



**MTConnect<sup>®</sup> Standard**  
**Part 3.0 – Observation Information Model**  
**Version 2.1.0**

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The normative XMI is located at the following URL: [MTConnectSysMLModel.xml](http://www.MTConnect.org/SysMLModel.xml)

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## 1 **1 Purpose of This Document**

2 This document, *MTConnect Standard: Part 3.0 - Observation Information Model* of the  
3 MTConnect Standard, establishes the rules and terminology that describes the informa-  
4 tion returned by an *MTConnect Agent* from a piece of equipment. The term (Observation  
5 Information Model also defines, in *MTConnect Standard: Part 3.0 - Observation Infor-*  
6 *mation Model*, the structure for the *response documents* that are returned from an *agent* in  
7 response to a *sample request* or *current request*.

8 *MTConnect Standard: Part 3.0 - Observation Information Model* is not a stand-alone doc-  
9 ument. This document is used in conjunction with *MTConnect Standard Part 1.0 - Fun-*  
10 *damentals* which defines the fundamentals of the operation of the MTConnect Standard  
11 and *MTConnect Standard: Part 2.0 - Device Information Model* that defines the semantic  
12 model representing the information that may be returned from a piece of equipment.

13 Note: *MTConnect Standard: Part 5.0 - Interface Interaction Model* provides  
14 details on extensions to the *Observation Information Model* required to de-  
15 scribe the interactions between pieces of equipment.

16 In the MTConnect Standard, equipment represents any tangible property that is used in the  
17 operation of a manufacturing facility. Examples of equipment are machine tools, ovens,  
18 sensor units, workstations, software applications, and bar feeders.

## 19 **2 Terminology and Conventions**

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

### 22 **2.1 General Terms**

#### 23 *adapter*

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

#### 26 *agent*

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

#### 31 *alarm limit*

32 limit used to trigger warning or alarm indicators.

#### 33 *application*

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

#### 36 *archetype*

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

#### 39 *asset buffer*

40 *buffer* for *Assets*.

#### 41 *attachment*

42 connection by which one thing is associated with another.

#### 43 *buffer*

44 section of an *agent* that provides storage for information published from pieces of  
45 equipment.

46 ***cartesian coordinate system***

47 3D orthogonal coordinate system [(ISO/IEC 19794-5:2011en).

48 ***client***

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

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

52 ***controlled vocabulary***

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

54 ***data dictionary***

55 listing of standardized terms and definitions used in *MTCConnect Information Model*.

56 ***data model***

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

59 ***data set***

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

61 ***data source***

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

63 ***deprecated***

64 indication that specific content in an *MTCConnect Document* is currently usable but  
65 is regarded as being obsolete or superseded.

66 ***deprecation warning***

67 indication that specific content in an *MTCConnect Document* may be changed to *dep-*  
68 *recated* in a future release of the standard.

69 ***document***

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

72 ***electric current***

73 rate of flow of electric charge.

74 ***element***

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

76 ***extensible***

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

79 ***force***

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

81 ***heartbeat***

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

85 ***higher level***

86 nested element that is above a lower level element.

87 ***implementation***

88 specific instantiation of the MTConnect Standard.

89 ***information model***

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

92 ***instance***

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

95 ***interaction model***

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

98 ***interface***

99 means by which communication is achieved between independent systems.

100 ***key***

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

102 ***key-value pair***

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



105 *lower camel case*

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

108 *lower level*

109 nested element that is below a higher level element.

110 *lower limit*

111 lower conformance boundary for a variable.

112 *lower warning*

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

114 *major*

115 identifier representing a consistent set of functionalities defined by the MTConnect  
116 Standard.

117 *maximum*

118 numeric upper constraint.

119 *message*

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

121 *metadata*

122 data that provides information about other data.

123 *minimum*

124 numeric lower constraint.

125 *minor*

126 identifier representing a specific set of functionalities defined by the MTConnect  
127 Standard.

128 *nominal*

129 ideal or desired value for a variable.

130 *organize*

131 act of containing and owning one or more elements.

132 *organizer*

133 entity that *organizes* one or more elements.

134 ***parameter***

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

137 ***part***

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

141 ***pascal case***

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

144 ***persistence***

145 method for retaining or restoring information.

146 ***probe***

147 instrument commonly used for measuring the physical geometrical characteristics  
148 of an object.

149 ***profile***

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

153 ***requester***

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

155 ***reset***

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

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

159 ***responder***

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

161 ***response document***

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

164 ***revision***

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

168 ***schema***

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

171 ***semantic data model***

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

174 ***sensing element***

175 mechanism that provides a signal or measured value.

176 ***sequence number***

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

179 ***specification limit***

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

181 ***spindle***

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

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

184 ***standard***

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

187 ***stereotype***

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

189 ***subtype***

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

191 ***table***

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

- 193 ***table cell***  
194       subdivision of a *table entry* representing a singular value.
- 195 ***table entry***  
196       subdivision of a *table* containing a set of *key-value pairs* representing *table cells*.
- 197 ***top level***  
198       element that represents the most significant physical or logical functions of a piece  
199       of equipment.
- 200 ***type***  
201       classification or categorization of information.
- 202 ***upper limit***  
203       upper conformance boundary for a variable.
- 204 ***upper warning***  
205       upper boundary indicating increased concern and supervision may be required.
- 206 ***version***  
207       unique identifier of the administered item. *Ref ISO/IEC 11179-:2015*

## 208 **2.2 Information Model Terms**

- 209 ***Asset Information Model***  
210       *information model* that provides semantic models for *Assets*.
- 211 ***Device Information Model***  
212       *information model* that describes the physical and logical configuration for a piece  
213       of equipment and the data that may be reported by that equipment.
- 214 ***Error Information Model***  
215       *information model* that describes the *response document* returned by an *agent* when  
216       it encounters an error while interpreting a *request* for information from a *client* or  
217       when an *agent* experiences an error while publishing the *response* to a *request* for  
218       information.
- 219 ***MTConnect Information Model***  
220       *information model* that defines the semantics of the MTConnect Standard.

221 ***Observation Information Model***

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

224 **2.3 Protocol Terms**

225 ***asset request***

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

227 ***current request***

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

231 ***data streaming***

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

234 ***MTConnect Request***

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

236 ***MTConnect Response Document***

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

238 ***MTConnectAssets Response Document***

239 *response document* published by an *MTConnect Agent* in response to an *asset re-*  
240 *quest*.

241 ***MTConnectDevices Response Document***

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

244 ***MTConnectErrors Response Document***

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

247 ***MTConnectStreams Response Document***

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

250 ***probe request***

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

253 ***protocol***

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

256 ***publish***

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

258 ***publish and subscribe***

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

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

263 ***request***

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

266 ***request and response***

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

269 ***response***

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

271 ***sample request***

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

275 ***streaming data***

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

277 ***subscribe***

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

279 ***transport protocol***

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

## 282 2.4 HTTP Terms

### 283 *HTTP Body*

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

### 286 *HTTP Error Message*

287 response provided by an *agent* indicating that an *HTTP Request* is incorrectly for-  
288 matted or identifies that the requested data is not available from the *agent*. *Ref IETF:RFC-*  
289 *2616*

### 290 *HTTP Header*

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

### 293 *HTTP Header Field*

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

### 296 *HTTP Message*

297 consist of requests from client to server and responses from server to client. *Ref IETF:RFC-*  
298 *2616*

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

### 301 *HTTP Messaging*

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

### 303 *HTTP Method*

304 portion of a command in an *HTTP Request* that indicates the desired action to be  
305 performed on the identified resource; often referred to as verbs. *Ref IETF:RFC-*  
306 *2616*

### 307 *HTTP Query*

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

### 310 *HTTP Request*

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

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

### 316 *HTTP Request Line*

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

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

### 322 *HTTP Request Method*

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

### 325 *HTTP Request URI*

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

### 328 *HTTP Response*

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

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

### 333 *HTTP Server*

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

### 336 *HTTP Status Code*

337 3-digit integer result code of the attempt to understand and satisfy the request.  
338 *Ref IETF:RFC-2616*

### 339 *HTTP Version*

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



## 341 2.5 XML Terms

### 342 *abstract element*

343 element that defines a set of common characteristics that are shared by a group of  
344 elements. An abstract entity cannot appear in a document. In a specific implemen-  
345 tation, an abstract entity is replaced by a derived element that is itself not an abstract  
346 entity. The characteristics for the derived element are inherited from the abstract  
347 entity.

### 348 *attribute*

349 additional information or property for an *element*.

### 350 *child element*

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

### 353 *document body*

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

### 357 *document header*

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

### 362 *element name*

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

### 365 *namespace*

366 organizes information into logical groups.

### 367 *parent element*

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

### 370 *root element*

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

372 ***structural element***

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

375 ***XML Document***

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

377 ***XML Schema***

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

379 **2.6 MTConnect Terms**380 ***Asset***

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

382 Note 1 to entry: An *Asset* relies upon an *Device* to provide observations  
 383 and information about itself and the *Device* revises the information to  
 384 reflect changes to the *Asset* during their interaction. Examples of *Assets*  
 385 are cutting tools, Part Information, Manufacturing Processes, Fixtures,  
 386 and Files.

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

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

393 ***Component***

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

395 ***Composition***

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

397 ***Configuration***

398 configuration for a *Component*

399 ***DataItem***

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

401 ***Device***

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

403 ***MTConnect Agent***

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

405 ***MTConnect Document***

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

407 ***MTConnect Event***

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

409 ***MTConnect Interface***

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

411 ***Observation***

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

413 **2.7 Acronyms**

414 ***2D***

415 two-dimensional

416 ***3D***

417 three-dimensional

418 ***AI***

419 artificial intelligence

420 ***ALM***

421 application lifecycle management

422 ***AMT***

423 The Association for Manufacturing Technology

424 ***ANSI***

425 American National Standards Institute

- 426 **AP**
- 427       Application Protocol
- 428 **API**
- 429       application programming interface
- 430 **ASME**
- 431       American Society of Mechanical Engineers
- 432 **ASTM**
- 433       American Society for Testing and Materials
- 434 **AWS**
- 435       American Welding Society
- 436 **BDD**
- 437       block definition diagram
- 438 **BOM**
- 439       bill of materials
- 440 **BST**
- 441       Board on Standardization and Testing
- 442 **C&R**
- 443       cause and remedy
- 444 **CA**
- 445       certificate authority
- 446 **CAD**
- 447       computer-aided design
- 448 **CAE**
- 449       computer-aided engineering
- 450 **CAI**
- 451       computer-aided inspection
- 452 **CAM**
- 453       computer-aided manufacturing

- 454 ***CAX***
- 455 computer-aided technologies
- 456 ***CDATA***
- 457 Character Data
- 458 ***CFD***
- 459 computational fluid dynamics
- 460 ***CM***
- 461 configuration management
- 462 ***CMS***
- 463 coordinate-measurement system
- 464 ***CNC***
- 465 Computer Numerical Controller
- 466 ***CNRI***
- 467 Corporation for National Research Initiatives
- 468 ***CPM***
- 469 Core Product Model
- 470 ***CPM2***
- 471 Revised Core Product Model
- 472 ***CPSC***
- 473 Consumer Product Safety Commission
- 474 ***cUAV***
- 475 configurable unmanned aerial vehicle
- 476 ***DARPA***
- 477 Defense Advanced Research Projects Agency
- 478 ***DER***
- 479 designated-engineering representative
- 480 ***DFM***
- 481 design for manufacturing

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

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

538	<b><i>IT</i></b>
539	information technology
540	<b><i>ITU-T</i></b>
541	Telecommunication Standardization Sector of the International Telecommunication
542	Union
543	<b><i>JSON</i></b>
544	JavaScript Object Notation
545	<b><i>JT</i></b>
546	Jupiter Tessellation
547	<b><i>LHS</i></b>
548	Lifecycle Handler System
549	<b><i>LIFT</i></b>
550	Lifecycle Information Framework and Technology
551	<b><i>LOI</i></b>
552	Lifecycle Object Identifier
553	<b><i>MAC</i></b>
554	media access control
555	<b><i>MADE</i></b>
556	Manufacturing Automation and Design Engineering
557	<b><i>MBD</i></b>
558	model-based definition
559	<b><i>MBE</i></b>
560	Model-Based Enterprise
561	<b><i>MBI</i></b>
562	model-based inspection
563	<b><i>MBM</i></b>
564	model-based manufacturing



- 565 ***MBSD***
- 566       model-based standards development
- 567 ***MBSE***
- 568       model-based systems engineering
- 569 ***MEDALS***
- 570       Military Engineering Data Asset Locator System
- 571 ***MES***
- 572       manufacturing execution system
- 573 ***MOI***
- 574       manufacturing object identifier
- 575 ***MOM***
- 576       Message Orienged Middleware
- 577 ***MQTT***
- 578       Message Queuing Telemetry Transport
- 579 ***MTC***
- 580       Manufacturing Technology Centre
- 581 ***NASA***
- 582       National Aeronautics and Space Administration
- 583 ***NC***
- 584       numerical control
- 585 ***NIST***
- 586       National Institute of Standards and Technology
- 587 ***NMTOKEN***
- 588       Name Token
- 589 ***NNMI***
- 590       National Network of Manufacturing Innovation
- 591 ***NSF***
- 592       National Science Foundation

- 593 ***NTSC***
- 594 National Transportation Safety Board
  
- 595 ***OASIS***
- 596 Organization for the Advancement of Structured Information Standards
  
- 597 ***ODI***
- 598 Open Data Institute
  
- 599 ***OEM***
- 600 original equipment manufacturer
  
- 601 ***OOI***
- 602 Ocean Observatories Initiative
  
- 603 ***OPC***
- 604 OLE for Process Control
  
- 605 ***OSLC***
- 606 Open Services for Lifecycle Collaboration
  
- 607 ***OSTP***
- 608 Office of Science and Technology Policy
  
- 609 ***OT***
- 610 operational technology
  
- 611 ***OWL***
- 612 Ontology Web Language
  
- 613 ***PDF***
- 614 Portable Document Format
  
- 615 ***PDM***
- 616 product-data management
  
- 617 ***PDQ***
- 618 product-data quality
  
- 619 ***PHM***
- 620 prognosis and health monitoring

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

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

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

705	<b><i>UML</i></b>
706	Unified Modeling Language
707	<b><i>URI</i></b>
708	Uniform Resource Identifier
709	<b><i>URL</i></b>
710	Uniform Resource Locator
711	<b><i>URN</i></b>
712	Uniform Resource Name
713	<b><i>UTC</i></b>
714	Coordinated Universal Time
715	<b><i>UUID</i></b>
716	Universally Unique Identifier
717	<b><i>V&amp;V</i></b>
718	verification and validation
719	<b><i>W3C</i></b>
720	World Wide Web Consortium
721	<b><i>WSN</i></b>
722	Wirth Syntax Notation
723	<b><i>WWW</i></b>
724	World Wide Web
725	<b><i>X.509-PKI</i></b>
726	Public Key Infrastructure
727	<b><i>X.509-PMI</i></b>
728	Privilege Management Infrastructure
729	<b><i>XML</i></b>
730	Extensible Markup Language
731	<b><i>XPath</i></b>
732	XML Path Language
733	<b><i>XSD</i></b>
734	XML Schema Definitions

## 735 **2.8 MTConnect References**

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

737 [MTConnect Part 2.0] *MTConnect Standard: Part 2.0 - Device Information Model. Ver-*  
738 *sion 2.0.*

739 [MTConnect Part 3.0] *MTConnect Standard: Part 3.0 - Observation Information Model.*  
740 *Version 2.0.*

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

743 [MTConnect Part 5.0] *MTConnect Standard: Part 5.0 - Interface Interaction Model. Ver-*  
744 *sion 2.0.*

745

## 746 3 Observation Information Model

747 The *Observation Information Model* provides a representation of the data reported by a  
 748 piece of equipment used for a manufacturing process, or used for any other purpose. Ad-  
 749 ditional descriptive information associated with the reported data is defined by the MT-  
 750 ConnectDevices entity, which is described in *MTConnect Standard: Part 2.0 - Device*  
 751 *Information Model*.

752 Information defined in the *Observation Information Model* allows a software application  
 753 to (1) determine the *Observations* for *DataItems* returned from a piece of equipment and  
 754 (2) interpret the data associated with those *Observations* with the same meaning, value,  
 755 and context that it had at its original source. To do this, the software application issues one  
 756 of two HTTP requests to an *agent* associated with a piece of equipment. They are:

- 757 • `sample`: Returns a designated number of time stamped *Observations* from an *agent*  
 758 associated with a piece of equipment; subject to any HTTP filtering associated with  
 759 the request. See `Agent` in *MTConnect Standard Part 1.0 - Fundamentals* for details  
 760 on the `sample` HTTP request.
- 761 • `current`: Returns a snapshot of either the most recent values or the values at a  
 762 given sequence number for all *Observations* associated with a piece of equipment  
 763 from an *agent*; subject to any HTTP filtering associated with the request. See `Agent`  
 764 in *MTConnect Standard Part 1.0 - Fundamentals* for details on the `current` HTTP  
 765 request.

766 An *agent* responds to either the `sample` or `current` HTTP request with an *MTCon-*  
 767 *nectStreams Response Document*. This document contains information describing *Ob-*  
 768 *servations* reported by an *agent* associated with a piece of equipment. A client software  
 769 application may correlate the information provided in the *MTConnectStreams Response*  
 770 *Document* with the physical and logical structure for that piece of equipment defined in  
 771 the `MTConnectDevices` entity to form a clear and unambiguous understanding of the  
 772 information provided. (See details on the structure for a piece of equipment described in  
 773 *MTConnect Standard: Part 2.0 - Device Information Model*).

774 `Streams` for an `MTConnectStreams` entity contains a `DeviceStream` entity for  
 775 each piece of equipment represented in the document. Each `DeviceStream` is com-  
 776 prised of two primary types of entities – *Components* and *Observations*. The contents  
 777 of the `DeviceStream` container are described in detail in this document, *MTConnect*  
 778 *Standard: Part 3.0 - Observation Information Model* of the *MTConnect Standard*.

779 *Components* are defined for both the `MTConnectDevices` and the `MTConnectStreams`



780 entities. These *Components* are used to provide a logical organization of the information  
781 provided in each entity.

782 • For an `MTConnectDevices` entity: *Components* organize information that rep-  
783 resents the physical and logical parts and sub-parts of a piece of equipment. (See  
784 *Component* in *MTConnect Standard: Part 2.0 - Device Information Model* for  
785 more details on *Components* used in the `MTConnectDevices` entity).

786 • For an `MTConnectStreams` entity: *Components* provide the structure to orga-  
787 nize the data returned from a piece of equipment and establishes the proper context  
788 for that data. The *Components* specifically defined for `MTConnectStreams` are  
789 `DeviceStream` (see *Section 3.1 - DeviceStream*) and `ComponentStream` (see  
790 *Section 3.2 - ComponentStream*).

791 `DeviceStream` and `ComponentStream` entities have a direct correlation to each of  
792 the *Component* defined in the `MTConnectDevices` entity.

793 Within each `ComponentStream` entity in the `MTConnectStreams` entity, *Observa-*  
794 *tions* are modeled as *Observation* entities. The three types of *Observation* entity  
795 are `Sample`, `Event`, and `Condition`. (See *Section 5 - Observation Types* for more  
796 information on these entities.)

## 797 3.1 DeviceStream

798 *organizes* data reported from a `Device`.

799 `DeviceStream` **MUST** be provided for each `Device` reporting data in an *MTConnect-*  
800 *Streams Response Document*.

801 If the response to the request for data from an *agent* does not contain any data for a specific  
802 `Device`, an empty `DeviceStream` entity **MAY** be created to indicate that the `Device`  
803 exists, but there was no data available.

### 804 3.1.1 Value Properties of DeviceStream

805 *Table 1* lists the Value Properties of `DeviceStream`.

Value Property name	Value Property type	Multiplicity
name	ID	1
uuid	ID	1

**Table 1:** Value Properties of DeviceStream

806 Descriptions for Value Properties of DeviceStream:

- 807 • name

808 name of the Device.

809 The value reported for name, DeviceStream **MUST** be the same as the value  
810 defined for the name, Device attribute of the same Device in the *MTConnect-*  
811 *Devices Response Document*.

- 812 • uuid

813 uuid of the Device.

814 The value reported for uuid, DeviceStream **MUST** be the same as the value  
815 defined for the uuid, Device attribute of the same Device in the *MTConnect-*  
816 *Devices Response Document*.

### 817 3.1.2 Part Properties of DeviceStream

818 Table 2 lists the Part Properties of DeviceStream.

Part Property name	Multiplicity
ComponentStream	1..*

**Table 2:** Part Properties of DeviceStream

819 Descriptions for Part Properties of DeviceStream:

- 820 • ComponentStream

821 organizes the data associated with each Component entity defined for a Device  
822 in the associated *MTConnectDevices Response Document*.

823 See Section 3.2 - ComponentStream.

## 824 3.2 ComponentStream

825 organizes the data associated with each component entity defined for a Device in the  
826 associated MTConnectDevices Response Document

827 At least one of Sample , Event , or Condition MUST be organized by a Compo-  
828 nentStream entity.

### 829 3.2.1 Value Properties of ComponentStream

830 Table 3 lists the Value Properties of ComponentStream .

Value Property name	Value Property type	Multiplicity
component	string	1
componentId	ID	1
name	string	0..1
nativeName	string	0..1
uuid	ID	0..1

Table 3: Value Properties of ComponentStream

831 Descriptions for Value Properties of ComponentStream :

- 832 • component
- 833 identifies the Component type associated with the ComponentStream .
- 834 Examples of component are Device , Controller , Linear and Loader .
- 835 • componentId
- 836 identifier of the Component as defined by the id attribute in the MTConnectDe-  
837 vices Response Document
- 838 • name
- 839 name of the Component associated with the ComponentStream .
- 840 • nativeName
- 841 common name of the Component associated with the ComponentStream .
- 842 • uuid
- 843 uuid of the Component associated with the ComponentStream .

844 **3.2.2 Reference Properties of ComponentStream**

845 Table 4 lists the Reference Properties of ComponentStream .

Reference Property name	Multiplicity
Event (organized by Events )	0..*
Sample (organized by Samples )	0..*
Condition (organized by Conditions )	0..*

Table 4: Reference Properties of ComponentStream

846 Descriptions for Reference Properties of ComponentStream :

- 847 • **Event**
  - 848 Observation that is a discrete piece of information from a piece of equipment.
  - 849 Events groups one or more Event entities. See Section 3.5 - Event
  - 850 • **Sample**
  - 851 Observation that is continuously changing or analog data value.
  - 852 Samples groups one or more Sample entities. See Section 3.4 - Sample
  - 853 • **Condition**
  - 854 Observation that provides the condition of a piece of equipment Component
  - 855
  - 856 Conditions groups one or more Condition entities. See Section 3.6 - Condition.
  - 857
- 858 Note: In the XML representation, Conditions MUST appear as a Condition
- 859 element in the MTConnectStreams Response Document

860 **3.3 Observation**

861 abstract entity that provides telemetry data for a DataItem at a point in time.

862 Note: See Section B.1 - Observations Schema Diagram for XML schema.

863 The XML schema also shows differences in XML representation of certain

864 MTConnect entities.

Figure 1: Observations

Figure 2: DeviceStream Example

865 Figure 2 shows a complete example of a DeviceStream for the Device shown in Figure  
866 2: Component Example in the MTConnect Standard: Part 2.0 - Device Information Model

867 Note: See Example 1 for the XML representation of the same example.

868 This section provides semantic information for the Observation model.

869 Note: See Section B.1 - Observations Schema Diagram for the XML schema of  
870 Observation types.

### 871 3.3.0.1 Observations made for DataItem

872 Component observes DataItem entities and creates Observation entities for the  
873 DataItem entities. See Figure 1.

874 Observation entities made by Component are organized by ComponentStream  
875 which is specially created for that Component.

Figure 3: Observations made for DataItem Example

876 Note: See Section C.2 - Observations made for DataItem Example for how  
 877 XML representation of the same example is separated into MTConnectDe-  
 878 vices Response Document and MTConnectStreams Response Document

879 Figure 3 is a subset of Figure 2. It shows an example of the association between a  
 880 DataItem Event type (EMERGENCY\_STOP) and an Observation Event type (EmergencyStop ).  
 881 See Section 3.3.0.2 - Naming Convention for Observation types

882 Figure 3 also shows example of the association between Component type (Controller )  
 883 and related ComponentStream .

### 884 3.3.0.2 Naming Convention for Observation types

885 The name of an Observation type MUST derive from the DataItem property type  
 886 converted to Pascal-Case by removing underscores (\_) and capitalizing each word. The  
 887 conversion MUST NOT apply to the following abbreviated words: BH, AC, DC and URI.  
 888 MTCONNECT MUST be converted to MTConnect . See Figure 3 for an example.

889 The name of an Observation type reported in the MTConnectStreams Response Doc-  
 890 ument is extended when the presentation property is used to further describe that  
 891 DataItem in the MTConnectDevices Response Document. See Section 4 - Representa-  
 892 tions for more details.

893 3.3.1 Value Properties of Observation

894 Table 5 lists the Value Properties of Observation .

Value Property name	Value Property type	Multiplicity
compositionId	ID	0..1
dataItemId	ID	1
name	string	0..1
sequence	integer	1
subType	DataItemSubTypeEnum	0..1
timestamp	datetime	1
type	DataItemTypeEnum	1
units	UnitEnum	0..1

Table 5: Value Properties of Observation

895 Descriptions for Value Properties of Observation :

- 896 • compositionId
- 897 identifier of the Composition entity defined in the MTConnectDevices Response
- 898 Document associated with the data reported for Observation .
- 899 • dataItemId
- 900 unique identifier of the DataItem associated with this Observation .
- 901 dataItemId MUST match the id attribute of the DataItem defined in the MT-
- 902 ConnectDevices Response Document
- 903 • name
- 904 name of the DataItem associated with this Observation .
- 905 name MUST match the name attribute of the DataItem defined in the MTCon-
- 906 nectDevices Response Document
- 907 • sequence
- 908 number representing the sequential position of an occurrence of an observation in
- 909 the data buffer of an agent
- 910 sequence MUST have a value represented as an unsigned 64-bit value from 1 to
- 911  $2^{64} - 1$ .
- 912 • subType
- 913 subtype of the DataItem associated with this Observation .

- 914 subType MUST match the subType attribute of the DataItem defined in the  
 915 MTConnectDevices Response Document
- 916 The value of subType MUST be one of the DataItemSubTypeEnum enumeration.  
 917
- 918 • timestamp
- 919 most accurate time available to a piece of equipment that represents the point in time  
 920 that the data reported was measured.
- 921 • type
- 922 type of the DataItem associated with this Observation .
- 923 type MUST match the type attribute of the DataItem defined in the MTCon-  
 924 nectDevices Response Document
- 925 The value of type MUST be one of the DataItemTypeEnum enumeration.
- 926 • units
- 927 units of the DataItem associated with this Observation .
- 928 units MUST match the units attribute of the DataItem defined in the MT-  
 929 ConnectDevices Response Document
- 930 The value of units MUST be one of the UnitEnum enumeration.
- 931 • result
- 932 observation of the Observation entity.
- 933 The default value type for result is string .

### 934 3.4 Sample

935 Observation that is continuously changing or analog data value.

936 It provides the information and data reported from a piece of equipment for DataItem  
 937 entities defined with category, DataItem property of SAMPLE in the MTConnect-  
 938 Devices Response Document

939 Sample MUST always be reported if float .

940 Figure 4 shows Sample type examples. It also shows an example for where result  
 941 is not available (dataItemId = cspeed ).

942 Note: See Example 4 for the XML representation of the same example.



Figure 4: Sample Example

943 The following Section 3.4.1 - Value Properties of Sample lists the additional and/or up-  
944 dated attributes for Sample .

945 The value of Sample MUST be float .

946 The units for Sample MUST always be specified.

### 947 3.4.1 Value Properties of Sample

948 Table 6 lists the Value Properties of Sample .

Value Property name	Value Property type	Multiplicity
duration	SECOND	0..1
resetTriggered	ResetTriggeredEnum	0..1
sampleRate	float	0..1
statistic	StatisticEnum	0..1

Table 6: Value Properties of Sample

949 Descriptions for Value Properties of Sample :

950 • duration

951 time-period over which the data was collected.

952 duration MUST be provided when the statistic attribute of the DataItem  
953 is defined in the MTConnectDevices Response Document

954 • resetTriggered

955 identifies when a reported value has been reset and what has caused that reset to  
956 occur for those DataItem entities that may be periodically reset to an initial value.

957 resetTriggered MUST only be provided for the specific occurrence of DataItem  
958 reported in the MTConnectStreams Response Document when the reset occurred.

959 ResetTriggeredEnum Enumeration:

960 – ACTION\_COMPLETE

961 result of the Observation that is measuring an action or operation was  
962 reset upon completion of that action or operation.

963 – ANNUAL

964 result of the Observation was reset at the end of a 12-month period.

965 – DAY

966 result of the Observation was reset at the end of a 24-hour period.

967 – MAINTENANCE

968 result of the Observation was reset upon completion of a maintenance  
969 event.

970 – MANUAL

971 result of the Observation was reset based on a physical reset action.

972 – MONTH

973 result of the Observation was reset at the end of a monthly period.

- 974           – POWER\_ON  
 975           result of theObservation was reset when power was applied to the piece  
 976           of equipment after a planned or unplanned interruption of power has occurred.
- 977           – SHIFT  
 978           result of theObservation was reset at the end of a work shift.
- 979           – WEEK  
 980           result of theObservation was reset at the end of a 7-day period.
- 981       • sampleRate  
 982           rate at which successive samples of the value are recorded.
- 983       • statistic  
 984           type of statistical calculation defined by thestatistic attribute of theDataItem  
 985           defined in theMTConnectDevices Response Document
- 986           The value ofstatistic MUST be one of theStatisticEnum enumeration.

## 987 3.5 Event

988 Observation that is a discrete piece of information from a piece of equipment.

989 It provides the information and data reported from a piece of equipment forDataItem  
 990 entities defined with acategory,DataItem property ofEVENTin theMTConnectDe-  
 991 vices Response Document

992 Figure 5 showsEvent type examples. It also shows an example for whereresult is  
 993 not available (dataItemId =d1\_asset\_rem ).

994 Note: SeeExample 5for the XML representation of the same example.

995 The followingSection 3.5.1 - Value Properties of Events lists the additional and/or updated  
 996 attributes forEvent .

### 997 3.5.1 Value Properties of Event

998 Table 7lists the Value Properties ofEvent .

Figure 5: Event Example

Value Property name	Value Property type	Multiplicity
resetTriggered	ResetTriggeredEnum	0..1

Table 7: Value Properties of Event

999 Descriptions for Value Properties of Event :

- 1000 • resetTriggered
- 1001 identifies when a reported value has been reset and what has caused that reset to
- 1002 occur for those DataItem entities that may be periodically reset to an initial value.
- 1003 resetTriggered MUST only be provided for the specific occurrence of DataItem
- 1004 reported in the MTConnectStreams Response Document when the reset occurred.
- 1005 The value of resetTriggered MUST be one of the ResetTriggeredEnum
- 1006 enumeration.

## 1007 3.6 Condition

1008 Observation that provides the condition of a piece of equipment Component

1009 It provides the information and data reported from a piece of equipment for DataItem  
 1010 entities defined with category, DataItem property of CONDITION in the MTCon-  
 1011 nectDevices Response Document

1012 Figure 6 shows Condition type examples for various state : Normal (dataItemId  
 1013 = path\_system ) and Warning (dataItemId = logic\_cond ). It also shows an  
 1014 example for when the state is not available (dataItemId = cont\_system ).

1015 Note: See Example 6 for the XML representation of the same example.

1016 The following Section 3.6.1 - Value Properties of Condition lists the additional and/or  
 1017 updated attributes for Condition .

### 1018 3.6.1 Value Properties of Condition

1019 Table 8 lists the Value Properties of Condition .

Value Property name	Value Property type	Multiplicity
nativeCode	string	0..1
nativeSeverity	string	0..1
qualifier	QualifierEnum	0..1
statistic	StatisticEnum	0..1
xs:lang	xslang	0..1
state	ConditionStateEnum	0..1

Table 8: Value Properties of Condition

Figure 6: Condition Example

1020 Descriptions for Value Properties of Condition :

- 1021 • nativeCode
- 1022 native code (usually an alpha-numeric value) generated by the controller of a piece
- 1023 of equipment providing a reference identifier for Condition .
- 1024 This is the same information an operator or maintenance personnel may see as a
- 1025 reference code designating a specific fault code provided by the piece of equipment.
- 1026 • nativeSeverity
- 1027 severity information to a client software application if the piece of equipment designates a severity level to a fault.
- 1028
- 1029 • qualifier
- 1030 additional information regarding a condition state associated with the measured
- 1031 value of a process variable.
- 1032 qualifier defines whether the condition state represented indicates a measured
- 1033 value that is above or below an expected value of a process variable.
- 1034 QualifierEnum Enumeration:
- 1035 – HIGH
- 1036 measured value is greater than the expected value for a process variable.
- 1037 – LOW
- 1038 measured value is less than the expected value for a process variable.
- 1039 • statistic
- 1040 statistic provides additional information describing the meaning of the
- 1041 condition element.
- 1042 statistic MUST match the statistic attribute of the DataItem entity
- 1043 defined in the MTConnectDevices Response Document
- 1044 The value of statistic MUST be one of the StatisticEnum enumeration.
- 1045 • xs:lang
- 1046 specifies the language of the result returned for the Condition .
- 1047 See Ref IETF RFC 4646 (<http://www.ietf.org/rfc/rfc4646.txt>).
- 1048 • state
- 1049 condition state of the piece of equipment Component .
- 1050 ConditionStateEnum Enumeration:



- 1051 – Fault
- 1052 condition state that requires intervention to continue operation to function prop-
- 1053 erly.
- 1054 – Normal
- 1055 condition state that indicates operation within speci ed limits.
- 1056 – Warning
- 1057 condition state that requires concern and supervision and may become haz-
- 1058 ardous if no action is taken.

## 1059 4 Representations

1060 This section provides semantic information for Representation model.

Figure 7: Representation

1061 Note: See Section B.2 - Representation Schema Diagrams XML schema.

### 1062 4.1 Representation

1063 specifies the format and structure of the result for an Observation .

1064 The Representation type for an Observation is defined by the associated DataItem's  
1065 property representation in the MTConnectDevices Response Document

1066 Value is the default Representation type for all Observation types.

1067 The name of the Observation type is modified for all Representation types other  
1068 than Value by appending the pascal case of Representation type.

1069 Example: The name for Sample Observation type Temperature with Repre-  
1070 sentation type of TimeSeries becomes TemperatureTimeSeries .

### 1071 4.2 Value

1072 default Representation type for all Observation types where result of the  
1073 Observation types is an MTConnect data type. See Section 6.1 - DataTypes

1074 **4.3 TimeSeries**

1075 Representation for anObservation composed of a series of sampled data.

1076 TimeSeries for anObservation is defined by the associatedDataItem's property  
1077 representation asTIME\_SERIES.

1078 DataItem with TIME\_SERIES representation MUST have acategory of  
1079 SAMPLE

1080 Figure 8 shows the model forTemperature (Sample type) with aRepresentation  
1081 type ofTimeSeries .

Figure 8: TemperatureTimeSeries

1082 Note: SeeSection B.2 - Representation Schema DiagramsXML schema.

1083 TimeSeries MUST report multiple values at fixed intervals in a singleObservation .  
1084 At minimum, one ofDataItem orObservation MUST specify thesampleRate in  
1085 Hertz (values/second); fractional rates are permitted. WhenObservation and the  
1086 DataItem specify thesampleRate , theObservation sampleRate supersedes  
1087 theDataItem .

1088 TheObservation MUST set thetimestamp to the time the last value was observed.  
1089 Theduration MAY indicate the time interval from the first to the last value in the series.

1090 Section 4.3.1 - Value Properties of TimeSeries defines additional attributes for an obser-  
1091 vation with TimeSeries Representation type.

1092 4.3.1 Value Properties of TimeSeries

1093 Table 9 lists the Value Properties of TimeSeries .

Value Property name	Value Property type	Multiplicity
sampleCount	integer	1

Table 9: Value Properties of TimeSeries

1094 Descriptions for Value Properties of TimeSeries :

- 1095 • sampleCount
- 1096 number of values given for the observation .

1097 4.4 <<deprecated>> Discrete

1098 DEPRECATED Representation for an Observation where each discrete occur-  
 1099 rence of the data may have the same value as the previous occurrence of the data.

1100 Discrete for an Observation is defined by the associated DataItem 's property  
 1101 representation as DISCRETE

1102 DataItem with DISCRETE representation MUST have a category of EVENT

1103 MTConnect Version 1.5 replaced representation DISCRETE with a discrete  
 1104 property for DataItem .

1105 Each occurrence of the Observation MAY have the same value as the previous occur-  
 1106 rence, and MUST NOT suppress duplicates.

1107 Examples of Discrete : A PartCount reporting the completion of each part using a 1  
 1108 to indicate completion of a single part. Message that occurs each time a door opens.

1109 4.5 DataSet

1110 Representation for an Observation composed of value(s) represented as a set of  
 1111 key-value pairs

1112 DataSet for an Observation is defined by the associated DataItem 's property  
 1113 representation as DATA\_SET

1114 DataItem with DATA\_SET representation MUST have a category of SAM-  
1115 PLE or EVENT

1116 Figure 9 shows the model for Variable (Event type) with a Representation type  
1117 of DataSet .

Figure 9: VariableDataSet

1118 Note: See Section B.2 - Representation Schema Diagrams XML schema.

1119 DataSet reports multiple values as a set of key-value pairs where each key MUST be  
1120 unique. The representation of the key-value pairs is an Entry . The value of each En-  
1121 try MUST have the same constraints and format as Observation defined for the  
1122 VALUE representation for the DataItem type (SeeValue ).

1123 The meaning of each Entry MAY be provided as the DataItem EntryDefinition .

1124 Figure 10 shows Event Observation type Variable with a Representation  
1125 type of DataSet .

1126 Note: See Example 7 for the XML representation of the same example.

Figure 10: DataSet Example

1127 4.5.0.1 Management of Data Set Observations

1128 An agent **MUST** maintain the current state of the DataSet as described in MTConnect  
1129 Standard Part 1.0 - Fundamentals

1130 One or more key-value pairs **MAY** be added, removed, or changed in an Observation .  
1131 An agent **MUST** publish the changes to one or more key-value pairs as a single Obser-  
1132 vation . An agent **MUST** indicate the removal of a key-value pair from a DataSet  
1133 using the removed attribute equal true .

1134 When the DataItem discrete, DataItem attribute is false or is not present, an  
1135 agent in response to a sample request **MUST** only publish the changed key-value pair  
1136 since the previous state of the DataSet .

1137 When the DataItem discrete, DataItem attribute is true , an agent in response  
1138 to a sample request **MUST** report all key-value pairs ignoring the state of the DataSet .

1139 When an agent responds to a current request, the response document **MUST** include the  
1140 full set of key-value pairs. If the current request includes a range query parameter, the agent

- 1141 MUST provide the set of key-value pairs at these sequence number
- 1142 When an Observation reset occurs, the DataSet MUST remove all key-value pairs  
 1143 making the set empty. The Observation MAY simultaneously populate the DataSet  
 1144 with new key-value pairs. The previous entries MUST NOT be included and MUST NOT  
 1145 have removed attribute equal true .
- 1146 When the Observation is UNAVAILABLE the DataSet MUST remove all key-value  
 1147 pairs making the set empty.

#### 1148 4.5.1 Value Properties of DataSet

1149 Table 10 lists the Value Properties of DataSet .

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 10: Value Properties of DataSet

1150 Descriptions for Value Properties of DataSet :

- 1151 • count
- 1152 number of Entry elements for the Observation .

#### 1153 4.5.2 Part Properties of DataSet

1154 Table 11 lists the Part Properties of DataSet .

Part Property name	Multiplicity
Entry	0..*

Table 11: Part Properties of DataSet

1155 Descriptions for Part Properties of DataSet :

- 1156 • Entry
- 1157 key-value pair published as part of DataSet .
- 1158 See Section 4.7 - Entry

1159 4.6 Table

1160 Representation for an Observation composed of two-dimensional sets of key-  
 1161 value pairs where the Entry represents rows containing sets of key-value pairs given by  
 1162 Cell entities.

1163 Table for an Observation is defined by the associated DataItem's property rep-  
 1164 resentation as TABLE

1165 DataItem with TABLE representation MUST have a category of SAMPLE or  
 1166 EVENT

1167 Figure 11 shows the model for WorkOffset (Event type) with a Representation  
 1168 type of Table .

Figure 11: WorkOffsetTable



1169 Note: See Section B.2 - Representation Schema Diagram for XML schema.

1170 Table has the same behavior as DataSet for change tracking, clearing, and history.

1171 When an Entry changes, all Cell entities update at the same time; they are not tracked  
1172 separately like Entry .

1173 The meaning of each Entry and Cell MAY be provided as the DataItem Entry-  
1174 Definition and CellDefinition .

1175 The Entry key attribute MUST be the unique identity of the Entry within an Obser-  
1176 vation . The Cell key attribute MUST be the unique identity of the Cell within an  
1177 Entry .

1178 Figure 12 shows Event Observation type WorkOffset with a Representation  
1179 type of Table .

Figure 12: Table Example

1180 Note: See Example 8 for the XML representation of the same example.

#### 1181 4.6.1 Value Properties of Table

1182 Table 12 lists the Value Properties of Table .

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 12: Value Properties of Table

1183 Descriptions for Value Properties of Table :

- 1184 • count
- 1185 number of key-value pairs represented as Entry entities.

## 1186 4.6.2 Part Properties of Table

1187 Table 13 lists the Part Properties of Table .

Part Property name	Multiplicity
TableEntry	0..*

Table 13: Part Properties of Table

1188 Descriptions for Part Properties of Table :

- 1189 • TableEntry
- 1190 key-value pair published as part of Table .
- 1191 Note: In the XML representation, TableEntry MUST appear as an
- 1192 entry .
- 1193 See Section 4.8 - TableEntry

## 1194 4.7 Entry

1195 key-value pair published as part of DataSet .

### 1196 4.7.0.1 Constraints for Entry Values

1197 The value of each Entry MUST have the same restrictions as the value of an observation  
1198 with representation of VALUE

1199 An Entry MAY be further constrained by the DataItem definition (see MTConnect  
1200 Standard: Part 2.0 - Device Information Model) for example a VariableDataSet  
1201 having a string value MAY have a coating-pointTemperature value. A restriction  
1202 MUST NOT be broadened or removed, for example, the value "READ" MUST NOT  
1203 occur with a TemperatureDataSet constrained to coating-point numbers.

1204 The MTConnect Standard: Part 2.0 - Device Information Model DataItem Definition  
1205 MAY provide the type and units of an Entry for a key .

1206 **4.7.1 Value Properties of Entry**

1207 Table 14 lists the Value Properties of Entry .

Value Property name	Value Property type	Multiplicity
key	ID	1
removed	boolean	0..1

Table 14: Value Properties of Entry

1208 Descriptions for Value Properties of Entry :

- 1209 • key
- 1210 unique identifier for each key-value pair
- 1211 • removed
- 1212 removal indicator of a key-value pair

1213 **4.8 TableEntry**

1214 key-value pair published as part of a Table .

1215 Note: In the XML representation, TableEntry MUST appear as an Entry .

1216 **4.8.1 Value Properties of TableEntry**

1217 Table 15 lists the Value Properties of TableEntry .

Value Property name	Value Property type	Multiplicity
key	ID	1
removed	boolean	0..1

Table 15: Value Properties of TableEntry

1218 Descriptions for Value Properties of TableEntry :

- 1219 • key
- 1220 unique identifier for each key-value pair

- 1221 • removed
- 1222 removal indicator of key-value pair

## 1223 4.8.2 Part Properties of TableEntry

1224 Table 16 lists the Part Properties of TableEntry .

Part Property name	Multiplicity
Cell	0..*

Table 16: Part Properties of TableEntry

1225 Descriptions for Part Properties of TableEntry :

- 1226 • Cell
- 1227 key-value pair published as part of TableEntry .
- 1228 See Section 4.9 - Cell

## 1229 4.9 Cell

1230 key-value pair published as part of TableEntry .

### 1231 4.9.0.1 Constraints for Cell Values

1232 The value of each Cell MUST have the same restrictions as the value of an observation  
 1233 with representation of VALUE

1234 An Cell MAY be further constrained by the Data Item definition (see MTConnect Stan-  
 1235 dard: Part 2.0 - Device Information Model) for example a variable DataSet having  
 1236 a string value MAY have a coating-point Temperature value. A restriction MUST  
 1237 NOT be broadened or removed, for example, the value READY MUST NOT occur with a  
 1238 Temperature DataSet constrained limited to coating-point numbers.

1239 The MTConnect Standard: Part 2.0 - Device Information Model Data Item Defini-  
 1240 tion MAY provide the type and units of a Cell for a key .

1241 4.9.1 Value Properties of Cell

1242 Table 17 lists the Value Properties of Cell .

Value Property name	Value Property type	Multiplicity
key	ID	1

Table 17: Value Properties of Cell

1243 Descriptions for Value Properties of Cell :

- 1244 • key

1245 unique identifier for each key-value pair

## 1246 5 Observation Types

1247 This section provides semantic information for Observation types.

1248 Observation entities are instantiated as Sample, Event or Condition entities  
1249 based upon the category and type attributes defined for the corresponding DataItem .

1250 See Figure 2 for examples on how Observation types are organized with ComponentStream .  
1251

### 1252 5.1 Condition Types

1253 This section provides semantic information for Condition types.

1254 Condition types are reported differently from other Observation types. They are  
1255 reported based on the condition state for each condition .

1256 The type and subType (where applicable) properties for Condition MAY be any  
1257 of the type and subType attributes defined for SAMPLE category or EVENT category DataItem listed in the Device Information Model  
1258

1259 This section lists additional Condition types that have been defined to represent the  
1260 health and fault status of components

#### 1261 5.1.1 Actuator

1262 indication of a fault associated with an actuator.

#### 1263 5.1.2 Communications

1264 indication that the piece of equipment has experienced a communications failure.

#### 1265 5.1.3 DataRange

1266 indication that the value of the data associated with a measured value or a calculation is  
1267 outside of an expected range.

1268 5.1.4 LogicProgram

1269 indication that an error occurred in the logic program or programmable logic controller  
1270 (PLC) associated with a piece of equipment.

1271 5.1.5 MotionProgram

1272 indication that an error occurred in the motion program associated with a piece of equip-  
1273 ment.

1274 5.1.6 System

1275 general purpose indication associated with an electronic component of a piece of equip-  
1276 ment or a controller that represents a fault that is not associated with the operator, program,  
1277 or hardware.

1278 5.2 Event Types

1279 This section provides semantic information ~~Event~~ types.

1280 5.2.1 ActivationCount

1281 accumulation of the number of times a function has attempted to, or is planned to attempt  
1282 to, activate or be performed.

1283 The defaultsubType of ActivationCount is ALL.

1284 The value ofActivationCount MUST be integer .

1285 5.2.1.1 Subtypes of ActivationCount

1286 • ABORTED

1287 accumulation of actions or activities that were attempted, but terminated before they  
1288 could be completed.

- 1289 • ALL
- 1290 accumulation of all actions, items, or activities being counted independent of the
- 1291 outcome.
- 1292 • BAD
- 1293 accumulation of actions, items, or activities being counted that do not conform to
- 1294 specification or expectation.
- 1295 • COMPLETE
- 1296 accumulation of actions, items, or activities that have been completed, independent
- 1297 of the outcome.
- 1298 • FAILED
- 1299 accumulation of actions or activities that were attempted, but failed to complete or
- 1300 resulted in an unexpected or unacceptable outcome.
- 1301 • GOOD
- 1302 accumulation of actions, items, or activities being counted that conform to speci -
- 1303 cation or expectation.
- 1304 • REMAINING
- 1305 accumulation of actions, items, or activities yet to be counted.
- 1306 • TARGET
- 1307 goal of the operation or process.

### 1308 5.2.2 ActiveAxes

- 1309 set of axes currently associated with Path or Controller .
- 1310 The value of ActiveAxes MUST be a list of string of size 0.. \* .

### 1311 5.2.3 ActuatorState

- 1312 operational state of an apparatus for moving or controlling a mechanism or system.
- 1313 ActuatorStateEnum Enumeration:



- 1314 • ACTIVE
- 1315 Actuator is operating.
- 1316 • INACTIVE
- 1317 Actuator is not operating.

1318 5.2.4 AdapterSoftwareVersion

1319 originator's software version of the adapter

1320 5.2.5 AdapterURI

1321 Uniform Resource Identifier (URI) of the adapter

1322 5.2.6 <<deprecated>> Alarm

1323 DEPRECATED: Replaced with CONDITION category data items in Version 1.1.0.

1324 5.2.6.1 Value Properties of Alarm

1325 Table 18 lists the Value Properties of Alarm .

Value Property name	Value Property type	Multiplicity
<<deprecated>> code	AlarmCodeEnum	1
<<deprecated>> severity	AlarmSeverityEnum	1
<<deprecated>> nativeCode	string	1
<<deprecated>> state	AlarmStateEnum	1
<<deprecated>> lang	xslang	0..1

Table 18: Value Properties of Alarm

1326 Descriptions for Value Properties of Alarm :

- 1327 • <<deprecated>> code
- 1328 type of alarm.

- 1329 • <<deprecated>> severity
- 1330 severity of the alarm.
- 1331 • <<deprecated>> nativeCode
- 1332 native code for the piece of equipment.
- 1333 • <<deprecated>> state
- 1334 state of the alarm.
- 1335 • <<deprecated>> lang
- 1336 specifies the language of the alarm text.
- 1337 SeeRef IETF RFC 4646(<http://www.ietf.org/rfc/rfc4646.txt>).

### 1338 5.2.7 AlarmLimit

1339 set of limits used to trigger warning or alarm indicators.

1340 TheEntry key MUST be one or more from theAlarmLimitResult keys.

1341 AlarmLimitResult keys:

- 1342 • UPPER\_LIMIT
- 1343 upper conformance boundary for a variable.
- 1344 Note: immediate concern or action may be required.
- 1345 The value ofUPPER\_LIMIT MUST befloat .
- 1346 • UPPER\_WARNING
- 1347 upper boundary indicating increased concern and supervision may be required.
- 1348 The value ofUPPER\_WARNINGMUST befloat .
- 1349 • LOWER\_WARNING
- 1350 lower boundary indicating increased concern and supervision may be required.
- 1351 The value ofLOWER\_WARNINGMUST befloat .
- 1352 • LOWER\_LIMIT
- 1353 lower conformance boundary for a variable.
- 1354 Note: immediate concern or action may be required.
- 1355 The value ofLOWER\_LIMITMUST befloat .

1356 5.2.8 Application

1357 application on a Component .

1358 A subType MUST always be specified.

1359 5.2.8.1 Subtypes of Application

1360 • INSTALL\_DATE

1361 date the hardware or software was installed.

1362 The value of Application MUST be datetime . SeeSection 6.1.5 - datetime

1363 datetime Enumeration:

1364 • LICENSE

1365 license code to validate or activate the hardware or software.

1366 • MANUFACTURER

1367 corporate identity for the maker of the hardware or software.

1368 • RELEASE\_DATE

1369 date the hardware or software was released for general use.

1370 The value of Application MUST be datetime . SeeSection 6.1.5 - datetime

1371 datetime Enumeration:

1372 • VERSION

1373 version of the hardware or software.

1374 5.2.9 AssetChanged

1375 assetId of the Asset that has been added or changed.

1376 5.2.9.1 Value Properties of AssetChanged

1377 Table 19 lists the Value Properties of AssetChanged .

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

Table 19: Value Properties of AssetChanged

1378 Descriptions for Value Properties of AssetChanged :

- 1379 • assetType

1380 type of Asset changed. See MTCConnect Standard: Part 4.0 - Asset Information  
 1381 Model for details on the Asset model.

### 1382 5.2.10 AssetCount

1383 data set of the number of Assets of a given type for a Device

1384 The value of AssetCount MUST be integer .

### 1385 5.2.11 AssetRemoved

1386 assetId of the Asset that has been removed.

#### 1387 5.2.11.1 Value Properties of AssetRemoved

1388 Table 20 lists the Value Properties of AssetRemoved .

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

Table 20: Value Properties of AssetRemoved

1389 Descriptions for Value Properties of AssetRemoved :

- 1390 • assetType

1391 type of Asset removed. See MTCConnect Standard: Part 4.0 - Asset Information  
 1392 Model for details on the Asset model.

1393 5.2.12 Availability

1394 agents ability to communicate with the data source.

1395 AvailabilityEnum Enumeration:

1396 • AVAILABLE

1397 data source is active and capable of providing data.

1398 • UNAVAILABLE

1399 data source is either inactive or not capable of providing data.

1400 5.2.13 AxisCoupling

1401 describes the way the axes will be associated to each other.

1402 This is used in conjunction with COUPLED\_AXES to indicate the way they are interacting.

1403 AxisCouplingEnum Enumeration:

1404 • MASTER

1405 axis is the master of the coupledAxes .

1406 • SLAVE

1407 axis is a slave to the coupledAxes .

1408 • SYNCHRONOUS

1409 axes are not physically connected to each other but are operating together in lock-  
1410 step.

1411 • TANDEM

1412 axes are physically connected to each other and operate as a single unit.

1413 5.2.14 AxisFeedrateOverride

1414 value of a signal or calculation issued to adjust the feedrate of an individual linear type  
1415 axis.

1416 The value of AxisFeedrateOverride MUST be float .

1417 5.2.14.1 Subtypes of AxisFeedrateOverride

1418 • JOG

1419 relating to momentary activation of a function or a movement.

1420 DEPRECATION WARNING : May be deprecated in the future.

1421 When the JOG subtype of AxisFeedrateOverride is applied, the resulting  
1422 commanded feedrate for the axis is limited to the value of the original  
1423 of the AxisFeedrate multiplied by the value of the JOG subtype of AxisFee-  
1424 drateOverride .

1425 • PROGRAMMED

1426 directive value without offsets and adjustments.

1427 • RAPID

1428 performing an operation faster or in less time than nominal rate.

1429 5.2.15 AxisInterlock

1430 state of the axis lockout function when power has been removed and the axis is allowed to  
1431 move freely.

1432 AxisInterlockEnum Enumeration:

1433 • ACTIVE

1434 axis lockout function is activated, power has been removed from the axis, and the  
1435 axis is allowed to move freely.

1436 • INACTIVE

1437 axis lockout function has not been activated, the axis may be powered, and the axis  
1438 is capable of being controlled by another component.

1439 5.2.16 AxisState

1440 state of a Linear or Rotary component representing an axis.

1441 AxisStateEnum Enumeration:

- 1442     • HOME
- 1443       axis is in its home position.
  
- 1444     • PARKED
- 1445       axis has been moved to a xed position and is being maintained in that position
- 1446       either electrically or mechanically.
- 1447       Action is required to release the axis from this position.
  
- 1448     • STOPPED
- 1449       axis is stopped.
  
- 1450     • TRAVEL
- 1451       axis is in motion.

#### 1452 5.2.17 BatteryState

1453 present status of the battery.

1454 BatteryStateEnum   Enumeration:

- 1455     • CHARGED
- 1456       Component is at it's maximum rated charge level.
  
- 1457     • CHARGING
- 1458       Component 's charge is increasing.
  
- 1459     • DISCHARGED
- 1460       Component is at it's minimum charge level.
  
- 1461     • DISCHARGING
- 1462       Component 's charge is decreasing.

#### 1463 5.2.18 Block

1464 line of code or command being executed by controller entity.

## 1465 5.2.19 BlockCount

1466 total count of the number of blocks of program code that have been executed since execu-  
1467 tion started.

1468 The value of BlockCount MUST be integer .

## 1469 5.2.20 ChuckInterlock

1470 state of an interlock function or control logic state intended to prevent the associated  
1471 Chuck component from being operated.

1472 ChuckInterlockEnum Enumeration:

1473 • ACTIVE  
1474 chuck cannot be unclamped.

1475 • INACTIVE  
1476 chuck can be unclamped.

### 1477 5.2.20.1 Subtypes of ChuckInterlock

1478 • MANUAL\_UNCLAMP  
1479 indication of the state of an operator controlled interlock that can inhibit the ability  
1480 to initiate an unclamp action of an electronically controlled chuck.

1481 When ChuckInterlockManualUnclamp is ACTIVE, it is expected that a chuck  
1482 cannot be unclamped until ChuckInterlockManualUnclamp is set to INAC-  
1483 TIVE .

## 1484 5.2.21 ChuckState

1485 operating state of a mechanism that holds a part or stock material during a manufacturing  
1486 process.

1487 It may also represent a mechanism that holds any other mechanism in place within a piece  
1488 of equipment.



1489 ChuckStateEnum Enumeration:

1490 • CLOSED

1491 Chuck is closed to the point of a positive con rmation.

1492 • OPEN

1493 Chuck is open to the point of a positive con rmation.

1494 • UNLATCHED

1495 Chuck is not closed to the point of a positive con rmation and not open to the point  
1496 of a positive con rmation.

1497 It is in an intermediate position.

### 1498 5.2.22 ClockTime

1499 time provided by a timing device at a speci c point in time.

1500 The value ofClockTime MUST be datetime . SeeSection 6.1.5 - datetime

### 1501 5.2.23 <<deprecated>> Code

1502 programmatic code being executed.

1503 DEPRECATED in Version 1.1

### 1504 5.2.24 CompositionState

1505 operating state of a mechanism represented by a composition entity.

1506 A subType MUST always be speci ed.

#### 1507 5.2.24.1 Subtypes of CompositionState

1508 • ACTION

1509 indication of the operating state of a mechanism.

1510 CompositionStateActionEnum Enumeration:

1511 – ACTIVE

1512 Composition is operating.

1513 – INACTIVE

1514 Composition is not operating.

1515 • LATERAL

1516 indication of the position of a mechanism that may move in a lateral direction.

1517 CompositionStateLateralEnum Enumeration:

1518 – LEFT

1519 position of theComposition is oriented to the left to the point of a positive  
1520 con rmation.

1521 – RIGHT

1522 position of theComposition is oriented to the right to the point of a positive  
1523 con rmation.

1524 – TRANSITIONING

1525 position of theComposition is not oriented to the right to the point of a  
1526 positive con rmation and is not oriented to the left to the point of a positive  
1527 con rmation.

1528 It is in an intermediate position.

1529 • MOTION

1530 indication of the open or closed state of a mechanism.

1531 CompositionStateMotionEnum Enumeration:

1532 – CLOSED

1533 position of theComposition is closed to the point of a positive con rmation.

1534 – OPEN

1535 position of theComposition is open to the point of a positive con rmation.

1536 – UNLATCHED

1537 position of theComposition is not open to the point of a positive con rma-  
1538 tion and is not closed to the point of a positive con rmation.

1539 It is in an intermediate position.

- 1540     • SWITCHED
- 1541     indication of the activation state of a mechanism.
- 1542     CompositionStateSwitchedEnum     Enumeration:
- 1543         – OFF
- 1544             activation state of theComposition     is in anOFFcondition, it is not operat-
- 1545             ing, or it is not powered.
- 1546         – ON
- 1547             activation state of theComposition     is in anONcondition, it is operating, or
- 1548             it is powered.
- 1549     • VERTICAL
- 1550     indication of the position of a mechanism that may move in a vertical direction.
- 1551     CompositionStateVerticalEnum     Enumeration:
- 1552         – DOWN
- 1553             position of theComposition     element is oriented in a downward direction to
- 1554             the point of a positive con rmation.
- 1555         – TRANSITIONING
- 1556             position of theComposition     element is not oriented in an upward direc-
- 1557             tion to the point of a positive con rmation and is not oriented in a downward
- 1558             direction to the point of a positive con rmation.
- 1559             It is in an intermediate position.
- 1560         – UP
- 1561             position of theComposition     element is oriented in an upward direction to
- 1562             the point of a positive con rmation.

### 1563 5.2.25 ConnectionStatus

1564 status of the connection between an adapter and an agent

1565 ConnectionStatusEnum     Enumeration:

- 1566     • CLOSED
- 1567     no connection at all.

- 1568 • ESTABLISHED
- 1569 open connection.
- 1570 The normal state for the data transfer phase of the connection.
- 1571 • LISTEN
- 1572 agentis waiting for a connection request from adapter

### 1573 5.2.26 ControlLimit

1574 set of limits used to indicate whether a process variable is stable and in control.

1575 TheEntry key MUST be one or more from theControlLimitResult keys.

1576 ControlLimitResult keys:

- 1577 • UPPER\_LIMIT
- 1578 upper conformance boundary for a variable.
- 1579 Note: immediate concern or action may be required.
- 1580 The value ofUPPER\_LIMIT MUST befloat .
- 1581 • UPPER\_WARNING
- 1582 upper boundary indicating increased concern and supervision may be required.
- 1583 The value ofUPPER\_WARNINGMUST befloat .
- 1584 • NOMINAL
- 1585 ideal or desired value for a variable.
- 1586 The value ofNOMINALMUST befloat .
- 1587 • LOWER\_WARNING
- 1588 lower boundary indicating increased concern and supervision may be required.
- 1589 The value ofLOWER\_WARNINGMUST befloat .
- 1590 • LOWER\_LIMIT
- 1591 lower conformance boundary for a variable.
- 1592 Note: immediate concern or action may be required.
- 1593 The value ofLOWER\_LIMITMUST befloat .

1594 5.2.27 ControllerMode

1595 current mode of the Controller component.

1596 ControllerModeEnum Enumeration:

- 1597 • AUTOMATIC

1598 Controller is configured to automatically execute a program.

- 1599 • EDIT

1600 Controller is currently functioning as a programming device and is not capable  
1601 of executing an active program.

- 1602 • <<deprecated>> FEED\_HOLD

1603 axes of the device are commanded to stop, but the spindle continues to function.

- 1604 • MANUAL

1605 Controller is not executing an active program.

1606 It is capable of receiving instructions from an external source – typically an operator.  
1607 The Controller executes operations based on the instructions received from the  
1608 external source.

- 1609 • MANUAL\_DATA\_INPUT

1610 operator can enter a series of operations for Controller to perform.

1611 The Controller will execute this specific series of operations and then stop.

- 1612 • SEMI\_AUTOMATIC

1613 Controller is operating in a mode that restricts the active program from process-  
1614 ing its next process step without operator intervention.

1615 5.2.28 ControllerModeOverride

1616 setting or operator selection that changes the behavior of a piece of equipment.

1617 ControllerModeOverrideEnum Enumeration:

- 1618 • OFF

1619 ControllerModeOverride is in the OFF state and the mode override is inac-  
1620 tive.

- 1621       • ON
- 1622       ControllerModeOverride       is in theONstate and the mode override is active.
- 1623   A subType MUST always be speci ed.
- 1624   5.2.28.1   Subtypes of ControllerModeOverride
- 1625       • DRY\_RUN
- 1626       setting or operator selection used to execute a test mode to con rm the execution of
- 1627       machine functions.
- 1628       WhenDRY\_RUNis ON the equipment performs all of its normal functions, except
- 1629       no part or product is produced. If the equipment has a spindle, spindle operation is
- 1630       suspended.
- 1631       • MACHINE\_AXIS\_LOCK
- 1632       setting or operator selection that changes the behavior of the controller on a piece of
- 1633       equipment.
- 1634       WhenMACHINE\_AXIS\_LOCKis ON program execution continues normally, but
- 1635       no equipment motion occurs.
- 1636       • OPTIONAL\_STOP
- 1637       setting or operator selection that changes the behavior of the controller on a piece of
- 1638       equipment.
- 1639       The program execution is stopped after a speci c program block is executed when
- 1640       OPTIONAL\_STOPis ON
- 1641       In the case of a G-Code program, a program block containing a M01 code designates
- 1642       the command for aOPTIONAL\_STOP
- 1643       Execution MUST change toOPTIONAL\_STOPafter a program block speci-
- 1644       fying an optional stop is executed and the ControllerModeOverride OP-
- 1645       TIONAL\_STOPselection isON
- 1646       • SINGLE\_BLOCK
- 1647       setting or operator selection that changes the behavior of the controller on a piece of
- 1648       equipment.
- 1649       Program execution is paused after each block of code is executedSINGLE\_BLOCK
- 1650       is ON
- 1651       When SINGLE\_BLOCKis ON Execution MUST change toINTERRUPTED
- 1652       after completion of each block of code.

- 1653     • **TOOL\_CHANGE\_STOP**  
1654         setting or operator selection that changes the behavior of the controller on a piece of  
1655         equipment.  
1656         Program execution is paused when a command is executed requesting a cutting tool  
1657         to be changed.  
1658         Execution **MUST** change to **INTERRUPTED** after completion of the command  
1659         requesting a cutting tool to be changed and **TOOL\_CHANGE\_STOP**.

### 1660 5.2.29 CoupledAxes

- 1661     set of associated axes.  
1662     The value of **CoupledAxes** **MUST** be a list of string    of size 0.. \* .

### 1663 5.2.30 CycleCount

- 1664     accumulation of the number of times a cyclic function has attempted to, or is planned to  
1665     attempt to execute.  
1666     The default **subType** of **CycleCount** is **ALL**.  
1667     The value of **CycleCount** **MUST** be integer .

#### 1668 5.2.30.1 Subtypes of CycleCount

- 1669     • **ABORTED**  
1670         accumulation of actions or activities that were attempted, but terminated before they  
1671         could be completed.  
1672     • **ALL**  
1673         accumulation of all actions, items, or activities being counted independent of the  
1674         outcome.  
1675     • **BAD**  
1676         accumulation of actions, items, or activities being counted that do not conform to  
1677         specification or expectation.

- 1678 • COMPLETE
- 1679 accumulation of actions, items, or activities that have been completed, independent
- 1680 of the outcome.
- 1681 • FAILED
- 1682 accumulation of actions or activities that were attempted, but failed to complete or
- 1683 resulted in an unexpected or unacceptable outcome.
- 1684 • GOOD
- 1685 accumulation of actions, items, or activities being counted that conform to speci -
- 1686 cation or expectation.
- 1687 • REMAINING
- 1688 accumulation of actions, items, or activities yet to be counted.
- 1689 • TARGET
- 1690 goal of the operation or process.

### 1691 5.2.31 DateCode

1692 time and date code associated with a material or other physical item.

1693 The value of DateCode MUST be datetime . SeeSection 6.1.5 - datetime

#### 1694 5.2.31.1 Subtypes of DateCode

- 1695 • EXPIRATION
- 1696 time and date code relating to the expiration or end of useful life for a material or
- 1697 other physical item.
- 1698 • FIRST\_USE
- 1699 time and date code relating the rst use of a material or other physical item.
- 1700 • MANUFACTURE
- 1701 time and date code relating to the production of a material or other physical item.



1702 5.2.32 DeactivationCount

1703 accumulation of the number of times a function has attempted to, or is planned to attempt  
1704 to, deactivate or cease.

1705 The defaultsubType of DeactivationCount is ALL.

1706 The value ofDeactivationCount MUST beinteger .

1707 5.2.32.1 Subtypes of DeactivationCount

1708 • ABORTED

1709 accumulation of actions or activities that were attempted, but terminated before they  
1710 could be completed.

1711 • ALL

1712 accumulation of all actions, items, or activities being counted independent of the  
1713 outcome.

1714 • BAD

1715 accumulation of actions, items, or activities being counted that do not conform to  
1716 specification or expectation.

1717 • COMPLETE

1718 accumulation of actions, items, or activities that have been completed, independent  
1719 of the outcome.

1720 • FAILED

1721 accumulation of actions or activities that were attempted, but failed to complete or  
1722 resulted in an unexpected or unacceptable outcome.

1723 • GOOD

1724 accumulation of actions, items, or activities being counted that conform to speci -  
1725 cation or expectation.

1726 • REMAINING

1727 accumulation of actions, items, or activities yet to be counted.

1728 • TARGET

1729 goal of the operation or process.

1730 5.2.33 DeviceAdded

1731 Universally Unique Identifier (UUID) of new device added to MTCConnect Agent

1732 5.2.34 DeviceChanged

1733 UUID of the device whose metadata has changed.

1734 5.2.35 DeviceRemoved

1735 UUID of a device removed from MTCConnect Agent

1736 5.2.36 DeviceUuid

1737 identifier of another piece of equipment that is temporarily associated with a component  
1738 of this piece of equipment to perform a particular function.

1739 5.2.37 Direction

1740 direction of motion.

1741 <<deprecated>> DirectionEnum Enumeration:

- 1742 • <<deprecated>> CLOCKWISE
- 1743 clockwise rotation using the right-hand rule.
- 1744 • <<deprecated>> COUNTER\_CLOCKWISE
- 1745 counter-clockwise rotation using the right-hand rule.
- 1746 • <<deprecated>> NEGATIVE
- 1747 • <<deprecated>> POSITIVE

1748 A subType MUST always be specified.

1749 5.2.37.1 Subtypes of Direction

1750 • LINEAR

1751 direction of motion of a linear motion.

1752 DirectionLinearEnum Enumeration:

1753 – NEGATIVE

1754 linear position is decreasing.

1755 – NONE

1756 no direction.

1757 – POSITIVE

1758 linear position is increasing.

1759 • ROTARY

1760 rotational direction of a rotary motion using the right hand rule convention.

1761 DirectionRotaryEnum Enumeration:

1762 – CLOCKWISE

1763 clockwise rotation using the right-hand rule.

1764 – COUNTER\_CLOCKWISE

1765 counter-clockwise rotation using the right-hand rule.

1766 – NONE

1767 no direction.

1768 5.2.38 DoorState

1769 operational state of Door component or composition element.

1770 DoorStateEnum Enumeration:

1771 • CLOSED

1772 Door is closed to the point of a positive con rmation.

1773 • OPEN

1774 Door is open to the point of a positive con rmation.

1775 • UNLATCHED

1776 Door is not closed to the point of a positive confirmation and not open to the point  
1777 of a positive confirmation.

1778 It is in an intermediate position.

### 1779 5.2.39 EmergencyStop

1780 state of the emergency stop signal for a piece of equipment, controller path, or any other  
1781 component or subsystem of a piece of equipment.

1782 EmergencyStopEnum Enumeration:

1783 • ARMED

1784 emergency stop circuit is complete and the piece of equipment, component, or com-  
1785 position is allowed to operate.

1786 • TRIGGERED

1787 operation of the piece of equipment, component, or composition is inhibited.

### 1788 5.2.40 EndOfBar

1789 indication of whether the end of a piece of bar stock being feed by a bar feeder has been  
1790 reached.

1791 EndOfBarEnum Enumeration:

1792 • NO

1793 EndOfBar has not been reached.

1794 • YES

1795 EndOfBar has been reached.

1796 The defaultsubType of EndOfBar is PRIMARY

1797 5.2.40.1 Subtypes of EndOfBar

1798 • AUXILIARY

1799 when multiple locations on a piece of bar stock are referenced as the indication for  
1800 the EndOfBar , the additional location(s) MUST be designated as AUXILIARY  
1801 indication(s) for the EndOfBar .

1802 • PRIMARY

1803 speci c applications MAY reference one or more locations on a piece of bar stock  
1804 as the indication for the EndOfBar .

1805 The main or most important location MUST be designated as the PRIMARY indica-  
1806 tion for the EndOfBar .

1807 If no subType is speci ed, PRIMARY MUST be the default EndOfBar indica-  
1808 tion.

1809 5.2.41 EquipmentMode

1810 indication that a piece of equipment, or a sub-part of a piece of equipment, is performing  
1811 speci c types of activities.

1812 EquipmentModeEnum Enumeration:

1813 • OFF

1814 equipment is not functioning in the mode designated by the type .

1815 • ON

1816 equipment is functioning in the mode designated by the type .

1817 A subType MUST always be speci ed.

1818 5.2.41.1 Subtypes of EquipmentMode

1819 • DELAY

1820 elapsed time of a temporary halt of action.

- 1821 • LOADED  
1822 indication that the sub-parts of a piece of equipment are under load.  
1823 Example: For traditional machine tools, this is an indication that the cutting tool is  
1824 assumed to be engaged with the part.
- 1825 • OPERATING  
1826 indication that the major sub-parts of a piece of equipment are powered or perform-  
1827 ing any activity whether producing a part or product or not.  
1828 Example: For traditional machine tools, this includes when the piece of equipment  
1829 is WORKING or it is idle.
- 1830 • POWERED  
1831 indication that primary power is applied to the piece of equipment and, as a min-  
1832 imum, the controller or logic portion of the piece of equipment is powered and  
1833 functioning or components that are required to remain on are powered.  
1834 Example: Heaters for an extrusion machine that required to be powered even when  
1835 the equipment is turned off.
- 1836 • WORKING  
1837 indication that a piece of equipment is performing any activity, the equipment is  
1838 active and performing a function under load or not.  
1839 Example: For traditional machine tools, this includes when the piece of equipment  
1840 is LOADED making rapid moves, executing a tool change, etc.

## 1841 5.2.42 Execution

1842 execution status of the component .

1843 ExecutionEnum Enumeration:

- 1844 • ACTIVE  
1845 Component is actively executing an instruction.
- 1846 • FEED\_HOLD  
1847 motion of the active axes are commanded to stop at their current position.
- 1848 • INTERRUPTED  
1849 Component suspends the execution of the program due to an external signal.  
1850 Action is required to resume execution.

- 1851 • OPTIONAL\_STOP
- 1852 command from the program has intentionally interrupted execution.
- 1853 The Component MAY have another state that indicates if the execution is inter-
- 1854 rupted or the execution ignores the interrupt instruction.
- 1855 • PROGRAM\_COMPLETED
- 1856 program completed execution.
- 1857 • PROGRAM\_STOPPED
- 1858 command from the program has intentionally interrupted execution.
- 1859 Action is required to resume execution.
- 1860 • READY
- 1861 Component is ready to execute instructions.
- 1862 It is currently idle.
- 1863 • STOPPED
- 1864 Component program is noREADYto execute.
- 1865 • WAIT
- 1866 Component suspends execution while a secondary operation executes.
- 1867 Execution resumes automatically once the secondary operation completes.

### 1868 5.2.43 Firmware

1869 embedded software of Component .

1870 A subType MUST always be speci ed.

#### 1871 5.2.43.1 Subtypes of Firmware

- 1872 • INSTALL\_DATE
- 1873 date the hardware or software was installed.
- 1874 The value ofFirmware MUST bedatetime . SeeSection 6.1.5 - datetime
- 1875 datetime Enumeration:

- 1876 • LICENSE
- 1877 license code to validate or activate the hardware or software.
- 1878 • MANUFACTURER
- 1879 corporate identity for the maker of the hardware or software.
- 1880 • RELEASE\_DATE
- 1881 date the hardware or software was released for general use.
- 1882 The value of `Firmware` MUST be `datetime` . See Section 6.1.5 - `datetime`
- 1883 `datetime` Enumeration:
- 1884 • VERSION
- 1885 version of the hardware or software.

#### 1886 5.2.44 `FixtureId`

1887 identifier for a fixture.

#### 1888 5.2.45 `FunctionalMode`

1889 current intended production status of `Component` .

1890 `FunctionalModeEnum` Enumeration:

- 1891 • MAINTENANCE
- 1892 `Component` is not currently producing product.
- 1893 It is currently being repaired, waiting to be repaired, or has not yet been returned to
- 1894 a normal production status after maintenance has been performed.
- 1895 • PROCESS\_DEVELOPMENT
- 1896 `Component` is being used to prove-out a new process, testing of equipment or
- 1897 processes, or any other active use that does not result in the production of product.
- 1898 • PRODUCTION
- 1899 `Component` is currently producing product, ready to produce product, or its current
- 1900 intended use is to be producing product.



- 1901 • SETUP
- 1902 Component is not currently producing product.
- 1903 It is being prepared or modified to begin production of product.
- 1904 • TEARDOWN
- 1905 Component is not currently producing product.
- 1906 Typically, it has completed the production of a product and is being modified or
- 1907 returned to a neutral state such that it may then be prepared to begin production of a
- 1908 different product.

## 1909 5.2.46 Hardness

1910 hardness of a material.

1911 The value of Hardness MUST be float .

1912 A subType MUST always be specified.

### 1913 5.2.46.1 Subtypes of Hardness

- 1914 • BRINELL
- 1915 scale to measure the resistance to deformation of a surface.
- 1916 • LEEB
- 1917 scale to measure the elasticity of a surface.
- 1918 • MOHS
- 1919 scale to measure the resistance to scratching of a surface.
- 1920 • ROCKWELL
- 1921 scale to measure the resistance to deformation of a surface.
- 1922 • SHORE
- 1923 scale to measure the resistance to deformation of a surface.
- 1924 • VICKERS
- 1925 scale to measure the resistance to deformation of a surface.

1926 5.2.47 Hardware

1927 hardware of aComponent .

1928 A subType MUST always be speci ed.

1929 5.2.47.1 Subtypes of Hardware

1930 • INSTALL\_DATE

1931 date the hardware or software was installed.

1932 The value ofHardware MUST be datetime . SeeSection 6.1.5 - datetime

1933 datetime Enumeration:

1934 • LICENSE

1935 license code to validate or activate the hardware or software.

1936 • MANUFACTURER

1937 corporate identity for the maker of the hardware or software.

1938 • RELEASE\_DATE

1939 date the hardware or software was released for general use.

1940 The value ofHardware MUST be datetime . SeeSection 6.1.5 - datetime

1941 datetime Enumeration:

1942 • VERSION

1943 version of the hardware or software.

1944 5.2.48 HostName

1945 name of the host computer supplying data.

1946 5.2.49 LeakDetect

1947 indication designating whether a leak has been detected.

1948 LeakDetectEnum Enumeration:

- 1949 • DETECTED
- 1950 leak is currently being detected.
- 1951 • NOT\_DETECTED
- 1952 leak is currently not being detected.

### 1953 5.2.50 Library

- 1954 software library on a Component
- 1955 A subType MUST always be specified.

#### 1956 5.2.50.1 Subtypes of Library

- 1957 • INSTALL\_DATE
- 1958 date the hardware or software was installed.
- 1959 The value of Library MUST be datetime . SeeSection 6.1.5 - datetime
- 1960 datetime Enumeration:
- 1961 • LICENSE
- 1962 license code to validate or activate the hardware or software.
- 1963 • MANUFACTURER
- 1964 corporate identity for the maker of the hardware or software.
- 1965 • RELEASE\_DATE
- 1966 date the hardware or software was released for general use.
- 1967 The value of Library MUST be datetime . SeeSection 6.1.5 - datetime
- 1968 datetime Enumeration:
- 1969 • VERSION
- 1970 version of the hardware or software.

1971 5.2.51 <<deprecated>> Line

1972 current line of code being executed.

1973 DEPRECATED in Version 1.4.0

1974 5.2.51.1 Subtypes of Line

1975 • MAXIMUM

1976 maximum line number of the code being executed.

1977 • MINIMUM

1978 minimum line number of the code being executed.

1979 5.2.52 LineLabel

1980 identifier for a Block of code in a Program .

1981 5.2.53 LineNumber

1982 position of a block of program code within a control program.

1983 The value of LineNumber MUST be integer .

1984 5.2.53.1 Subtypes of LineNumber

1985 • ABSOLUTE

1986 position of a block of program code relative to the beginning of the control program.

1987 • INCREMENTAL

1988 position of a block of program code relative to the occurrence of the last La-  
1989 bel encountered in the control program.

1990 5.2.54 LoadCount

1991 accumulation of the number of times an operation has attempted to, or is planned to attempt  
1992 to, load materials, parts, or other items.

1993 The defaultsubType of LoadCount is ALL.

1994 The value ofLoadCount MUST beinteger .

1995 5.2.54.1 Subtypes of LoadCount

1996 • ABORTED

1997 accumulation of actions or activities that were attempted, but terminated before they  
1998 could be completed.

1999 • ALL

2000 accumulation of all actions, items, or activities being counted independent of the  
2001 outcome.

2002 • BAD

2003 accumulation of actions, items, or activities being counted that do not conform to  
2004 specification or expectation.

2005 • COMPLETE

2006 accumulation of actions, items, or activities that have been completed, independent  
2007 of the outcome.

2008 • FAILED

2009 accumulation of actions or activities that were attempted, but failed to complete or  
2010 resulted in an unexpected or unacceptable outcome.

2011 • GOOD

2012 accumulation of actions, items, or activities being counted that conform to speci -  
2013 cation or expectation.

2014 • REMAINING

2015 accumulation of actions, items, or activities yet to be counted.

2016 • TARGET

2017 goal of the operation or process.

2018 5.2.55 LockState

2019 state or operating mode of Lock .

2020 LockStateEnum Enumeration:

- 2021 • LOCKED

2022 mechanism is engaged and preventing the associated component from being opened  
2023 or operated.

- 2024 • UNLOCKED

2025 mechanism is disengaged and the associated component is able to be opened or  
2026 operated.

2027 5.2.56 MTConnectVersion

2028 reference version of the MTConnect Standard supported by chapter

2029 5.2.57 MaintenanceList

2030 actions or activities to be performed in support of a piece of equipment.

2031 If the INTERVAL key is not provided, it is assumed to be ABSOLUTE

2032 If the DIRECTION key is not provided, it is assumed to be UP.

2033 If the UNITS key is not provided, it is assumed to be COUNT

2034 TheEntry key MUST be one or more from the MaintenanceListResult keys.

2035 MaintenanceListResult keys:

- 2036 • VALUE

2037 current interval value of the activity.

2038 The value of VALUE MUST be float .

- 2039 • INTERVAL

- 2040 interval of the value observed.
- 2041 MaintenanceListIntervalEnum Enumeration:
- 2042 – ABSOLUTE
- 2043 – INCREMENTAL
- 2044 • NEXT\_SERVICE\_DATE
- 2045 next date/time stamp that maintenance should be performed.
- 2046 The value ofNEXT\_SERVICE\_DATEMUST be datetime . SeeSection 6.1.5 -
- 2047 datetime
- 2048 • RESET
- 2049 last date/time stamp of the observation was reset.
- 2050 The value ofRESETMUST be datetime . SeeSection 6.1.5 - datetime
- 2051 • SEVERITY
- 2052 level of severity on a scale of 1-10.
- 2053 The value ofSEVERITYMUST beinteger .
- 2054 • DIRECTION
- 2055 direction of the value observed.
- 2056 MaintenanceListDirectionEnum Enumeration:
- 2057 – DOWN
- 2058 – UP
- 2059 • NAME
- 2060 identifier of the maintenance activity.
- 2061 The value ofNAMEMUST bestring .
- 2062 • LAST\_SERVICE\_DATE
- 2063 last date/time stamp that maintenance was performed.
- 2064 The value ofLAST\_SERVICE\_DATEMUST be datetime . SeeSection 6.1.5 -
- 2065 datetime
- 2066 • UNITS
- 2067 same asDataItem units . SeeMTConnect Standard: Part 2.0 - Device Informa-
- 2068 tion Model
- 2069 The value ofUNITS MUST be one of theUnitEnum enumeration.

- 2070 • TARGET
- 2071 target value of the next maintenance.
- 2072 The value of TARGET MUST be float .

### 2073 5.2.58 Material

2074 identifier of a material used or consumed in the manufacturing process.

### 2075 5.2.59 MaterialLayer

2076 identifies the layers of material applied to a part or product as part of an additive manufacturing process.

2077

2078 The value of MaterialLayer MUST be integer .

#### 2079 5.2.59.1 Subtypes of MaterialLayer

- 2080 • ACTUAL
- 2081 measured or reported value of an observation.
- 2082 • TARGET
- 2083 goal of the operation or process.

### 2084 5.2.60 Message

2085 information to be transferred from a piece of equipment to a client software application.

#### 2086 5.2.60.1 Value Properties of Message

2087 Table 21 lists the Value Properties of Message .



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

Table 21: Value Properties of Message

2088 Descriptions for Value Properties of Message :

- 2089 • nativeCode
- 2090 control system local identification of the information being transferred.

## 2091 5.2.61 Network

2092 network details of a Component .

2093 A subType MUST always be specified.

### 2094 5.2.61.1 Subtypes of Network

- 2095 • GATEWAY
- 2096 Gateway for the component network.
- 2097 • IPV4\_ADDRESS
- 2098 IPV4 network address of the component.
- 2099 • IPV6\_ADDRESS
- 2100 IPV6 network address of the component.
- 2101 • MAC\_ADDRESS
- 2102 Media Access Control Address.
- 2103 The unique physical address of the network hardware.
- 2104 • SUBNET\_MASK
- 2105 SubNet mask for the component network.
- 2106 • VLAN\_ID
- 2107 layer2 Virtual Local Network (VLAN) ID for the component network.

- 2108 • WIRELESS
- 2109 identifies whether the connection type is wireless.
- 2110 NetworkWirelessEnum Enumeration:
- 2111 – NO
- 2112 – YES

### 2113 5.2.62 NetworkPort

- 2114 number of the TCP/IP or UDP/IP port for the connection endpoint.
- 2115 The value of NetworkPort MUST be integer .

### 2116 5.2.63 OperatingMode

- 2117 state of Component or Composition that describes the automatic or manual operation
- 2118 of the entity.

- 2119 OperatingModeEnum Enumeration:

- 2120 • AUTOMATIC
- 2121 automatically execute instructions from a recipe or program.

2122 Note: Setpoint comes from a recipe.

- 2123 • MANUAL
- 2124 execute instructions from an external agent or person.

2125 Note 1 to entry: Valve or switch is manipulated by an agent/person.

2126 Note 2 to entry: Direct control of the PID output. % of the range: A user

2127 manually sets the % output, not the setpoint.

- 2128 • SEMI\_AUTOMATIC
- 2129 executes a single instruction from a recipe or program.

2130 Note 1 to entry: Setpoint is entered and xed, but the PID is controlling.

2131 Note 2 to entry: Still goes through the PID control system.

2132 Note 3 to entry: Manual xed entry from a recipe.

2133 5.2.64 OperatingSystem

2134 Operating System (OS) of Component .

2135 A subType MUST always be specified.

2136 5.2.64.1 Subtypes of OperatingSystem

2137 • INSTALL\_DATE

2138 date the hardware or software was installed.

2139 The value of OperatingSystem MUST be datetime . SeeSection 6.1.5 -  
2140 datetime

2141 datetime Enumeration:

2142 • LICENSE

2143 license code to validate or activate the hardware or software.

2144 • MANUFACTURER

2145 corporate identity for the maker of the hardware or software.

2146 • RELEASE\_DATE

2147 date the hardware or software was released for general use.

2148 The value of OperatingSystem MUST be datetime . SeeSection 6.1.5 -  
2149 datetime

2150 datetime Enumeration:

2151 • VERSION

2152 version of the hardware or software.

2153 5.2.65 OperatorId

2154 identifier of the person currently responsible for operating the piece of equipment.

2155 5.2.66 PalletId

2156 identifier for a pallet.

2157 5.2.67 PartCount

2158 aggregate count of parts.

2159 The value of PartCount MUST be integer .

2160 The default subType of PartCount is ALL.

2161 5.2.67.1 Subtypes of PartCount

2162 • ABORTED

2163 accumulation of actions or activities that were attempted, but terminated before they  
2164 could be completed.

2165 • ALL

2166 accumulation of all actions, items, or activities being counted independent of the  
2167 outcome.

2168 • BAD

2169 accumulation of actions, items, or activities being counted that do not conform to  
2170 specification or expectation.

2171 • COMPLETE

2172 accumulation of actions, items, or activities that have been completed, independent  
2173 of the outcome.

2174 • FAILED

2175 accumulation of actions or activities that were attempted, but failed to complete or  
2176 resulted in an unexpected or unacceptable outcome.

2177 • GOOD

2178 accumulation of actions, items, or activities being counted that conform to speci -  
2179 cation or expectation.

2180 • REMAINING

2181 accumulation of actions, items, or activities yet to be counted.

2182 • TARGET

2183 goal of the operation or process.

2184 5.2.68 PartCountType

2185 interpretation of PART\_COUNT

2186 PartCountTypeEnum Enumeration:

- 2187 • BATCH
- 2188 pre-specified group of items.
- 2189 • EACH
- 2190 count is of individual items.

2191 5.2.69 PartDetect

2192 indication designating whether a part or work piece has been detected or is present.

2193 PartDetectEnum Enumeration:

- 2194 • NOT\_PRESENT
- 2195 part or work piece is not detected or is not present.
- 2196 • PRESENT
- 2197 part or work piece is detected or is present.

2198 5.2.70 PartGroupId

2199 identifier given to a collection of individual parts.

2200 If no subType is specified, UUID is default.

2201 The default subType of PartGroupId is UUID.

2202 5.2.70.1 Subtypes of PartGroupId

- 2203 • BATCH
- 2204 identifier that references a group of parts produced in a batch.

- 2205 • HEAT\_TREAT
- 2206 identifier used to reference a material heat number.
- 2207 • LOT
- 2208 identifier that references a group of parts tracked as a lot.
- 2209 • RAW\_MATERIAL
- 2210 material that is used to produce parts.
- 2211 • UUID
- 2212 universally unique identifier as specified in ISO 11578 or RFC 4122.

### 2213 5.2.71 PartId

2214 identifier of a part in a manufacturing operation.

### 2215 5.2.72 PartKindId

2216 identifier given to link the individual occurrence to a class of parts, typically distinguished  
2217 by a particular part design.

2218 If no subType is specified, UUID is default.

2219 The default subType of PartKindId is UUID.

#### 2220 5.2.72.1 Subtypes of PartKindId

- 2221 • PART\_FAMILY
- 2222 identifier given to a group of parts having similarities in geometry, manufacturing  
2223 process, and/or functions.
- 2224 • PART\_NAME
- 2225 word or set of words by which a part is known, addressed, or referred to.
- 2226 • PART\_NUMBER
- 2227 identifier of a particular part design or model.
- 2228 • UUID
- 2229 universally unique identifier as specified in ISO 11578 or RFC 4122.

2230 5.2.73 <<deprecated>> PartNumber

2231 identifier of a part or product moving through the manufacturing process.

2232 DEPRECATED in Version 1.7 PART\_NUMBER is now a subType of PART\_KIND\_ID.

2233 5.2.74 PartProcessingState

2234 particular condition of the part occurrence at a specific time.

2235 PartProcessingStateEnum Enumeration:

2236 • IN\_PROCESS

2237 part occurrence is actively being processed.

2238 • IN\_TRANSIT

2239 part occurrence is being transported to its destination.

2240 • NEEDS\_PROCESSING

2241 part occurrence is not actively being processed, but the processing has not ended.

2242 Processing requirements exist that have not yet been fulfilled. This is the default  
2243 entry state when the part occurrence is originally received. In some cases, the part  
2244 occurrence may return to this state while it waits for additional processing to be  
2245 performed.

2246 • PROCESSING\_ENDED

2247 part occurrence is no longer being processed.

2248 A general state when the reason for termination is unknown.

2249 • PROCESSING\_ENDED\_ABORTED

2250 processing of the part occurrence has come to a premature end.

2251 • PROCESSING\_ENDED\_COMPLETE

2252 part occurrence has completed processing successfully.

2253 • PROCESSING\_ENDED\_LOST

2254 terminal state when the part occurrence has been removed from the equipment by  
2255 an external entity and it no longer exists at the equipment.

- 2256 • PROCESSING\_ENDED\_REJECTED
- 2257 part occurrence has been processed completely. However, the processing may have
- 2258 a problem.
- 2259 • PROCESSING\_ENDED\_SKIPPED
- 2260 part occurrence has been skipped for processing on the piece of equipment.
- 2261 • PROCESSING\_ENDED\_STOPPED
- 2262 process has been stopped during the processing.
- 2263 The part occurrence will require special treatment.
- 2264 • TRANSIT\_COMPLETE
- 2265 part occurrence has been placed at its designated destination.
- 2266 • WAITING\_FOR\_TRANSIT
- 2267 part occurrence is waiting for transit.

#### 2268 5.2.75 PartStatus

2269 state or condition of a part.

2270 If unique identifier is given, part status is for that individual. If group identifier is given  
2271 without a unique identifier, then the status is assumed to be for the whole group.

2272 PartStatusEnum Enumeration:

- 2273 • FAIL
- 2274 part does not conform to some given requirements.
- 2275 • PASS
- 2276 part conforms to given requirements.

#### 2277 5.2.76 PartUniqueid

2278 identifier given to a distinguishable, individual part.

2279 If no subtype is specified, UUID is default.

2280 The default subtype of PartUniqueid is UUID.



2281 5.2.76.1 Subtypes of PartUniqueId

2282 • RAW\_MATERIAL

2283 material that is used to produce parts.

2284 • SERIAL\_NUMBER

2285 serial number that uniquely identifies a specific part.

2286 • UUID

2287 universally unique identifier as specified in ISO 11578 or RFC 4122.

2288 5.2.77 PathFeedrateOverride

2289 value of a signal or calculation issued to adjust the feedrate for the axes associated with a  
2290 Path component that may represent a single axis or the coordinated movement of multiple  
2291 axes.

2292 The value of PathFeedrateOverride MUST be float .

2293 5.2.77.1 Subtypes of PathFeedrateOverride

2294 • JOG

2295 relating to momentary activation of a function or a movement.

2296 DEPRECATION WARNING : May be deprecated in the future.

2297 • PROGRAMMED

2298 directive value without offsets and adjustments.

2299 • RAPID

2300 performing an operation faster or in less time than nominal rate.

2301 5.2.78 PathMode

2302 describes the operational relationship between a Path entity and another Path entity for  
2303 pieces of equipment comprised of multiple logical groupings of controlled axes or other  
2304 logical operations.

2305 PathModeEnum Enumeration:

2306 • INDEPENDENT

2307 path is operating independently and without the influence of another path.

2308 • MASTER

2309 path provides information or state values that influence the operation of ~~the~~ item  
2310 of similar type.

2311 • MIRROR

2312 axes associated with the path are mirroring the motion of ~~the~~ MASTER path.

2313 • SYNCHRONOUS

2314 physical or logical parts which are not physically connected to each other but are  
2315 operating together.

2316 5.2.79 PowerState

2317 indication of the status of the source of energy for an entity to allow it to perform its  
2318 intended function or the state of an enabling signal providing permission for the entity to  
2319 perform its functions.

2320 PowerStateEnum Enumeration:

2321 • OFF

2322 source of energy for an entity or the enabling signal providing permission for the  
2323 entity to perform its function(s) is not present or is disconnected.

2324 • ON

2325 source of energy for an entity or the enabling signal providing permission for the  
2326 entity to perform its function(s) is present and active.

2327 5.2.79.1 Subtypes of PowerState

2328 • CONTROL

2329 state of the enabling signal or control logic that enables or disables the function or  
2330 operation of the entity.

- 2331 • LINE
- 2332 state of the power source for the entity.

### 2333 5.2.80 <<deprecated>> PowerStatus

2334 status of the Component .

2335 DEPRECATED in Version 1.1.0

2336 <<deprecated>> PowerStatusEnum Enumeration:

- 2337 • <<deprecated>> OFF
- 2338 • <<deprecated>> ON

### 2339 5.2.81 ProcessAggregateId

2340 identifier given to link the individual occurrence to a group of related occurrences, such as  
2341 a process step in a process plan.

#### 2342 5.2.81.1 Subtypes of ProcessAggregateId

- 2343 • ORDER\_NUMBER

2344 identifier of the authorization of the process occurrence. Synonyms include “job id”,  
2345 “work order”.

- 2346 • PROCESS\_PLAN

2347 identifier of the process plan that this occurrence belongs to. Synonyms include  
2348 “routing id”, “job id”.

- 2349 • PROCESS\_STEP

2350 identifier of the step in the process plan that this occurrence corresponds to. Syn-  
2351 onyms include “operation id”.

2352 5.2.82 ProcessKindId

2353 identifier given to link the individual occurrence to a class of processes or process de-  
2354 finition.

2355 5.2.82.1 Subtypes of ProcessKindId

2356 • ISO\_STEP\_EXECUTABLE

2357 reference to a ISO 10303 Executable.

2358 • PROCESS\_NAME

2359 word or set of words by which a process being executed (process occurrence) by the  
2360 device is known, addressed, or referred to.

2361 • UUID

2362 universally unique identifier as specified in ISO 11578 or RFC 4122.

2363 5.2.83 ProcessOccurrenceId

2364 identifier of a process being executed by the device.

2365 5.2.83.1 Subtypes of ProcessOccurrenceId

2366 • ACTIVITY

2367 phase or segment of a recipe or program.

2368 • OPERATION

2369 step of a discrete manufacturing process.

2370 • RECIPE

2371 process as part of product production; can be a subprocess of a larger process.

2372 • SEGMENT

2373 phase of a recipe process.

2374 5.2.84 ProcessState

2375 particular condition of the process occurrence at a specific time.

2376 ProcessStateEnum Enumeration:

2377 • ABORTED

2378 process occurrence has come to a premature end and cannot be resumed.

2379 • ACTIVE

2380 process occurrence is actively executing.

2381 • COMPLETE

2382 process occurrence is now finished.

2383 • INITIALIZING

2384 device is preparing to execute the process occurrence.

2385 • INTERRUPTED

2386 process occurrence has been stopped and may be resumed.

2387 • READY

2388 process occurrence is ready to be executed.

2389 5.2.85 ProcessTime

2390 time and date associated with an activity or event.

2391 A subType MUST always be specified.

2392 5.2.85.1 Subtypes of ProcessTime

2393 • COMPLETE

2394 time and date associated with the completion of an activity or event.

2395 • START

2396 boundary when an activity or an event commences.

2397 • TARGET\_COMPLETION

2398 projected time and date associated with the end or completion of an activity or event.

2399 5.2.86 Program

2400 name of the logic or motion program being executed by Controller component.

2401 5.2.86.1 Subtypes of Program

2402 • ACTIVE

2403 identity of the logic or motion program currently executing.

2404 • ACTIVITY

2405 phase or segment of a recipe or program.

2406 • MAIN

2407 identity of the primary logic or motion program currently being executed.

2408 It is the starting nest level in a call structure and may contain calls to sub programs.

2409 • OPERATION

2410 step of a discrete manufacturing process.

2411 • RECIPE

2412 process as part of product production; can be a subprocess of a larger process.

2413 • SCHEDULE

2414 identity of a control program that is used to specify the order of execution of other  
2415 programs.

2416 • SEGMENT

2417 phase of a recipe process.

2418 5.2.87 ProgramComment

2419 comment or non-executable statement in the control program.

2420 5.2.87.1 Subtypes of ProgramComment

2421 • ACTIVE

2422 identity of the logic or motion program currently executing.

2423 • MAIN

2424 identity of the primary logic or motion program currently being executed.

2425 It is the starting nest level in a call structure and may contain calls to sub programs.

2426 • SCHEDULE

2427 identity of a control program that is used to specify the order of execution of other  
2428 programs.

2429 5.2.88 ProgramEdit

2430 indication of the status of the controller components program editing mode.

2431 A program may be edited while another is executed.

2432 ProgramEditEnum Enumeration:

2433 • ACTIVE

2434 Controller is in the program edit mode.

2435 • NOT\_READY

2436 Controller is being inhibited by a function from entering the program edit mode.

2437 • READY

2438 Controller is capable of entering the program edit mode and no function is  
2439 inhibiting a change to that mode.

2440 5.2.89 ProgramEditName

2441 name of the program being edited.

2442 This is used in conjunction with ProgramEdit when in ACTIVE state.

2443 5.2.90 ProgramHeader

2444 non-executable header section of the control program.

2445 The defaultsubType of ProgramHeader is MAIN.

2446 5.2.90.1 Subtypes of ProgramHeader

2447 • ACTIVE

2448 identity of the logic or motion program currently executing.

2449 • MAIN

2450 identity of the primary logic or motion program currently being executed.

2451 It is the starting nest level in a call structure and may contain calls to sub programs.

2452 • SCHEDULE

2453 identity of a control program that is used to specify the order of execution of other  
2454 programs.

2455 5.2.91 ProgramLocation

2456 URI for the source le associated with Program .

2457 5.2.91.1 Subtypes of ProgramLocation

2458 • ACTIVE

2459 identity of the logic or motion program currently executing.

2460 • MAIN

2461 identity of the primary logic or motion program currently being executed.

2462 It is the starting nest level in a call structure and may contain calls to sub programs.

2463 • SCHEDULE

2464 identity of a control program that is used to specify the order of execution of other  
2465 programs.



2466 5.2.92 ProgramLocationType

2467 defines whether the logic or motion program defined by `Program` is being executed from  
2468 the local memory of the controller or from an outside source.

2469 `ProgramLocationTypeEnum` Enumeration:

2470     • EXTERNAL  
2471         not managed by the controller.

2472     • LOCAL  
2473         managed by the controller.

2474 5.2.92.1 Subtypes of ProgramLocationType

2475     • ACTIVE  
2476         identity of the logic or motion program currently executing.

2477     • MAIN  
2478         identity of the primary logic or motion program currently being executed.  
2479         It is the starting nest level in a call structure and may contain calls to sub programs.

2480     • SCHEDULE  
2481         identity of a control program that is used to specify the order of execution of other  
2482         programs.

2483 5.2.93 ProgramNestLevel

2484 indication of the nesting level within a control program that is associated with the code or  
2485 instructions that is currently being executed.

2486 If an initial value is not defined, the nesting level associated with the highest or initial  
2487 nesting level of the program **MUST** default to zero (0).

2488 The value of `ProgramNestLevel` **MUST** be integer .

#### 2489 5.2.94 RotaryMode

2490 current operating mode for Rotary type axis.

2491 RotaryModeEnum Enumeration:

- 2492 • CONTOUR  
2493 position of the axis is being interpolated.
- 2494 • INDEX  
2495 axis is configured to index.
- 2496 • SPINDLE  
2497 axis is functioning as a spindle.

#### 2498 5.2.95 RotaryVelocityOverride

2499 percentage change to the velocity of the programmed velocity for Rotary axis.

2500 This command represents a percentage change to the velocity calculated by a logic or  
2501 motion program or set by a switch for Rotary type axis.

2502 The value of RotaryVelocityOverride MUST be float .

#### 2503 5.2.96 Rotation

2504 three space angular displacement of an object or coordinate system relative to a  
2505 cartesian coordinate system

2506 The units of Rotation MUST be DEGREE\_3D

2507 The value of Rotation MUST be a list of float of size 0..3 .

#### 2508 5.2.97 SensorAttachment

2509 attachment between a sensor and an entity.

2510 TheEntry key MUST be one or more from theSensorAttachmentResult keys.

2511 SensorAttachmentResult keys:

2512 • SENSOR\_ID

2513 The identity of a sensor used to observe some measurement of an item.

2514 The value ofSENSOR\_IDMUST be string .

## 2515 5.2.98 SerialNumber

2516 serial number associated withComponent , Asset , or Device .

## 2517 5.2.99 SpecificationLimit

2518 set of limits defining a range of values designating acceptable performance for a variable.

2519 TheEntry key MUST be one or more from theSpecificationLimitResult  
2520 keys.

2521 SpecificationLimitResult keys:

2522 • UPPER\_LIMIT

2523 upper conformance boundary for a variable.

2524 Note: immediate concern or action may be required.

2525 The value ofUPPER\_LIMIT MUST befloat .

2526 • NOMINAL

2527 ideal or desired value for a variable.

2528 The value ofNOMINALMUST befloat .

2529 • LOWER\_LIMIT

2530 lower conformance boundary for a variable.

2531 Note: immediate concern or action may be required.

2532 The value ofLOWER\_LIMITMUST befloat .

2533 5.2.100 SpindleInterlock

2534 indication of the status of the spindle for a piece of equipment when power has been  
2535 removed and it is free to rotate.

2536 SpindleInterlockEnum Enumeration:

2537 • ACTIVE

2538 power has been removed and the spindle cannot be operated.

2539 • INACTIVE

2540 spindle has not been deactivated.

2541 5.2.101 ToolAssetId

2542 identifier of an individual tool asset.

2543 5.2.102 ToolGroup

2544 identifier for the tool group associated with a specific tool. Commonly used to designate  
2545 spare tools.

2546 5.2.103 <<deprecated>> ToolId

2547 identifier of the tool currently in use for a given path .

2548 DEPRECATED in Version 1.2.0 See TOOL\_ASSET\_ID

2549 5.2.104 ToolNumber

2550 identifier assigned by the Controller component to a cutting tool when in use by a  
2551 piece of equipment.

2552 5.2.105 ToolOffset

2553 reference to the tool offset variables applied to the active cutting tool associated with a  
2554 Path in a Controller type component.

2555 The value of ToolOffset MUST be float .

2556 A subType MUST always be specified.

2557 5.2.105.1 Subtypes of ToolOffset

2558 • LENGTH

2559 reference to a length type tool offset variable.

2560 • RADIAL

2561 reference to a radial type tool offset variable.

2562 5.2.106 TransferCount

2563 accumulation of the number of times an operation has attempted to, or is planned to attempt  
2564 to, transfer materials, parts, or other items from one location to another.

2565 The default subType of TransferCount is ALL.

2566 The value of TransferCount MUST be integer .

2567 5.2.106.1 Subtypes of TransferCount

2568 • ABORTED

2569 accumulation of actions or activities that were attempted, but terminated before they  
2570 could be completed.

2571 • ALL

2572 accumulation of all actions, items, or activities being counted independent of the  
2573 outcome.

- 2574 • BAD
- 2575 accumulation of actions, items, or activities being counted that do not conform to
- 2576 specification or expectation.
  
- 2577 • COMPLETE
- 2578 accumulation of actions, items, or activities that have been completed, independent
- 2579 of the outcome.
  
- 2580 • FAILED
- 2581 accumulation of actions, items, or activities being counted that do not conform to
- 2582 specification or expectation.
  
- 2583 • GOOD
- 2584 accumulation of actions, items, or activities being counted that conform to speci -
- 2585 cation or expectation.
  
- 2586 • REMAINING
- 2587 accumulation of actions, items, or activities yet to be counted.
  
- 2588 • TARGET
- 2589 goal of the operation or process.

### 2590 5.2.107 Translation

2591 three space linear displacement of an object or coordinate system relative to a cartesian  
2592 coordinate system

2593 The units of Translation MUST be MILLIMETER\_3D.

2594 The value of Translation MUST be a list of float of size 0..3 .

### 2595 5.2.108 UnloadCount

2596 accumulation of the number of times an operation has attempted to, or is planned to attempt  
2597 to, unload materials, parts, or other items.

2598 The default subtype of UnloadCount is ALL.

2599 The value of UnloadCount MUST be integer .

2600 5.2.108.1 Subtypes of UnloadCount

2601 • ABORTED

2602 accumulation of actions or activities that were attempted, but terminated before they  
2603 could be completed.

2604 • ALL

2605 accumulation of all actions, items, or activities being counted independent of the  
2606 outcome.

2607 • BAD

2608 accumulation of actions, items, or activities being counted that do not conform to  
2609 specification or expectation.

2610 • COMPLETE

2611 accumulation of actions, items, or activities that have been completed, independent  
2612 of the outcome.

2613 • FAILED

2614 accumulation of actions, items, or activities being counted that do not conform to  
2615 specification or expectation.

2616 • GOOD

2617 accumulation of actions, items, or activities being counted that conform to speci -  
2618 cation or expectation.

2619 • REMAINING

2620 accumulation of actions, items, or activities yet to be counted.

2621 • TARGET

2622 goal of the operation or process.

2623 5.2.109 User

2624 identifier of the person currently responsible for operating the piece of equipment.

2625 A subType MUST always be specified.

2626 5.2.109.1 Subtypes of User

2627 • MAINTENANCE

2628 identifier of the person currently responsible for performing maintenance on the  
2629 piece of equipment.

2630 • OPERATOR

2631 identifier of the person currently responsible for operating the piece of equipment.

2632 • SET\_UP

2633 identifier of the person currently responsible for preparing a piece of equipment for  
2634 production or restoring the piece of equipment to a neutral state after production.

2635 5.2.110 ValveState

2636 state of a valve is one of open, closed, or transitioning between the states.

2637 ValveStateEnum Enumeration:

2638 • CLOSED

2639 ValveState where flow is not possible, the aperture is static, and the valve is  
2640 completely shut.

2641 • CLOSING

2642 valve is transitioning from a `OPEN` state to a `CLOSED` state.

2643 • OPEN

2644 ValveState where flow is allowed and the aperture is static.

2645 Note: For a binary value `OPEN` indicates the valve has the maximum  
2646 possible aperture.

2647 • OPENING

2648 valve is transitioning from a `CLOSED` state to an `OPEN` state.



2649 5.2.110.1 Subtypes of ValveState

- 2650 • ACTUAL
- 2651 measured or reported value of an observation.
- 2652 • PROGRAMMED
- 2653 directive value without offsets and adjustments.

2654 5.2.111 Variable

2655 data whose meaning may change over time due to changes in the operation of a piece of  
2656 equipment or the process being executed on that piece of equipment.

2657 5.2.112 WaitState

2658 indication of the reason that execution is reporting a value of WAIT.

2659 WaitStateEnum Enumeration:

- 2660 • MATERIAL\_LOAD
- 2661 execution is waiting while material is being loaded.
- 2662 • MATERIAL\_UNLOAD
- 2663 execution is waiting while material is being unloaded.
- 2664 • PART\_LOAD
- 2665 execution is waiting while one or more discrete workpieces are being loaded.
- 2666 • PART\_UNLOAD
- 2667 execution is waiting while one or more discrete workpieces are being unloaded.
- 2668 • PAUSING
- 2669 execution is waiting while the equipment is pausing but the piece of equipment has  
2670 not yet reached a fully paused state.
- 2671 • POWERING\_DOWN
- 2672 execution is waiting while the equipment is powering down but has not fully reached  
2673 a stopped state.

- 2674 • POWERING\_UP
- 2675 execution is waiting while the equipment is powering up and is not currently avail-
- 2676 able to begin producing parts or products.
- 2677 • RESUMING
- 2678 execution is waiting while the equipment is resuming the production cycle but has
- 2679 not yet resumed execution.
- 2680 • SECONDARY\_PROCESS
- 2681 execution is waiting while another process is completed before the execution can
- 2682 resume.
- 2683 • TOOL\_LOAD
- 2684 execution is waiting while a tool or tooling is being loaded.
- 2685 • TOOL\_UNLOAD
- 2686 execution is waiting while a tool or tooling is being unloaded.

### 2687 5.2.113 Wire

2688 identifier for the type of wire used as the cutting mechanism in Electrical Discharge Ma-  
2689 chining or similar processes.

### 2690 5.2.114 WorkOffset

2691 offset variables for a work piece or part associated with a Path in a Controller type  
2692 component.

### 2693 5.2.115 WorkholdingId

2694 identifier for the current workholding or part clamp in use by a piece of equipment.

## 2695 5.3 Sample Types

2696 This section provides semantic information on sample types.

2697 5.3.1 Acceleration

2698 positive rate of change of velocity.

2699 The units of Acceleration MUST be MILLIMETER/SECOND<sup>3</sup>.

2700 The default subType of Acceleration is ACTUAL

2701 5.3.1.1 Subtypes of Acceleration

2702 • ACTUAL

2703 measured or reported value of an observation.

2704 • COMMANDED

2705 directive value including adjustments such as an offset or overrides.

2706 • PROGRAMMED

2707 directive value without offsets and adjustments.

2708 5.3.2 AccumulatedTime

2709 accumulated time for an activity or event.

2710 The units of AccumulatedTime MUST be SECOND

2711 5.3.3 <<deprecated>> Amperage

2712 strength of electrical current.

2713 DEPRECATED in Version 1.6 Replaced by AMPERAGE\_AC and AMPERAGE\_DC

2714 The units of Amperage MUST be AMPERE

2715 5.3.3.1 Subtypes of Amperage

- 2716 • ACTUAL
- 2717 measured or reported value of an observation.
- 2718 DEPRECATED in Version 1.6
- 2719 • ALTERNATING
- 2720 measurement of alternating voltage or current.
- 2721 If not specified further in statistic, defaults to RMS voltage.
- 2722 DEPRECATED in Version 1.6
- 2723 • DIRECT
- 2724 measurement of DC current or voltage.
- 2725 DEPRECATED in Version 1.6
- 2726 • TARGET
- 2727 goal of the operation or process.
- 2728 DEPRECATED in Version 1.6

#### 2729 5.3.4 AmperageAC

- 2730 electrical current that reverses direction at regular short intervals.
- 2731 The units of AmperageAC MUST be AMPERE
- 2732 A subType MUST always be specified.

##### 2733 5.3.4.1 Subtypes of AmperageAC

- 2734 • ACTUAL
- 2735 measured or reported value of an observation.
- 2736 • COMMANDED
- 2737 directive value including adjustments such as an offset or overrides.
- 2738 • PROGRAMMED
- 2739 directive value without offsets and adjustments.

2740 5.3.5 AmperageDC

2741 electric current owing in one direction only.

2742 The units of AmperageDC MUST be AMPERE

2743 A subType MUST always be specified.

2744 5.3.5.1 Subtypes of AmperageDC

2745 • ACTUAL

2746 measured or reported value of an observation.

2747 • COMMANDED

2748 directive value including adjustments such as an offset or overrides.

2749 • PROGRAMMED

2750 directive value without offsets and adjustments.

2751 5.3.6 Angle

2752 angular position.

2753 The units of Angle MUST be DEGREE

2754 5.3.6.1 Subtypes of Angle

2755 • ACTUAL

2756 measured or reported value of an observation.

2757 • COMMANDED

2758 directive value including adjustments such as an offset or overrides.

2759 5.3.7 AngularAcceleration

2760 positive rate of change of angular velocity.

2761 The units of AngularAcceleration MUST be DEGREE/SECOND

2762 The default subType of AngularAcceleration is ACTUAL

2763 5.3.7.1 Subtypes of AngularAcceleration

2764 • ACTUAL

2765 measured or reported value of an observation.

2766 • COMMANDED

2767 directive value including adjustments such as an offset or overrides.

2768 • PROGRAMMED

2769 directive value without offsets and adjustments.

2770 5.3.8 AngularDeceleration

2771 negative rate of change of angular velocity.

2772 The units of AngularDeceleration MUST be DEGREE/SECOND

2773 The default subType of AngularDeceleration is ACTUAL

2774 5.3.8.1 Subtypes of AngularDeceleration

2775 • ACTUAL

2776 measured or reported value of an observation.

2777 • COMMANDED

2778 directive value including adjustments such as an offset or overrides.

2779 • PROGRAMMED

2780 directive value without offsets and adjustments.

2781 5.3.9 AngularVelocity

2782 rate of change of angular position.

2783 The units of AngularVelocity MUST be DEGREE/SECOND

2784 5.3.10 AssetUpdateRate

2785 average rate of change of values for assets in the MTConnect streams.

2786 The average is computed over a rolling window defined by the implementation.

2787 The units of AssetUpdateRate MUST be COUNT/SECOND

2788 5.3.11 AxisFeedrate

2789 feedrate of a linear axis.

2790 The units of AxisFeedrate MUST be MILLIMETER/SECOND

2791 5.3.11.1 Subtypes of AxisFeedrate

2792 • ACTUAL

2793 measured or reported value of an observation.

2794 • COMMANDED

2795 directive value including adjustments such as an offset or overrides.

2796 • JOG

2797 relating to momentary activation of a function or a movement.

2798 DEPRECATION WARNING : May be deprecated in the future.

2799 • OVERRIDE

2800 operator's overridden value.

2801 • PROGRAMMED

2802 directive value without offsets and adjustments.

- 2803 • RAPID
- 2804 performing an operation faster or in less time than nominal rate.

### 2805 5.3.12 BatteryCapacity

2806 maximum rated charge a battery is capable of maintaining based on the battery discharging  
2807 at a specified current over a specified time period.

2808 The units of BatteryCapacity MUST be COULOMB

2809 The default subType of BatteryCapacity is ACTUAL

#### 2810 5.3.12.1 Subtypes of BatteryCapacity

- 2811 • ACTUAL
- 2812 measured or reported value of an observation.

- 2813 • TARGET
- 2814 goal of the operation or process.

### 2815 5.3.13 BatteryCharge

2816 value of the battery's present capacity expressed as a percentage of the battery's maximum  
2817 rated capacity.

2818 The units of BatteryCharge MUST be PERCENT

2819 The default subType of BatteryCharge is ACTUAL

#### 2820 5.3.13.1 Subtypes of BatteryCharge

- 2821 • ACTUAL
- 2822 measured or reported value of an observation.

- 2823 • TARGET
- 2824 goal of the operation or process.



2825 5.3.14 CapacityFluid

2826 fluid capacity of an object or container.

2827 The units of CapacityFluid MUST be MILLILITER .

2828 5.3.15 CapacitySpatial

2829 geometric capacity of an object or container.

2830 The units of CapacitySpatial MUST be CUBIC\_MILLIMETER.

2831 5.3.16 ChargeRate

2832 value of the current being supplied to a component for the purpose of charging.

2833 The units of ChargeRate MUST be AMPERE

2834 The default subType of ChargeRate is ACTUAL

2835 5.3.16.1 Subtypes of ChargeRate

2836 • ACTUAL

2837 measured or reported value of an observation.

2838 • TARGET

2839 goal of the operation or process.

2840 5.3.17 Concentration

2841 percentage of one component within a mixture of components.

2842 The units of Concentration MUST be PERCENT

2843 5.3.18 Conductivity

2844 ability of a material to conduct electricity.

2845 The units of Conductivity MUST be SIEMENS/METER

2846 5.3.19 CuttingSpeed

2847 speed difference (relative velocity) between the cutting mechanism and the surface of the  
2848 workpiece it is operating on.

2849 The units of CuttingSpeed MUST be MILLIMETER/SECOND

2850 5.3.19.1 Subtypes of CuttingSpeed

2851 • ACTUAL

2852 measured or reported value of an observation.

2853 • COMMANDED

2854 directive value including adjustments such as an offset or overrides.

2855 • PROGRAMMED

2856 directive value without offsets and adjustments.

2857 5.3.20 Deceleration

2858 negative rate of change of velocity.

2859 The units of Deceleration MUST be MILLIMETER/SECOND<sup>2</sup>.

2860 The default subType of Deceleration is ACTUAL

2861 5.3.20.1 Subtypes of Deceleration

2862 • ACTUAL

2863 measured or reported value of an observation.

- 2864 • COMMANDED
- 2865 directive value including adjustments such as an offset or overrides.
- 2866 • PROGRAMMED
- 2867 directive value without offsets and adjustments.

### 2868 5.3.21 Density

- 2869 volumetric mass of a material per unit volume of that material.
- 2870 The units of Density MUST be MILLIGRAM/CUBIC\_MILLIMETER .

### 2871 5.3.22 DepositionAccelerationVolumetric

- 2872 rate of change in spatial volume of material deposited in an additive manufacturing process.
- 2873
- 2874 The units of DepositionAccelerationVolumetric MUST be CUBIC\_MILLIMETER/SECOND

#### 2875 5.3.22.1 Subtypes of DepositionAccelerationVolumetric

- 2876 • ACTUAL
- 2877 measured or reported value of an observation.
- 2878 • COMMANDED
- 2879 directive value including adjustments such as an offset or overrides.

### 2880 5.3.23 DepositionDensity

- 2881 density of the material deposited in an additive manufacturing process per unit of volume.
- 2882 The units of DepositionDensity MUST be MILLIGRAM/CUBIC\_MILLIMETER .

2883 5.3.23.1 Subtypes of DepositionDensity

- 2884 • ACTUAL

2885 measured or reported value of an observation.

- 2886 • COMMANDED

2887 directive value including adjustments such as an offset or overrides.

2888 5.3.24 DepositionMass

2889 mass of the material deposited in an additive manufacturing process.

2890 The units of DepositionMass MUST be MILLIGRAM.

2891 5.3.24.1 Subtypes of DepositionMass

- 2892 • ACTUAL

2893 measured or reported value of an observation.

- 2894 • COMMANDED

2895 directive value including adjustments such as an offset or overrides.

2896 5.3.25 DepositionRateVolumetric

2897 rate at which a spatial volume of material is deposited in an additive manufacturing process.  
2898

2899 The units of DepositionRateVolumetric MUST be CUBIC\_MILLIMETER/SECOND

2900 5.3.25.1 Subtypes of DepositionRateVolumetric

- 2901 • ACTUAL

2902 measured or reported value of an observation.

- 2903 • COMMANDED

2904 directive value including adjustments such as an offset or overrides.

2905 **5.3.26 DepositionVolume**

2906 spatial volume of material to be deposited in an additive manufacturing process.

2907 The units of DepositionVolume MUST be CUBIC\_MILLIMETER.

2908 **5.3.26.1 Subtypes of DepositionVolume**

2909 • ACTUAL

2910 measured or reported value of an observation.

2911 • COMMANDED

2912 directive value including adjustments such as an offset or overrides.

2913 **5.3.27 DewPoint**

2914 temperature at which moisture begins to condense, corresponding to saturation for a given  
2915 absolute humidity.

2916 The units of DewPoint MUST be CELSIUS.

2917 **5.3.28 Diameter**

2918 dimension of a diameter.

2919 The units of Diameter MUST be MILLIMETER.

2920 **5.3.29 DischargeRate**

2921 value of current being drawn from the component .

2922 The units of DischargeRate MUST be AMPERE

2923 The default subType of DischargeRate is ACTUAL

2924 5.3.29.1 Subtypes of DischargeRate

- 2925 • ACTUAL
- 2926 measured or reported value of an observation.
- 2927 • TARGET
- 2928 goal of the operation or process.

2929 5.3.30 Displacement

- 2930 change in position of an object.
- 2931 The units of Displacement MUST be MILLIMETER.

2932 5.3.31 DisplacementAngular

- 2933 absolute value of the change in angular position around a vector
- 2934 Note: The displacement vector MAY be defined by the motion of the owning
- 2935 Component .
- 2936 The units of DisplacementAngular MUST be DEGREE

2937 5.3.32 DisplacementLinear

- 2938 absolute value of the change in position along a vector.
- 2939 Note: The displacement vector MAY be defined by the motion of the owning
- 2940 Component .
- 2941 The units of DisplacementLinear MUST be MILLIMETER.

2942 5.3.33 ElectricalEnergy

2943 Wattage used or generated by a component over an interval of time.

2944 The units of ElectricalEnergy MUST be WATT\_SECOND

2945 5.3.34 EquipmentTimer

2946 amount of time a piece of equipment or a sub-part of a piece of equipment has performed  
2947 specific activities.

2948 The units of EquipmentTimer MUST be SECOND

2949 A subType MUST always be specified.

2950 5.3.34.1 Subtypes of EquipmentTimer

2951 • DELAY

2952 elapsed time of a temporary halt of action.

2953 • LOADED

2954 time that the sub-parts of a piece of equipment are under load.

2955 Example: For traditional machine tools, this is a measurement of the time that the  
2956 cutting tool is assumed to be engaged with the part.

2957 • OPERATING

2958 time that the major sub-parts of a piece of equipment are powered or performing any  
2959 activity whether producing a part or product or not.

2960 Example: For traditional machine tools, this includes WORKING, plus idle time.

2961 • POWERED

2962 time that primary power is applied to the piece of equipment and, as a minimum, the  
2963 controller or logic portion of the piece of equipment is powered and functioning or  
2964 components that are required to remain on are powered.

2965 Example: Heaters for an extrusion machine that are required to be powered even  
2966 when the equipment is turned off.

2967 • WORKING

2968 time that a piece of equipment is performing any activity the equipment is active and  
2969 performing a function under load or not.

2970 Example: For traditional machine tools, this includes LOADED plus rapid moves,  
2971 tool changes, etc.

### 2972 5.3.35 FillLevel

2973 amount of a substance remaining compared to the planned maximum amount of that sub-  
2974 stance.

2975 The units of FillLevel MUST be PERCENT

### 2976 5.3.36 Flow

2977 rate of flow of a fluid.

2978 The units of Flow MUST be LITER/SECOND.

### 2979 5.3.37 FollowingError

2980 difference between actual and commanded position at any specific point in time during a  
2981 motion.

2982 The units of FollowingError MUST be COUNT

#### 2983 5.3.37.1 Subtypes of FollowingError

2984 • ACTUAL

2985 measured or reported value of an observation.



2986 5.3.38 FollowingErrorAngular

2987 angular difference between the commanded encoder/resolver position and the actual en-  
2988 coder/resolver position at any speci ed point in time during a motion.

2989 Theunits of FollowingErrorAngular MUST beDEGREE

2990 5.3.38.1 Subtypes of FollowingErrorAngular

2991 • ACTUAL

2992 measured or reported value of an observation.

2993 5.3.39 FollowingErrorLinear

2994 difference between the commanded encoder/resolver position and the actual encoder/re-  
2995 solver position at any speci ed point in time during a motion.

2996 Theunits of FollowingErrorLinear MUST beMILLIMETER.

2997 5.3.39.1 Subtypes of FollowingErrorLinear

2998 • ACTUAL

2999 measured or reported value of an observation.

3000 5.3.40 Frequency

3001 number of occurrences of a repeating event per unit time.

3002 Theunits of Frequency MUST beHERTZ

3003 5.3.41 <<deprecated>> GlobalPosition

3004 position in three-dimensional space.

3005 DEPRECATED in Version 1.1.

3006 The units of GlobalPosition MUST be MILLIMETER.

3007 5.3.41.1 Subtypes of GlobalPosition

3008 • ACTUAL

3009 measured or reported value of an observation.

3010 • COMMANDED

3011 directive value including adjustments such as an offset or overrides.

3012 5.3.42 GravitationalAcceleration

3013 acceleration relative to Earth's gravity of 9.80665 METER/SECOND<sup>2</sup>

3014 The units of GravitationalAcceleration MUST be GRAVITATIONAL\_ACCELERATION

3015 5.3.43 GravitationalForce

3016 force relative to earth's gravity.

3017 Note: Mass GravitationalAcceleration

3018 The units of GravitationalForce MUST be GRAVITATIONAL\_FORCE

3019 5.3.44 HumidityAbsolute

3020 amount of water vapor expressed in grams per cubic meter.

3021 The units of HumidityAbsolute MUST be GRAM/CUBIC\_METER

3022 5.3.44.1 Subtypes of HumidityAbsolute

- 3023 • ACTUAL

3024 measured or reported value of an observation.

- 3025 • COMMANDED

3026 directive value including adjustments such as an offset or overrides.

3027 5.3.45 HumidityRelative

3028 amount of water vapor present expressed as a percent to reach saturation at the same tem-  
3029 perature.

3030 The units of HumidityRelative MUST be PERCENT

3031 5.3.45.1 Subtypes of HumidityRelative

- 3032 • ACTUAL

3033 measured or reported value of an observation.

- 3034 • COMMANDED

3035 directive value including adjustments such as an offset or overrides.

3036 5.3.46 HumiditySpecific

3037 ratio of the water vapor present over the total weight of the water vapor and air present  
3038 expressed as a percent.

3039 The units of HumiditySpecific MUST be PERCENT

3040 5.3.46.1 Subtypes of HumiditySpecific

- 3041 • ACTUAL

3042 measured or reported value of an observation.

- 3043 • COMMANDED
- 3044 directive value including adjustments such as an offset or overrides.

### 3045 5.3.47 Length

3046 length of an object.

3047 The units of Length MUST be MILLIMETER.

#### 3048 5.3.47.1 Subtypes of Length

- 3049 • REMAINING
- 3050 remaining total length of an object.
- 3051 • STANDARD
- 3052 standard or original length of an object.
- 3053 • USEABLE
- 3054 remaining usable length of an object.

### 3055 5.3.48 <<deprecated>> Level

3056 level of a resource.

3057 DEPRECATED in Version 1.2 See FILL\_LEVEL .

3058 The units of Level MUST be PERCENT

### 3059 5.3.49 LinearForce

3060 force applied to a mass in one direction only.

3061 The units of LinearForce MUST be NEWTON

3062 5.3.50 Load

3063 actual versus the standard rating of a piece of equipment.

3064 The units of Load MUST be PERCENT

3065 5.3.51 Mass

3066 mass of an object(s) or an amount of material.

3067 The units of Mass MUST be KILOGRAM

3068 5.3.52 ObservationUpdateRate

3069 average rate of change of values for data items in the MTConnect streams. The average is  
3070 computed over a rolling window defined by the implementation.

3071 The units of ObservationUpdateRate MUST be COUNT/SECOND

3072 5.3.53 Openness

3073 percentage open where 100% is fully open and 0% is fully closed.

3074 The units of Openness MUST be PERCENT

3075 5.3.54 Orientation

3076 angular position of a plane or vector relative to a Cartesian coordinate system

3077 The units of Orientation MUST be DEGREE\_3D

3078 The value of Orientation MUST be a list of float of size 0..3

3079 5.3.54.1 Subtypes of Orientation

- 3080 • ACTUAL
- 3081 measured or reported value of an observation.
- 3082 • COMMANDED
- 3083 directive value including adjustments such as an offset or overrides.

### 3084 5.3.55 PH

3085 acidity or alkalinity of a solution.

3086 The units of PH MUST be PH

### 3087 5.3.56 PathFeedrate

3088 feedrate for the axes, or a single axis, associated with a component.

3089 The units of PathFeedrate MUST be MILLIMETER/SECOND

#### 3090 5.3.56.1 Subtypes of PathFeedrate

- 3091 • ACTUAL
- 3092 measured or reported value of an observation.
- 3093 • COMMANDED
- 3094 directive value including adjustments such as an offset or overrides.
- 3095 • JOG
- 3096 relating to momentary activation of a function or a movement.
- 3097 DEPRECATION WARNING : May be deprecated in the future.
- 3098 • OVERRIDE
- 3099 operator's overridden value.
- 3100 DEPRECATED in Version 1.3
- 3101 • PROGRAMMED
- 3102 directive value without offsets and adjustments.

- 3103 • RAPID
- 3104 performing an operation faster or in less time than nominal rate.

### 3105 5.3.57 PathFeedratePerRevolution

3106 feedrate for the axes, or a single axis.

3107 The units of PathFeedratePerRevolution MUST be MILLIMETER/REVO-  
3108 LUTION.

#### 3109 5.3.57.1 Subtypes of PathFeedratePerRevolution

- 3110 • ACTUAL
- 3111 measured or reported value of an observation.
- 3112 • COMMANDED
- 3113 directive value including adjustments such as an offset or overrides.
- 3114 • PROGRAMMED
- 3115 directive value without offsets and adjustments.

### 3116 5.3.58 PathPosition

3117 position of a control point associated with a Controller or a Path .

3118 The units of PathPosition MUST be MILLIMETER\_3D.

3119 The value of PathPosition MUST be a list of float of size 0..3 .

#### 3120 5.3.58.1 Subtypes of PathPosition

- 3121 • ACTUAL
- 3122 measured or reported value of an observation.
- 3123 • COMMANDED
- 3124 directive value including adjustments such as an offset or overrides.

- 3125     • PROBE
- 3126         position provided by a measurement probe.
- 3127         DEPRECATION WARNING : May be deprecated in the future.
- 3128     • TARGET
- 3129         goal of the operation or process.

### 3130 5.3.59 Position

- 3131 point along an axis in cartesian coordinate system
- 3132 The units of Position MUST be MILLIMETER.

#### 3133 5.3.59.1 Subtypes of Position

- 3134     • ACTUAL
- 3135         measured or reported value of an observation.
- 3136     • COMMANDED
- 3137         directive value including adjustments such as an offset or overrides.
- 3138     • PROGRAMMED
- 3139         directive value without offsets and adjustments.
- 3140     • TARGET
- 3141         goal of the operation or process.

### 3142 5.3.60 PositionCartesian

- 3143 point in a cartesian coordinate system
- 3144 The units of PositionCartesian MUST be MILLIMETER\_3D.
- 3145 The value of PositionCartesian MUST be a list of float of size 0..3 .



3146 5.3.61 PowerFactor

3147 ratio of real power owing to a load to the apparent power in that AC circuit.

3148 Theunits of PowerFactor MUST bePERCENT

3149 5.3.62 Pressure

3150 force per unit area measured relative to atmospheric pressure.

3151 Commonly referred to as gauge pressure.

3152 Theunits of Pressure MUST bePASCAL

3153 5.3.63 PressureAbsolute

3154 The force per unit area measured relative to a vacuum.

3155 Theunits of PressureAbsolute MUST bePASCAL

3156 5.3.64 PressurizationRate

3157 change of pressure per unit time.

3158 Theunits of PressurizationRate MUST bePASCAL/SECOND

3159 5.3.64.1 Subtypes of PressurizationRate

3160 • ACTUAL

3161 measured or reported value of an observation.

3162 • COMMANDED

3163 directive value including adjustments such as an offset or overrides.

3164 • PROGRAMMED

3165 directive value without offsets and adjustments.

3166 5.3.65 ProcessTimer

3167 amount of time a piece of equipment has performed different types of activities associated  
3168 with the process being performed at that piece of equipment.

3169 Theunits of ProcessTimer MUST beSECOND

3170 A subType MUST always be speci ed.

3171 5.3.65.1 Subtypes of ProcessTimer

3172 • DELAY

3173 elapsed time of a temporary halt of action.

3174 • PROCESS

3175 time from the beginning of production of a part or product on a piece of equipment  
3176 until the time that production is complete for that part or product on that piece of  
3177 equipment.

3178 This includes the time that the piece of equipment is running, producing parts or  
3179 products, or in the process of producing parts.

3180 5.3.66 Resistance

3181 degree to which a substance opposes the passage of an electric current.

3182 Theunits of Resistance MUST beOHM

3183 5.3.67 RotaryVelocity

3184 rotational speed of a rotary axis.

3185 Theunits of RotaryVelocity MUST beREVOLUTION/MINUTE

3186 5.3.67.1 Subtypes of RotaryVelocity

- 3187     • ACTUAL
- 3188       measured or reported value of an observation.
- 3189     • COMMANDED
- 3190       directive value including adjustments such as an offset or overrides.
- 3191     • OVERRIDE
- 3192       The operators overridden value.
- 3193     • PROGRAMMED
- 3194       directive value without offsets and adjustments.

### 3195 5.3.68 SettlingError

- 3196   difference between actual and commanded position at the end of a motion.
- 3197   The units of SettlingError     MUST be COUNT

#### 3198 5.3.68.1 Subtypes of SettlingError

- 3199     • ACTUAL
- 3200       measured or reported value of an observation.

### 3201 5.3.69 SettlingErrorAngular

- 3202   angular difference between the commanded encoder/resolver position, and the actual en-
- 3203   coder/resolver position when motion is complete.
- 3204   The units of SettlingErrorAngular     MUST be DEGREE

#### 3205 5.3.69.1 Subtypes of SettlingErrorAngular

- 3206     • ACTUAL
- 3207       measured or reported value of an observation.

3208 5.3.70 SettlingErrorLinear

3209 difference between the commanded encoder/resolver position, and the actual encoder/re-  
3210 solver position when motion is complete.

3211 The units of SettlingErrorLinear MUST be MILLIMETER.

3212 5.3.70.1 Subtypes of SettlingErrorLinear

3213 • ACTUAL

3214 measured or reported value of an observation.

3215 5.3.71 SoundLevel

3216 sound level or sound pressure level relative to atmospheric pressure.

3217 The units of SoundLevel MUST be DECIBEL.

3218 The default subType of SoundLevel is A\_SCALE

3219 5.3.71.1 Subtypes of SoundLevel

3220 • A\_SCALE

3221 A Scale weighting factor. This is the default weighting factor if no factor is speci ed

3222 • B\_SCALE

3223 B Scale weighting factor

3224 • C\_SCALE

3225 C Scale weighting factor

3226 • D\_SCALE

3227 D Scale weighting factor

3228 • NO\_SCALE

3229 No weighting factor on the frequency scale

3230 5.3.72 <<deprecated>> SpindleSpeed

3231 rotational speed of the rotary axis.

3232 DEPRECATED in Version 1.2 Replaced by ROTARY\_VELOCITY

3233 The units of SpindleSpeed MUST be REVOLUTION/MINUTE

3234 5.3.72.1 Subtypes of SpindleSpeed

3235 • ACTUAL

3236 measured or reported value of an observation.

3237 DEPRECATED in Version 1.3

3238 • COMMANDED

3239 directive value including adjustments such as an offset or overrides.

3240 DEPRECATED in Version 1.3

3241 • OVERRIDE

3242 operator's overridden value.

3243 DEPRECATED in Version 1.3

3244 5.3.73 Strain

3245 amount of deformation per unit length of an object when a load is applied.

3246 The units of Strain MUST be PERCENT

3247 5.3.74 Temperature

3248 degree of hotness or coldness measured on a definite scale.

3249 The units of Temperature MUST be CELSIUS.

3250 5.3.75 Tension

3251 force that stretches or elongates an object.

3252 The units of Tension MUST be NEWTON

3253 5.3.76 Tilt

3254 angular displacement.

3255 The units of Tilt MUST be MICRO\_RADIAN

3256 5.3.77 Torque

3257 turning force exerted on an object or by an object.

3258 The units of Torque MUST be NEWTON\_METER

3259 5.3.78 Velocity

3260 rate of change of position of a component .

3261 The units of Velocity MUST be MILLIMETER/SECOND

3262 5.3.79 Viscosity

3263 fluid's resistance to flow.

3264 The units of Viscosity MUST be PASCAL\_SECOND

3265 5.3.80 VoltAmpere

3266 apparent power in an electrical circuit, equal to the product of root-mean-square (RMS)

3267 voltage and RMS current (commonly referred to as VA).

3268 The units of VoltAmpere MUST be VOLT\_AMPERE

### 3269 5.3.81 VoltAmpereReactive

3270 reactive power in an AC electrical circuit (commonly referred to as VAR).

3271 The units of VoltAmpereReactive MUST be VOLT\_AMPERE\_REACTIVE

### 3272 5.3.82 <<deprecated>> Voltage

3273 electrical potential between two points.

3274 DEPRECATED in Version 1.6 Replaced by VOLTAGE\_AC and VOLTAGE\_DC

3275 The units of Voltage MUST be VOLT.

#### 3276 5.3.82.1 Subtypes of Voltage

3277 • ACTUAL

3278 measured or reported value of an observation.

3279 DEPRECATED in Version 1.6

3280 • ALTERNATING

3281 alternating voltage or current.

3282 If not specified further in statistic, defaults to RMS voltage.

3283 DEPRECATED in Version 1.6

3284 • DIRECT

3285 DC current or voltage.

3286 DEPRECATED in Version 1.6

3287 • TARGET

3288 goal of the operation or process.

3289 DEPRECATED in Version 1.6

3290 5.3.83 VoltageAC

3291 electrical potential between two points in an electrical circuit in which the current period-  
3292 ically reverses direction.

3293 The units of VoltageAC MUST be VOLT.

3294 A subType MUST always be specified.

3295 5.3.83.1 Subtypes of VoltageAC

3296 • ACTUAL

3297 measured or reported value of an observation.

3298 • COMMANDED

3299 directive value including adjustments such as an offset or overrides.

3300 • PROGRAMMED

3301 directive value without offsets and adjustments.

3302 5.3.84 VoltageDC

3303 electrical potential between two points in an electrical circuit in which the current is uni-  
3304 directional.

3305 The units of VoltageDC MUST be VOLT.

3306 A subType MUST always be specified.

3307 5.3.84.1 Subtypes of VoltageDC

3308 • ACTUAL

3309 measured or reported value of an observation.

3310 • COMMANDED

3311 directive value including adjustments such as an offset or overrides.

3312 • PROGRAMMED

3313 directive value without offsets and adjustments.



3314 5.3.85 VolumeFluid

3315 uid volume of an object or container.

3316 Theunits of VolumeFluid MUST beMILLILITER .

3317 5.3.85.1 Subtypes of VolumeFluid

3318 • ACTUAL

3319 measured or reported value of an observation.

3320 • CONSUMED

3321 reported or measured value of the amount used in the manufacturing process.

3322 • ENDED

3323 boundary when an activity or an event terminates.

3324 • PART

3325 reported or measured value of amount included in ~~the~~.

3326 • START

3327 boundary when an activity or an event commences.

3328 • WASTE

3329 reported or measured value of the amount discarded.

3330 5.3.86 VolumeSpatial

3331 geometric volume of an object or container.

3332 Theunits of VolumeSpatial MUST beCUBIC\_MILLIMETER.

3333 5.3.86.1 Subtypes of VolumeSpatial

3334 • ACTUAL

3335 measured or reported value of an observation.

- 3336 • CONSUMED
- 3337 reported or measured value of the amount used in the manufacturing process.
- 3338 • ENDED
- 3339 boundary when an activity or an event terminates.
- 3340 • PART
- 3341 reported or measured value of amount included in ~~part~~.
- 3342 • START
- 3343 boundary when an activity or an event commences.
- 3344 • WASTE
- 3345 reported or measured value of the amount discarded

### 3346 5.3.87 Wattage

- 3347 power owing through or dissipated by an electrical circuit or piece of equipment.
- 3348 The units of Wattage MUST be WATT

#### 3349 5.3.87.1 Subtypes of Wattage

- 3350 • ACTUAL
- 3351 measured or reported value of an observation.
- 3352 • TARGET
- 3353 goal of the operation or process.

### 3354 5.3.88 XDimension

- 3355 dimension of an entity relative to the X direction of the referenced coordinate system.
- 3356 The units of XDimension MUST be MILLIMETER.

3357 5.3.89 YDimension

3358 dimension of an entity relative to the Y direction of the referenced coordinate system.

3359 Theunits of YDimension MUST beMILLIMETER.

3360 5.3.90 ZDimension

3361 dimension of an entity relative to the Z direction of the referenced coordinate system.

3362 Theunits of ZDimension MUST beMILLIMETER.

## 3363 6 Profile

3364 MTConnect Profile is a profile that extends the Systems Modeling Language (SysML)  
3365 metamodel for the MTConnect domain using additional data types and stereotypes.

### 3366 6.1 DataTypes

Figure 13: DataTypes

#### 3367 6.1.1 boolean

3368 primitive type.

#### 3369 6.1.2 ID

3370 string that represents an identifier (ID).

#### 3371 6.1.3 string

3372 primitive type.

#### 3373 6.1.4 float

3374 primitive type.

3375 **6.1.5 datetime**

3376 string that represents timestamp in ISO 8601 format.

3377 **6.1.6 integer**

3378 primitive type.

3379 **6.1.7 xlinktype**

3380 string that represents the type of an XLink element. ~~Spec~~<https://www.w3.org/TR/xlink11/> .

3382 **6.1.8 xslang**

3383 string that represents a language tag. ~~Spec~~<https://www.ietf.org/rfc/rfc4646>.  
3384 txt .

3385 **6.1.9 SECOND**

3386 oat that represents time in seconds.

3387 **6.1.10 IDREF**

3388 string that represents a reference tda

3389 **6.1.11 xlinkhref**

3390 string that represents the locator attribute of an XLink element. ~~Spec~~<https://www.w3.org/TR/xlink11/> .  
3391 org/TR/xlink11/ .

3392 6.1.12 x509

3393 string that represents an x509 data block. Ref ISO/IEC 9594-8:2020

3394 6.1.13 int32

3395 32-bit integer.

3396 6.1.14 int64

3397 64-bit integer.

3398 6.1.15 version

3399 series of four numeric values, separated by a decimal point, representing a minor,  
3400 and revision number of the MTConnect Standard and the revision number of a specific  
3401 schema

3402 6.1.16 uint32

3403 32-bit unsigned integer.

3404 6.1.17 uint64

3405 64-bit unsigned integer.

## 3406 6.2 Stereotypes

3407 6.2.1 organizer

3408 element that organizes other elements of a type.

3409 **6.2.2 deprecated**

3410 element that has been deprecated.

3411 **6.2.3 extensible**

3412 enumeration that can be extended.

3413 **6.2.4 informative**

3414 element that is descriptive and non-normative.

3415 **6.2.5 valueType**

3416 extends SysML<<ValueType>> to includeClass as a value type.

3417 **6.2.6 normative**

3418 element that has been added to the standard.

3419 **6.2.7 observes**

3420 association in which Component makes Observations about an observableItem

Figure 14: Stereotypes



## 3421 Appendices

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 3427 integration Product data representation and exchange Part 238: Application Protocols: Ap-  
 3428 plication interpreted model for computerized numerical controllers. Geneva, Switzerland,  
 3429 2004.
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 3431 tems and integration – Physical device control – Data model for computerized numerical  
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- 3433 International Organization for Standardization. ISO 14649: Industrial automation sys-  
 3434 tems and integration – Physical device control – Data model for computerized numerical  
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 3450 1996.
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3471 15, 2004.

## 3472 B XML Schema Diagrams

### 3473 B.1 Observations Schema Diagrams

3474 SeeStreams element inMTConnectStreams schema.

3475 SeeDeviceStream element inMTConnectStreams schema.

3476 SeeComponentStream element inMTConnectStreams schema.

3477 SeeSample element inMTConnectStreams schema.

3478 SeeEvent element inMTConnectStreams schema.

3479 SeeCondition element inMTConnectStreams schema.

### 3480 B.2 Representation Schema Diagrams

3481 SeeAbsTimeSeries element inMTConnectStreams schema.

3482 SeePartCountDiscrete element inMTConnectStreams schema.

3483 SeeVariableDataSet element inMTConnectStreams schema.

3484 SeeEntry element inMTConnectStreams schema.

3485 SeeWorkOffsetTable element inMTConnectStreams schema.

## 3486 C XML Examples

### 3487 C.1 DeviceStream Example

#### Example 1: DeviceStream Example

```

3488 1 <Streams>
3489 2   <DeviceStream name="M12346" uuid="M8010W4194N" >
3490 3     <ComponentStream component="Device" name="M12346" componentId="
3491     d1" >
3492 4       <Events>
3493 5         <Availability dataItemId="avail" sequence="156" timestamp="
3494         2021-10-01T14:26:38.668505Z" >AVAILABLE</Availability>

```

```

3495 6      <AssetChanged  assetType="CuttingTool"  dataltemId="d1\
3496      textunderscore  _asset\textunderscore  _chg"  sequence="75570"
3497      timestamp="2021-10-07T05:08:53.870206Z"  >M8010W4194N1
3498      .120</AssetChanged>
3499 7      <AssetRemoved  assetType="CuttingTool"  dataltemId="d1\
3500      textunderscore  _asset\textunderscore  _rem"  sequence="140"
3501      timestamp="2021-10-01T11:40:08.101461Z"  >UNAVAILABLE</
3502      AssetRemoved>
3503 8      </Events>
3504 9      </ComponentStream>
3505 10     <ComponentStream  component="Controller"  name="controller"
3506      componentId="cont"  >
3507 11     <Events>
3508 12     <EmergencyStop  dataltemId="estop"  sequence="159"  timestamp="
3509 2021-10-01T14:26:38.66869Z"  >ARMED</EmergencyStop>
3510 13     </Events>
3511 14     <Samples>
3512 15     <AccumulatedTime  dataltemId="cut\textunderscore  _time"
3513      sequence="75437"  timestamp="2021-10-07T05:08:28.221704Z"  >
3514      1763070.0</AccumulatedTime>
3515 16     </Samples>
3516 17     <Condition>
3517 18     <Unavailable  dataltemId="cont\textunderscore  _system"
3518      sequence="72"  timestamp="2021-10-11T21:04:03.251999Z"  type="
3519      SYSTEM"/>
3520 19     <Warning  dataltemId="cont\textunderscore  _system"  nativecode=
3521      "313"  nativeSeverity="50"  sequence="75573"  timestamp="
3522      2021-10-07T05:08:58.518317Z"  type="LOGIC\textunderscore  _
3523      PROGRAM"PALLET ARM DOWN RS. MALF.</Warning>
3524 20     </Condition>
3525 21     </ComponentStream>
3526 22     <ComponentStream  component="Path"  name="path"  componentId="path1
3527      "  >
3528 23     <Events>
3529 24     <Execution  dataltemId="execution"  name="execution"  sequence=
3530      "222623"  timestamp="2021-10-12T06:04:32.761198Z"  >INTERRUPTED</
3531      Execution>
3532 25     <VariableDataSet  count="2"  dataltemId="cvars"  sequence="
3533      126513"  timestamp="2021-10-12T03:57:31.106559Z"  >
3534 26     <Entry  key="100"  >66.3314</Entry>
3535 27     <Entry  key="101"  >167.2</Entry>
3536 28     </VariableDataSet>
3537 29     <WorkOffsetTable  count="2"  dataltemId="woffset"  sequence="
3538      222101"  timestamp="2021-10-12T06:04:11.990531Z"  >
3539 30     <Entry  key="G53.1"  >
3540 31     <Cell  key="X"  >1</Cell>
3541 32     <Cell  key="Y"  >2</Cell>
3542 33     <Cell  key="Z"  >3</Cell>
3543 34     </Entry>
3544 35     <Entry  key="G53.2"  >
3545 36     <Cell  key="X"  >4</Cell>

```

```

3546 37         <Cell key="Y" >5</Cell>
3547 38         <Cell key="Z" >6</Cell>
3548 39     </Entry>
3549 40     </WorkOffsetTable>
3550 41     </Events>
3551 42     <Samples>
3552 43         <CuttingSpeed dataItemId="cspeed" sequence="112" timestamp="
3553 2021-10-07T05:08:28.221704Z" subType="ACTUAL" >UNAVAILABLE</
3554 CuttingSpeed>
3555 44     </Samples>
3556 45     <Condition>
3557 46         <Normal dataItemId="path\textunderscore _system" sequence="
3558 153" timestamp="2021-10-11T21:04:03.262845Z" type="SYSTEM" />
3559 47     </Condition>
3560 48     </ComponentStream>
3561 49 </DeviceStream>
3562 50 </Streams>

```

## 3563 C.2 Observations made for DataItem Example

### Example 2: MTConnectDevices Response Document

```

3564 1 <Components>
3565 2   <Controller id="cont" name="controller" >
3566 3     <DataItems>
3567 4       <DataItem category="EVENT" id="estop" name="estop" type="
3568 EMERGENCY\textunderscore _STOP"/>
3569 5     </DataItems>
3570 6   </Controller>
3571 7 </Components>

```

### Example 3: MTConnectStreams Response Document

```

3572 1 <ComponentStream component="Controller" name="controller"
3573 componentId="cont" >
3574 2 <Events>
3575 3   <EmergencyStop dataItemId="estop" sequence="159" timestamp="
3576 2021-10-01T14:26:38.66869Z" >ARMED</EmergencyStop>
3577 4 </Events>
3578 5 </ComponentStream>

```

## 3579 C.3 Sample Example

### Example 4: Sample Example

```

3580 1 <Samples>

```

```

3581 2 <Accumul atedTi me dataItemId="cut\textunderscore_time" sequence="
3582 75437" timestamp="2021-10-07T05:08:28.221704Z">1763070.0</
3583 Accumul atedTi me>
3584 3 <CuttingSpeed dataItemId="cspeed" sequence="112" timestamp="
3585 2021-10-07T05:08:28.221704Z" subType="ACTUAL">UNAVAI LABLE</
3586 Cutti ngSpeed>
3587 4 </Sampl es>

```

## 3588 C.4 Event Example

### Example 5: Event Example

```

3589 1 <Events>
3590 2 <Avai lability dataItemId="avail" sequence="156" timestamp="
3591 2021-10-01T14:26:38.668505Z">AVAI LABLE</Avai lability>
3592 3 <AssetRemoved assetType="CuttingTool" dataItemId="d1\
3593 textunderscore_asset\textunderscore_rem" sequence="140"
3594 timestamp="2021-10-01T11:40:08.101461Z">UNAVAI LABLE</
3595 AssetRemoved>
3596 4 </Events>

```

## 3597 C.5 Condition Example

3598 Condition types are represented differently in XML when compared to Sample and  
3599 Event types. The element name is the condition state of the Condition type in Pascal  
3600 Case. The name of the Condition type is represented by the attribute type.

3601 If the condition state is unavailable then the element name is represented by Unavail-  
3602 able.

### Example 6: Condition Example

```

3603 1 <Condi ti on>
3604 2 <Unavai lable dataItemId="cont\textunderscore_system" sequence="72"
3605 timestamp="2021-10-11T21:04:03.251999Z" type="SYSTEM"/>
3606 3 <Normal dataItemId="path\textunderscore_system" sequence="153"
3607 timestamp="2021-10-11T21:04:03.262845Z" type="SYSTEM"/>
3608 4 <Warni ng dataItemId="cont\textunderscore_system" nativecode="313"
3609 nativeSeverity="50" sequence="75573" timestamp="2021-10-07T05
3610 :08:58.518317Z" type="LOGIC\textunderscore_PROGRAM">PALLET ARM
3611 DOWN RS. MALF. </Warni ng>
3612 5 </Condi ti on>

```

## 3613 C.6 DataSet Example

### Example 7: DataSet Example

```

3614 1 <Events>
3615 2   <VariableDataSet count="2" dataItemId="cvars" sequence="126513"
3616   timestamp="2021-10-12T03:57:31.106559Z">
3617 3     <Entry key="100">66.3314</Entry>
3618 4     <Entry key="101">167.2</Entry>
3619 5   </VariableDataSet>
3620 6 </Events>

```

## 3621 C.7 Table Example

### Example 8: Table Example

```

3622 1 <Events>
3623 2   <WorkOffsetTable count="2" dataItemId="woffset" sequence="222101"
3624   timestamp="2021-10-12T06:04:11.990531Z">
3625 3     <Entry key="G53.1">
3626 4       <Cell key="X">1</Cell>
3627 5       <Cell key="Y">2</Cell>
3628 6       <Cell key="Z">3</Cell>
3629 7     </Entry>
3630 8     <Entry key="G53.2">
3631 9       <Cell key="X">4</Cell>
3632 10      <Cell key="Y">5</Cell>
3633 11      <Cell key="Z">6</Cell>
3634 12     </Entry>
3635 13   </WorkOffsetTable>
3636 14 </Events>

```