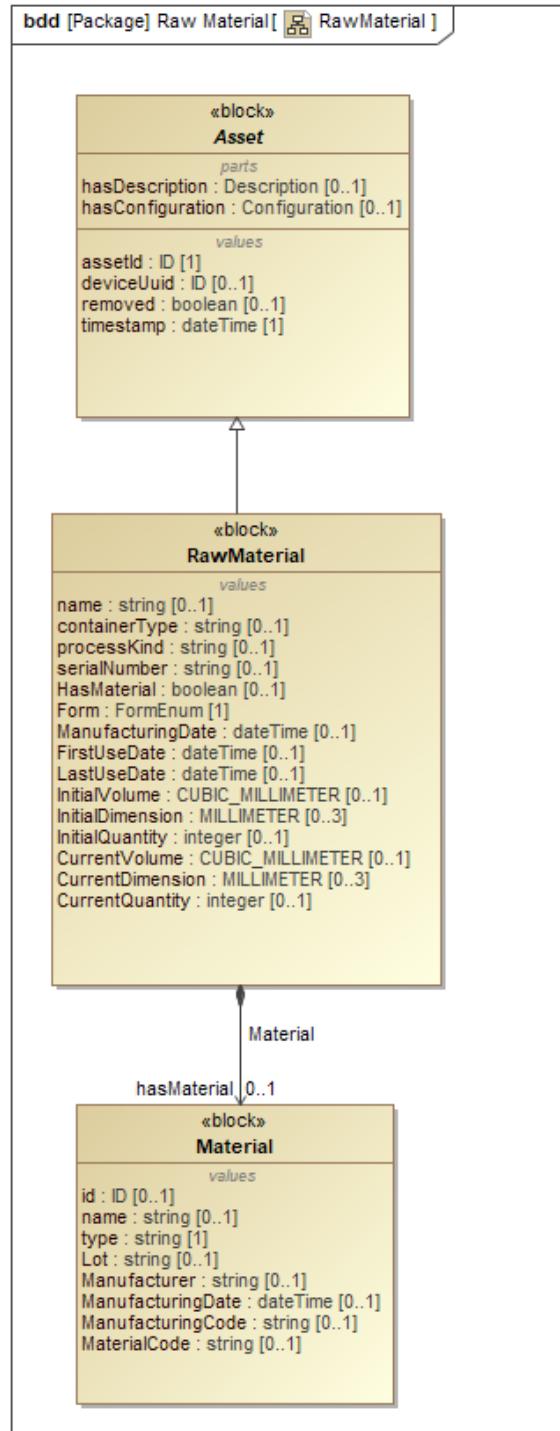
1658 Asset that represents raw material.

1659 6.1.1.1 Value Properties of RawMaterial

1660 *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

1661 Descriptions for Value Properties of RawMaterial:

1662 • name

1663 name of the raw material.

1664 Examples: Container1 and AcrylicContainer.

1665 • containerType

1666 type of container holding the raw material.

1667 Examples: Pallet, Canister, Cartridge, Tank, Bin, Roll, and Spool.

1668 • processKind

1669 ISO process type supported by this raw material.

1670 Examples include: VAT_POLYMERIZATION, BINDER_JETTING, MATERIAL_EXTRUSION,
1671 MATERIAL_JETTING, SHEET_LAMINATION, POWDER_BED_FUSION and DI-
1672 RECTED_ENERGY_DEPOSITION.

1673 • serialNumber

1674 serial number of the raw material.

1675 • HasMaterial

1676 Material has existing usable volume.

1677 • Form

1678 form of the raw material.

1679 FormEnum Enumeration:

1680 – BAR

1681 – BLOCK

1682 – CASTING

1683 – FILAMENT

1684 – GAS

1685 – GEL

1686 – LIQUID

1687 – POWDER

1688 – SHEET

1689 • ManufacturingDate

1690 date the raw material was created.

- 1691 • FirstUseDate
 1692 date raw material was first used.
- 1693 • LastUseDate
 1694 date raw material was last used.
- 1695 • InitialVolume
 1696 amount of material initially placed in raw material when manufactured.
- 1697 • InitialDimension
 1698 dimension of material initially placed in raw material when manufactured.
- 1699 • InitialQuantity
 1700 quantity of material initially placed in raw material when manufactured.
- 1701 • CurrentVolume
 1702 amount of material currently in raw material.
- 1703 • CurrentDimension
 1704 dimension of material currently in raw material.
- 1705 • CurrentQuantity
 1706 quantity of material currently in raw material.

1707 **6.1.1.2 Part Properties of RawMaterial**

1708 *Table 30* lists the Part Properties of RawMaterial.

Part Property name	Multiplicity
Material	0..1

Table 30: Part Properties of RawMaterial

1709 Descriptions for Part Properties of RawMaterial:

- 1710 • Material
 1711 material used as the RawMaterial.
 1712 See *Section 6.1.2 - Material*.

1713 6.1.2 Material

1714 material used as the RawMaterial.

1715 6.1.2.1 Value Properties of Material

1716 *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

1717 Descriptions for Value Properties of Material:

1718 • id

1719 unique identifier for the material.

1720 • name

1721 name of the material.

1722 Examples: ULM9085, ABS, 4140.

1723 • type

1724 type of material.

1725 Examples: Metal, Polymer, Wood, 4140, Recycled, Prestine and Used.

1726 • Lot

1727 manufacturer's lot code of the material.

1728 • Manufacturer

1729 name of the material manufacturer.

- 1730 • ManufacturingDate
- 1731 manufacturing date of the material from the material manufacturer.
- 1732 • ManufacturingCode
- 1733 lot code of the raw feed stock for the material, from the feed stock manufacturer.
- 1734 • MaterialCode
- 1735 American Society for Testing and Materials (ASTM) standard code that the material
- 1736 complies with.

1737 7 QIF Asset Information Model

1738 The Quality Information Framework (QIF) is an American National Standards Institute
1739 (ANSI) accredited standard developed by the Digital Metrology Standards Consortium
1740 (DMSC) standards development organization. The DMSC is an A-liaison to the Interna-
1741 tional Standards Organization (ISO) Technical Committee (TC) 184. QIF addresses the
1742 needs of the metrology community to have a semantic information model for the exchange
1743 of metrology data throughout the verification lifecycle from product design to execution,
1744 analysis, and reporting.

1745 The MTConnect QIF Asset Information Model provides a wrapper around a QIF document
1746 (i.e., a dataset conforming to the QIF Information model) in its native XML representation.
1747 The MTConnect standard does not alter or extend the QIF standard and regards the QIF
1748 standard as a passthrough.

1749 Information about the QIF standards is at the following location: <https://qifstandards.org>

1750 7.1 QIF

1751 This section provides semantic information for the `QIFDocumentWrapper` model.

1752 Note: See *Section B.9 - QIFDocumentWrapper Schema Diagrams* for XML
1753 schema.

1754 7.1.1 QIFDocument

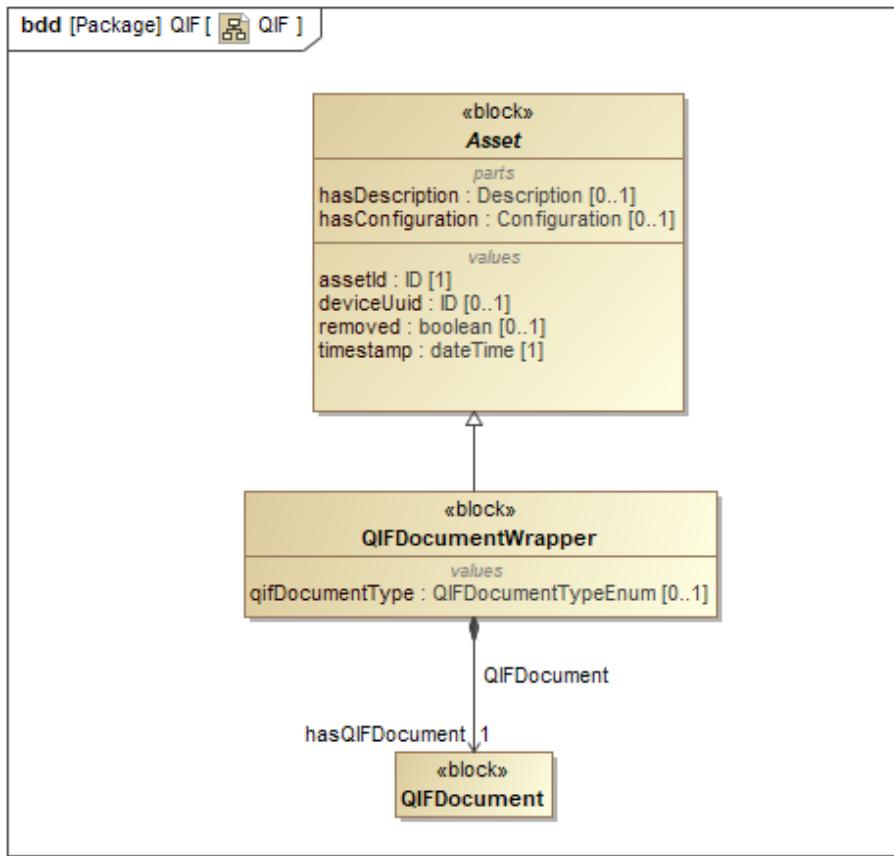
1755 QIF Document as given by the QIF standard.

1756 7.1.2 QIFDocumentWrapper

1757 Asset that carries the QIF Document.

1758 7.1.2.1 Value Properties of QIFDocumentWrapper

1759 *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

1760 Descriptions for Value Properties of QIFDocumentWrapper:

- 1761 • qifDocumentType
 1762 contained QIF Document type as defined in the QIF Standard.
 1763 QIFDocumentTypeEnum Enumeration:
 1764 – MEASUREMENT_RESOURCE
 1765 – PLAN
 1766 – PRODUCT
 1767 – RESULTS

- 1768 – RULES
 1769 – STATISTICS

1770 **7.1.2.2 Part Properties of QIFDocumentWrapper**

1771 *Table 33* lists the Part Properties of QIFDocumentWrapper.

Part Property name	Multiplicity
QIFDocument	1

Table 33: Part Properties of QIFDocumentWrapper

1772 Descriptions for Part Properties of QIFDocumentWrapper:

- 1773 • QIFDocument
 1774 QIF Document as given by the QIF standard.

1775 8 Component Configuration Parameters

1776 This section provides semantic information for the ComponentConfigurationPa-
 1777 rameters model.

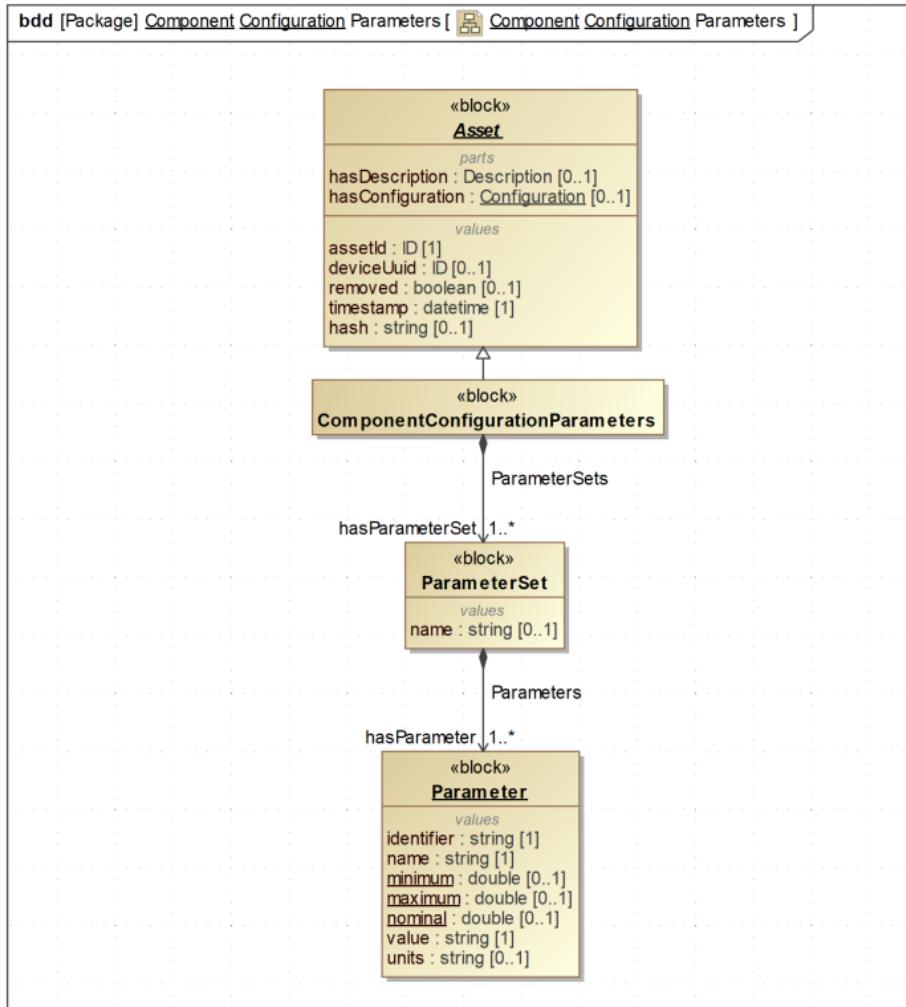


Figure 18: ComponentConfigurationParameters

1778 8.1 ComponentConfigurationParameters

1779 set of parameters that govern the functionality of the related Component.

1780 8.1.1 Part Properties of ComponentConfigurationParameters

1781 *Table 34* lists the Part Properties of ComponentConfigurationParameters.

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

Table 34: Part Properties of ComponentConfigurationParameters

1782 Descriptions for Part Properties of ComponentConfigurationParameters:

1783 • ParameterSet

1784 set of parameters defining the configuration of a Component.

1785 8.2 ParameterSet

1786 set of parameters defining the configuration of a Component.

1787 8.2.1 Value Properties of ParameterSet

1788 *Table 35* lists the Value Properties of ParameterSet.

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

Table 35: Value Properties of ParameterSet

1789 Descriptions for Value Properties of ParameterSet:

1790 • name

1791 name of the parameter set if more than one exists.

1792 8.2.2 Part Properties of ParameterSet

1793 *Table 36* lists the Part Properties of ParameterSet.

Part Property name	Multiplicity
Parameter (organized by Parameters)	1..*

Table 36: Part Properties of ParameterSet

1794 Descriptions for Part Properties of ParameterSet:

- 1795 • Parameter
 1796 property defining a configuration of a Component.

1797 8.3 Parameter

1798 property defining a configuration of a Component.

1799 The value of Parameter **MUST** be string.

1800 8.3.1 Value Properties of Parameter

1801 *Table 37* lists the Value Properties of Parameter.

Value Property name	Value Property type	Multiplicity
identifier	string	1
name	string	1
minimum	double	0..1
maximum	double	0..1
nominal	double	0..1
units	string	0..1

Table 37: Value Properties of Parameter

1802 Descriptions for Value Properties of Parameter:

- 1803 • identifier
 1804 internal identifier, register, or address.
 1805 • name
 1806 descriptive name.

- 1807 • minimum
- 1808 minimal allowed value.
- 1809 • maximum
- 1810 maximum allowed value.
- 1811 • nominal
- 1812 nominal value.
- 1813 • units
- 1814 engineering units.
- 1815 units **SHOULD** be SI or MTConnect Units.

1816 9 Profile

1817 MTConnect Profile is a *profile* that extends the Systems Modeling Language (SysML)
 1818 metamodel for the MTConnect domain using additional data types and *stereotypes*.

1819 9.1 DataTypes

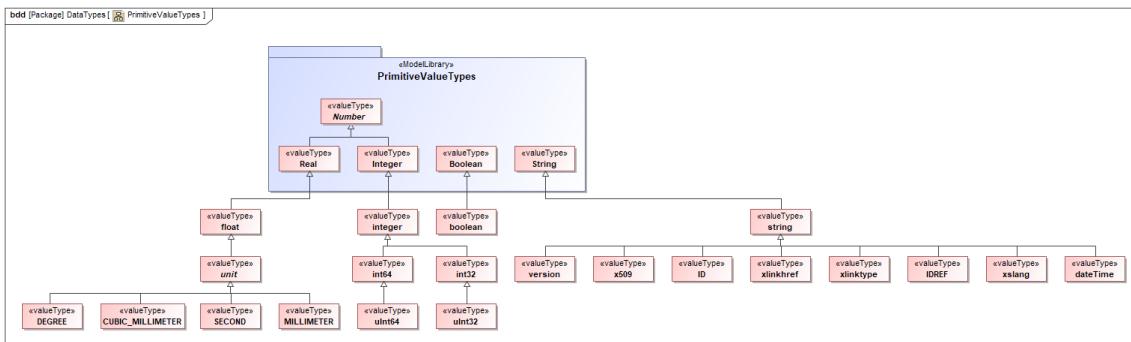


Figure 19: DataTypes

1820 9.2 boolean

1821 primitive type.

1822 9.3 ID

1823 string that represents an identifier (ID).

1824 9.4 string

1825 primitive type.

1826 9.5 float

1827 primitive type.

1828 9.6 datetime

1829 string that represents timestamp in ISO 8601 format.

1830 9.7 integer

1831 primitive type.

1832 9.8 xlinktype

1833 string that represents the type of an XLink element. See <https://www.w3.org/TR/xlink11/>.

1835 9.9 xslang

1836 string that represents a language tag. See <http://www.ietf.org/rfc/rfc4646.txt>.

1838 9.10 SECOND

1839 float that represents time in seconds.

1840 9.11 IDREF

1841 string that represents a reference to an ID.

1842 9.12 xlinkhref

1843 string that represents the locator attribute of an XLink element. See <https://www.w3.org/TR/xlink11/>.

1845 9.13 x509

1846 string that represents an x509 data block. *Ref ISO/IEC 9594-8:2020.*

1847 9.14 int32

1848 32-bit integer.

1849 9.15 int64

1850 64-bit integer.

1851 9.16 version

1852 series of four numeric values, separated by a decimal point, representing a *major*, *minor*,
1853 and *revision* number of the MTConnect Standard and the revision number of a specific
1854 *schema*.

1855 9.17 uint32

1856 32-bit unsigned integer.

1857 9.18 uint64

1858 64-bit unsigned integer.

1859 9.19 binary

1860 base-2 numeral system or binary numeral system represented by two digits: “0” and “1”.

1861 9.20 double

1862 primitive type.

1863 9.21 Stereotypes

1864 9.22 organizer

1865 element that *organizes* other elements of a type.

1866 9.23 deprecated

1867 element that has been deprecated.

1868 9.24 extensible

1869 enumeration that can be extended.

1870 9.25 informative

1871 element that is descriptive and non-normative.

1872 9.26 valueType

1873 extends SysML <<ValueType>> to include Class as a value type.

1874 9.27 normative

1875 element that has been added to the standard.

1876 **9.28 observes**

1877 association in which a *Component* makes *Observations* about an observable *DataItem*.

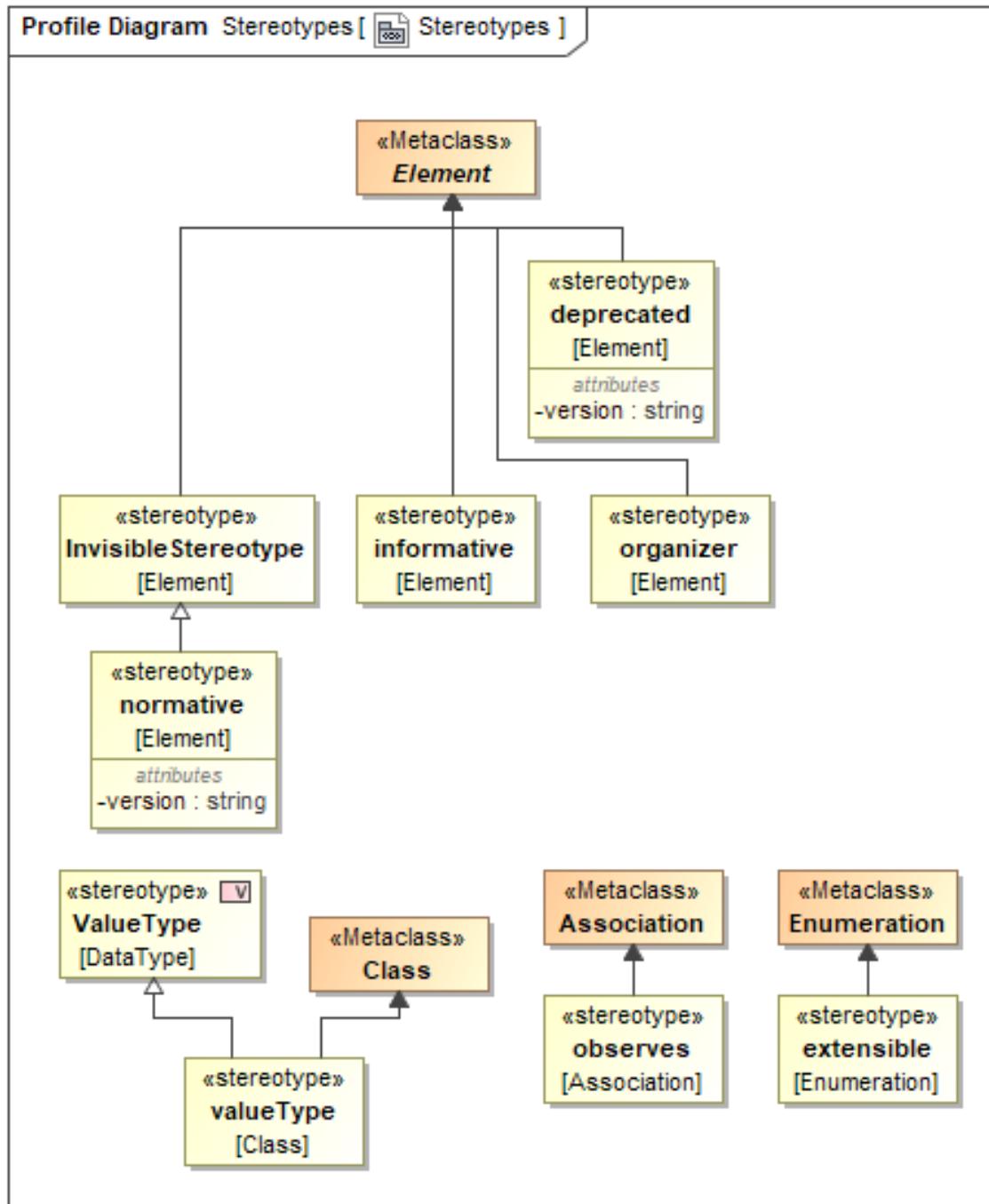


Figure 20: Stereotypes

1878 Appendices

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1928 15, 2004.

1929 B XML Schema Diagrams

1930 See XML schemas for the MTConnect standard here: <https://schemas.mtconnect.org/>.

1932 B.1 Assets Schema Diagrams

1933 See Asset element in MTConnectAssets schema.

1934 See Description element in MTConnectAssets schema.

1935 B.2 CuttingTool Schema Diagrams

1936 See CuttingTool element in MTConnectAssets schema.

1937 See CuttingToolDefinition element in MTConnectAssets schema.

1938 See CuttingToolArchetypeReference element in MTConnectAssets schema.

1939 B.3 CuttingToolLifeCycle Schema Diagrams

1940 See CuttingToolLifeCycle element in MTConnectAssets schema.

1941 See CutterStatus element in MTConnectAssets schema.

1942 See Location element in MTConnectAssets schema.

1943 See Measurement element in MTConnectAssets schema.

1944 See ProcessFeedRate element in MTConnectAssets schema.

1945 See ProcessSpindleSpeed element in MTConnectAssets schema.

1946 See ReconditionCount element in MTConnectAssets schema.

1947 See ToolLife element in MTConnectAssets schema.

1948 B.4 CuttingItem Schema Diagrams

1949 See CuttingItems element in MTConnectAssets schema.

1950 See CuttingItem element in MTConnectAssets schema.

1951 See ItemLife element in MTConnectAssets schema.

1952 B.5 ISO 13399 Diagrams

1953 B.5.1 Measurement Diagrams

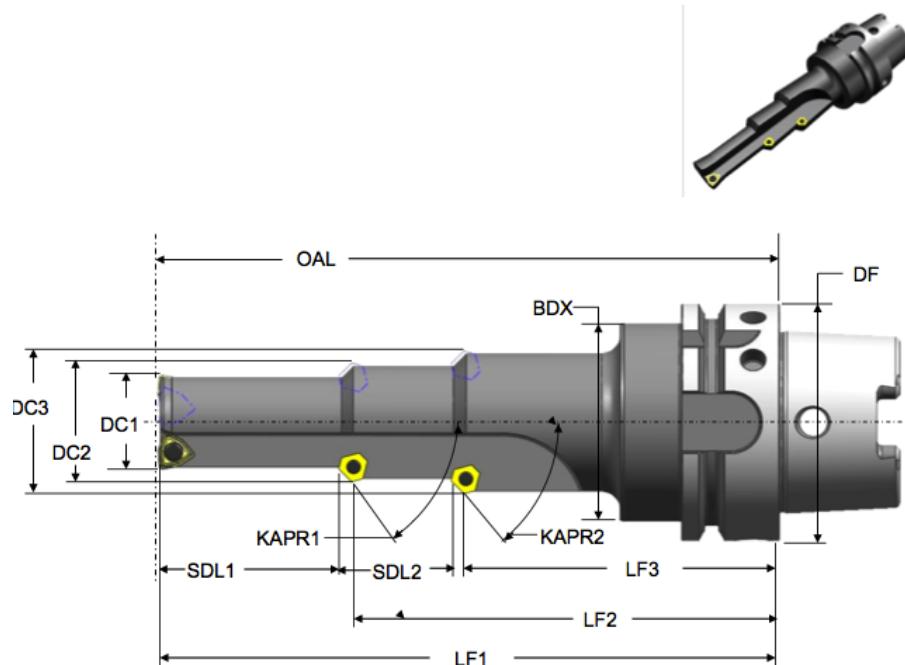


Figure 21: Cutting Tool Measurement 3

1954 B.6 Cutting Tool Examples

1955 B.6.1 Shell Mill

Example 1: Example for Indexable Insert Measurements

1956 1 <?xml version="1.0" encoding="UTF-8"?>

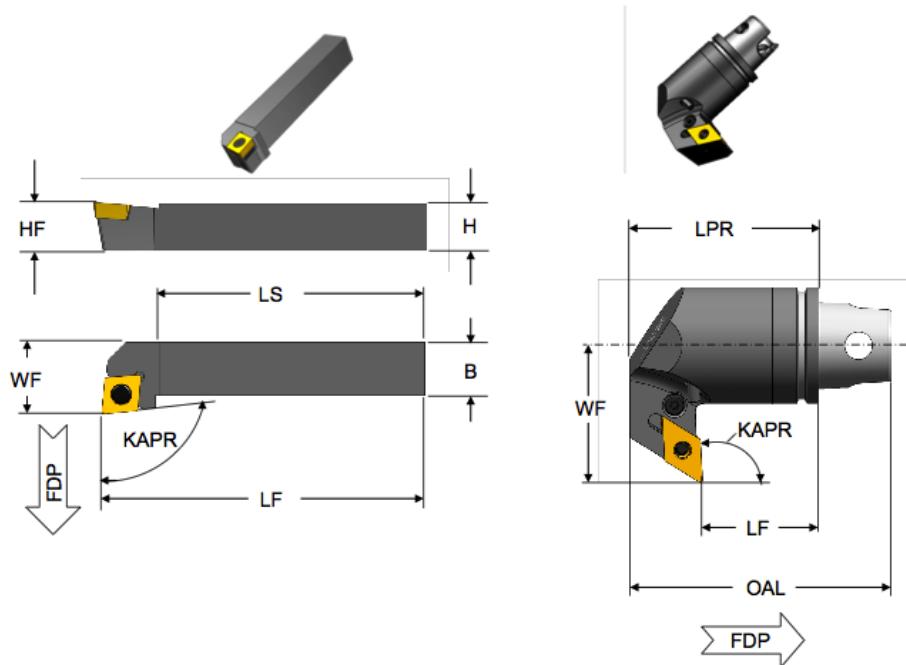
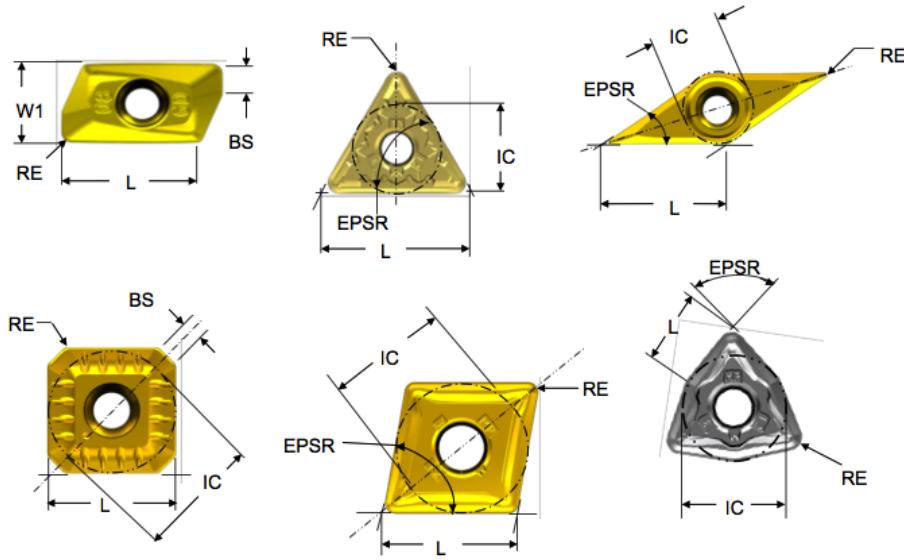


Figure 22: Cutting Tool Measurement 4

```

1957 2 <MTConnectAssets
1958 3   xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
1959 4   xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
1960 5   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1961 6   xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
1962 7   http://mtconnect.org/schemas/MTConnectAssets\textunderscore 1.2.xsd"
1963 8     >
1964 9     <Header creationTime="2011-05-11T13:55:22"
1965 10    assetBufferSize="1024" sender="localhost"
1966 11    assetCount="2" version="1.2" instanceId="1234" />
1967 12    <Assets>
1968 13      <CuttingTool serialNumber="1" toolId="KSSP300R4SD43L240"
1969 14        timestamp="2011-05-11T13:55:22" assetId="KSSP300R4SD43L240.1"
1970 15        manufacturers="KMT, Parlec">
1971 16          <CuttingToolLifeCycle>
1972 17            <CutterStatus><Status>NEW</Status></CutterStatus>
1973 18            <ProcessSpindleSpeed maximum="13300"
1974 19              nominal="605">10000</ProcessSpindleSpeed>
1975 20            <ProcessFeedRate
1976 21              nominal="9.22">9.22</ProcessFeedRate>
1977 22            <ConnectionCodeMachineSide>CV50
1978 23            </ConnectionCodeMachineSide>
1979 24          <Measurements>
1980 25            <BodyDiameterMax code="BDX">73.25
1981 26            </BodyDiameterMax>
1982 27            <OverallToolLength nominal="222.25" />

```

**Figure 23:** Cutting Tool Measurement 5

```

1983 27 <minimum="221.996" maximum="222.504"
1984 28 <code="OAL">222.25</OverallToolLength>
1985 29 <UsableLengthMax_code="LUX" nominal="82.55">82.55
1986 30 </UsableLengthMax>
1987 31 <CuttingDiameterMax_code="DC" nominal="76.2"
1988 32 <maximum="76.213" minimum="76.187">76.2
1989 33 </CuttingDiameterMax>
1990 34 <BodyLengthMax_code="LF" nominal="120.65"
1991 35 <maximum="120.904" minimum="120.404">120.65
1992 36 </BodyLengthMax>
1993 37 <DepthOfCutMax_code="APMX"
1994 38 <nominal="60.96">60.95</DepthOfCutMax>
1995 39 <FlangeDiameterMax_code="DF"
1996 40 <nominal="98.425">98.425</FlangeDiameterMax>
1997 41 </Measurements>
1998 42 <CuttingItems_count="24">
1999 43 <CuttingItem_indices="1-24" itemId="SDET43PDER8GB"
2000 44 <manufacturers="KMT" grade="KC725M">
2001 45 <Measurements>
2002 46 <CuttingEdgeLength_code="L" nominal="12.7"
2003 47 <minimum="12.675" maximum="12.725">12.7
2004 48 </CuttingEdgeLength>
2005 49 <WiperEdgeLength_code="BS" nominal=
2006 50 <value="2.56">2.56</WiperEdgeLength>
2007 51 <InscribedCircleDiameter_code="IC"
2008 52 <nominal="12.7">12.7
2009 53 </InscribedCircleDiameter>
2010 54 <CornerRadius_code="RE" nominal="0.8">
2011 55 <value="0.8">0.8</CornerRadius>

```

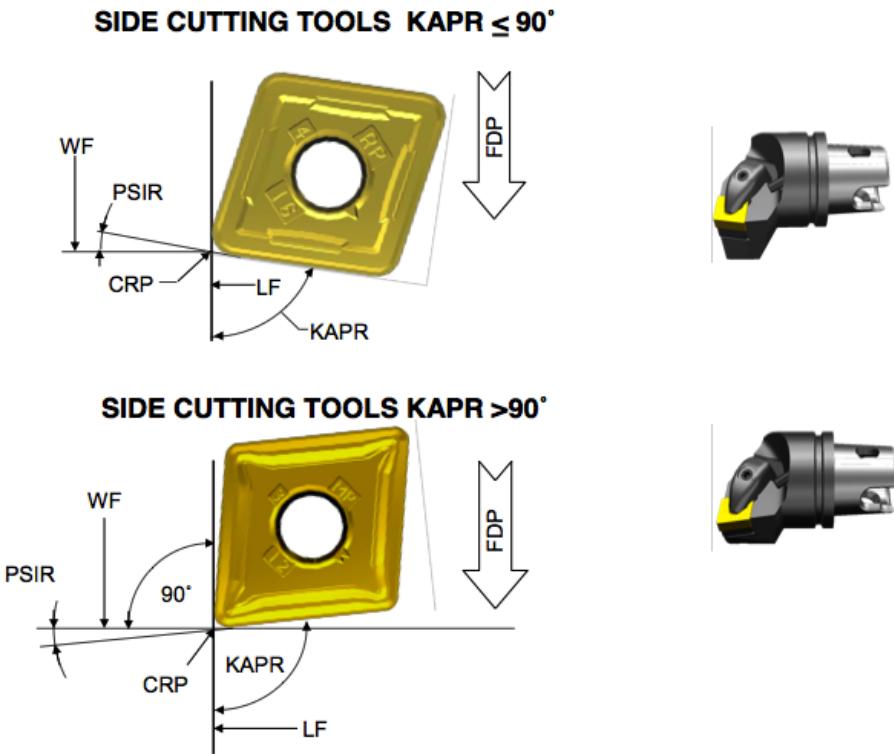


Figure 24: Cutting Tool Measurement 6

```

2012 56  
```

`</Measurements>`

```

2013 57  
```

`</CuttingItem>`

```

2014 58  
```

`</CuttingItems>`

```

2015 59  
```

`</CuttingToolLifeCycle>`

```

2016 60  
```

`</CuttingTool>`

```

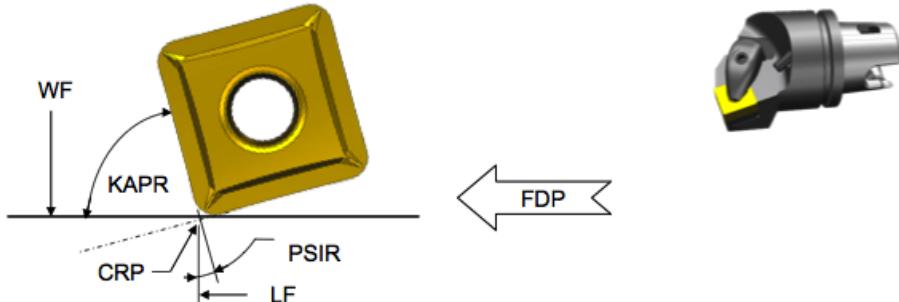
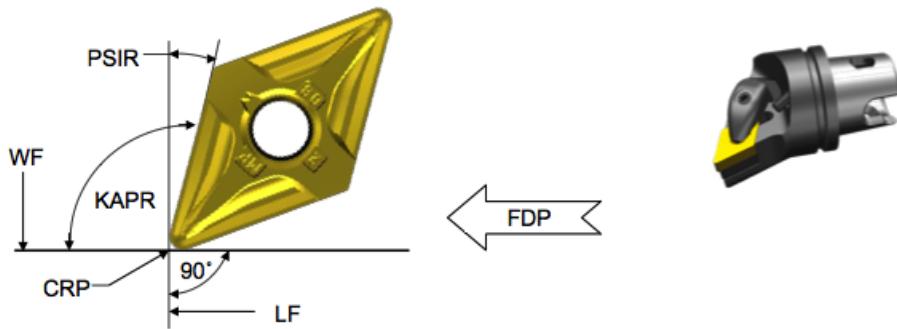
2017 61  
```

`</Assets>`

```

2018 62  
```

`</MTConnectAssets>`

END CUTTING TOOLS KAPR $\leq 90^\circ$ **END CUTTING TOOLS KAPR >90°****Figure 25:** Cutting Tool Measurement 72019 **B.6.2 Step Drill****Example 2:** Example for Step Mill Side View

```

2020 1  <?xml version="1.0" encoding="UTF-8"?>
2021 2  <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2022 3  xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2023 4  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2024 5  xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2025 6  http://mtconnect.org/schemas/MTConnectAssets\textunderscore1.2.xsd"
2026 7  >
2027 8  <Header creationTime="2011-05-
2028 9  11T13:55:22" assetBufferSize="1024"
2029 10  sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2030 11  />
2031 12  <Assets>
2032 13  <CuttingTool serialNumber="1" toolId="B732A08500HP"
2033 14  timestamp="2011-05-11T13:55:22" assetId="B732A08500HP"
2034 15  manufacturers="KMT, Parlec">
2035 16  <Description>
2036 17  Step Drill - KMT, B732A08500HP Grade KC7315
2037 18  Adapter - Parlec, C50-M12SF300-6
2038 19  </Description>
```

BCH = CHAMFER FLAT LENGTH

CHW = CHAMFER WIDTH

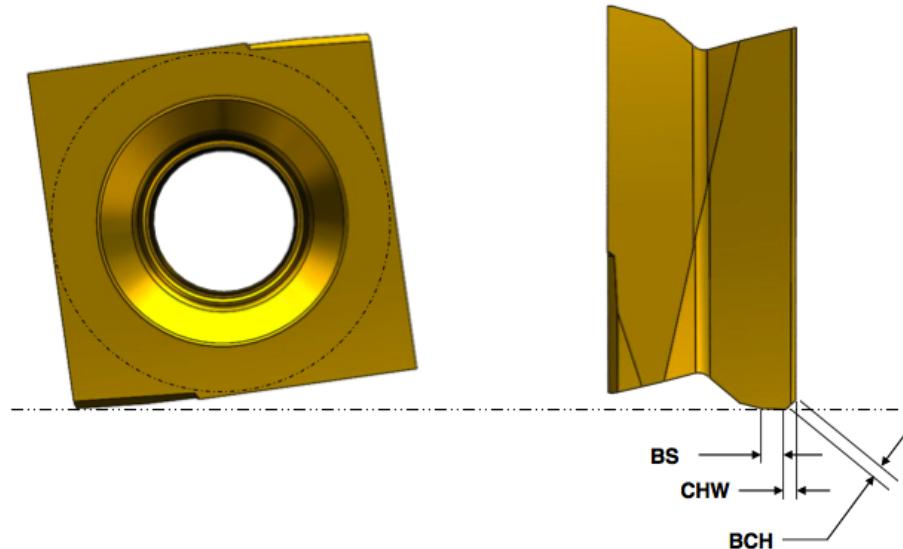


Figure 26: Cutting Tool Measurement 8

```

2039 18    <CuttingToolLifeCycle>
2040 19      <CutterStatus><Status>NEW</Status></CutterStatus>
2041 20      <ProcessSpindleSpeed nominal="5893">5893</
2042 ProcessSpindleSpeed>
2043 21      <ProcessFeedRate nominal="2.5">2.5</ProcessFeedRate>
2044 22      <ConnectionCodeMachineSide>CV50 Taper</
2045           ConnectionCodeMachineSide>
2046 23      <Measurements>
2047 24        <BodyDiameterMax code="BDX">31.8</BodyDiameterMax>
2048 25        <BodyLengthMax code="LBX" nominal="120.825" maximum="
2049           126.325"
2050 26        minimum="115.325">120.825</BodyLengthMax>
2051 27        <ProtrudingLength code="LPR" nominal="155.75" maximum="
2052           161.25"
2053 28        minimum="150.26">155.75</ProtrudingLength>
2054 29        <FlangeDiameterMax code="DF"
2055 30          nominal="98.425">98.425</FlangeDiameterMax>
2056 31        <OverallToolLength nominal="257.35" minimum="251.85"
2057 32          maximum="262.85" code="OAL">257.35</OverallToolLength>
2058 33      </Measurements>
2059 34      <CuttingItems count="2">
2060 35        <CuttingItem indices="1" manufacturers="KMT" grade="KC7315
2061           ">>
2062 36        <Measurements>
```

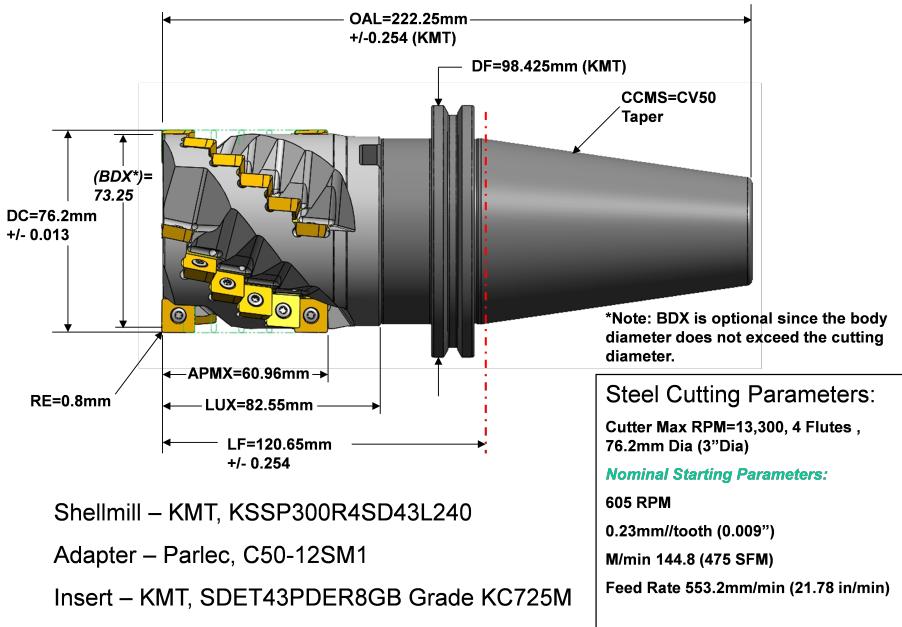


Figure 27: Shell Mill Side View

```

2063 37 <CuttingDiameter code="DC1" nominal="8.5" maximum="8.521"
2064 38 <StepIncludedAngle code="STA1" nominal="90" maximum="91"
2065 39 <FunctionalLength code="LF1" nominal="154.286" minimum="148.786"
2066 40 <StepDiameterLength code="SDL1" nominal="9">9</StepDiameterLength>
2067 41 <PointAngle code="SIG" nominal="135" minimum="133" maximum="137">135</PointAngle>
2068 42 </Measurements>
2069 43 </CuttingItem>
2070 44 <CuttingItem indices="2" manufacturer="KMT" grade="KC7315">>
2071 45 <Measurements>
2072 46 <CuttingDiameter code="DC2" nominal="12" maximum="12.011"
2073 47 <FunctionalLength code="LF2" nominal="122.493" minimum="116.993"
2074 48 <StepDiameterLength code="SDL2" nominal="9">9</StepDiameterLength>
2075 49 </Measurements>
2076 50 </CuttingItem>
2077 51 <CuttingItem indices="2" manufacturer="KMT" grade="KC7315">>
2078 52 <Measurements>
2079 53 <CuttingDiameter code="DC3" nominal="12" maximum="12.011"
2080 54 <FunctionalLength code="LF3" nominal="122.493" minimum="116.993"
2081 55 <StepDiameterLength code="SDL3" nominal="9">9</StepDiameterLength>
2082 56 </Measurements>
2083 57 </CuttingItem>
2084 58 </Measurements>
2085 59 </CuttingItem>

```

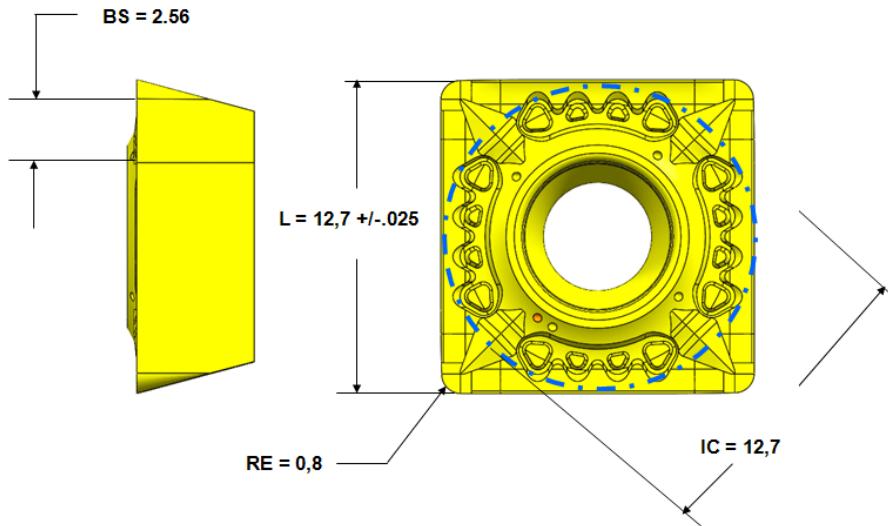
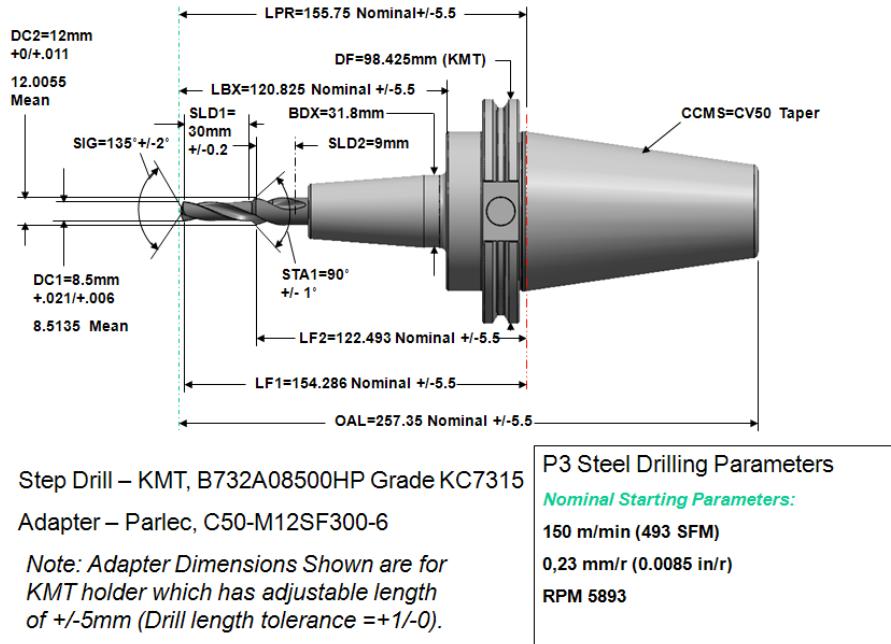


Figure 28: Indexable Insert Measurements

```
2090 60      </CuttingItem>
2091 61      </CuttingItems>
2092 62      </CuttingToolLifeCycle>
2093 63      </CuttingTool>
2094 64      </Assets>
2095 65 </MTConnectAssets>
```

**Figure 29: Step Mill Side View****2096 B.6.3 Shell Mill with Individual Loci****Example 3: Example for Shell Mill with Explicate Loci**

```

2097 1 <?xml version="1.0" encoding="UTF-8"?>
2098 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2099 3   xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2100 4   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2101 5   xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2102 6   http://mtconnect.org/schemas/MTConnectAssets\textunderscore1.2.xsd"
2103 7   >
2104 8 <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
2105 9   sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2106 10  />
2107 11 <Assets>
2108 12   <CuttingTool serialNumber="1" toolId="KSSP300R4SD43L240"
2109 13     timestamp="2011-05-11T13:55:22" assetId="KSSP300R4SD43L240.1"
2110 14     manufacturers="KMT,Parlec">
2111 15     <Description>Keyway: 55 degrees</Description>
2112 16     <CuttingToolLifeCycle>
2113 17       <CutterStatus><Status>NEW</Status></CutterStatus>
2114 18     <Measurements>
2115 19       <UsableLengthMax code="LUX"
2116 20         nominal="82.55">82.55</UsableLengthMax>
2117 21       <CuttingDiameterMax code="DC" nominal="76.2" maximum=
2118 22         76.213"
2119 23         minimum="76.187">76.2</CuttingDiameterMax>
```

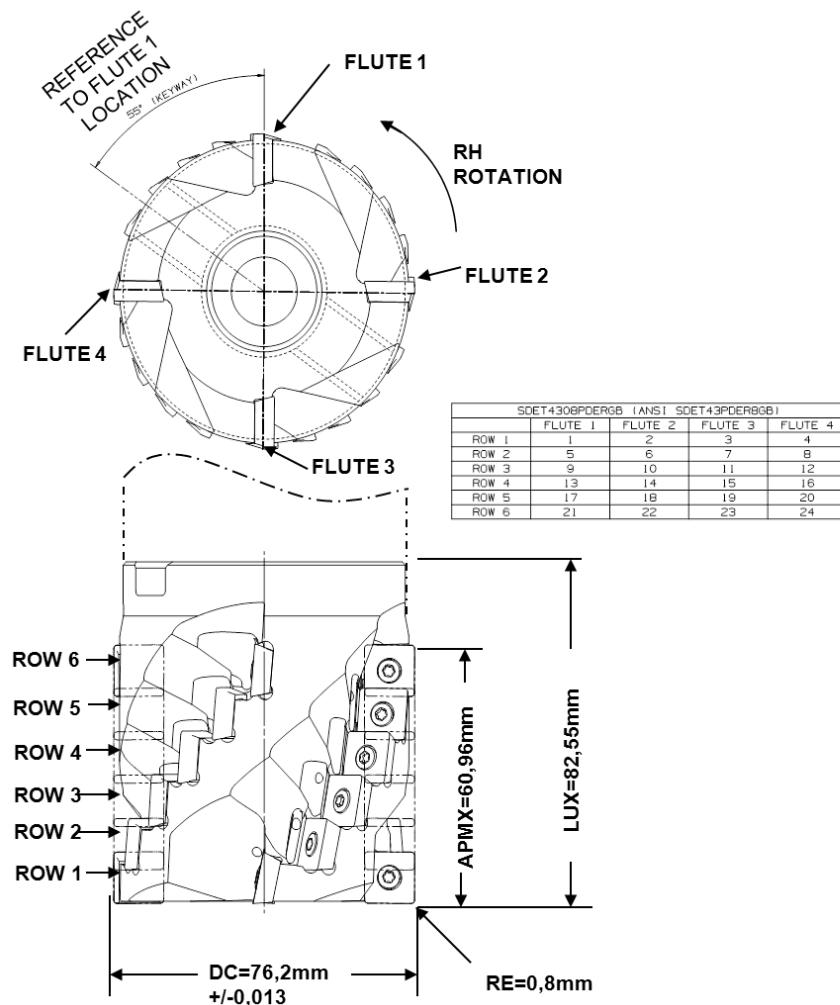


Figure 30: Shell Mill with Explicate Loci

```

2120 21 <DepthOfCutMax code="APMX" nominal="60.96">60.95</
2121 DepthOfCutMax>
2122 22 </Measurements>
2123 23 <CuttingItems count="24">
2124 24 <CuttingItem indices="1" itemId="SDET43PDER8GB">
2125 25 manufacturers="KMT">
2126 26 <Locus>FLUTE: 1, ROW: 1</Locus>
2127 27 <Measurements>
2128 28 <DriveAngle code="DRVA" nominal="55">55</DriveAngle>
2129 29 </Measurements>
2130 30 </CuttingItem>
2131 31 <CuttingItem indices="2-24" itemId="SDET43PDER8GB">
2132 32 manufacturers="KMT">
2133 33 <Locus>FLUTE: 2-4, ROW: 1; FLUTE: 1-4, ROW 2-6</Locus>
2134 34 </CuttingItem>

```

```
2135 35      </CuttingItems>
2136 36      </CuttingToolLifeCycle>
2137 37      </CuttingTool>
2138 38      </Assets>
2139 39  </MTConnectAssets>
```

2140 B.6.4 Drill with Individual Loci

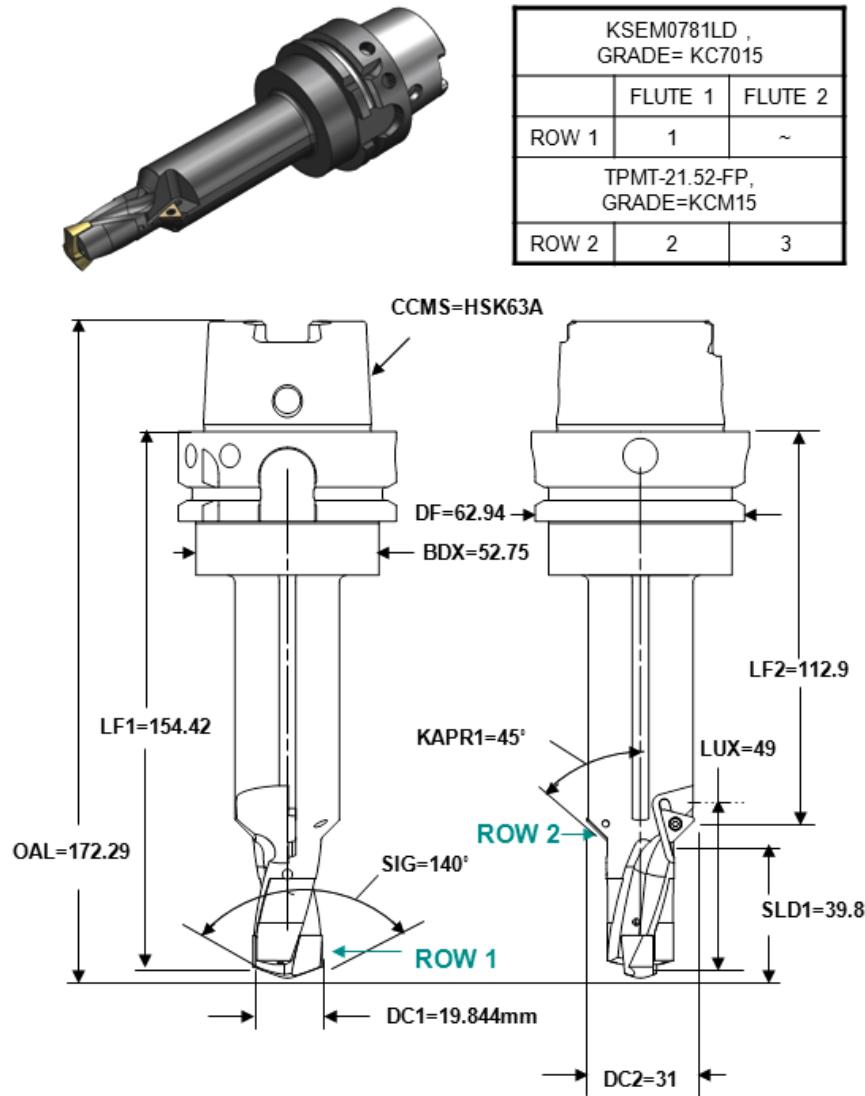


Figure 31: Step Drill with Explicate Loci

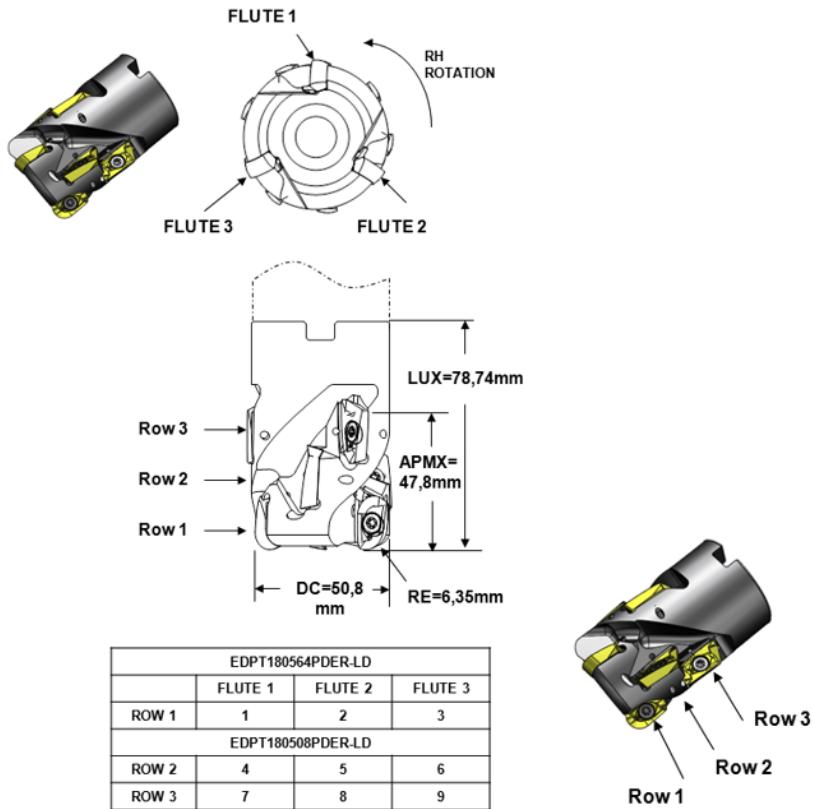
Example 4: Example for Step Drill with Explicate Loci

```

2141 1 <?xml version="1.0" encoding="UTF-8"?>
2142 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2143 3   xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2144 4   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2145 5   xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2146 6   http://mtconnect.org/schemas/MTConnectAssets\textunderscore1.2.xsd"
2147 7   >
2148 7   <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
```

```

2149  8    sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2150   9    />
2151  10   <Assets>
2152  11     <CuttingTool serialNumber="1" toolId="KSEM0781LD"
2153  12       timestamp="2011-05-11T13:55:22" assetId="KSEM0781LD.1"
2154  13         manufacturers="KMT">
2155  14         <CuttingToolLifeCycle>
2156  15           <CutterStatus><Status>NEW</Status></CutterStatus>
2157  16           <ConnectionCodeMachineSide>HSK63A</ConnectionCodeMachineSide
2158  17     >
2159  18   <Measurements>
2160  19     <BodyDiameterMax code="BDX">52.75</BodyDiameterMax>
2161  20     <OverallToolLength nominal="172.29"
2162  21       code="OAL">172.29</OverallToolLength>
2163  22     <UsableLengthMax code="LUX" nominal="49">49</
2164  23       UsableLengthMax>
2165  24     <FlangeDiameterMax code="DF"
2166  25       nominal="62.94">62.94</FlangeDiameterMax>
2167  26   </Measurements>
2168  27   <CuttingItems count="3">
2169  28     <CuttingItem indices="1" itemId="KSEM0781LD" manufacturers
2170  29       ="KMT"
2171  30       grade="KC7015">
2172  31         <Locus>FLUTE: 1, ROW: 1</Locus>
2173  32         <Measurements>
2174  33           <FunctionalLength code="LF1" nominal="154.42">154.42</
2175  34             FunctionalLength>
2176  35           <CuttingDiameter code="DC1" nominal="19.844">19.844</
2177  36             CuttingDiameter>
2178  37           <PointAngle code="SIG" nominal="140">140</PointAngle>
2179  38           <ToolCuttingEdgeAngle code="KAPR1" nominal="45">45</
2180  39             ToolCuttingEdgeAngle>
2181  40           <StepDiameterLength code="SLD1" nominal="39.8">39.8</
2182  41             StepDiameterLength>
2183  42           </Measurements>
2184  43         </CuttingItem>
2185  44         <CuttingItem indices="2-3" itemId="TPMT-21.52-FP"
2186  45           manufacturers="KMT" grade="KCM15">
2187  46             <Locus>FLUTE: 1-2, ROW: 2</Locus>
2188  47             <Measurements>
2189  48               <FunctionalLength code="LF2" nominal="112.9">119.2</
2190  49                 FunctionalLength>
2191  50               <CuttingDiameter code="DC2" nominal="31">31</
2192  51                 CuttingDiameter>
2193  52               </Measurements>
2194  53             </CuttingItem>
2195  54           </CuttingItems>
2196  55         </CuttingToolLifeCycle>
2197  56       </CuttingTool>
2198  57     </Assets>
2199  58   </MTConnectAssets>
```

2200 **B.6.5 Shell Mill with Different Inserts on First Row****Figure 32:** Shell Mill with Different Inserts on First Row**Example 5:** Example for Shell Mill with Different Inserts on First Row

```

2201 1 <?xml version="1.0" encoding="UTF-8"?>
2202 2 <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
2203 3   xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
2204 4   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2205 5   xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
2206 6   http://mtconnect.org/schemas/MTConnectAssets\textunderscore_1.2.xsd"
2207 7   >
2208 8     <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
2209 9     sender="localhost" assetCount="2" version="1.2" instanceId="1234"
2210 10    />
2211 11    <Assets>
2212 12      <CuttingTool serialNumber="1" toolId="XXX" timestamp="2011-05-11
2213 13        T13:55:22"
2214 14        assetId="XXX.1" manufacturers="KMT">
2215 15        <CuttingToolLifeCycle>
2216 16        <CutterStatus><Status>NEW</Status></CutterStatus>
2217 17        <Measurements>
```

```

2218 15      <DepthOfCutMax code="APMX" nominal="47.8">47.8</
2219 DepthOfCutMax>
2220 16      <CuttingDiameterMax code="DC"
2221 17      nominal="50.8">50.8</CuttingDiameterMax>
2222 18      <UsableLengthMax code="LUX"
2223 19      nominal="78.74">78.74</UsableLengthMax>
2224 20      </Measurements>
2225 21      <CuttingItems count="9">
2226 22          <CuttingItem indices="1-3" itemId="EDPT180564PDER-LD"
2227 23          manufacturers="KMT">
2228 24              <Locus>FLUTE: 1-3, ROW: 1</Locus>
2229 25          <Measurements>
2230 26              <CornerRadius code="RE" nominal="6.25">6.35</
2231 CornerRadius>
2232 27          </Measurements>
2233 28      </CuttingItem>
2234 29      <CuttingItem indices="4-9" itemId="EDPT180508PDER-LD"
2235 30          manufacturers="KMT">
2236 31              <Locus>FLANGE: 1-4, ROW: 2-3</Locus>
2237 32      </CuttingItem>
2238 33      </CuttingItems>
2239 34      </CuttingToolLifeCycle>
2240 35      </CuttingTool>
2241 36      </Assets>
2242 37  </MTConnectAssets>

```

2243 B.7 File Schema Diagrams

2244 See `File` element in `MTConnectAssets` schema.

2245 B.8 RawMaterial Schema Diagrams

2246 See `RawMaterial` element in `MTConnectAssets` schema.

2247 B.9 QIFDocumentWrapper Schema Diagrams

2248 See `QIFDocumentWrapper` element in `MTConnectAssets` schema.