



**MTConnect<sup>®</sup> Standard**  
**Part 3.0 – Observation Information Model**  
**Version 2.2.0**

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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 [(JISO/IEC 19794-5:2011en).

48 ***characteristic***49 control placed on an element of a *feature* such as its size, location, or form, which  
50 may be a specification limit, a nominal with tolerance, or some other numerical or  
51 non-numerical control. *Ref QIF 3.0 3.4.29. Ref AS9102-B.*52 ***client***53 *application* that sends *request* for information to an *agent*.54 Note: Examples include software applications or a function that imple-  
55 ments the *request* portion of an *interface interaction model*.56 ***combined standard uncertainty***57 *standard uncertainty* of the result of a measurement when that result is obtained  
58 from the values of a number of other quantities, equal to the positive square root of a  
59 sum of terms, the terms being the variances or covariances of these other quantities  
60 weighted according to how the measurement result varies with changes in these  
61 quantities. *Ref JCGM 100:2008 2.3.4*62 ***controlled vocabulary***

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

64 ***data dictionary***65 listing of standardized terms and definitions used in *MTConnect Information Model*.66 ***data model***67 organizes elements of data and standardizes how they relate to one another and to  
68 the properties of real-world entities.69 ***data set***70 *key-value pairs* where each entry is uniquely identified by the *key*.71 ***data source***72 piece of equipment that can produce data that is published to an *agent*.73 ***deprecated***74 indication that specific content in an *MTConnect Document* is currently usable but  
75 is regarded as being obsolete or superseded.

76 deprecation warning

77 indication that specific content in an MTConnect Document may be changed or dep-  
78 recated in a future release of the standard.

79 document

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

82 electric current

83 rate of flow of electric charge.

84 element

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

86 extensible

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

89 feature

90 topological entity(ies) or design requirements related to a geometric model. Ref: QIF  
91 3.0-3.4.59

92 force

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

94 heartbeat

95 function that indicates to a client that the communications connection to a server is  
96 still viable during times when there is no new data available to report often referred  
97 to as a “keep alive” message.

98 higher level

99 nested element that is above a lower level element.

100 implementation

101 specific instantiation of the MTConnect Standard.

102 information model

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



- 105 instance  
106 describes a set of streaming data an agent. Each time an agent is restarted with  
107 an empty buffer, data placed in the buffer represents a new instance of the agent.
- 108 interaction model  
109 model that defines how information is exchanged across an interface to enable in-  
110 teractions between independent systems.
- 111 interface  
112 means by which communication is achieved between independent systems.
- 113 key  
114 unique identifier in a key-value pair association.
- 115 key-value pair  
116 association between an identifier referred to as a key and a value which taken  
117 together create a key-value pair.
- 118 location  
119 place or named space associated with an object or that can be occupied by an object.
- 120 lower camel case  
121 first word is lowercase and the remaining words are capitalized and all spaces be-  
122 tween words are removed.
- 123 lower level  
124 nested element that is below a higher level element.
- 125 lower limit  
126 lower conformance boundary for a variable.
- 127 lower warning  
128 lower boundary indicating increased concern and supervision may be required.
- 129 major  
130 identifier representing a consistent set of functionalities defined by the MTConnect  
131 Standard.
- 132 maximum  
133 numeric upper constraint.

- 134 message  
135       communication in writing, in speech, or by signals.
- 136 metadata  
137       data that provides information about other data.
- 138 minimum  
139       numeric lower constraint.
- 140 minor  
141       identifier representing a specific set of functionalities defined by the MTConnect  
142       Standard.
- 143 nominal  
144       ideal or desired value for a variable.
- 145 organize  
146       act of containing and owning one or more elements.
- 147 organizer  
148       entity that organizes one or more elements.
- 149 parameter  
150       variable that must be given a value during the execution of a program or a commu-  
151       nications command.
- 152 part  
153       discrete item that has both defined and measurable physical characteristics including  
154       mass, material, and features, and is created by applying one or more manufacturing  
155       process steps to a workpiece
- 156 pascal case  
157       first letter of each word is capitalized and the remaining letters are in lowercase. All  
158       space is removed between letters
- 159 persistence  
160       method for retaining or restoring information.
- 161 position  
162       location that is represented by a point in space relative to a reference.

- 163 probe  
164 instrument commonly used for measuring the physical geometrical characteristics  
165 of an object.
- 166 profile  
167 extends a reference metamodel (such as Unified Modeling Language (UML)) by  
168 allowing to adapt or customize the metamodel with constructs that are specific to a  
169 particular domain, platform, or a software development method.
- 170 requester  
171 entity that initiates a request for information in a communications exchange.
- 172 reset  
173 act of reverting back the accumulated value or statistic to their initial value.
- 174 Note: An Observation with a data set representation removes all key-  
175 value pairs setting the data set to an empty set.
- 176 responder  
177 entity that responds to a request for information in a communications exchange.
- 178 response document  
179 electronic document published by an MTConnect Agent in response to a probe re-  
180 quest, current request, sample request, or asset request
- 181 revision  
182 supplemental identifier representing only organizational or editorial changes to a  
183 minor version document with no changes in the functionality described in that doc-  
184 ument.
- 185 schema  
186 definition of the structure, rules, and vocabularies used to define the information  
187 published in an electronic document.
- 188 semantic data model  
189 methodology for defining the structure and meaning for data in a specific logical  
190 way that can be interpreted by a software system.
- 191 sensing element  
192 mechanism that provides a signal or measured value.

- 193 sequence number
- 194 primary key identifier used to manage and locate a specific piece of framing data  
195 in an agent
- 196 specification limit
- 197 limit defining a range of values designating acceptable performance for a variable.
- 198 spindle
- 199 mechanism that provides rotational capabilities to a piece of equipment.
- 200 Note: Typically used for either work holding, materials or cutting tools.
- 201 standard
- 202 document established by consensus that provides rules, guidelines, or characteristics  
203 for activities or their results. Ref ISO/IEC Guide 2:2004
- 204 standard uncertainty
- 205 uncertainty of the result of a measurement expressed as a standard deviation. Ref JCGM  
206 100:2008 2.3.1
- 207 stereotype
- 208 defines how an existing UML metaclass may be extended as part of a class.
- 209 subtype
- 210 secondary or subordinate type of categorization or classification of information.
- 211 table
- 212 two dimensional set of values given by a set of key-value pairs table entries
- 213 table cell
- 214 subdivision of a table entry representing a singular value.
- 215 table entry
- 216 subdivision of a table containing a set of key-value pairs representing table cells
- 217 top level
- 218 element that represents the most significant physical or logical functions of a piece  
219 of equipment.
- 220 type
- 221 classification or categorization of information.

- 222 uncertainty
- 223       uncertainty (of measurement) parameter, associated with the result of a measure-  
224       ment, that characterizes the dispersion of the values that could reasonably be at-  
225       tributed to the measurement. Ref JCGM 100:2008 2.2.3
- 226       Note: Use of the term uncertainty refers to uncertainty of measurement.
- 227 upper limit
- 228       upper conformance boundary for a variable.
- 229 upper warning
- 230       upper boundary indicating increased concern and supervision may be required.
- 231 version
- 232       unique identifier of the administered item. Ref ISO/IEC 11179-:2015

## 233 2.2 Information Model Terms

- 234 Asset Information Model
- 235       information model that provides semantic models for assets
- 236 Device Information Model
- 237       information model that describes the physical and logical configuration for a piece  
238       of equipment and the data that may be reported by that equipment.
- 239 Error Information Model
- 240       information model that describes the response document returned by an agent when  
241       it encounters an error while interpreting a request for information from a client or  
242       when an agent experiences an error while publishing the response to a request for  
243       information.
- 244 MTConnect Information Model
- 245       information model that defines the semantics of the MTConnect Standard.
- 246 Observation Information Model
- 247       information model that describes the streaming data reported by a piece of equip-  
248       ment.

## 249 2.3 Protocol Terms

250 asset request

251 HTTP Request to the agent regarding Assets

252 current request

253 request to an agent to produce an MTConnectStreams Response Document contain-  
 254 ing the Observation Information Model for a snapshot of the latest observations at  
 255 the moment of the requestor at a given sequence number

256 data streaming

257 method for an agent to provide a continuous stream of information in response to a  
 258 single request from a client.

259 MTConnect Request

260 request for information issued from a client to an MTConnect Agent

261 MTConnect Response Document

262 response document published by an MTConnect Agent

263 MTConnectAssets Response Document

264 response document published by an MTConnect Agent in response to an asset re-  
 265 quest

266 MTConnectDevices Response Document

267 response document published by an MTConnect Agent in response to a probe re-  
 268 quest

269 MTConnectErrors Response Document

270 response document published by an MTConnect Agent whenever it encounters an  
 271 error while interpreting an MTConnect Request

272 MTConnectStreams Response Document

273 response document published by an MTConnect Agent in response to a current re-  
 274 questor a sample request

275 probe request

276 request to an agent to produce an MTConnectDevices Response Document contain-  
 277 ing the Device Information Model

- 278 protocol
- 279 set of rules that allow two or more entities to transmit information from one to the  
280 other.
- 281 publish
- 282 sending of messages in publish and subscribe pattern.
- 283 publish and subscribe
- 284 asynchronous communication method in which messages are exchanged between  
285 applications without knowing the identity of the sender or recipient.
- 286 Note: In the MTConnect Standard, a communications messaging pattern  
287 that may be used to publish streaming data from an agent
- 288 request
- 289 communications method where client transmits a message to agent. That mes-  
290 sage instructs the agent to respond with specific information.
- 291 request and response
- 292 communications pattern that supports the transfer of information between agent  
293 and client.
- 294 response
- 295 response interface which responds to request
- 296 sample request
- 297 request to an agent to produce an MTConnect Streams Response Document contain-  
298 ing the Observation Information Model for a set of timestamped observations made  
299 by Components
- 300 streaming data
- 301 observations published by a piece of equipment defined by the equipment metadata.
- 302 subscribe
- 303 receiving messages in publish and subscribe pattern.
- 304 transport protocol
- 305 set of capabilities that provide the rules and procedures used to transport information  
306 between an agent and a client software application through a physical connection.

## 307 2.4 HTTP Terms

### 308 HTTP Body

309 data bytes transmitted in an HTTP transaction message immediately following the  
310 headersRef IETF:RFC-2616

### 311 HTTP Error Message

312 response provided by agent indicating that an HTTP Request is incorrectly for-  
313 matted or identifies that the requested data is not available from agent Ref IETF:RFC-  
314 2616

### 315 HTTP Header

316 header of either an HTTP Request from a client or an HTTP Response from an agent  
317 Ref IETF:RFC-2616

### 318 HTTP Header Field

319 components of the header section of request and response messages in an HTTP  
320 transactionRef IETF:RFC-2616

### 321 HTTP Message

322 consist of requests from client to server and responses from server to client Ref IETF:RFC-  
323 2616

324 Note: In MTConnect Standard, it describes the information that is ex-  
325 changed between agent and client.

### 326 HTTP Messaging

327 interface for information exchange functionalityRef IETF:RFC-2616

### 328 HTTP Method

329 portion of a command in an HTTP Request that indicates the desired action to be  
330 performed on the identified resource; often referred to as verb Ref IETF:RFC-  
331 2616

### 332 HTTP Query

333 portion of a request for information that more precisely defines the specific informa-  
334 tion to be published in response to the requestRef IETF:RFC-2616

### 335 HTTP Request

336 request message from a client to a server includes, within the first line of that mes-  
337 sage, the method to be applied to the resource, the identifier of the resource, and the  
338 protocol version in useRef IETF:RFC-2616



339 Note: In MTConnect Standard, a request issued by a client to an agent  
340 requesting information defined in the HTTP Request Line

#### 341 HTTP Request Line

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

345 Note: the first line of an HTTP Request describing a specific response  
346 document to be published by an agent

#### 347 HTTP Request Method

348 indicates the method to be performed on the resource identified by the Request-URI.  
349 Ref IETF:RFC-2616

#### 350 HTTP Request URI

351 Uniform Resource Identifier that identifies the resource upon which to apply the  
352 request. Ref IETF:RFC-2616

#### 353 HTTP Response

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

356 Note: In MTConnect Standard, the information published from an agent  
357 in reply to an HTTP Request

#### 358 HTTP Server

359 server that accepts HTTP Requests from client and publishes HTTP Responses as a  
360 reply to those HTTP Requests. Ref IETF:RFC-2616

#### 361 HTTP Status Code

362 3-digit integer result code of the attempt to understand and satisfy the request.  
363 Ref IETF:RFC-2616

#### 364 HTTP Version

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

## 366 2.5 XML Terms

### 367 abstract element

368 element that defines a set of common characteristics that are shared by a group of  
 369 elements. An abstract entity cannot appear in a document. In a specific implemen-  
 370 tation, an abstract entity is replaced by a derived element that is itself not an abstract  
 371 entity. The characteristics for the derived element are inherited from the abstract  
 372 entity.

### 373 attribute

374 additional information or property for an element

### 375 child element

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

### 378 document body

379 portion of the content of an MTConnect Response Document that is defined by the  
 380 relative MTConnect Information Model. The document body contains the structural  
 381 elements and Observations or Data Items reported in a response document

### 382 document header

383 portion of the content of an MTConnect Response Document that provides infor-  
 384 mation from an agent defining version information, storage capacity, protocol, and  
 385 other information associated with the management of the data stored in or retrieved  
 386 from the agent

### 387 element name

388 descriptive identifier contained in both the start-tag and end-tag of an XML  
 389 element that provides the name of the element.

### 390 namespace

391 organizes information into logical groups.

### 392 parent element

393 element of a data modeling structure that illustrates the relationship between itself  
 394 and the lower-level child element

### 395 root element

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

397 structural element  
 398 element that organizes information that represents the physical and logical parts and  
 399 sub-parts of a piece of equipment.

400 XML Document  
 401 structured text file encoded using Extensible Markup Language (XML).

402 XML Schema  
 403 schema defining a specific document encoded in XML.

## 404 2.6 MTConnect Terms

405 Asset  
 406 asset that is used by the manufacturing process to perform tasks.

407 Note 1 to entry: An Asset relies upon a Device to provide observations  
 408 and information about itself and the Device revises the information to  
 409 reflect changes to the Asset during their interaction. Examples of Assets  
 410 are cutting tools, Part Information, Manufacturing Processes, Fixtures,  
 411 and Files.

412 Note 2 to entry: A singular assetId, Asset uniquely identifies an  
 413 Asset throughout its lifecycle and is used to track and relate Assets to  
 414 other Devices and entities.

415 Note 3 to entry: Assets are temporally associated with a device and can  
 416 be removed from the device without damage or alteration to its primary  
 417 functions.

418 Component  
 419 engineered system part of a Device composed of zero or more Components

420 Composition  
 421 Component belonging to a Component and not composed of any Components

422 Configuration  
 423 configuration for a Component

424 DataItem  
 425 observable observed by a Component that may make Observations

- 426 Device  
427       Component not belonging to any Component that may have assets
- 428 MTConnect Agent  
429       agent for the MTConnect Information Model
- 430 MTConnect Document  
431       document that represents a Part(s) of the MTConnect Standard.
- 432 MTConnect Event  
433       observation of either a state or discrete value of Component
- 434 MTConnect Interface  
435       interaction mode for interoperability between pieces of equipment.
- 436 Observation  
437       observation that provides telemetry data for Data Item

## 438 2.7 Acronyms

- 439 2D  
440       two-dimensional
- 441 3D  
442       three-dimensional
- 443 AI  
444       artificial intelligence
- 445 ALM  
446       application lifecycle management
- 447 AMT  
448       The Association for Manufacturing Technology
- 449 ANSI  
450       American National Standards Institute

451	AP
452	Application Protocol
453	API
454	application programming interface
455	ASME
456	American Society of Mechanical Engineers
457	ASTM
458	American Society for Testing and Materials
459	AWS
460	American Welding Society
461	BDD
462	block definition diagram
463	BOM
464	bill of materials
465	BST
466	Board on Standardization and Testing
467	C&R
468	cause and remedy
469	CA
470	certificate authority
471	CAD
472	computer-aided design
473	CAE
474	computer-aided engineering
475	CAI
476	computer-aided inspection
477	CAM
478	computer-aided manufacturing

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

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

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



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

590	MBSD
591	model-based standards development
592	MBSE
593	model-based systems engineering
594	MEDALS
595	Military Engineering Data Asset Locator System
596	MES
597	manufacturing execution system
598	MOI
599	manufacturing object identifier
600	MOM
601	Message Oriented Middleware
602	MQTT
603	Message Queuing Telemetry Transport
604	MTC
605	Manufacturing Technology Centre
606	NASA
607	National Aeronautics and Space Administration
608	NC
609	numerical control
610	NIST
611	National Institute of Standards and Technology
612	NMTOKEN
613	Name Token
614	NNMI
615	National Network of Manufacturing Innovation
616	NSF
617	National Science Foundation

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

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

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

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

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

## 760 2.8 MTConnect References

- 761 [MTConnect Part 1.0] MTConnect Standard Part 1.0 - Fundamentals Version 2.0.  
762 [MTConnect Part 2.0] MTConnect Standard: Part 2.0 - Device Information Model Ver-  
763 sion 2.0.  
764 [MTConnect Part 3.0] MTConnect Standard: Part 3.0 - Observation Information Model  
765 Version 2.0.  
766 [MTConnect Part 4.0] MTConnect Standard: Part 4.0 - Asset Information Model Ver-  
767 sion 2.0.  
768 [MTConnect Part 5.0] MTConnect Standard: Part 5.0 - Interface Interaction Model Ver-  
769 sion 2.0.

770



### 771 3 Observation Information Model

772 The Observation Information Model provides a representation of the data reported by a  
 773 piece of equipment used for a manufacturing process, or used for any other purpose. Ad-  
 774 ditional descriptive information associated with the reported data is defined by the  
 775 ConnectDevices entity, which is described in MTConnect Standard: Part 2.0 - Device  
 776 Information Model

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

- 782 • sample : Returns a designated number of time stamped Observations from an agent  
 783 associated with a piece of equipment; subject to any HTTP filtering associated with  
 784 the request. See Agent in MTConnect Standard Part 1.0 - Fundamentals for details  
 785 on the sample HTTP request.
- 786 • current : Returns a snapshot of either the most recent values or the values at a  
 787 given sequence number for Observations associated with a piece of equipment  
 788 from an agent, subject to any HTTP filtering associated with the request. See Agent  
 789 in MTConnect Standard Part 1.0 - Fundamentals for details on the current HTTP  
 790 request.

791 An agent responds to either the sample or current HTTP request with an MTCon-  
 792 nectStreams Response Document. This document contains information describing Ob-  
 793 servations reported by an agent associated with a piece of equipment. A client software  
 794 application may correlate the information provided in the MTConnectStreams Response  
 795 Document with the physical and logical structure for that piece of equipment defined in  
 796 the MTConnectDevices entity to form a clear and unambiguous understanding of the  
 797 information provided. (See details on the structure for a piece of equipment described in  
 798 MTConnect Standard: Part 2.0 - Device Information Model)

799 Streams for an MTConnectStreams entity contains a DeviceStream entity for  
 800 each piece of equipment represented in the document. Each DeviceStream is com-  
 801 prised of two primary types of entities: Components and Observations. The contents  
 802 of the DeviceStream container are described in detail in this document. MTConnect  
 803 Standard: Part 3.0 - Observation Information Model of the MTConnect Standard.

804 Components are defined for both the MTConnectDevices and the MTConnectStreams

805 entities. These Components are used to provide a logical organization of the information  
 806 provided in each entity.

- 807 • For an MTConnectDevices entity: Components organize information that rep-  
 808 represents the physical and logical parts and sub-parts of a piece of equipment. (See  
 809 Component in MTConnect Standard: Part 2.0 - Device Information Model  
 810 more details on Components used in the MTConnectDevices entity).
- 811 • For an MTConnectStreams entity: Components provide the structure to orga-  
 812 nize the data returned from a piece of equipment and establishes the proper context  
 813 for that data. The Components specifically defined for MTConnectStreams are  
 814 DeviceStream (see Section 3.1 - DeviceStream) and ComponentStream (see  
 815 Section 3.2 - ComponentStream)

816 DeviceStream and ComponentStream entities have a direct correlation to each of  
 817 the Components defined in the MTConnectDevices entity.

818 Within each ComponentStream entity in the MTConnectStreams entity, Observa-  
 819 tions are modeled as Observation entities. The three types of Observation entity  
 820 are Sample, Event, and Condition. (See Section 5 - Observation Types for more  
 821 information on these entities.)

## 822 3.1 DeviceStream

823 organizes data reported from Device .

824 DeviceStream MUST be provided for each Device reporting data in a MTConnect-  
 825 Streams Response Document

826 If the response to the request for data from an agent does not contain any data for a speci c  
 827 Device, an empty DeviceStream entity MAY be created to indicate that the Device  
 828 exists, but there was no data available.

### 829 3.1.1 Value Properties of DeviceStream

830 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

831 Descriptions for Value Properties of DeviceStream :

- 832 • name

833 name of the Device .

834 The value reported for name, DeviceStream MUST be the same as the value  
 835 defined for the name, Device attribute of the same Device in the MTConnect-  
 836 Devices Response Document

- 837 • uuid

838 uuid of the Device .

839 The value reported for uuid, DeviceStream MUST be the same as the value  
 840 defined for the uuid, Device attribute of the same Device in the MTConnect-  
 841 Devices Response Document

### 842 3.1.2 Part Properties of DeviceStream

843 Table 2 lists the Part Properties of DeviceStream .

Part Property name	Multiplicity
ComponentStream	1..*

Table 2: Part Properties of DeviceStream

844 Descriptions for Part Properties of DeviceStream :

- 845 • ComponentStream

846 organizes the data associated with each component entity defined for a Device  
 847 in the associated MTConnect Devices Response Document

848 See Section 3.2 - ComponentStream

## 849 3.2 ComponentStream

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

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

### 854 3.2.1 Value Properties of ComponentStream

855 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

856 Descriptions for Value Properties of ComponentStream :

- 857 • component
- 858 identifies the Component type associated with the ComponentStream .
- 859 Examples of component are Device , Controller , Linear and Loader .
- 860 • componentId
- 861 identifier of the Component as defined by the id attribute in the MTConnectDe-  
862 vices Response Document
- 863 • name
- 864 name of the Component associated with the ComponentStream .
- 865 • nativeName
- 866 common name of the Component associated with the ComponentStream .
- 867 • uuid
- 868 uuid of the Component associated with the ComponentStream .

## 869 3.2.2 Reference Properties of ComponentStream

870 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

871 Descriptions for Reference Properties of ComponentStream :

872 • Event

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

874 Events groups one or more Event entities. See Section 3.5 - Event

875 • Sample

876 Observation that is continuously changing or analog data value.

877 Samples groups one or more Sample entities. See Section 3.4 - Sample

878 • Condition

879 Observation that provides the condition of a piece of equipment Component  
880

881 Conditions groups one or more Condition entities. See Section 3.6 - Condi-  
882 tion.

883 Note: In the XML representation, Conditions MUST appear as a Con-  
884 dition element in the MTConnectStreams Response Document

## 885 3.3 Observation

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

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

888 The XML schema also shows differences in XML representation of certain  
889 MTConnect entities.

Figure 1: Observations

Figure 2: DeviceStream Example

890 Figure 2 shows a complete example of a DeviceStream for the Device shown in Figure  
891 2: Component Example in the MTConnect Standard: Part 2.0 - Device Information Model

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

893 This section provides semantic information for the Observation model.

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

### 896 3.3.0.1 Observations made for DataItem

897 Component observes DataItem entities and creates Observation entities for the  
898 DataItem entities. See Figure 1.

899 Observation entities made by Component are organized by ComponentStream  
900 which is specially created for that Component.

Figure 3: Observations made for DataItem Example

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

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

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

### 909 3.3.0.2 Naming Convention for Observation types

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

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

918 3.3.1 Value Properties of Observation

919 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
isUnavailable	boolean	1

Table 5: Value Properties of Observation

920 Descriptions for Value Properties of Observation :

- 921 • compositionId
- 922 identifier of the Composition entity defined in the MTConnectDevices Response
- 923 Document associated with the data reported for Observation .
- 924 • dataItemId
- 925 unique identifier of the DataItem associated with this Observation .
- 926 dataItemId MUST match the id attribute of the DataItem defined in the MT-
- 927 ConnectDevices Response Document
- 928 • name
- 929 name of the DataItem associated with this Observation .
- 930 name MUST match the name attribute of the DataItem defined in the MTCon-
- 931 nectDevices Response Document
- 932 • sequence
- 933 number representing the sequential position of an occurrence of an observation in
- 934 the data buffer of an agent
- 935 sequence MUST have a value represented as an unsigned 64-bit value from 1 to
- 936  $2^{64} - 1$ .



- 937 • subType
- 938 subtype of the `DataItem` associated with this `Observation` .
- 939 subType MUST match the subType attribute of the `DataItem` defined in the
- 940 MTCConnectDevices Response Document
- 941 The value of subType MUST be one of the `DataItemSubTypeEnum` enumer-
- 942 ation.
  
- 943 • timestamp
- 944 most accurate time available to a piece of equipment that represents the point in time
- 945 that the data reported was measured.
  
- 946 • type
- 947 type of the `DataItem` associated with this `Observation` .
- 948 type MUST match the type attribute of the `DataItem` defined in the MTCCon-
- 949 nectDevices Response Document
- 950 The value of type MUST be one of the `DataItemTypeEnum` enumeration.
  
- 951 • units
- 952 units of the `DataItem` associated with this `Observation` .
- 953 units MUST match the units attribute of the `DataItem` defined in the MT-
- 954 ConnectDevices Response Document
- 955 The value of units MUST be one of the `UnitEnum` enumeration.
  
- 956 • isUnavailable
- 957 when true , result is indeterminate.
  
- 958 Note 1 to entry: In XML, when isUnavailable is true , the XML
- 959 CDATA of the `Observation` MUST be UNAVAILABLE “`<Execution dataItemId=“...” ...>UNAVAILABLE</Execution>`”
  
- 960
  
- 961 Note 2 to entry: In JavaScript Object Notation (JSON), when isUnavail-
- 962 able is true , the JSON value of the `Observation` MUST be UN-
- 963 AVAILABLE.json "Execution" : [ "dataItemId": "..."
- 964 ..., "value": "UNAVAILABLE" ]
  
- 965 • result
- 966 observation of the `Observation` entity.
- 967 The default value type for result is string .

968 Note 1 to entry: in XML the Observation:result is the CDATA of  
 969 the Observation element

970 `xml <Execution dataItemId="..." ...>READY</Execution>`

971 Note 2 to entry: in JSON the Observation:result is the member  
 972 value of the Observation object.

973 `json "Execution": [ "dataItemId": "...", "value": "READY" ]`

### 974 3.4 Sample

975 Observation that is continuously changing or analog data value.

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

979 Sample MUST always be reported if float .

980 Figure 4 shows Sample type examples. It also shows an example for where result  
 981 is not available (dataItemId = speed ).

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

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

985 The value of Sample MUST be float .

986 The units for Sample MUST always be specified.

#### 987 3.4.1 Value Properties of Sample

988 Table 6 lists the Value Properties of Sample .

Figure 4: Sample Example

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

989 Descriptions for Value Properties Sample :

990 • duration

991 time-period over which the data was collected.

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

994 • resetTriggered

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

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

999 ResetTriggeredEnum Enumeration:

1000 – ACTION\_COMPLETE

1001 result of the Observation that is measuring an action or operation was  
1002 reset upon completion of that action or operation.

1003 – ANNUAL

1004 result of the Observation was reset at the end of a 12-month period.

1005 – DAY

1006 result of the Observation was reset at the end of a 24-hour period.

1007 – MAINTENANCE

1008 result of the Observation was reset upon completion of a maintenance  
1009 event.

1010 – MANUAL

1011 result of the Observation was reset based on a physical reset action.

1012 – MONTH

1013 result of the Observation was reset at the end of a monthly period.

1014 – POWER\_ON

1015 result of the Observation was reset when power was applied to the piece  
1016 of equipment after a planned or unplanned interruption of power has occurred.

1017 – SHIFT

1018 result of the Observation was reset at the end of a work shift.

1019 – WEEK

1020 result of the Observation was reset at the end of a 7-day period.

- 1021 • sampleRate
- 1022 rate at which successive samples of the value are recorded.
- 1023 • statistic
- 1024 type of statistical calculation defined by the statistic attribute of the DataItem
- 1025 defined in the MTConnectDevices Response Document
- 1026 The value of statistic MUST be one of the StatisticEnum enumeration.

1027 **3.5 Event**

- 1028 Observation that is a discrete piece of information from a piece of equipment.
- 1029 It provides the information and data reported from a piece of equipment for DataItem
- 1030 entities defined with category, DataItem property of EVENT in the MTConnectDe-
- 1031 vices Response Document
- 1032 Figure 5 shows Event type examples. It also shows an example for where result is
- 1033 not available (dataItemId =d1\_asset\_rem ).

1034 Note: See Example 5 for the XML representation of the same example.

1035 The following Section 3.5.1 - Value Properties of Events lists the additional and/or updated

1036 attributes for Event .

1037 **3.5.1 Value Properties of Event**

1038 Table 7 lists the Value Properties of Event .

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

Table 7: Value Properties of Event

Figure 5: Event Example

1039 Descriptions for Value Properties Event :

1040 • resetTriggered

1041 identifies when a reported value has been reset and what has caused that reset to  
1042 occur for those DataItem entities that may be periodically reset to an initial value.

1043 resetTriggered MUST only be provided for the specific occurrence of a DataItem  
1044 reported in the MTConnectStreams Response Document when the reset occurred.

1045 The value of resetTriggered MUST be one of the ResetTriggeredEnum  
1046 enumeration.

1047 **3.6 Condition**

1048 Observation that provides the condition of a piece of equipment Component

1049 It provides the information and data reported from a piece of equipment for DataItem  
 1050 entities defined with category, DataItem property of CONDITION in the MTCon-  
 1051 nectDevices Response Document

1052 Figure 6 shows Condition type examples for various state : Normal (dataItemId  
 1053 = path\_system ) and Warning (dataItemId = logic\_cond ). It also shows an  
 1054 example for when the state is not available (dataItemId = cont\_system ).

1055 Note: See Example 6 for the XML representation of the same example.

1056 The following Section 3.6.1 - Value Properties of Condition lists the additional and/or  
 1057 updated attributes for Condition .

1058 **3.6.1 Value Properties of Condition**

1059 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



1060 Descriptions for Value Properties of Condition :

- 1061 • nativeCode
- 1062 native code (usually an alpha-numeric value) generated by the controller of a piece
- 1063 of equipment providing a reference identifier for Condition .
- 1064 This is the same information an operator or maintenance personnel may see as a
- 1065 reference code designating a specific fault code provided by the piece of equipment.
- 1066 • nativeSeverity
- 1067 severity information to a client software application if the piece of equipment designates a severity level to a fault.
- 1068
- 1069 • qualifier
- 1070 additional information regarding a condition state associated with the measured
- 1071 value of a process variable.
- 1072 qualifier defines whether the condition state represented indicates a measured
- 1073 value that is above or below an expected value of a process variable.
- 1074 QualifierEnum Enumeration:
- 1075 – HIGH
- 1076 measured value is greater than the expected value for a process variable.
- 1077 – LOW
- 1078 measured value is less than the expected value for a process variable.
- 1079 • statistic
- 1080 statistic provides additional information describing the meaning of the
- 1081 condition element.
- 1082 statistic MUST match the statistic attribute of the DataItem entity
- 1083 defined in the MTConnectDevices Response Document
- 1084 The value of statistic MUST be one of the StatisticEnum enumeration.
- 1085 • xs:lang
- 1086 specifies the language of the result returned for the Condition .
- 1087 See Ref IETF RFC 4646 (<http://www.ietf.org/rfc/rfc4646.txt>).
- 1088 • state
- 1089 condition state of the piece of equipment Component .
- 1090 ConditionStateEnum Enumeration:

- 1091 – Fault
- 1092 condition state that requires intervention to continue operation to function prop-
- 1093 erly.
- 1094 – Normal
- 1095 condition state that indicates operation within speci ed limits.
- 1096 – Warning
- 1097 condition state that requires concern and supervision and may become haz-
- 1098 ardous if no action is taken.

## 1099 4 Representations

1100 This section provides semantic information for Representation model.

Figure 7: Representation

1101 Note: See Section B.2 - Representation Schema Diagrams XML schema.

### 1102 4.1 Representation

1103 specifies the format and structure of the result for an Observation .

1104 The Representation type for an Observation is defined by the associated DataItem's  
1105 property representation in the MTConnectDevices Response Document

1106 Value is the default Representation type for all Observation types.

1107 The name of the Observation type is modified for all Representation types other  
1108 than Value by appending the pascal case of Representation type.

1109 Example: The name for Sample Observation type Temperature with Repre-  
1110 sentation type of TimeSeries becomes TemperatureTimeSeries .

### 1111 4.2 Value

1112 default Representation type for all Observation types where result of the  
1113 Observation types is an MTConnect data type. See Section 6.1 - DataTypes

### 1114 4.3 TimeSeries

1115 Representation for an Observation composed of a series of sampled data.

1116 TimeSeries for an Observation is defined by the associated DataItem's property  
1117 representation as TIME\_SERIES.

1118 DataItem with TIME\_SERIES representation MUST have a category of  
1119 SAMPLE

1120 Figure 8 shows the model for Temperature (Sample type) with a Representation  
1121 type of TimeSeries .

Figure 8: Temperature TimeSeries

1122 Note: See Section B.2 - Representation Schema Diagrams XML schema.

1123 TimeSeries MUST report multiple values at fixed intervals in a single Observation .  
1124 At minimum, one of DataItem or Observation MUST specify the sampleRate in  
1125 Hertz (values/second); fractional rates are permitted. When Observation and the  
1126 DataItem specify the sampleRate , the Observation sampleRate supersedes  
1127 the DataItem .

1128 The Observation MUST set the timestamp to the time the last value was observed.  
1129 The duration MAY indicate the time interval from the first to the last value in the series.

1130 Section 4.3.1 - Value Properties of TimeSeries defines additional attributes for an obser-  
1131 vation with TimeSeries Representation type.

### 1132 4.3.1 Value Properties of TimeSeries

1133 Table 9 lists the Value Properties of TimeSeries .

Value Property name	Value Property type	Multiplicity
sampleCount	integer	1

Table 9: Value Properties of TimeSeries

1134 Descriptions for Value Properties of TimeSeries :

- 1135 • sampleCount
- 1136 number of values given for the observation .

### 1137 4.4 <<deprecated>> Discrete

1138 DEPRECATED Representation for an Observation where each discrete occur-  
1139 rence of the data may have the same value as the previous occurrence of the data.

1140 Discrete for an Observation is defined by the associated DataItem 's property  
1141 representation as DISCRETE

1142 DataItem with DISCRETE representation MUST have a category of EVENT

1143 MTConnect Version 1.5 replaced representation DISCRETE with a discrete  
1144 property for DataItem .

1145 Each occurrence of the Observation MAY have the same value as the previous occur-  
1146 rence, and MUST NOT suppress duplicates.

1147 Examples of Discrete : A PartCount reporting the completion of each part using a 1  
1148 to indicate completion of a single part. Message that occurs each time a door opens.

### 1149 4.5 DataSet

1150 Representation for an Observation composed of value(s) represented as a set of  
1151 key-value pairs

1152 DataSet for an Observation is defined by the associated DataItem 's property  
1153 representation as DATA\_SET

1154 DataItem with DATA\_SET representation MUST have a category of SAM-  
1155 PLE or EVENT

1156 Figure 9 shows the model for Variable (Event type) with a Representation type  
1157 of DataSet .

Figure 9: VariableDataSet

1158 DataSet reports multiple values as a set of key-value pairs where each key MUST be  
1159 unique. The representation of the key-value pairs is an Entry . The value of each En-  
1160 try MUST have the same constraints and format as Observation defined for the  
1161 VALUE representation for the DataItem type (See Value ).

1162 The meaning of each Entry MAY be provided as the DataItem EntryDefinition .

1163 Figure 10 shows Event Observation type Variable with a Representation  
1164 type of DataSet .

1165 Note: See Example 7 for the XML representation of the same example.

1166 4.5.0.1 Management of Data Set Observations

Figure 10: DataSet Example

1167 An agent **MUST** maintain the current state of the DataSet as described in MTConnect  
 1168 Standard Part 1.0 - Fundamentals

1169 One or more key-value pairs **MAY** be added, removed, or changed in an Observation .  
 1170 An agent **MUST** publish the changes to one or more key-value pairs as a single Obser-  
 1171 vation . An agent **MUST** indicate the removal of a key-value pair from a DataSet  
 1172 using the removed attribute equal true .

1173 When the DataItem discrete, DataItem attribute is false or is not present, an  
 1174 agent in response to a sample request **MUST** only publish the changed key-value pair  
 1175 since the previous state of the DataSet .

1176 When the DataItem discrete, DataItem attribute is true , an agent in response  
 1177 to a sample request **MUST** report all key-value pairs ignoring the state of the DataSet .

1178 When an agent responds to a current request the response document **MUST** include the  
 1179 full set of key-value pairs. If the current request includes a start query parameter, the agent  
 1180 **MUST** provide the set of key-value pairs at this sequence number

1181 When an Observation is reset occurs, the DataSet MUST remove all key-value pairs  
 1182 making the set empty. The Observation MAY simultaneously populate the DataSet  
 1183 with new key-value pairs. The previous entries MUST NOT be included and MUST NOT  
 1184 have removed attribute equal true .

1185 When the Observation is UNAVAILABLE the DataSet MUST remove all key-value  
 1186 pairs making the set empty.

#### 1187 4.5.1 Value Properties of DataSet

1188 Table 10 lists the Value Properties of DataSet .

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 10: Value Properties of DataSet

1189 Descriptions for Value Properties of DataSet :

- 1190 • count
- 1191 number of Entry elements for the Observation .

#### 1192 4.5.2 Part Properties of DataSet

1193 Table 11 lists the Part Properties of DataSet .

Part Property name	Multiplicity
Entry	0..*

Table 11: Part Properties of DataSet

1194 Descriptions for Part Properties of DataSet :

- 1195 • Entry
- 1196 key-value pair published as part of DataSet .
- 1197 See Section 4.7 - Entry



## 1198 4.6 Table

1199 Representation for an Observation composed of two-dimensional sets of key-  
 1200 value pairs where the Entry represents rows containing sets of key-value pairs given by  
 1201 Cell entities.

1202 Table for an Observation is defined by the associated DataItem's property rep-  
 1203 resentation as TABLE

1204 DataItem with TABLE representation MUST have a category of SAMPLE or  
 1205 EVENT

1206 Figure 11 shows the model for WorkOffset (Event type) with a Representation  
 1207 type of Table .

Figure 11: WorkOffsetTable

1208 Note: See Section B.2 - Representation Schema Diagram for XML schema.

1209 Table has the same behavior as DataSet for change tracking, clearing, and history.

1210 When an Entry changes, all Cell entities update at the same time; they are not tracked  
 1211 separately like Entry .

1212 The meaning of each Entry and Cell MAY be provided as the DataItem Entry-  
 1213 Definition and CellDefinition .

1214 The Entry key attribute MUST be the unique identity of the Entry within an Obser-  
 1215 vation . The Cell key attribute MUST be the unique identity of the Cell within an  
 1216 Entry .

1217 Figure 12 shows Event Observation type WorkOffset with a Representation  
 1218 type of Table .

Figure 12: Table Example

1219 Note: See Example 8 for the XML representation of the same example.

#### 1220 4.6.1 Value Properties of Table

1221 Table 12 lists the Value Properties of Table .

Value Property name	Value Property type	Multiplicity
count	integer	1

Table 12: Value Properties of Table

1222 Descriptions for Value Properties of Table :

- 1223 • count
- 1224 number of key-value pairs represented as Entry entities.

## 1225 4.6.2 Part Properties of Table

1226 Table 13 lists the Part Properties of Table .

Part Property name	Multiplicity
TableEntry	0..*

Table 13: Part Properties of Table

1227 Descriptions for Part Properties of Table :

- 1228 • TableEntry
- 1229 key-value pair published as part of Table .
- 1230 Note: In the XML representation, TableEntry MUST appear as an
- 1231 entry .
- 1232 See Section 4.8 - TableEntry

## 1233 4.7 Entry

1234 key-value pair published as part of DataSet .

### 1235 4.7.0.1 Constraints for Entry Values

1236 The value of each Entry MUST have the same restrictions as the value of an observation  
 1237 with representation of VALUE

1238 An Entry MAY be further constrained by the DataItem definition (see MTConnect  
 1239 Standard: Part 2.0 - Device Information Model) for example a VariableDataSet  
 1240 having a string value MAY have a boiling-pointTemperature value. A restriction  
 1241 MUST NOT be broadened or removed, for example, the value "READ" MUST NOT  
 1242 occur with a TemperatureDataSet constrained to boiling-point numbers.

1243 The MTConnect Standard: Part 2.0 - Device Information Model DataItem Defini-  
 1244 tion MAY provide the type and units of an Entry for a key .

1245 **4.7.1 Value Properties of Entry**

1246 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

1247 Descriptions for Value Properties of Entry :

- 1248 • key
- 1249     unique identifier for each key-value pair
- 1250 • removed
- 1251     removal indicator of a key-value pair

1252 **4.8 TableEntry**

1253 key-value pair published as part of a Table .

1254     Note: In the XML representation, TableEntry MUST appear as an Entry .

1255 **4.8.1 Value Properties of TableEntry**

1256 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

1257 Descriptions for Value Properties of TableEntry :

- 1258 • key
- 1259     unique identifier for each key-value pair

- 1260 • removed
- 1261 removal indicator of key-value pair

## 1262 4.8.2 Part Properties of TableEntry

1263 Table 16 lists the Part Properties of TableEntry .

Part Property name	Multiplicity
Cell	0..*

Table 16: Part Properties of TableEntry

1264 Descriptions for Part Properties of TableEntry :

- 1265 • Cell
- 1266 key-value pair published as part of TableEntry .
- 1267 See Section 4.9 - Cell

## 1268 4.9 Cell

1269 key-value pair published as part of TableEntry .

### 1270 4.9.0.1 Constraints for Cell Values

1271 The value of each Cell MUST have the same restrictions as the value of an observation  
 1272 with representation of VALUE

1273 An Cell MAY be further constrained by the DataItem definition (see MTConnect Stan-  
 1274 dard: Part 2.0 - Device Information Model) for example a variable DataSet having  
 1275 a string value MAY have a coating-pointTemperature value. A restriction MUST  
 1276 NOT be broadened or removed, for example, the value READY MUST NOT occur with a  
 1277 TemperatureDataSet constrained limited to coating-point numbers.

1278 The MTConnect Standard: Part 2.0 - Device Information Model DataItem Defini-  
 1279 tion MAY provide the type and units of a Cell for a key .

1280 4.9.1 Value Properties of Cell

1281 Table 17 lists the Value Properties of Cell .

Value Property name	Value Property type	Multiplicity
key	ID	1

Table 17: Value Properties of Cell

1282 Descriptions for Value Properties of Cell :

- 1283 • key
- 1284 unique identifier for each key-value pair

## 1285 5 Observation Types

1286 This section provides semantic information for Observation types.

1287 Observation entities are instantiated as Sample, Event or Condition entities  
1288 based upon the category and type attributes defined for the corresponding DataItem .

1289 See Figure 2 for examples on how Observation types are organized with ComponentStream .  
1290

### 1291 5.1 Condition Types

1292 This section provides semantic information for Condition types.

1293 Condition types are reported differently from other Observation types. They are  
1294 reported based on the condition state for each condition .

1295 The type and subType (where applicable) properties for Condition MAY be any  
1296 of the type and subType attributes defined for SAMPLE category or EVENT category DataItem listed in the Device Information Model  
1297

1298 This section lists additional Condition types that have been defined to represent the  
1299 health and fault status of components

#### 1300 5.1.1 Actuator

1301 indication of a fault associated with an actuator.

#### 1302 5.1.2 Communications

1303 indication that the piece of equipment has experienced a communications failure.

#### 1304 5.1.3 DataRange

1305 indication that the value of the data associated with a measured value or a calculation is  
1306 outside of an expected range.

#### 1307 5.1.4 LogicProgram

1308 indication that an error occurred in the logic program or programmable logic controller  
1309 (PLC) associated with a piece of equipment.

#### 1310 5.1.5 MotionProgram

1311 indication that an error occurred in the motion program associated with a piece of equip-  
1312 ment.

#### 1313 5.1.6 System

1314 general purpose indication associated with an electronic component of a piece of equip-  
1315 ment or a controller that represents a fault that is not associated with the operator, program,  
1316 or hardware.

### 1317 5.2 Event Types

1318 This section provides semantic information ~~Event~~ types.

#### 1319 5.2.1 ActivationCount

1320 accumulation of the number of times a function has attempted to, or is planned to attempt  
1321 to, activate or be performed.

1322 The defaultsubType of ActivationCount is ALL.

1323 The value ofActivationCount MUST be integer .

##### 1324 5.2.1.1 Subtypes of ActivationCount

1325 • ABORTED

1326 accumulation of actions or activities that were attempted, but terminated before they  
1327 could be completed.



- 1328 • ALL
- 1329 accumulation of all actions, items, or activities being counted independent of the
- 1330 outcome.
- 1331 • BAD
- 1332 accumulation of actions, items, or activities being counted that do not conform to
- 1333 specification or expectation.
- 1334 • COMPLETE
- 1335 accumulation of actions, items, or activities that have been completed, independent
- 1336 of the outcome.
- 1337 • FAILED
- 1338 accumulation of actions or activities that were attempted, but failed to complete or
- 1339 resulted in an unexpected or unacceptable outcome.
- 1340 • GOOD
- 1341 accumulation of actions, items, or activities being counted that conform to speci -
- 1342 cation or expectation.
- 1343 • REMAINING
- 1344 accumulation of actions, items, or activities yet to be counted.
- 1345 • TARGET
- 1346 goal of the operation or process.

## 1347 5.2.2 ActiveAxes

- 1348 set of axes currently associated with Path or Controller .
- 1349 The value of ActiveAxes MUST be a list of string of size 0.. \* .

## 1350 5.2.3 ActuatorState

- 1351 operational state of an apparatus for moving or controlling a mechanism or system.
- 1352 ActuatorStateEnum Enumeration:

- 1353 • ACTIVE
- 1354 Actuator is operating.
- 1355 • INACTIVE
- 1356 Actuator is not operating.

1357 5.2.4 AdapterSoftwareVersion

1358 originator's software version of the adapter

1359 5.2.5 AdapterURI

1360 Uniform Resource Identifier (URI) of the adapter

1361 5.2.6 <<deprecated>> Alarm

1362 DEPRECATED: Replaced with CONDITION category data items in Version 1.1.0.

1363 5.2.6.1 Value Properties of Alarm

1364 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

1365 Descriptions for Value Properties of Alarm :

- 1366 • <<deprecated>> code
- 1367 type of alarm.

- 1368 • <<deprecated>> severity
- 1369 severity of the alarm.
- 1370 • <<deprecated>> nativeCode
- 1371 native code for the piece of equipment.
- 1372 • <<deprecated>> state
- 1373 state of the alarm.
- 1374 • <<deprecated>> lang
- 1375 specifies the language of the alarm text.
- 1376 SeeRef IETF RFC 4646(<http://www.ietf.org/rfc/rfc4646.txt>).

### 1377 5.2.7 AlarmLimit

1378 set of limits used to trigger warning or alarm indicators.

1379 TheEntry key MUST be one or more from theAlarmLimitResult keys.

1380 AlarmLimitResult keys:

- 1381 • UpperLimit
- 1382 upper conformance boundary for a variable.
- 1383 Note: immediate concern or action may be required.
- 1384 The value ofUpperLimit MUST befloat .
- 1385 • UpperWarning
- 1386 upper boundary indicating increased concern and supervision may be required.
- 1387 The value ofUpperWarning MUST befloat .
- 1388 • LowerWarning
- 1389 lower boundary indicating increased concern and supervision may be required.
- 1390 The value ofLowerWarning MUST befloat .
- 1391 • LowerLimit
- 1392 lower conformance boundary for a variable.
- 1393 Note: immediate concern or action may be required.
- 1394 The value ofLowerLimit MUST befloat .

1395 5.2.8 Application

1396 application on a Component .

1397 A subType MUST always be specified.

1398 5.2.8.1 Subtypes of Application

1399 • INSTALL\_DATE

1400 date the hardware or software was installed.

1401 The value of Application MUST be datetime . SeeSection 6.1.5 - datetime

1402 datetime Enumeration:

1403 • LICENSE

1404 license code to validate or activate the hardware or software.

1405 • MANUFACTURER

1406 corporate identity for the maker of the hardware or software.

1407 • RELEASE\_DATE

1408 date the hardware or software was released for general use.

1409 The value of Application MUST be datetime . SeeSection 6.1.5 - datetime

1410 datetime Enumeration:

1411 • VERSION

1412 version of the hardware or software.

1413 5.2.9 AssetChanged

1414 assetId of the Asset that has been added or changed.

1415 5.2.9.1 Value Properties of AssetChanged

1416 Table 19 lists the Value Properties of AssetChanged .

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

Table 19: Value Properties of AssetChanged

1417 Descriptions for Value Properties of AssetChanged :

1418 • assetType

1419 type of Asset changed. See MTConnect Standard: Part 4.0 - Asset Information  
 1420 Model for details on the Asset model.

1421 • hash

1422 condensed message digest from a secure one-way hash function. See FIPS PUB  
 1423 180-4

### 1424 5.2.10 AssetCount

1425 data set of the number of Assets of a given type for a Device

1426 The value of AssetCount MUST be integer .

### 1427 5.2.11 AssetRemoved

1428 assetId of the Asset that has been removed.

#### 1429 5.2.11.1 Value Properties of AssetRemoved

1430 Table 20 lists the Value Properties of AssetRemoved .

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

Table 20: Value Properties of AssetRemoved

1431 Descriptions for Value Properties of AssetRemoved :

- 1432     • **assetType**  
1433       type of Asset removed. See MTConnect Standard: Part 4.0 - Asset Information  
1434       Model for details on the Asset model.
- 1435     • **hash**  
1436       condensed message digest from a secure one-way hash function. For FIPS PUB  
1437       180-4

### 1438 5.2.12 Availability

1439 agents ability to communicate with the data source.

1440 **AvailabilityEnum**     Enumeration:

- 1441     • **AVAILABLE**  
1442       data source is active and capable of providing data.
- 1443     • **UNAVAILABLE**  
1444       data source is either inactive or not capable of providing data.

### 1445 5.2.13 AxisCoupling

1446 describes the way the axes will be associated to each other.

1447 This is used in conjunction with **COUPLED\_AXES** to indicate the way they are interacting.

1448 **AxisCouplingEnum**     Enumeration:

- 1449     • **MASTER**  
1450       axis is the master of the **CoupledAxes** .
- 1451     • **SLAVE**  
1452       axis is a slave to the **CoupledAxes** .
- 1453     • **SYNCHRONOUS**  
1454       axes are not physically connected to each other but are operating together in lock-  
1455       step.

- 1456 • TANDEM
- 1457 axes are physically connected to each other and operate as a single unit.

#### 1458 5.2.14 AxisFeedrateOverride

1459 value of a signal or calculation issued to adjust the feedrate of an individual linear type  
1460 axis.

1461 The value of AxisFeedrateOverride MUST be float .

##### 1462 5.2.14.1 Subtypes of AxisFeedrateOverride

- 1463 • JOG
- 1464 relating to momentary activation of a function or a movement.
- 1465 DEPRECATION WARNING : May be deprecated in the future.
- 1466 When the JOG subtype of AxisFeedrateOverride is applied, the resulting  
1467 commanded feedrate for the axis is limited to the value of the original  
1468 of the AxisFeedrate multiplied by the value of the JOG subtype of AxisFeed-  
1469 rateOverride .
- 1470 • PROGRAMMED
- 1471 directive value without offsets and adjustments.
- 1472 • RAPID
- 1473 performing an operation faster or in less time than nominal rate.

#### 1474 5.2.15 AxisInterlock

1475 state of the axis lockout function when power has been removed and the axis is allowed to  
1476 move freely.

1477 AxisInterlockEnum Enumeration:

- 1478 • ACTIVE
- 1479 axis lockout function is activated, power has been removed from the axis, and the  
1480 axis is allowed to move freely.

- 1481     • INACTIVE
- 1482       axis lockout function has not been activated, the axis may be powered, and the axis
- 1483       is capable of being controlled by another component.

#### 1484   5.2.16   AxisState

1485   state of dLinear   or Rotary   component representing an axis.

1486   AxisStateEnum   Enumeration:

- 1487     • HOME
- 1488       axis is in its home position.
  
- 1489     • PARKED
- 1490       axis has been moved to a fixed position and is being maintained in that position
- 1491       either electrically or mechanically.
- 1492       Action is required to release the axis from this position.
  
- 1493     • STOPPED
- 1494       axis is stopped.
  
- 1495     • TRAVEL
- 1496       axis is in motion.

#### 1497   5.2.17   BatteryState

1498   present status of the battery.

1499   BatteryStateEnum   Enumeration:

- 1500     • CHARGED
- 1501       Component is at it's maximum rated charge level.
  
- 1502     • CHARGING
- 1503       Component 's charge is increasing.



- 1504 • DISCHARGED
- 1505 Component is at it's minimum charge level.
- 1506 • DISCHARGING
- 1507 Component 's charge is decreasing.

### 1508 5.2.18 Block

1509 line of code or command being executed by controller entity.

### 1510 5.2.19 BlockCount

1511 total count of the number of blocks of program code that have been executed since execu-  
1512 tion started.

1513 The value of BlockCount MUST be integer .

### 1514 5.2.20 CharacteristicPersistentId

1515 Universally Unique Identifier (UUID) of the characteristic

1516 The value of CharacteristicPersistentId MUST be ID . See Section 6.1.2 - ID

### 1517 5.2.21 CharacteristicStatus

1518 pass/fail result of the measurement.

1519 CharacteristicStatusEnum Enumeration:

- 1520 • BASIC\_OR\_THEORETIC\_EXACT\_DIMENSION
- 1521 nominal provided without tolerance limit Ref QIF 3:2018 5.10.2.6
- 1522 • FAIL
- 1523 measurement is not within acceptable tolerances.

- 1524 • INDETERMINATE
- 1525 measurement cannot be determined.
- 1526 • NOT\_ANALYZED
- 1527 measurement cannot be evaluated.
- 1528 • PASS
- 1529 measurement is within acceptable tolerances.
- 1530 • REWORK
- 1531 failed, but acceptable constraints achievable by utilizing additional manufacturing
- 1532 processes.
- 1533 • SYSTEM\_ERROR
- 1534 measurement is indeterminate due to an equipment failure.
- 1535 • UNDEFINED
- 1536 status of measurement cannot be determined.

## 1537 5.2.22 ChuckInterlock

1538 state of an interlock function or control logic state intended to prevent the associated  
1539 Chuck component from being operated.

1540 ChuckInterlockEnum Enumeration:

- 1541 • ACTIVE
- 1542 chuck cannot be unclamped.
- 1543 • INACTIVE
- 1544 chuck can be unclamped.

### 1545 5.2.22.1 Subtypes of ChuckInterlock

- 1546 • MANUAL\_UNCLAMP
- 1547 indication of the state of an operator controlled interlock that can inhibit the ability
- 1548 to initiate an unclamp action of an electronically controlled chuck.

1549 WhenChuckInterlockManualUnclamp is ACTIVE, it is expected that a chuck  
1550 cannot be unclamped until ChuckInterlockManualUnclamp is set to INAC-  
1551 TIVE .

### 1552 5.2.23 ChuckState

1553 operating state of a mechanism that holds a part or stock material during a manufacturing  
1554 process.

1555 It may also represent a mechanism that holds any other mechanism in place within a piece  
1556 of equipment.

1557 ChuckStateEnum Enumeration:

- 1558 • CLOSED

1559 Chuck is closed to the point of a positive con rmation.

- 1560 • OPEN

1561 Chuck is open to the point of a positive con rmation.

- 1562 • UNLATCHED

1563 Chuck is not closed to the point of a positive con rmation and not open to the point  
1564 of a positive con rmation.

1565 It is in an intermediate position.

### 1566 5.2.24 ClockTime

1567 time provided by a timing device at a speci c point in time.

1568 The value ofClockTime MUST be datetime . SeeSection 6.1.5 - datetime

### 1569 5.2.25 <<deprecated>> Code

1570 programmatic code being executed.

1571 DEPRECATED in Version 1.1

## 1572 5.2.26 ComponentData

1573 tabularEvent that represents Component where theEntryDefinition identifies  
 1574 es the Component and theCellDefinition s define theComponent's observed  
 1575 DataItem s.

1576 If the Component multiplicity can be determined, the device model MUST use a fixed  
 1577 set ofComponent s.

1578 ComponentData MUST provide aDataItem Definition .

## 1579 5.2.27 CompositionState

1580 operating state of a mechanism represented by a Composition entity.

1581 A subType MUST always be specified.

### 1582 5.2.27.1 Subtypes of CompositionState

- 1583 • ACTION

1584 indication of the operating state of a mechanism.

1585 CompositionStateActionEnum Enumeration:

- 1586 – ACTIVE

1587 Composition is operating.

- 1588 – INACTIVE

1589 Composition is not operating.

- 1590 • LATERAL

1591 indication of the position of a mechanism that may move in a lateral direction.

1592 CompositionStateLateralEnum Enumeration:

- 1593 – LEFT

1594 position of theComposition is oriented to the left to the point of a positive  
 1595 con rmation.

- 1596 – RIGHT

1597 position of theComposition is oriented to the right to the point of a positive  
 1598 con rmation.

- 1599           – TRANSITIONING  
 1600           position of theComposition    is not oriented to the right to the point of a  
 1601           positive con rmation and is not oriented to the left to the point of a positive  
 1602           con rmation.  
 1603           It is in an intermediate position.
- 1604   • MOTION  
 1605           indication of the open or closed state of a mechanism.  
 1606           CompositionStateMotionEnum    Enumeration:
- 1607           – CLOSED  
 1608           position of theComposition    is closed to the point of a positive con rmation.  
 1609           – OPEN  
 1610           position of theComposition    is open to the point of a positive con rmation.  
 1611           – UNLATCHED  
 1612           position of theComposition    is not open to the point of a positive con rma-  
 1613           tion and is not closed to the point of a positive con rmation.  
 1614           It is in an intermediate position.
- 1615   • SWITCHED  
 1616           indication of the activation state of a mechanism.  
 1617           CompositionStateSwitchedEnum    Enumeration:
- 1618           – OFF  
 1619           activation state of theomposition    is in anOFFcondition, it is not operat-  
 1620           ing, or it is not powered.  
 1621           – ON  
 1622           activation state of theomposition    is in anONcondition, it is operating, or  
 1623           it is powered.
- 1624   • VERTICAL  
 1625           indication of the position of a mechanism that may move in a vertical direction.  
 1626           CompositionStateVerticalEnum    Enumeration:
- 1627           – DOWN  
 1628           position of theComposition    element is oriented in a downward direction to  
 1629           the point of a positive con rmation.

- 1630 – TRANSITIONING  
1631 position of theComposition element is not oriented in an upward direc-  
1632 tion to the point of a positive con rmation and is not oriented in a downward  
1633 direction to the point of a positive con rmation.  
1634 It is in an intermediate position.  
1635 – UP  
1636 position of theComposition element is oriented in an upward direction to  
1637 the point of a positive con rmation.

## 1638 5.2.28 ConnectionStatus

1639 status of the connection between **adapter** and **agent**

1640 ConnectionStatusEnum Enumeration:

- 1641 • CLOSED  
1642 no connection at all.
- 1643 • ESTABLISHED  
1644 open connection.  
1645 The normal state for the data transfer phase of the connection.
- 1646 • LISTEN  
1647 **agent** is waiting for a connection request from **adapter**

## 1648 5.2.29 ControlLimit

1649 set of limits used to indicate whether a process variable is stable and in control.

1650 TheEntry key MUST be one or more from theControlLimitResult keys.

1651 ControlLimitResult keys:

- 1652 • UpperLimit  
1653 upper conformance boundary for a variable.  
1654 Note: immediate concern or action may be required.

- 1655 The value ofUpperLimit MUST befloat .
- 1656 • UpperWarning
- 1657 upper boundary indicating increased concern and supervision may be required.
- 1658 The value ofUpperWarning MUST befloat .
- 1659 • Nominal
- 1660 ideal or desired value for a variable.
- 1661 The value ofNominal MUST befloat .
- 1662 • LowerWarning
- 1663 lower boundary indicating increased concern and supervision may be required.
- 1664 The value ofLowerWarning MUST befloat .
- 1665 • LowerLimit
- 1666 lower conformance boundary for a variable.
- 1667 Note: immediate concern or action may be required.
- 1668 The value ofLowerLimit MUST befloat .

### 1669 5.2.30 ControllerMode

1670 current mode of theController component.

1671 ControllerModeEnum Enumeration:

- 1672 • AUTOMATIC
- 1673 Controller is configured to automatically execute a program.
- 1674 • EDIT
- 1675 Controller is currently functioning as a programming device and is not capable
- 1676 of executing an active program.
- 1677 • <<deprecated>> FEED\_HOLD
- 1678 axes of the device are commanded to stop, but the spindle continues to function.

- 1679     • MANUAL  
 1680     Controller is not executing an active program.  
 1681     It is capable of receiving instructions from an external source – typically an operator.  
 1682     The Controller executes operations based on the instructions received from the  
 1683     external source.
- 1684     • MANUAL\_DATA\_INPUT  
 1685     operator can enter a series of operations for Controller to perform.  
 1686     The Controller will execute this specific series of operations and then stop.
- 1687     • SEMI\_AUTOMATIC  
 1688     Controller is operating in a mode that restricts the active program from process-  
 1689     ing its next process step without operator intervention.

### 1690 5.2.31 ControllerModeOverride

1691 setting or operator selection that changes the behavior of a piece of equipment.

1692 ControllerModeOverrideEnum Enumeration:

- 1693     • OFF  
 1694     ControllerModeOverride is in the OFF state and the mode override is inac-  
 1695     tive.
- 1696     • ON  
 1697     ControllerModeOverride is in the ON state and the mode override is active.

1698 A subType MUST always be specified.

#### 1699 5.2.31.1 Subtypes of ControllerModeOverride

- 1700     • DRY\_RUN  
 1701     setting or operator selection used to execute a test mode to confirm the execution of  
 1702     machine functions.  
 1703     When DRY\_RUN is ON, the equipment performs all of its normal functions, except  
 1704     no part or product is produced. If the equipment has a spindle, spindle operation is  
 1705     suspended.



- 1706 • MACHINE\_AXIS\_LOCK
- 1707 setting or operator selection that changes the behavior of the controller on a piece of
- 1708 equipment.
- 1709 When MACHINE\_AXIS\_LOCK is ON program execution continues normally, but
- 1710 no equipment motion occurs.
- 1711 • OPTIONAL\_STOP
- 1712 setting or operator selection that changes the behavior of the controller on a piece of
- 1713 equipment.
- 1714 The program execution is stopped after a specific program block is executed when
- 1715 OPTIONAL\_STOP is ON
- 1716 In the case of a G-Code program, a program block containing a M01 code designates
- 1717 the command for an OPTIONAL\_STOP
- 1718 Execution MUST change to OPTIONAL\_STOP after a program block speci-
- 1719 fying an optional stop is executed and the ControllerModeOverride OP-
- 1720 TIONAL\_STOP selection is ON
- 1721 • SINGLE\_BLOCK
- 1722 setting or operator selection that changes the behavior of the controller on a piece of
- 1723 equipment.
- 1724 Program execution is paused after each block of code is executed when SINGLE\_BLOCK
- 1725 is ON
- 1726 When SINGLE\_BLOCK is ON Execution MUST change to INTERRUPTED
- 1727 after completion of each block of code.
- 1728 • TOOL\_CHANGE\_STOP
- 1729 setting or operator selection that changes the behavior of the controller on a piece of
- 1730 equipment.
- 1731 Program execution is paused when a command is executed requesting a cutting tool
- 1732 to be changed.
- 1733 Execution MUST change to INTERRUPTED after completion of the command
- 1734 requesting a cutting tool to be changed and TOOL\_CHANGE\_STOP is ON

### 1735 5.2.32 CoupledAxes

1736 set of associated axes.

1737 The value of CoupledAxes MUST be a list of string of size 0.. \* .

### 1738 5.2.33 CycleCount

1739 accumulation of the number of times a cyclic function has attempted to, or is planned to  
1740 attempt to execute.

1741 The defaultsubType of CycleCount is ALL.

1742 The value ofCycleCount MUST be integer .

#### 1743 5.2.33.1 Subtypes of CycleCount

1744 • ABORTED

1745 accumulation of actions or activities that were attempted, but terminated before they  
1746 could be completed.

1747 • ALL

1748 accumulation of all actions, items, or activities being counted independent of the  
1749 outcome.

1750 • BAD

1751 accumulation of actions, items, or activities being counted that do not conform to  
1752 specification or expectation.

1753 • COMPLETE

1754 accumulation of actions, items, or activities that have been completed, independent  
1755 of the outcome.

1756 • FAILED

1757 accumulation of actions or activities that were attempted, but failed to complete or  
1758 resulted in an unexpected or unacceptable outcome.

1759 • GOOD

1760 accumulation of actions, items, or activities being counted that conform to speci -  
1761 cation or expectation.

1762 • REMAINING

1763 accumulation of actions, items, or activities yet to be counted.

1764 • TARGET

1765 goal of the operation or process.

1766 5.2.34 DateCode

1767 time and date code associated with a material or other physical item.

1768 The value of DateCode MUST be datetime . See Section 6.1.5 - datetime

1769 5.2.34.1 Subtypes of DateCode

1770 • EXPIRATION

1771 time and date code relating to the expiration or end of useful life for a material or  
1772 other physical item.

1773 • FIRST\_USE

1774 time and date code relating the first use of a material or other physical item.

1775 • MANUFACTURE

1776 time and date code relating to the production of a material or other physical item.

1777 5.2.35 DeactivationCount

1778 accumulation of the number of times a function has attempted to, or is planned to attempt  
1779 to, deactivate or cease.

1780 The default subtype of DeactivationCount is ALL.

1781 The value of DeactivationCount MUST be integer .

1782 5.2.35.1 Subtypes of DeactivationCount

1783 • ABORTED

1784 accumulation of actions or activities that were attempted, but terminated before they  
1785 could be completed.

1786 • ALL

1787 accumulation of all actions, items, or activities being counted independent of the  
1788 outcome.

- 1789 • BAD
- 1790 accumulation of actions, items, or activities being counted that do not conform to
- 1791 speci cation or expectation.
- 1792 • COMPLETE
- 1793 accumulation of actions, items, or activities that have been completed, independent
- 1794 of the outcome.
- 1795 • FAILED
- 1796 accumulation of actions or activities that were attempted, but failed to complete or
- 1797 resulted in an unexpected or unacceptable outcome.
- 1798 • GOOD
- 1799 accumulation of actions, items, or activities being counted that conform to speci -
- 1800 cation or expectation.
- 1801 • REMAINING
- 1802 accumulation of actions, items, or activities yet to be counted.
- 1803 • TARGET
- 1804 goal of the operation or process.

1805 5.2.36 DeviceAdded

1806 UUID of new device added to an MTConnect Agent

1807 5.2.36.1 Value Properties of DeviceAdded

1808 Table 21 lists the Value Properties of DeviceAdded .

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

Table 21: Value Properties of DeviceAdded

1809 Descriptions for Value Properties of DeviceAdded :

- 1810 • hash
- 1811 condensed message digest from a secure one-way hash function. NIST FIPS PUB
- 1812 180-4

1813 5.2.37 DeviceChanged

1814 UUID of the device whose metadata has changed.

1815 5.2.37.1 Value Properties of DeviceChanged

1816 Table 22 lists the Value Properties of DeviceChanged .

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

Table 22: Value Properties of DeviceChanged

1817 Descriptions for Value Properties of DeviceChanged :

- 1818 • hash
- 1819 condensed message digest from a secure one-way hash function, FIPS PUB
- 1820 180-4

1821 5.2.38 DeviceRemoved

1822 UUID of a device removed from an MTConnect Agent

1823 5.2.38.1 Value Properties of DeviceRemoved

1824 Table 23 lists the Value Properties of DeviceRemoved .

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

Table 23: Value Properties of DeviceRemoved

1825 Descriptions for Value Properties of DeviceRemoved :

- 1826 • hash
- 1827 condensed message digest from a secure one-way hash function, FIPS PUB
- 1828 180-4

1829 5.2.39 DeviceUuid

1830 identifier of another piece of equipment that is temporarily associated with a component  
1831 of this piece of equipment to perform a particular function.

1832 5.2.40 Direction

1833 direction of motion.

1834 <<deprecated>> DirectionEnum Enumeration:

- 1835 • <<deprecated>> CLOCKWISE
- 1836 clockwise rotation using the right-hand rule.
- 1837 • <<deprecated>> COUNTER\_CLOCKWISE
- 1838 counter-clockwise rotation using the right-hand rule.
- 1839 • <<deprecated>> NEGATIVE
- 1840 • <<deprecated>> POSITIVE

1841 A subType MUST always be specified.

1842 5.2.40.1 Subtypes of Direction

- 1843 • LINEAR
- 1844 direction of motion of a linear motion.
- 1845 DirectionLinearEnum Enumeration:
- 1846 – NEGATIVE
- 1847 linear position is decreasing.
- 1848 – NONE
- 1849 no direction.
- 1850 – POSITIVE
- 1851 linear position is increasing.

- 1852     • ROTARY
- 1853         rotational direction of a rotary motion using the right hand rule convention.
- 1854         DirectionRotaryEnum     Enumeration:
- 1855             – CLOCKWISE
- 1856                 clockwise rotation using the right-hand rule.
- 1857             – COUNTER\_CLOCKWISE
- 1858                 counter-clockwise rotation using the right-hand rule.
- 1859             – NONE
- 1860                 no direction.

#### 1861 5.2.41 DoorState

1862 operational state of Door component or composition element.

1863 DoorStateEnum Enumeration:

- 1864     • CLOSED
- 1865         Door is closed to the point of a positive con rmation.
- 1866     • OPEN
- 1867         Door is open to the point of a positive con rmation.
- 1868     • UNLATCHED
- 1869         Door is not closed to the point of a positive con rmation and not open to the point
- 1870         of a positive con rmation.
- 1871         It is in an intermediate position.

#### 1872 5.2.42 EmergencyStop

1873 state of the emergency stop signal for a piece of equipment, controller path, or any other

1874 component or subsystem of a piece of equipment.

1875 EmergencyStopEnum Enumeration:

- 1876 • ARMED
- 1877 emergency stop circuit is complete and the piece of equipment, component, or com-
- 1878 position is allowed to operate.
- 1879 • TRIGGERED
- 1880 operation of the piece of equipment, component, or composition is inhibited.

### 1881 5.2.43 EndOfBar

1882 indication of whether the end of a piece of bar stock being feed by a bar feeder has been  
1883 reached.

1884 EndOfBarEnum Enumeration:

- 1885 • NO
- 1886 EndOfBar has not been reached.
- 1887 • YES
- 1888 EndOfBar has been reached.

1889 The defaultsubType of EndOfBar is PRIMARY

#### 1890 5.2.43.1 Subtypes of EndOfBar

- 1891 • AUXILIARY
- 1892 when multiple locations on a piece of bar stock are referenced as the indication for
- 1893 the EndOfBar , the additional location(s)MUST be designated asAUXILIARY
- 1894 indication(s) for theEndOfBar .
- 1895 • PRIMARY
- 1896 speci c applicationsMAY reference one or more locations on a piece of bar stock
- 1897 as the indication for theEndOfBar .
- 1898 The main or most important locationMUST be designated as thePRIMARYindica-
- 1899 tion for theEndOfBar .
- 1900 If no subType is speci ed,PRIMARYMUST be the defaultEndOfBar indica-
- 1901 tion.



## 1902 5.2.44 EquipmentMode

1903 indication that a piece of equipment, or a sub-part of a piece of equipment, is performing  
1904 specific types of activities.

1905 EquipmentModeEnum Enumeration:

1906     • OFF  
1907         equipment is not functioning in the mode designated by ~~the~~ subType .

1908     • ON  
1909         equipment is functioning in the mode designated by ~~the~~ subType .

1910 A subType MUST always be specified.

### 1911 5.2.44.1 Subtypes of EquipmentMode

1912     • DELAY  
1913         elapsed time of a temporary halt of action.

1914     • LOADED  
1915         indication that the sub-parts of a piece of equipment are under load.  
1916         Example: For traditional machine tools, this is an indication that the cutting tool is  
1917         assumed to be engaged with the part.

1918     • OPERATING  
1919         indication that the major sub-parts of a piece of equipment are powered or perform-  
1920         ing any activity whether producing a part or product or not.  
1921         Example: For traditional machine tools, this includes when the piece of equipment  
1922         is WORKING or it is idle.

1923     • POWERED  
1924         indication that primary power is applied to the piece of equipment and, as a min-  
1925         imum, the controller or logic portion of the piece of equipment is powered and  
1926         functioning or components that are required to remain on are powered.  
1927         Example: Heaters for an extrusion machine that required to be powered even when  
1928         the equipment is turned off.

- 1929 • WORKING
- 1930 indication that a piece of equipment is performing any activity, the equipment is
- 1931 active and performing a function under load or not.
- 1932 Example: For traditional machine tools, this includes when the piece of equipment
- 1933 is LOADED making rapid moves, executing a tool change, etc.

#### 1934 5.2.45 Execution

1935 execution status of the component .

1936 ExecutionEnum Enumeration:

- 1937 • ACTIVE
- 1938 Component is actively executing an instruction.
- 1939 • FEED\_HOLD
- 1940 motion of the active axes are commanded to stop at their current position.
- 1941 • INTERRUPTED
- 1942 Component suspends the execution of the program due to an external signal.
- 1943 Action is required to resume execution.
- 1944 • OPTIONAL\_STOP
- 1945 command from the program has intentionally interrupted execution.
- 1946 The Component MAY have another state that indicates if the execution is inter-
- 1947 rupted or the execution ignores the interrupt instruction.
- 1948 • PROGRAM\_COMPLETED
- 1949 program completed execution.
- 1950 • <<deprecated>> PROGRAM\_OPTIONAL\_STOP
- 1951 program has been intentionally optionally stopped using an M01 or similar code.
- 1952 DEPRECATED in version 1.4 and replaced with OPTIONAL\_STOP
- 1953 • PROGRAM\_STOPPED
- 1954 command from the program has intentionally interrupted execution.
- 1955 Action is required to resume execution.

- 1956 • READY
- 1957 Component is ready to execute instructions.
- 1958 It is currently idle.
- 1959 • STOPPED
- 1960 Component program is not READY to execute.
- 1961 • WAIT
- 1962 Component suspends execution while a secondary operation executes.
- 1963 Execution resumes automatically once the secondary operation completes.

#### 1964 5.2.46 FeatureMeasurement

1965 tabular representation of assessing elements for a

1966 FeatureMeasurement MAY include a characteristic in which case it MAY include a  
1967 CHARACTERISTIC\_STATUS

1968 The Entry key MUST be one or more from the FeatureMeasurementResult  
1969 keys.

1970 FeatureMeasurementResult keys:

- 1971 • MeasurementId
- 1972 identifier of this measurement.
- 1973 The value of MeasurementId MUST be ID . See Section 6.1.2 - ID
- 1974 • FeaturePersistentId
- 1975 UUID of the feature.
- 1976 The value of FeaturePersistentId MUST be ID . See Section 6.1.2 - ID
- 1977 • CharacteristicPersistentId
- 1978 UUID of the characteristic.
- 1979 The value of CharacteristicPersistentId MUST be ID . See Section 6.1.2
- 1980 - ID.

- 1981 • MeasurementType
- 1982 class of measurement being performed. Ref QIF 3:2018 Section 6.3
- 1983 Examples: POINT, RADIUS, ANGLE, LENGTH, etc.
- 1984 The value of MeasurementType MUST be string .
- 1985 • MeasurementValue
- 1986 measurement based on the measurement type.
- 1987 The value of MeasurementValue MUST be float .
- 1988 • MeasurementUnits
- 1989 engineering units of the measurement.
- 1990 The value of MeasurementUnits MUST be string .
- 1991 • CharacteristicStatus
- 1992 pass/fail result of the measurement.
- 1993 The value of CharacteristicStatus MUST be one of the Characteristic-
- 1994 ticStatusEnum enumeration.
- 1995 CharacteristicStatusEnum Enumeration:
- 1996 – BASIC\_OR\_THEORETIC\_EXACT\_DIMENSION
- 1997 nominal provided without tolerance limit. Ref QIF 3:2018 5.10.2.6
- 1998 – FAIL
- 1999 measurement is not within acceptable tolerances.
- 2000 – INDETERMINATE
- 2001 measurement cannot be determined.
- 2002 – NOT\_ANALYZED
- 2003 measurement cannot be evaluated.
- 2004 – PASS
- 2005 measurement is within acceptable tolerances.
- 2006 – REWORK
- 2007 failed, but acceptable constraints achievable by utilizing additional manufac-
- 2008 turing processes.
- 2009 – SYSTEM\_ERROR
- 2010 measurement is indeterminate due to an equipment failure.
- 2011 – UNDEFINED
- 2012 status of measurement cannot be determined.

- 2013 • UncertaintyType
- 2014 method used to compute standard uncertainty
- 2015 UncertaintyTypeEnum Enumeration:
- 2016 – COMBINED
- 2017 combined standard uncertainty
- 2018 – MEAN
- 2019 standard uncertainty using arithmetic mean or average the observations Ref JCGM
- 2020 100:2008 4.2
  
- 2021 • Uncertainty
- 2022 uncertainty specified by UNCERTAINTY\_TYPE
- 2023 The value of Uncertainty MUST be float .

#### 2024 5.2.47 FeaturePersistentId

2025 UUID of a feature Ref ISO 10303 AP 242/239

2026 The value of FeaturePersistentId MUST be ID . See Section 6.1.2 - ID

#### 2027 5.2.48 Firmware

2028 embedded software of Component .

2029 A subtype MUST always be specified.

##### 2030 5.2.48.1 Subtypes of Firmware

- 2031 • INSTALL\_DATE
- 2032 date the hardware or software was installed.
- 2033 The value of Firmware MUST be datetime . See Section 6.1.5 - datetime
- 2034 datetime Enumeration:
  
- 2035 • LICENSE
- 2036 license code to validate or activate the hardware or software.

- 2037 • MANUFACTURER  
2038 corporate identity for the maker of the hardware or software.
- 2039 • RELEASE\_DATE  
2040 date the hardware or software was released for general use.  
2041 The value of `Firmware` MUST be `datetime` . See Section 6.1.5 - `datetime`  
2042 `datetime` Enumeration:
- 2043 • VERSION  
2044 version of the hardware or software.

#### 2045 5.2.49 `FixtureId`

2046 identifier for a fixture.

#### 2047 5.2.50 `FunctionalMode`

2048 current intended production status of `Component` .

2049 `FunctionalModeEnum` Enumeration:

- 2050 • MAINTENANCE  
2051 `Component` is not currently producing product.  
2052 It is currently being repaired, waiting to be repaired, or has not yet been returned to  
2053 a normal production status after maintenance has been performed.
- 2054 • PROCESS\_DEVELOPMENT  
2055 `Component` is being used to prove-out a new process, testing of equipment or  
2056 processes, or any other active use that does not result in the production of product.
- 2057 • PRODUCTION  
2058 `Component` is currently producing product, ready to produce product, or its current  
2059 intended use is to be producing product.
- 2060 • SETUP  
2061 `Component` is not currently producing product.  
2062 It is being prepared or modified to begin production of product.

- 2063 • TEARDOWN
- 2064 Component is not currently producing product.
- 2065 Typically, it has completed the production of a product and is being modified or
- 2066 returned to a neutral state such that it may then be prepared to begin production of a
- 2067 different product.

## 2068 5.2.51 Hardness

2069 hardness of a material.

2070 The value of Hardness MUST be float .

2071 A subType MUST always be specified.

### 2072 5.2.51.1 Subtypes of Hardness

- 2073 • BRINELL
- 2074 scale to measure the resistance to deformation of a surface.
- 2075 • LEEB
- 2076 scale to measure the elasticity of a surface.
- 2077 • MOHS
- 2078 scale to measure the resistance to scratching of a surface.
- 2079 • ROCKWELL
- 2080 scale to measure the resistance to deformation of a surface.
- 2081 • SHORE
- 2082 scale to measure the resistance to deformation of a surface.
- 2083 • VICKERS
- 2084 scale to measure the resistance to deformation of a surface.

2085 5.2.52 Hardware

2086 hardware of a Component .

2087 A subType MUST always be specified.

2088 5.2.52.1 Subtypes of Hardware

2089 • INSTALL\_DATE

2090 date the hardware or software was installed.

2091 The value of Hardware MUST be datetime . See Section 6.1.5 - datetime

2092 datetime Enumeration:

2093 • LICENSE

2094 license code to validate or activate the hardware or software.

2095 • MANUFACTURER

2096 corporate identity for the maker of the hardware or software.

2097 • RELEASE\_DATE

2098 date the hardware or software was released for general use.

2099 The value of Hardware MUST be datetime . See Section 6.1.5 - datetime

2100 datetime Enumeration:

2101 • VERSION

2102 version of the hardware or software.

2103 5.2.53 HostName

2104 name of the host computer supplying data.

2105 5.2.54 LeakDetect

2106 indication designating whether a leak has been detected.

2107 LeakDetectEnum Enumeration:



2108 • DETECTED  
2109 leak is currently being detected.

2110 • NOT\_DETECTED  
2111 leak is currently not being detected.

## 2112 5.2.55 Library

2113 software library on a Component

2114 A subType MUST always be specified.

### 2115 5.2.55.1 Subtypes of Library

2116 • INSTALL\_DATE  
2117 date the hardware or software was installed.  
2118 The value of Library MUST be datetime . See Section 6.1.5 - datetime  
2119 datetime Enumeration:

2120 • LICENSE  
2121 license code to validate or activate the hardware or software.

2122 • MANUFACTURER  
2123 corporate identity for the maker of the hardware or software.

2124 • RELEASE\_DATE  
2125 date the hardware or software was released for general use.  
2126 The value of Library MUST be datetime . See Section 6.1.5 - datetime  
2127 datetime Enumeration:

2128 • VERSION  
2129 version of the hardware or software.

2130 5.2.56 <<deprecated>> Line

2131 current line of code being executed.

2132 DEPRECATED in Version 1.4.0

2133 5.2.56.1 Subtypes of Line

2134 • MAXIMUM

2135 maximum line number of the code being executed.

2136 • MINIMUM

2137 minimum line number of the code being executed.

2138 5.2.57 LineLabel

2139 identifier for a Block of code in a Program .

2140 5.2.58 LineNumber

2141 position of a block of program code within a control program.

2142 The value of LineNumber MUST be integer .

2143 5.2.58.1 Subtypes of LineNumber

2144 • ABSOLUTE

2145 position of a block of program code relative to the beginning of the control program.

2146 • INCREMENTAL

2147 position of a block of program code relative to the occurrence of the last La-  
2148 bel encountered in the control program.

2149 5.2.59 LoadCount

2150 accumulation of the number of times an operation has attempted to, or is planned to attempt  
2151 to, load materials, parts, or other items.

2152 The defaultsubType of LoadCount is ALL.

2153 The value ofLoadCount MUST beinteger .

2154 5.2.59.1 Subtypes of LoadCount

2155 • ABORTED

2156 accumulation of actions or activities that were attempted, but terminated before they  
2157 could be completed.

2158 • ALL

2159 accumulation of all actions, items, or activities being counted independent of the  
2160 outcome.

2161 • BAD

2162 accumulation of actions, items, or activities being counted that do not conform to  
2163 specification or expectation.

2164 • COMPLETE

2165 accumulation of actions, items, or activities that have been completed, independent  
2166 of the outcome.

2167 • FAILED

2168 accumulation of actions or activities that were attempted, but failed to complete or  
2169 resulted in an unexpected or unacceptable outcome.

2170 • GOOD

2171 accumulation of actions, items, or activities being counted that conform to speci -  
2172 cation or expectation.

2173 • REMAINING

2174 accumulation of actions, items, or activities yet to be counted.

2175 • TARGET

2176 goal of the operation or process.

2177 5.2.60 LockState

2178 state or operating mode of Lock .

2179 LockStateEnum Enumeration:

- 2180 • LOCKED

2181 mechanism is engaged and preventing the associated component from being opened  
2182 or operated.

- 2183 • UNLOCKED

2184 mechanism is disengaged and the associated component is able to be opened or  
2185 operated.

2186 5.2.61 MTConnectVersion

2187 reference version of the MTConnect Standard supported by chapter

2188 5.2.62 MaintenanceList

2189 actions or activities to be performed in support of a piece of equipment.

2190 If the INTERVAL key is not provided, it is assumed to be ABSOLUTE

2191 If the DIRECTION key is not provided, it is assumed to be UP.

2192 If the UNITS key is not provided, it is assumed to be COUNT

2193 TheEntry key MUST be one or more from the MaintenanceListResult keys.

2194 MaintenanceListResult keys:

- 2195 • Value

2196 current interval value of the activity.

2197 The value ofValue MUST be float .

- 2198 • Interval

- 2199 interval of the value observed.
- 2200 MaintenanceListIntervalEnum Enumeration:
- 2201 – ABSOLUTE
- 2202 – INCREMENTAL
- 2203 • NextServiceDate
- 2204 next date/time stamp that maintenance should be performed.
- 2205 The value ofNextServiceDate MUST be datetime . SeeSection 6.1.5 -
- 2206 datetime
- 2207 • Reset
- 2208 last date/time stamp of the observation was reset.
- 2209 The value ofReset MUST be datetime . SeeSection 6.1.5 - datetime
- 2210 • Severity
- 2211 level of severity on a scale of 1-10.
- 2212 The value ofSeverity MUST beinteger .
- 2213 • Direction
- 2214 direction of the value observed.
- 2215 MaintenanceListDirectionEnum Enumeration:
- 2216 – DOWN
- 2217 – UP
- 2218 • Name
- 2219 identifier of the maintenance activity.
- 2220 The value ofNameMUST bestring .
- 2221 • LastServiceDate
- 2222 last date/time stamp that maintenance was performed.
- 2223 The value ofLastServiceDate MUST be datetime . SeeSection 6.1.5 -
- 2224 datetime
- 2225 • Units
- 2226 same asDataItem units . SeeMTConnect Standard: Part 2.0 - Device Informa-
- 2227 tion Model
- 2228 The value ofUnits MUST be one of theUnitEnum enumeration.

- 2229 • Target
- 2230 target value of the next maintenance.
- 2231 The value ofTarget MUST befloat .

### 2232 5.2.63 Material

2233 identifier of a material used or consumed in the manufacturing process.

### 2234 5.2.64 MaterialLayer

2235 identifies the layers of material applied to a part or product as part of an additive manufacturing process.

2236 The value ofMaterialLayer MUST beinteger .

#### 2238 5.2.64.1 Subtypes of MaterialLayer

- 2239 • ACTUAL
- 2240 measured or reported value of an observation.

- 2241 • TARGET
- 2242 goal of the operation or process.

### 2243 5.2.65 MeasurementType

2244 class of measurement being performed. Ref QIF 3:2018 Section 6.3

2245 Examples:POINT, RADIUS, ANGLE, LENGTH, etc.

### 2246 5.2.66 MeasurementUnits

2247 engineering units of the measurement.

2248 **5.2.67 MeasurementValue**

2249 measurement based on the measurement type.

2250 The value of MeasurementValue MUST be double .

2251 **5.2.68 Message**

2252 information to be transferred from a piece of equipment to a client software application.

2253 **5.2.68.1 Value Properties of Message**

2254 Table 24 lists the Value Properties of Message .

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

Table 24: Value Properties of Message

2255 Descriptions for Value Properties of Message :

- 2256 • nativeCode

2257 control system local identification of the information being transferred.

2258 **5.2.69 Network**

2259 network details of a Component .

2260 A subType MUST always be specified.

2261 **5.2.69.1 Subtypes of Network**

- 2262 • GATEWAY

2263 Gateway for the component network.

- 2264 • IPV4\_ADDRESS
- 2265 IPV4 network address of the component.
- 2266 • IPV6\_ADDRESS
- 2267 IPV6 network address of the component.
- 2268 • MAC\_ADDRESS
- 2269 Media Access Control Address.
- 2270 The unique physical address of the network hardware.
- 2271 • SUBNET\_MASK
- 2272 SubNet mask for the component network.
- 2273 • VLAN\_ID
- 2274 layer2 Virtual Local Network (VLAN) ID for the component network.
- 2275 • WIRELESS
- 2276 identifies whether the connection type is wireless.
- 2277 NetworkWirelessEnum Enumeration:
- 2278 – NO
- 2279 – YES

## 2280 5.2.70 NetworkPort

- 2281 number of the TCP/IP or UDP/IP port for the connection endpoint.
- 2282 The value of NetworkPort MUST be integer .

## 2283 5.2.71 OperatingMode

- 2284 state of Component or Composition that describes the automatic or manual operation
- 2285 of the entity.
- 2286 OperatingModeEnum Enumeration:
- 2287 • AUTOMATIC
- 2288 automatically execute instructions from a recipe or program.



2289 Note: Setpoint comes from a recipe.

2290 • MANUAL

2291 execute instructions from an external agent or person.

2292 Note 1 to entry: Valve or switch is manipulated by an agent/person.

2293 Note 2 to entry: Direct control of the PID output. % of the range: A user  
2294 manually sets the % output, not the setpoint.

2295 • SEMI\_AUTOMATIC

2296 executes a single instruction from a recipe or program.

2297 Note 1 to entry: Setpoint is entered and held, but the PID is controlling.

2298 Note 2 to entry: Still goes through the PID control system.

2299 Note 3 to entry: Manual held entry from a recipe.

## 2300 5.2.72 OperatingSystem

2301 Operating System (OS) of a Component .

2302 A subType MUST always be specified.

### 2303 5.2.72.1 Subtypes of OperatingSystem

2304 • INSTALL\_DATE

2305 date the hardware or software was installed.

2306 The value of OperatingSystem MUST be datetime . See Section 6.1.5 -  
2307 datetime

2308 datetime Enumeration:

2309 • LICENSE

2310 license code to validate or activate the hardware or software.

2311 • MANUFACTURER

2312 corporate identity for the maker of the hardware or software.

- 2313 • RELEASE\_DATE
- 2314 date the hardware or software was released for general use.
- 2315 The value of OperatingSystem MUST be datetime . See Section 6.1.5 -
- 2316 datetime
- 2317 datetime Enumeration:
- 2318 • VERSION
- 2319 version of the hardware or software.

### 2320 5.2.73 OperatorId

2321 identifier of the person currently responsible for operating the piece of equipment.

### 2322 5.2.74 PalletId

2323 identifier for a pallet.

### 2324 5.2.75 PartCount

2325 aggregate count of parts.

2326 The value of PartCount MUST be integer .

2327 The default subType of PartCount is ALL.

#### 2328 5.2.75.1 Subtypes of PartCount

- 2329 • ABORTED
- 2330 accumulation of actions or activities that were attempted, but terminated before they
- 2331 could be completed.
- 2332 • ALL
- 2333 accumulation of all actions, items, or activities being counted independent of the
- 2334 outcome.

- 2335 • BAD
- 2336 accumulation of actions, items, or activities being counted that do not conform to
- 2337 specification or expectation.
- 2338 • COMPLETE
- 2339 accumulation of actions, items, or activities that have been completed, independent
- 2340 of the outcome.
- 2341 • FAILED
- 2342 accumulation of actions or activities that were attempted, but failed to complete or
- 2343 resulted in an unexpected or unacceptable outcome.
- 2344 • GOOD
- 2345 accumulation of actions, items, or activities being counted that conform to speci -
- 2346 cation or expectation.
- 2347 • REMAINING
- 2348 accumulation of actions, items, or activities yet to be counted.
- 2349 • TARGET
- 2350 goal of the operation or process.

### 2351 5.2.76 PartCountType

2352 interpretation of PART\_COUNT

2353 PartCountTypeEnum Enumeration:

- 2354 • BATCH
- 2355 pre-specified group of items.
- 2356 • EACH
- 2357 count is of individual items.

### 2358 5.2.77 PartDetect

2359 indication designating whether a part or work piece has been detected or is present.

2360 PartDetectEnum Enumeration:

- 2361 • NOT\_PRESENT
- 2362 part or work piece is not detected or is not present.
- 2363 • PRESENT
- 2364 part or work piece is detected or is present.

## 2365 5.2.78 PartGroupId

- 2366 identifier given to a collection of individual parts.
- 2367 If no subType is specified, UUID is default.
- 2368 The default subType of PartGroupId is UUID.

### 2369 5.2.78.1 Subtypes of PartGroupId

- 2370 • BATCH
- 2371 identifier that references a group of parts produced in a batch.
- 2372 • HEAT\_TREAT
- 2373 identifier used to reference a material heat number.
- 2374 • LOT
- 2375 identifier that references a group of parts tracked as a lot.
- 2376 • RAW\_MATERIAL
- 2377 material that is used to produce parts.
- 2378 • UUID
- 2379 universally unique identifier as specified in ISO 11578 or RFC 4122.

## 2380 5.2.79 PartId

- 2381 identifier of a part in a manufacturing operation.

2382 5.2.80 PartKindId

2383 identifier given to link the individual occurrence to a class of parts, typically distinguished  
2384 by a particular part design.

2385 If no subType is specified, UUID is default.

2386 The default subType of PartKindId is UUID.

2387 5.2.80.1 Subtypes of PartKindId

2388 • PART\_FAMILY

2389 identifier given to a group of parts having similarities in geometry, manufacturing  
2390 process, and/or functions.

2391 • PART\_NAME

2392 word or set of words by which a part is known, addressed, or referred to.

2393 • PART\_NUMBER

2394 identifier of a particular part design or model.

2395 • UUID

2396 universally unique identifier as specified in ISO 11578 or RFC 4122.

2397 5.2.81 <<deprecated>> PartNumber

2398 identifier of a part or product moving through the manufacturing process.

2399 DEPRECATED in Version 1.7 PART\_NUMBER is now a subType of PART\_KIND\_ID.

2400 5.2.82 PartProcessingState

2401 particular condition of the part occurrence at a specific time.

2402 PartProcessingStateEnum Enumeration:

- 2403 • IN\_PROCESS
- 2404 part occurrence is actively being processed.
- 2405 • IN\_TRANSIT
- 2406 part occurrence is being transported to its destination.
- 2407 • NEEDS\_PROCESSING
- 2408 part occurrence is not actively being processed, but the processing has not ended.
- 2409 Processing requirements exist that have not yet been fulfilled. This is the default
- 2410 entry state when the part occurrence is originally received. In some cases, the part
- 2411 occurrence may return to this state while it waits for additional processing to be
- 2412 performed.
- 2413 • PROCESSING\_ENDED
- 2414 part occurrence is no longer being processed.
- 2415 A general state when the reason for termination is unknown.
- 2416 • PROCESSING\_ENDED\_ABORTED
- 2417 processing of the part occurrence has come to a premature end.
- 2418 • PROCESSING\_ENDED\_COMPLETE
- 2419 part occurrence has completed processing successfully.
- 2420 • PROCESSING\_ENDED\_LOST
- 2421 terminal state when the part occurrence has been removed from the equipment by
- 2422 an external entity and it no longer exists at the equipment.
- 2423 • PROCESSING\_ENDED\_REJECTED
- 2424 part occurrence has been processed completely. However, the processing may have
- 2425 a problem.
- 2426 • PROCESSING\_ENDED\_SKIPPED
- 2427 part occurrence has been skipped for processing on the piece of equipment.
- 2428 • PROCESSING\_ENDED\_STOPPED
- 2429 process has been stopped during the processing.
- 2430 The part occurrence will require special treatment.
- 2431 • TRANSIT\_COMPLETE
- 2432 part occurrence has been placed at its designated destination.
- 2433 • WAITING\_FOR\_TRANSIT
- 2434 part occurrence is waiting for transit.

### 2435 5.2.83 PartStatus

2436 state or condition of a part.

2437 If unique identifier is given, part status is for that individual. If group identifier is given  
2438 without a unique identifier, then the status is assumed to be for the whole group.

2439 PartStatusEnum Enumeration:

2440 • FAIL

2441 part does not conform to some given requirements.

2442 • PASS

2443 part conforms to given requirements.

### 2444 5.2.84 PartUniqueld

2445 identifier given to a distinguishable, individual part.

2446 If no subtype is specified, UUID is default.

2447 The default subtype of PartUniqueld is UUID.

#### 2448 5.2.84.1 Subtypes of PartUniqueld

2449 • RAW\_MATERIAL

2450 material that is used to produce parts.

2451 • SERIAL\_NUMBER

2452 serial number that uniquely identifies a specific part.

2453 • UUID

2454 universally unique identifier as specified in ISO 11578 or RFC 4122.

## 2455 5.2.85 PathFeedrateOverride

2456 value of a signal or calculation issued to adjust the feedrate for the axes associated with a  
2457 Path component that may represent a single axis or the coordinated movement of multiple  
2458 axes.

2459 The value of PathFeedrateOverride MUST be float .

### 2460 5.2.85.1 Subtypes of PathFeedrateOverride

- 2461 • JOG

2462 relating to momentary activation of a function or a movement.

2463 DEPRECATION WARNING : May be deprecated in the future.

- 2464 • PROGRAMMED

2465 directive value without offsets and adjustments.

- 2466 • RAPID

2467 performing an operation faster or in less time than nominal rate.

## 2468 5.2.86 PathMode

2469 describes the operational relationship between Path entity and another Path entity for  
2470 pieces of equipment comprised of multiple logical groupings of controlled axes or other  
2471 logical operations.

2472 PathModeEnum Enumeration:

- 2473 • INDEPENDENT

2474 path is operating independently and without the influence of another path.

- 2475 • MASTER

2476 path provides information or state values that influence the operation of DataItem  
2477 of similar type.

- 2478 • MIRROR

2479 axes associated with the path are mirroring the motion of MASTER path.



- 2480 • SYNCHRONOUS
- 2481 physical or logical parts which are not physically connected to each other but are
- 2482 operating together.

### 2483 5.2.87 PowerState

2484 indication of the status of the source of energy for an entity to allow it to perform its  
2485 intended function or the state of an enabling signal providing permission for the entity to  
2486 perform its functions.

2487 PowerStateEnum Enumeration:

- 2488 • OFF
- 2489 source of energy for an entity or the enabling signal providing permission for the
- 2490 entity to perform its function(s) is not present or is disconnected.
- 2491 • ON
- 2492 source of energy for an entity or the enabling signal providing permission for the
- 2493 entity to perform its function(s) is present and active.

#### 2494 5.2.87.1 Subtypes of PowerState

- 2495 • CONTROL
- 2496 state of the enabling signal or control logic that enables or disables the function or
- 2497 operation of the entity.
- 2498 • LINE
- 2499 state of the power source for the entity.

### 2500 5.2.88 <<deprecated>> PowerStatus

2501 status of the Component .

2502 DEPRECATED in Version 1.1.0

2503 <<deprecated>> PowerStatusEnum Enumeration:

2504 • <<deprecated>> OFF

2505 • <<deprecated>> ON

## 2506 5.2.89 ProcessAggregateld

2507 identifier given to link the individual occurrence to a group of related occurrences, such as  
2508 a process step in a process plan.

### 2509 5.2.89.1 Subtypes of ProcessAggregateld

2510 • ORDER\_NUMBER

2511 identifier of the authorization of the process occurrence. Synonyms include “job id”,  
2512 “work order”.

2513 • PROCESS\_PLAN

2514 identifier of the process plan that this occurrence belongs to. Synonyms include  
2515 “routing id”, “job id”.

2516 • PROCESS\_STEP

2517 identifier of the step in the process plan that this occurrence corresponds to. Syn-  
2518 onyms include “operation id”.

## 2519 5.2.90 ProcessKindId

2520 identifier given to link the individual occurrence to a class of processes or process de ni-  
2521 tion.

### 2522 5.2.90.1 Subtypes of ProcessKindId

2523 • ISO\_STEP\_EXECUTABLE

2524 reference to a ISO 10303 Executable.

2525 • PROCESS\_NAME

2526 word or set of words by which a process being executed (process occurrence) by the  
2527 device is known, addressed, or referred to.

- 2528 • UUID
- 2529 universally unique identifier as specified in ISO 11578 or RFC 4122.

### 2530 5.2.91 ProcessOccurrenceId

2531 identifier of a process being executed by the device.

#### 2532 5.2.91.1 Subtypes of ProcessOccurrenceId

- 2533 • ACTIVITY
- 2534 phase or segment of a recipe or program.
- 2535 • OPERATION
- 2536 step of a discrete manufacturing process.
- 2537 • RECIPE
- 2538 process as part of product production; can be a subprocess of a larger process.
- 2539 • SEGMENT
- 2540 phase of a recipe process.

### 2541 5.2.92 ProcessState

2542 particular condition of the process occurrence at a specific time.

2543 ProcessStateEnum Enumeration:

- 2544 • ABORTED
- 2545 process occurrence has come to a premature end and cannot be resumed.
- 2546 • ACTIVE
- 2547 process occurrence is actively executing.
- 2548 • COMPLETE
- 2549 process occurrence is now finished.

- 2550 • INITIALIZING
- 2551 device is preparing to execute the process occurrence.
- 2552 • INTERRUPTED
- 2553 process occurrence has been stopped and may be resumed.
- 2554 • READY
- 2555 process occurrence is ready to be executed.

### 2556 5.2.93 ProcessTime

- 2557 time and date associated with an activity or event.
- 2558 A subType MUST always be specified.

#### 2559 5.2.93.1 Subtypes of ProcessTime

- 2560 • COMPLETE
- 2561 time and date associated with the completion of an activity or event.
- 2562 • START
- 2563 boundary when an activity or an event commences.
- 2564 • TARGET\_COMPLETION
- 2565 projected time and date associated with the end or completion of an activity or event.

### 2566 5.2.94 Program

- 2567 name of the logic or motion program being executed by Controller component.

#### 2568 5.2.94.1 Subtypes of Program

- 2569 • ACTIVE
- 2570 identity of the logic or motion program currently executing.

- 2571 • ACTIVITY
- 2572 phase or segment of a recipe or program.
- 2573 • MAIN
- 2574 identity of the primary logic or motion program currently being executed.
- 2575 It is the starting nest level in a call structure and may contain calls to sub programs.
- 2576 • OPERATION
- 2577 step of a discrete manufacturing process.
- 2578 • RECIPE
- 2579 process as part of product production; can be a subprocess of a larger process.
- 2580 • SCHEDULE
- 2581 identity of a control program that is used to specify the order of execution of other
- 2582 programs.
- 2583 • SEGMENT
- 2584 phase of a recipe process.

## 2585 5.2.95 ProgramComment

2586 comment or non-executable statement in the control program.

### 2587 5.2.95.1 Subtypes of ProgramComment

- 2588 • ACTIVE
- 2589 identity of the logic or motion program currently executing.
- 2590 • MAIN
- 2591 identity of the primary logic or motion program currently being executed.
- 2592 It is the starting nest level in a call structure and may contain calls to sub programs.
- 2593 • SCHEDULE
- 2594 identity of a control program that is used to specify the order of execution of other
- 2595 programs.

## 2596 5.2.96 ProgramEdit

2597 indication of the status of the controller components program editing mode.

2598 A program may be edited while another is executed.

2599 ProgramEditEnum Enumeration:

2600 • ACTIVE

2601 Controller is in the program edit mode.

2602 • NOT\_READY

2603 Controller is being inhibited by a function from entering the program edit mode.

2604 • READY

2605 Controller is capable of entering the program edit mode and no function is  
2606 inhibiting a change to that mode.

## 2607 5.2.97 ProgramEditName

2608 name of the program being edited.

2609 This is used in conjunction with ProgramEdit when in ACTIVE state.

## 2610 5.2.98 ProgramHeader

2611 non-executable header section of the control program.

2612 The default subtype of ProgramHeader is MAIN.

### 2613 5.2.98.1 Subtypes of ProgramHeader

2614 • ACTIVE

2615 identity of the logic or motion program currently executing.

- 2616 • MAIN
- 2617 identity of the primary logic or motion program currently being executed.
- 2618 It is the starting nest level in a call structure and may contain calls to sub programs.
- 2619 • SCHEDULE
- 2620 identity of a control program that is used to specify the order of execution of other
- 2621 programs.

## 2622 5.2.99 ProgramLocation

2623 URI for the source le associated with Program .

### 2624 5.2.99.1 Subtypes of ProgramLocation

- 2625 • ACTIVE
- 2626 identity of the logic or motion program currently executing.
- 2627 • MAIN
- 2628 identity of the primary logic or motion program currently being executed.
- 2629 It is the starting nest level in a call structure and may contain calls to sub programs.
- 2630 • SCHEDULE
- 2631 identity of a control program that is used to specify the order of execution of other
- 2632 programs.

## 2633 5.2.100 ProgramLocationType

2634 defines whether the logic or motion program defined by Program is being executed from  
2635 the local memory of the controller or from an outside source.

2636 ProgramLocationTypeEnum Enumeration:

- 2637 • EXTERNAL
- 2638 not managed by the controller.
- 2639 • LOCAL
- 2640 managed by the controller.

2641 5.2.100.1 Subtypes of ProgramLocationType

- 2642 • ACTIVE

2643 identity of the logic or motion program currently executing.

- 2644 • MAIN

2645 identity of the primary logic or motion program currently being executed.

2646 It is the starting nest level in a call structure and may contain calls to sub programs.

- 2647 • SCHEDULE

2648 identity of a control program that is used to specify the order of execution of other  
2649 programs.

2650 5.2.101 ProgramNestLevel

2651 indication of the nesting level within a control program that is associated with the code or  
2652 instructions that is currently being executed.

2653 If an initial value is not defined, the nesting level associated with the highest or initial  
2654 nesting level of the program MUST default to zero (0).

2655 The value of ProgramNestLevel MUST be integer .

2656 5.2.102 RotaryMode

2657 current operating mode for Rotary type axis.

2658 RotaryModeEnum Enumeration:

- 2659 • CONTOUR

2660 position of the axis is being interpolated.

- 2661 • INDEX

2662 axis is configured to index.

- 2663 • SPINDLE

2664 axis is functioning as a spindle.



2665 5.2.103 RotaryVelocityOverride

2666 percentage change to the velocity of the programmed velocity ~~Rotary~~ axis.

2667 This command represents a percentage change to the velocity calculated by a logic or  
2668 motion program or set by a switch for ~~Rotary~~ type axis.

2669 The value of ~~RotaryVelocityOverride~~ MUST be float .

2670 5.2.104 Rotation

2671 three space angular displacement of an object or coordinate system relative to a  
2672 coordinate system ~~Cartesian~~

2673 The units of Rotation MUST be DEGREE\_3D

2674 The value of ~~Rotation~~ MUST be a list of float of size 0..3 .

2675 5.2.105 SensorAttachment

2676 attachment between a sensor and an entity.

2677 The Entry key MUST be one or more from the ~~SensorAttachmentResult~~ keys.

2678 ~~SensorAttachmentResult~~ keys:

2679 • SensorId

2680 identity of a sensor used to observe some measurement of an item.

2681 The value of ~~SensorId~~ MUST be ID . See Section 6.1.2 - ID

2682 5.2.106 SensorState

2683 detection result of a sensor.

2684 The default ~~subType~~ of SensorState is BINARY.

2685 5.2.106.1 Subtypes of SensorState

2686 • BINARY

2687 detection result of a sensor.

2688 where the state is observed as a binary data type.

2689 The value of SensorState MUST be binary . See Section 6.1.18 - binary

2690 binary Enumeration:

2691 • BOOLEAN

2692 detection result of a sensor.

2693 where the state is observed as a boolean data type.

2694 The value of SensorState MUST be boolean .

2695 boolean Enumeration:

2696 • DETECT

2697 detection result of a sensor.

2698 where the state is indicated by the presence or existence of something.

2699 The value of SensorState MUST be one of the CompositionStateSwitchedE-  
2700 num enumeration.

2701 • ENUMERATED

2702 detection result of a sensor.

2703 where the state is observed as a set containing a restricted number of discrete values  
2704 where each discrete value is named and unique. Ref. ISO 21961:2003, 013

2705 The value of SensorState MUST be integer .

2706 integer Enumeration:

2707 5.2.107 SerialNumber

2708 serial number associated with Component , Asset , or Device .

2709 5.2.108 SpecificationLimit

2710 set of limits defining a range of values designating acceptable performance for a variable.

2711 The Entry key MUST be one or more from the SpecificationLimitResult  
2712 keys.

2713 SpecificationLimitResult keys:

2714 • UpperLimit

2715 upper conformance boundary for a variable.

2716 Note: immediate concern or action may be required.

2717 The value ofUpperLimit MUST befloat .

2718 • Nominal

2719 ideal or desired value for a variable.

2720 The value ofNominal MUST befloat .

2721 • LowerLimit

2722 lower conformance boundary for a variable.

2723 Note: immediate concern or action may be required.

2724 The value ofLowerLimit MUST befloat .

2725 5.2.109 SpindleInterlock

2726 indication of the status of the spindle for a piece of equipment when power has been  
2727 removed and it is free to rotate.

2728 SpindleInterlockEnum Enumeration:

2729 • ACTIVE

2730 power has been removed and the spindle cannot be operated.

2731 • INACTIVE

2732 spindle has not been deactivated.

2733 5.2.110 ToolAssetId

2734 identifier of an individual tool asset.

2735 5.2.111 ToolGroup

2736 identifier for the tool group associated with a specific tool. Commonly used to designate  
2737 spare tools.

2738 5.2.112 <<deprecated>> ToolId

2739 identifier of the tool currently in use for a given path .

2740 DEPRECATED in Version 1.2.0 See TOOL\_ASSET\_ID

2741 5.2.113 ToolNumber

2742 identifier assigned by the Controller component to a cutting tool when in use by a  
2743 piece of equipment.

2744 5.2.114 ToolOffset

2745 reference to the tool offset variables applied to the active cutting tool.

2746 The value of ToolOffset MUST be float .

2747 A subType MUST always be specified.

2748 5.2.114.1 Subtypes of ToolOffset

2749 • LENGTH

2750 reference to a length type tool offset variable.

2751 • RADIAL

2752 reference to a radial type tool offset variable.

2753 5.2.115 ToolOffsets

2754 tabular representation of properties of each addressable tool offset.

2755 5.2.116 TransferCount

2756 accumulation of the number of times an operation has attempted to, or is planned to attempt  
2757 to, transfer materials, parts, or other items from one location to another.

2758 The defaultsubType of TransferCount is ALL.

2759 The value ofTransferCount MUST beinteger .

2760 5.2.116.1 Subtypes of TransferCount

2761 • ABORTED

2762 accumulation of actions or activities that were attempted, but terminated before they  
2763 could be completed.

2764 • ALL

2765 accumulation of all actions, items, or activities being counted independent of the  
2766 outcome.

2767 • BAD

2768 accumulation of actions, items, or activities being counted that do not conform to  
2769 speci cation or expectation.

2770 • COMPLETE

2771 accumulation of actions, items, or activities that have been completed, independent  
2772 of the outcome.

2773 • FAILED

2774 accumulation of actions, items, or activities being counted that do not conform to  
2775 speci cation or expectation.

2776 • GOOD

2777 accumulation of actions, items, or activities being counted that conform to speci -  
2778 cation or expectation.

- 2779 • REMAINING
- 2780 accumulation of actions, items, or activities yet to be counted.
- 2781 • TARGET
- 2782 goal of the operation or process.

### 2783 5.2.117 Translation

- 2784 three space linear displacement of an object or coordinate system relative to a Cartesian
- 2785 coordinate system
- 2786 The units of Translation MUST be MILLIMETER\_3D.
- 2787 The value of Translation MUST be a list of float of size 0..3 .

### 2788 5.2.118 Uncertainty

- 2789 uncertainty specified by UncertaintyType .
- 2790 The value of Uncertainty MUST be double .

### 2791 5.2.119 UncertaintyType

- 2792 method used to compute standard uncertainty
- 2793 The value of UncertaintyType MUST be one of the UncertaintyTypeEnum
- 2794 enumeration.
- 2795 UncertaintyTypeEnum Enumeration:

- 2796 • COMBINED
- 2797 combined standard uncertainty
- 2798 • MEAN
- 2799 standard uncertainty using arithmetic mean or average the observation. Ref. JCGM
- 2800 100:2008 4.2

2801 5.2.120 UnloadCount

2802 accumulation of the number of times an operation has attempted to, or is planned to attempt  
2803 to, unload materials, parts, or other items.

2804 The default subType of UnloadCount is ALL.

2805 The value of UnloadCount MUST be integer .

2806 5.2.120.1 Subtypes of UnloadCount

2807 • ABORTED

2808 accumulation of actions or activities that were attempted, but terminated before they  
2809 could be completed.

2810 • ALL

2811 accumulation of all actions, items, or activities being counted independent of the  
2812 outcome.

2813 • BAD

2814 accumulation of actions, items, or activities being counted that do not conform to  
2815 specification or expectation.

2816 • COMPLETE

2817 accumulation of actions, items, or activities that have been completed, independent  
2818 of the outcome.

2819 • FAILED

2820 accumulation of actions, items, or activities being counted that do not conform to  
2821 specification or expectation.

2822 • GOOD

2823 accumulation of actions, items, or activities being counted that conform to speci -  
2824 cation or expectation.

2825 • REMAINING

2826 accumulation of actions, items, or activities yet to be counted.

2827 • TARGET

2828 goal of the operation or process.

2829 5.2.121 User

2830 identifier of the person currently responsible for operating the piece of equipment.

2831 A subType MUST always be specified.

2832 5.2.121.1 Subtypes of User

2833 • MAINTENANCE

2834 identifier of the person currently responsible for performing maintenance on the  
2835 piece of equipment.

2836 • OPERATOR

2837 identifier of the person currently responsible for operating the piece of equipment.

2838 • SET\_UP

2839 identifier of the person currently responsible for preparing a piece of equipment for  
2840 production or restoring the piece of equipment to a neutral state after production.

2841 5.2.122 ValveState

2842 state of a valve is one of open, closed, or transitioning between the states.

2843 ValveStateEnum Enumeration:

2844 • CLOSED

2845 ValveState where flow is not possible, the aperture is static, and the valve is  
2846 completely shut.

2847 • CLOSING

2848 valve is transitioning from an OPEN state to a CLOSED state.

2849 • OPEN

2850 ValveState where flow is allowed and the aperture is static.

2851 Note: For a binary value OPEN indicates the valve has the maximum  
2852 possible aperture.

2853 • OPENING

2854 valve is transitioning from a CLOSED state to an OPEN state.



2855 5.2.122.1 Subtypes of ValveState

2856 • ACTUAL

2857 measured or reported value of an observation.

2858 • PROGRAMMED

2859 directive value without offsets and adjustments.

2860 5.2.123 Variable

2861 data whose meaning may change over time due to changes in the operation of a piece of  
2862 equipment or the process being executed on that piece of equipment.

2863 5.2.124 WaitState

2864 indication of the reason that Execution is reporting a value of WAIT.

2865 When Execution result is not WAIT, the isUnavailable property of Wait-  
2866 State MUST be true .

2867 WaitStateEnum Enumeration:

2868 • MATERIAL\_LOAD

2869 execution is waiting while material is being loaded.

2870 • MATERIAL\_UNLOAD

2871 execution is waiting while material is being unloaded.

2872 • PART\_LOAD

2873 execution is waiting while one or more discrete workpieces are being loaded.

2874 • PART\_UNLOAD

2875 execution is waiting while one or more discrete workpieces are being unloaded.

2876 • PAUSING

2877 execution is waiting while the equipment is pausing but the piece of equipment has  
2878 not yet reached a fully paused state.

- 2879 • POWERING\_DOWN
- 2880 execution is waiting while the equipment is powering down but has not fully reached
- 2881 a stopped state.
  
- 2882 • POWERING\_UP
- 2883 execution is waiting while the equipment is powering up and is not currently avail-
- 2884 able to begin producing parts or products.
  
- 2885 • RESUMING
- 2886 execution is waiting while the equipment is resuming the production cycle but has
- 2887 not yet resumed execution.
  
- 2888 • SECONDARY\_PROCESS
- 2889 execution is waiting while another process is completed before the execution can
- 2890 resume.
  
- 2891 • TOOL\_LOAD
- 2892 execution is waiting while a tool or tooling is being loaded.
  
- 2893 • TOOL\_UNLOAD
- 2894 execution is waiting while a tool or tooling is being unloaded.

#### 2895 5.2.125 Wire

2896 identifier for the type of wire used as the cutting mechanism in Electrical Discharge Ma-  
2897 chining or similar processes.

#### 2898 5.2.126 WorkOffset

2899 reference to offset variables for a work piece or part.

#### 2900 5.2.127 WorkOffsets

2901 tabular representation of properties of each addressable work offset.

2902 5.2.128 WorkholdingId

2903 identifier for the current workholding or part clamp in use by a piece of equipment.

2904 5.3 Sample Types

2905 This section provides semantic information for sample types.

2906 5.3.1 Acceleration

2907 positive rate of change of velocity.

2908 The units of Acceleration MUST be MILLIMETER/SECOND<sup>2</sup>.

2909 The default subType of Acceleration is ACTUAL

2910 5.3.1.1 Subtypes of Acceleration

2911 • ACTUAL

2912 measured or reported value of an observation.

2913 • COMMANDED

2914 directive value including adjustments such as an offset or overrides.

2915 • PROGRAMMED

2916 directive value without offsets and adjustments.

2917 5.3.2 AccumulatedTime

2918 accumulated time for an activity or event.

2919 The units of AccumulatedTime MUST be SECOND

2920 5.3.3 <<deprecated>> Amperage

2921 strength of electrical current.

2922 DEPRECATED in Version 1.6 Replaced by AMPERAGE\_AC and AMPERAGE\_DC

2923 The units of Amperage MUST be AMPERE

2924 5.3.3.1 Subtypes of Amperage

2925 • ACTUAL

2926 measured or reported value of an observation.

2927 DEPRECATED in Version 1.6

2928 • ALTERNATING

2929 measurement of alternating voltage or current.

2930 If not specified further in statistic, defaults to RMS voltage.

2931 DEPRECATED in Version 1.6

2932 • DIRECT

2933 measurement of DC current or voltage.

2934 DEPRECATED in Version 1.6

2935 • TARGET

2936 goal of the operation or process.

2937 DEPRECATED in Version 1.6

2938 5.3.4 AmperageAC

2939 electrical current that reverses direction at regular short intervals.

2940 The units of AmperageAC MUST be AMPERE

2941 A subtype MUST always be specified.

2942 5.3.4.1 Subtypes of AmperageAC

- 2943 • ACTUAL
- 2944 measured or reported value of an observation.
- 2945 • COMMANDED
- 2946 directive value including adjustments such as an offset or overrides.
- 2947 • PROGRAMMED
- 2948 directive value without offsets and adjustments.

2949 5.3.5 AmperageDC

- 2950 electric current owing in one direction only.
- 2951 The units of AmperageDC MUST be AMPERE
- 2952 A subType MUST always be speci ed.

2953 5.3.5.1 Subtypes of AmperageDC

- 2954 • ACTUAL
- 2955 measured or reported value of an observation.
- 2956 • COMMANDED
- 2957 directive value including adjustments such as an offset or overrides.
- 2958 • PROGRAMMED
- 2959 directive value without offsets and adjustments.

2960 5.3.6 Angle

- 2961 angular position.
- 2962 The units of Angle MUST be DEGREE

2963 5.3.6.1 Subtypes of Angle

- 2964 • ACTUAL
- 2965 measured or reported value of an observation.
- 2966 • COMMANDED
- 2967 directive value including adjustments such as an offset or overrides.

2968 5.3.7 AngularAcceleration

2969 positive rate of change of angular velocity.

2970 The units of AngularAcceleration MUST be DEGREE/SECOND

2971 The default subType of AngularAcceleration is ACTUAL

2972 5.3.7.1 Subtypes of AngularAcceleration

- 2973 • ACTUAL
- 2974 measured or reported value of an observation.
- 2975 • COMMANDED
- 2976 directive value including adjustments such as an offset or overrides.
- 2977 • PROGRAMMED
- 2978 directive value without offsets and adjustments.

2979 5.3.8 AngularDeceleration

2980 negative rate of change of angular velocity.

2981 The units of AngularDeceleration MUST be DEGREE/SECOND

2982 The default subType of AngularDeceleration is ACTUAL

2983 5.3.8.1 Subtypes of AngularDeceleration

- 2984 • ACTUAL
- 2985 measured or reported value of an observation.
- 2986 • COMMANDED
- 2987 directive value including adjustments such as an offset or overrides.
- 2988 • PROGRAMMED
- 2989 directive value without offsets and adjustments.

2990 5.3.9 AngularVelocity

2991 rate of change of angular position.

2992 The units of AngularVelocity MUST be DEGREE/SECOND

2993 5.3.10 AssetUpdateRate

2994 average rate of change of values for assets in the MTConnect streams.

2995 The average is computed over a rolling window defined by the implementation.

2996 The units of AssetUpdateRate MUST be COUNT/SECOND

2997 5.3.11 AxisFeedrate

2998 feedrate of a linear axis.

2999 The units of AxisFeedrate MUST be MILLIMETER/SECOND

3000 5.3.11.1 Subtypes of AxisFeedrate

- 3001 • ACTUAL
- 3002 measured or reported value of an observation.

- 3003 • COMMANDED
- 3004 directive value including adjustments such as an offset or overrides.
- 3005 • JOG
- 3006 relating to momentary activation of a function or a movement.
- 3007 DEPRECATION WARNING : May be deprecated in the future.
- 3008 • OVERRIDE
- 3009 operator's overridden value.
- 3010 • PROGRAMMED
- 3011 directive value without offsets and adjustments.
- 3012 • RAPID
- 3013 performing an operation faster or in less time than nominal rate.

### 3014 5.3.12 BatteryCapacity

- 3015 maximum rated charge a battery is capable of maintaining based on the battery discharging  
3016 at a specified current over a specified time period.
- 3017 The units of BatteryCapacity MUST be COULOMB
- 3018 The default subtype of BatteryCapacity is ACTUAL

#### 3019 5.3.12.1 Subtypes of BatteryCapacity

- 3020 • ACTUAL
- 3021 measured or reported value of an observation.
- 3022 • TARGET
- 3023 goal of the operation or process.



### 3024 5.3.13 BatteryCharge

3025 value of the battery's present capacity expressed as a percentage of the battery's maximum  
3026 rated capacity.

3027 The units of BatteryCharge MUST be PERCENT

3028 The default subType of BatteryCharge is ACTUAL

#### 3029 5.3.13.1 Subtypes of BatteryCharge

3030 • ACTUAL  
3031 measured or reported value of an observation.

3032 • TARGET  
3033 goal of the operation or process.

### 3034 5.3.14 CapacityFluid

3035 fluid capacity of an object or container.

3036 The units of CapacityFluid MUST be MILLILITER .

### 3037 5.3.15 CapacitySpatial

3038 geometric capacity of an object or container.

3039 The units of CapacitySpatial MUST be CUBIC\_MILLIMETER.

### 3040 5.3.16 ChargeRate

3041 value of the current being supplied to the component for the purpose of charging.

3042 The units of ChargeRate MUST be AMPERE

3043 The default subType of ChargeRate is ACTUAL

3044 5.3.16.1 Subtypes of ChargeRate

- 3045 • ACTUAL
- 3046 measured or reported value of an observation.
- 3047 • TARGET
- 3048 goal of the operation or process.

3049 5.3.17 Concentration

3050 percentage of one component within a mixture of components.

3051 The units of Concentration MUST be PERCENT

3052 5.3.18 Conductivity

3053 ability of a material to conduct electricity.

3054 The units of Conductivity MUST be SIEMENS/METER

3055 5.3.19 CuttingSpeed

3056 speed difference (relative velocity) between the cutting mechanism and the surface of the  
3057 workpiece it is operating on.

3058 The units of CuttingSpeed MUST be MILLIMETER/SECOND

3059 5.3.19.1 Subtypes of CuttingSpeed

- 3060 • ACTUAL
- 3061 measured or reported value of an observation.
- 3062 • COMMANDED
- 3063 directive value including adjustments such as an offset or overrides.

- 3064 • PROGRAMMED
- 3065 directive value without offsets and adjustments.

### 3066 5.3.20 Deceleration

3067 negative rate of change of velocity.

3068 The units of Deceleration MUST be MILLIMETER/SECOND.

3069 The default subType of Deceleration is ACTUAL

#### 3070 5.3.20.1 Subtypes of Deceleration

- 3071 • ACTUAL
- 3072 measured or reported value of an observation.
- 3073 • COMMANDED
- 3074 directive value including adjustments such as an offset or overrides.
- 3075 • PROGRAMMED
- 3076 directive value without offsets and adjustments.

### 3077 5.3.21 Density

3078 volumetric mass of a material per unit volume of that material.

3079 The units of Density MUST be MILLIGRAM/CUBIC\_MILLIMETER.

### 3080 5.3.22 DepositionAccelerationVolumetric

3081 rate of change in spatial volume of material deposited in an additive manufacturing pro-  
3082 cess.

3083 The units of DepositionAccelerationVolumetric MUST be CUBIC\_MILLIMETER/SECOND.

3084 5.3.22.1 Subtypes of DepositionAccelerationVolumetric

- 3085 • ACTUAL

3086 measured or reported value of an observation.

- 3087 • COMMANDED

3088 directive value including adjustments such as an offset or overrides.

3089 5.3.23 DepositionDensity

3090 density of the material deposited in an additive manufacturing process per unit of volume.

3091 Theunits of DepositionDensity MUST beMILLIGRAM/CUBIC\_MILLIMETER.

3092 5.3.23.1 Subtypes of DepositionDensity

- 3093 • ACTUAL

3094 measured or reported value of an observation.

- 3095 • COMMANDED

3096 directive value including adjustments such as an offset or overrides.

3097 5.3.24 DepositionMass

3098 mass of the material deposited in an additive manufacturing process.

3099 Theunits of DepositionMass MUST beMILLIGRAM.

3100 5.3.24.1 Subtypes of DepositionMass

- 3101 • ACTUAL

3102 measured or reported value of an observation.

- 3103 • COMMANDED

3104 directive value including adjustments such as an offset or overrides.

3105 5.3.25 DepositionRateVolumetric

3106 rate at which a spatial volume of material is deposited in an additive manufacturing pro-  
3107 cess.

3108 Theunits of DepositionRateVolumetric MUST beCUBIC\_MILLIMETER/SECOND

3109 5.3.25.1 Subtypes of DepositionRateVolumetric

3110 • ACTUAL

3111 measured or reported value of an observation.

3112 • COMMANDED

3113 directive value including adjustments such as an offset or overrides.

3114 5.3.26 DepositionVolume

3115 spatial volume of material to be deposited in an additive manufacturing process.

3116 Theunits of DepositionVolume MUST beCUBIC\_MILLIMETER.

3117 5.3.26.1 Subtypes of DepositionVolume

3118 • ACTUAL

3119 measured or reported value of an observation.

3120 • COMMANDED

3121 directive value including adjustments such as an offset or overrides.

3122 5.3.27 DewPoint

3123 temperature at which moisture begins to condense, corresponding to saturation for a given  
3124 absolute humidity.

3125 Theunits of DewPoint MUST beCELSIUS.

3126 5.3.28 Diameter

3127 dimension of a diameter.

3128 The units of Diameter MUST be MILLIMETER.

3129 5.3.29 DischargeRate

3130 value of current being drawn from the component .

3131 The units of DischargeRate MUST be AMPERE

3132 The default subType of DischargeRate is ACTUAL

3133 5.3.29.1 Subtypes of DischargeRate

3134 • ACTUAL

3135 measured or reported value of an observation.

3136 • TARGET

3137 goal of the operation or process.

3138 5.3.30 Displacement

3139 change in position of an object.

3140 The units of Displacement MUST be MILLIMETER.

3141 5.3.31 DisplacementAngular

3142 absolute value of the change in angular position around a vector

3143 Note: The displacement vector MAY be defined by the motion of the owning  
3144 Component .

3145 The units of DisplacementAngular MUST be DEGREE

3146 5.3.32 DisplacementLinear

3147 absolute value of the change in position along a vector.

3148 Note: The displacement vector **MAY** be defined by the motion of the owning  
3149 Component .

3150 The units of DisplacementLinear **MUST** be MILLIMETER.

3151 5.3.33 ElectricalEnergy

3152 Wattage used or generated by a component over an interval of time.

3153 The units of ElectricalEnergy **MUST** be WATT\_SECOND

3154 5.3.34 EquipmentTimer

3155 amount of time a piece of equipment or a sub-part of a piece of equipment has performed  
3156 specific activities.

3157 The units of EquipmentTimer **MUST** be SECOND

3158 A subType **MUST** always be specified.

3159 5.3.34.1 Subtypes of EquipmentTimer

3160 • DELAY

3161 elapsed time of a temporary halt of action.

3162 • LOADED

3163 time that the sub-parts of a piece of equipment are under load.

3164 Example: For traditional machine tools, this is a measurement of the time that the  
3165 cutting tool is assumed to be engaged with the part.

- 3166      • OPERATING  
3167      time that the major sub-parts of a piece of equipment are powered or performing any  
3168      activity whether producing a part or product or not.  
3169      Example: For traditional machine tools, this includes WORKING plus idle time.
- 3170      • POWERED  
3171      time that primary power is applied to the piece of equipment and, as a minimum, the  
3172      controller or logic portion of the piece of equipment is powered and functioning or  
3173      components that are required to remain on are powered.  
3174      Example: Heaters for an extrusion machine that are required to be powered even  
3175      when the equipment is turned off.
- 3176      • WORKING  
3177      time that a piece of equipment is performing any activity the equipment is active and  
3178      performing a function under load or not.  
3179      Example: For traditional machine tools, this includes LOADED plus rapid moves,  
3180      tool changes, etc.

### 3181 5.3.35 FillLevel

3182 amount of a substance remaining compared to the planned maximum amount of that sub-  
3183 stance.

3184 The units of FillLevel MUST be PERCENT

### 3185 5.3.36 Flow

3186 rate of flow of a fluid.

3187 The units of Flow MUST be LITER/SECOND.

### 3188 5.3.37 FollowingError

3189 difference between actual and commanded position at any specific point in time during a  
3190 motion.

3191 The units of FollowingError MUST be COUNT



3192 5.3.37.1 Subtypes of FollowingError

- 3193 • ACTUAL
- 3194 measured or reported value of an observation.

3195 5.3.38 FollowingErrorAngular

3196 angular difference between the commanded encoder/resolver position and the actual en-  
3197 coder/resolver position at any speci ed point in time during a motion.

3198 Theunits of FollowingErrorAngular MUST beDEGREE

3199 5.3.38.1 Subtypes of FollowingErrorAngular

- 3200 • ACTUAL
- 3201 measured or reported value of an observation.

3202 5.3.39 FollowingErrorLinear

3203 difference between the commanded encoder/resolver position and the actual encoder/re-  
3204 solver position at any speci ed point in time during a motion.

3205 Theunits of FollowingErrorLinear MUST beMILLIMETER.

3206 5.3.39.1 Subtypes of FollowingErrorLinear

- 3207 • ACTUAL
- 3208 measured or reported value of an observation.

3209 5.3.40 Frequency

3210 number of occurrences of a repeating event per unit time.

3211 Theunits of Frequency MUST beHERTZ

3212 5.3.41 <<deprecated>> GlobalPosition

3213 position in three-dimensional space.

3214 DEPRECATED in Version 1.1.

3215 Theunits of GlobalPosition MUST beMILLIMETER.

3216 5.3.41.1 Subtypes of GlobalPosition

3217 • ACTUAL

3218 measured or reported value of an observation.

3219 • COMMANDED

3220 directive value including adjustments such as an offset or overrides.

3221 5.3.42 GravitationalAcceleration

3222 acceleration relative to Earth's gravity of 9.80665 METER/SECOND<sup>2</sup>

3223 Theunits of GravitationalAcceleration MUST beGRAVITATIONAL\_ACCELERATION

3224 5.3.43 GravitationalForce

3225 force relative to earth's gravity.

3226 Note: Mass GravitationalAcceleration

3227 Theunits of GravitationalForce MUST beGRAVITATIONAL\_FORCE

3228 5.3.44 HumidityAbsolute

3229 amount of water vapor expressed in grams per cubic meter.

3230 Theunits of HumidityAbsolute MUST beGRAM/CUBIC\_METER

3231 5.3.44.1 Subtypes of HumidityAbsolute

- 3232 • ACTUAL

3233 measured or reported value of an observation.

- 3234 • COMMANDED

3235 directive value including adjustments such as an offset or overrides.

3236 5.3.45 HumidityRelative

3237 amount of water vapor present expressed as a percent to reach saturation at the same tem-  
3238 perature.

3239 The units of HumidityRelative MUST be PERCENT

3240 5.3.45.1 Subtypes of HumidityRelative

- 3241 • ACTUAL

3242 measured or reported value of an observation.

- 3243 • COMMANDED

3244 directive value including adjustments such as an offset or overrides.

3245 5.3.46 HumiditySpecific

3246 ratio of the water vapor present over the total weight of the water vapor and air present  
3247 expressed as a percent.

3248 The units of HumiditySpecific MUST be PERCENT

3249 5.3.46.1 Subtypes of HumiditySpecific

- 3250 • ACTUAL

3251 measured or reported value of an observation.

- 3252 • COMMANDED
- 3253 directive value including adjustments such as an offset or overrides.

### 3254 5.3.47 Length

- 3255 length of an object.
- 3256 The units of Length MUST be MILLIMETER.

#### 3257 5.3.47.1 Subtypes of Length

- 3258 • REMAINING
- 3259 remaining total length of an object.
- 3260 • STANDARD
- 3261 standard or original length of an object.
- 3262 • USEABLE
- 3263 remaining usable length of an object.

### 3264 5.3.48 <<deprecated>> Level

- 3265 level of a resource.
- 3266 DEPRECATED in Version 1.2 See FILL\_LEVEL .
- 3267 The units of Level MUST be PERCENT

### 3268 5.3.49 LinearForce

- 3269 force applied to a mass in one direction only.
- 3270 The units of LinearForce MUST be NEWTON

3271 5.3.50 Load

3272 actual versus the standard rating of a piece of equipment.

3273 The units of Load MUST be PERCENT

3274 5.3.51 Mass

3275 mass of an object(s) or an amount of material.

3276 The units of Mass MUST be KILOGRAM

3277 5.3.52 ObservationUpdateRate

3278 average rate of change of values for data items in the MTConnect streams. The average is  
3279 computed over a rolling window defined by the implementation.

3280 The units of ObservationUpdateRate MUST be COUNT/SECOND

3281 5.3.53 Openness

3282 percentage open where 100% is fully open and 0% is fully closed.

3283 The units of Openness MUST be PERCENT

3284 5.3.54 Orientation

3285 angular position of a plane or vector relative to a cartesian coordinate system

3286 The units of Orientation MUST be DEGREE\_3D

3287 The value of Orientation MUST be a list of float of size 0..3 .

3288 5.3.54.1 Subtypes of Orientation

- 3289 • ACTUAL
- 3290 measured or reported value of an observation.
- 3291 • COMMANDED
- 3292 directive value including adjustments such as an offset or overrides.

### 3293 5.3.55 PH

3294 acidity or alkalinity of a solution.

3295 The units of PH MUST be PH

### 3296 5.3.56 PathFeedrate

3297 feedrate for the axes, or a single axis, associated with a component.

3298 The units of PathFeedrate MUST be MILLIMETER/SECOND

#### 3299 5.3.56.1 Subtypes of PathFeedrate

- 3300 • ACTUAL
- 3301 measured or reported value of an observation.
- 3302 • COMMANDED
- 3303 directive value including adjustments such as an offset or overrides.
- 3304 • JOG
- 3305 relating to momentary activation of a function or a movement.
- 3306 DEPRECATION WARNING : May be deprecated in the future.
- 3307 • OVERRIDE
- 3308 operator's overridden value.
- 3309 DEPRECATED in Version 1.3
- 3310 • PROGRAMMED
- 3311 directive value without offsets and adjustments.

- 3312 • RAPID
- 3313 performing an operation faster or in less time than nominal rate.

### 3314 5.3.57 PathFeedratePerRevolution

3315 feedrate for the axes, or a single axis.

3316 The units of PathFeedratePerRevolution MUST be MILLIMETER/REVO-  
3317 LUTION.

#### 3318 5.3.57.1 Subtypes of PathFeedratePerRevolution

- 3319 • ACTUAL
- 3320 measured or reported value of an observation.
- 3321 • COMMANDED
- 3322 directive value including adjustments such as an offset or overrides.
- 3323 • PROGRAMMED
- 3324 directive value without offsets and adjustments.

### 3325 5.3.58 PathPosition

3326 position of a control point associated with a Controller or a Path .

3327 The units of PathPosition MUST be MILLIMETER\_3D.

3328 The value of PathPosition MUST be a list of float of size 0..3 .

#### 3329 5.3.58.1 Subtypes of PathPosition

- 3330 • ACTUAL
- 3331 measured or reported value of an observation.
- 3332 • COMMANDED
- 3333 directive value including adjustments such as an offset or overrides.

- 3334 • PROBE
- 3335 position provided by a measurement probe.
- 3336 DEPRECATION WARNING : May be deprecated in the future.
- 3337 • TARGET
- 3338 goal of the operation or process.

### 3339 5.3.59 Position

- 3340 point along an axis in cartesian coordinate system
- 3341 The units of Position MUST be MILLIMETER.

#### 3342 5.3.59.1 Subtypes of Position

- 3343 • ACTUAL
- 3344 measured or reported value of an observation.
- 3345 • COMMANDED
- 3346 directive value including adjustments such as an offset or overrides.
- 3347 • PROGRAMMED
- 3348 directive value without offsets and adjustments.
- 3349 • TARGET
- 3350 goal of the operation or process.

### 3351 5.3.60 PositionCartesian

- 3352 point in a cartesian coordinate system
- 3353 The units of PositionCartesian MUST be MILLIMETER\_3D.
- 3354 The value of PositionCartesian MUST be a list of float of size 0..3 .



3355 5.3.61 PowerFactor

3356 ratio of real power owing to a load to the apparent power in that AC circuit.

3357 The units of PowerFactor MUST be PERCENT

3358 5.3.62 Pressure

3359 force per unit area measured relative to atmospheric pressure.

3360 Commonly referred to as gauge pressure.

3361 The units of Pressure MUST be PASCAL

3362 5.3.63 PressureAbsolute

3363 The force per unit area measured relative to a vacuum.

3364 The units of PressureAbsolute MUST be PASCAL

3365 5.3.64 PressurizationRate

3366 change of pressure per unit time.

3367 The units of PressurizationRate MUST be PASCAL/SECOND

3368 5.3.64.1 Subtypes of PressurizationRate

3369 • ACTUAL

3370 measured or reported value of an observation.

3371 • COMMANDED

3372 directive value including adjustments such as an offset or overrides.

3373 • PROGRAMMED

3374 directive value without offsets and adjustments.

3375 5.3.65 ProcessTimer

3376 amount of time a piece of equipment has performed different types of activities associated  
3377 with the process being performed at that piece of equipment.

3378 The units of ProcessTimer MUST be SECOND

3379 A subType MUST always be specified.

3380 5.3.65.1 Subtypes of ProcessTimer

3381 • DELAY

3382 elapsed time of a temporary halt of action.

3383 • PROCESS

3384 time from the beginning of production of a part or product on a piece of equipment  
3385 until the time that production is complete for that part or product on that piece of  
3386 equipment.

3387 This includes the time that the piece of equipment is running, producing parts or  
3388 products, or in the process of producing parts.

3389 5.3.66 Resistance

3390 degree to which a substance opposes the passage of an electric current.

3391 The units of Resistance MUST be OHM

3392 5.3.67 RotaryVelocity

3393 rotational speed of a rotary axis.

3394 The units of RotaryVelocity MUST be REVOLUTION/MINUTE

3395 5.3.67.1 Subtypes of RotaryVelocity

- 3396 • ACTUAL
- 3397 measured or reported value of an observation.
- 3398 • COMMANDED
- 3399 directive value including adjustments such as an offset or overrides.
- 3400 • OVERRIDE
- 3401 The operators overridden value.
- 3402 • PROGRAMMED
- 3403 directive value without offsets and adjustments.

### 3404 5.3.68 SettlingError

- 3405 difference between actual and commanded position at the end of a motion.
- 3406 The units of SettlingError MUST be COUNT

#### 3407 5.3.68.1 Subtypes of SettlingError

- 3408 • ACTUAL
- 3409 measured or reported value of an observation.

### 3410 5.3.69 SettlingErrorAngular

- 3411 angular difference between the commanded encoder/resolver position, and the actual en-
- 3412 coder/resolver position when motion is complete.
- 3413 The units of SettlingErrorAngular MUST be DEGREE

#### 3414 5.3.69.1 Subtypes of SettlingErrorAngular

- 3415 • ACTUAL
- 3416 measured or reported value of an observation.

3417 5.3.70 SettlingErrorLinear

3418 difference between the commanded encoder/resolver position, and the actual encoder/re-  
3419 solver position when motion is complete.

3420 The units of SettlingErrorLinear MUST be MILLIMETER.

3421 5.3.70.1 Subtypes of SettlingErrorLinear

3422 • ACTUAL

3423 measured or reported value of an observation.

3424 5.3.71 SoundLevel

3425 sound level or sound pressure level relative to atmospheric pressure.

3426 The units of SoundLevel MUST be DECIBEL.

3427 The default subType of SoundLevel is A\_SCALE

3428 5.3.71.1 Subtypes of SoundLevel

3429 • A\_SCALE

3430 A Scale weighting factor. This is the default weighting factor if no factor is speci ed

3431 • B\_SCALE

3432 B Scale weighting factor

3433 • C\_SCALE

3434 C Scale weighting factor

3435 • D\_SCALE

3436 D Scale weighting factor

3437 • NO\_SCALE

3438 No weighting factor on the frequency scale

3439 5.3.72 <<deprecated>> SpindleSpeed

3440 rotational speed of the rotary axis.

3441 DEPRECATED in Version 1.2 Replaced by ROTARY\_VELOCITY

3442 The units of SpindleSpeed MUST be REVOLUTION/MINUTE

3443 5.3.72.1 Subtypes of SpindleSpeed

3444 • ACTUAL

3445 measured or reported value of an observation.

3446 DEPRECATED in Version 1.3

3447 • COMMANDED

3448 directive value including adjustments such as an offset or overrides.

3449 DEPRECATED in Version 1.3

3450 • OVERRIDE

3451 operator's overridden value.

3452 DEPRECATED in Version 1.3

3453 5.3.73 Strain

3454 amount of deformation per unit length of an object when a load is applied.

3455 The units of Strain MUST be PERCENT

3456 5.3.74 Temperature

3457 degree of hotness or coldness measured on a definite scale.

3458 The units of Temperature MUST be CELSIUS.

3459 5.3.75 Tension

3460 force that stretches or elongates an object.

3461 The units of Tension MUST be NEWTON

3462 5.3.76 Tilt

3463 angular displacement.

3464 The units of Tilt MUST be MICRO\_RADIAN

3465 5.3.77 Torque

3466 turning force exerted on an object or by an object.

3467 The units of Torque MUST be NEWTON\_METER

3468 5.3.78 Velocity

3469 rate of change of position of a component .

3470 The units of Velocity MUST be MILLIMETER/SECOND

3471 5.3.79 Viscosity

3472 fluid's resistance to flow.

3473 The units of Viscosity MUST be PASCAL\_SECOND

3474 5.3.80 VoltAmpere

3475 apparent power in an electrical circuit, equal to the product of root-mean-square (RMS)

3476 voltage and RMS current (commonly referred to as VA).

3477 The units of VoltAmpere MUST be VOLT\_AMPERE

### 3478 5.3.81 VoltAmpereReactive

3479 reactive power in an AC electrical circuit (commonly referred to as VAR).

3480 The units of VoltAmpereReactive MUST be VOLT\_AMPERE\_REACTIVE

### 3481 5.3.82 <<deprecated>> Voltage

3482 electrical potential between two points.

3483 DEPRECATED in Version 1.6 Replaced by VOLTAGE\_AC and VOLTAGE\_DC

3484 The units of Voltage MUST be VOLT.

#### 3485 5.3.82.1 Subtypes of Voltage

- 3486 • ACTUAL

3487 measured or reported value of an observation.

3488 DEPRECATED in Version 1.6

- 3489 • ALTERNATING

3490 alternating voltage or current.

3491 If not specified further in statistic, defaults to RMS voltage.

3492 DEPRECATED in Version 1.6

- 3493 • DIRECT

3494 DC current or voltage.

3495 DEPRECATED in Version 1.6

- 3496 • TARGET

3497 goal of the operation or process.

3498 DEPRECATED in Version 1.6

3499 5.3.83 VoltageAC

3500 electrical potential between two points in an electrical circuit in which the current period-  
3501 ically reverses direction.

3502 The units of VoltageAC MUST be VOLT.

3503 A subType MUST always be specified.

3504 5.3.83.1 Subtypes of VoltageAC

3505 • ACTUAL

3506 measured or reported value of an observation.

3507 • COMMANDED

3508 directive value including adjustments such as an offset or overrides.

3509 • PROGRAMMED

3510 directive value without offsets and adjustments.

3511 5.3.84 VoltageDC

3512 electrical potential between two points in an electrical circuit in which the current is uni-  
3513 directional.

3514 The units of VoltageDC MUST be VOLT.

3515 A subType MUST always be specified.

3516 5.3.84.1 Subtypes of VoltageDC

3517 • ACTUAL

3518 measured or reported value of an observation.

3519 • COMMANDED

3520 directive value including adjustments such as an offset or overrides.

3521 • PROGRAMMED

3522 directive value without offsets and adjustments.



3523 5.3.85 VolumeFluid

3524 uid volume of an object or container.

3525 Theunits of VolumeFluid MUST beMILLILITER .

3526 5.3.85.1 Subtypes of VolumeFluid

3527 • ACTUAL

3528 measured or reported value of an observation.

3529 • CONSUMED

3530 reported or measured value of the amount used in the manufacturing process.

3531 • ENDED

3532 boundary when an activity or an event terminates.

3533 • PART

3534 reported or measured value of amount included in ~~the~~.

3535 • START

3536 boundary when an activity or an event commences.

3537 • WASTE

3538 reported or measured value of the amount discarded.

3539 5.3.86 VolumeSpatial

3540 geometric volume of an object or container.

3541 Theunits of VolumeSpatial MUST beCUBIC\_MILLIMETER.

3542 5.3.86.1 Subtypes of VolumeSpatial

3543 • ACTUAL

3544 measured or reported value of an observation.

- 3545 • CONSUMED
- 3546 reported or measured value of the amount used in the manufacturing process.
- 3547 • ENDED
- 3548 boundary when an activity or an event terminates.
- 3549 • PART
- 3550 reported or measured value of amount included in ~~part~~.
- 3551 • START
- 3552 boundary when an activity or an event commences.
- 3553 • WASTE
- 3554 reported or measured value of the amount discarded

### 3555 5.3.87 Wattage

- 3556 power owing through or dissipated by an electrical circuit or piece of equipment.
- 3557 The units of Wattage MUST be WATT

#### 3558 5.3.87.1 Subtypes of Wattage

- 3559 • ACTUAL
- 3560 measured or reported value of an observation.
- 3561 • TARGET
- 3562 goal of the operation or process.

### 3563 5.3.88 XDimension

- 3564 dimension of an entity relative to the X direction of the referenced coordinate system.
- 3565 The units of XDimension MUST be MILLIMETER.

3566 5.3.89 YDimension

3567 dimension of an entity relative to the Y direction of the referenced coordinate system.

3568 Theunits of YDimension MUST beMILLIMETER.

3569 5.3.90 ZDimension

3570 dimension of an entity relative to the Z direction of the referenced coordinate system.

3571 Theunits of ZDimension MUST beMILLIMETER.

## 3572 6 Profile

3573 MTConnect Profile is a profile that extends the Systems Modeling Language (SysML)  
3574 metamodel for the MTConnect domain using additional data types and stereotypes.

### 3575 6.1 DataTypes

Figure 13: DataTypes

#### 3576 6.1.1 boolean

3577 primitive type.

#### 3578 6.1.2 ID

3579 string that represents an identifier (ID).

#### 3580 6.1.3 string

3581 primitive type.

#### 3582 6.1.4 float

3583 primitive type.

3584 **6.1.5 datetime**

3585 string that represents timestamp in ISO 8601 format.

3586 **6.1.6 integer**

3587 primitive type.

3588 **6.1.7 xlinktype**

3589 string that represents the type of an XLink element. ~~Spec~~<https://www.w3.org/TR/xlink11/> .

3591 **6.1.8 xslang**

3592 string that represents a language tag. ~~Spec~~<https://www.ietf.org/rfc/rfc4646>.  
3593 txt .

3594 **6.1.9 SECOND**

3595 float that represents time in seconds.

3596 **6.1.10 IDREF**

3597 string that represents a reference to an

3598 **6.1.11 xlinkhref**

3599 string that represents the locator attribute of an XLink element. ~~Spec~~<https://www.w3.org/TR/xlink11/> .  
3600

3601 6.1.12 x509

3602 string that represents an x509 data block. Ref ISO/IEC 9594-8:2020

3603 6.1.13 int32

3604 32-bit integer.

3605 6.1.14 int64

3606 64-bit integer.

3607 6.1.15 version

3608 series of four numeric values, separated by a decimal point, representing a minor,  
3609 and revision number of the MTCConnect Standard and the revision number of a specific  
3610 schema

3611 6.1.16 uint32

3612 32-bit unsigned integer.

3613 6.1.17 uint64

3614 64-bit unsigned integer.

3615 6.1.18 binary

3616 base-2 numeral system or binary numeral system represented by two digits: "0" and "1".

3617 6.1.19 double

3618 primitive type.

## 3619 6.2 Stereotypes

3620 6.2.1 organizer

3621 element that organizes other elements of a type.

3622 6.2.2 deprecated

3623 element that has been deprecated.

3624 6.2.3 extensible

3625 enumeration that can be extended.

3626 6.2.4 informative

3627 element that is descriptive and non-normative.

3628 6.2.5 valueType

3629 extends SysML<<ValueType>> to includeClass as a value type.

3630 6.2.6 normative

3631 element that has been added to the standard.

3632 6.2.7 observes

3633 association in which ~~Component~~ makes ~~Observations~~ about an observable ~~Data~~Item



Figure 14: Stereotypes

## 3634 Appendices

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## 3685 B XML Schema Diagrams

### 3686 B.1 Observations Schema Diagrams

3687 SeeStreams element inMTConnectStreams schema.

3688 SeeDeviceStream element inMTConnectStreams schema.

3689 SeeComponentStream element inMTConnectStreams schema.

3690 SeeSample element inMTConnectStreams schema.

3691 SeeEvent element inMTConnectStreams schema.

3692 SeeCondition element inMTConnectStreams schema.

### 3693 B.2 Representation Schema Diagrams

3694 SeeAbsTimeSeries element inMTConnectStreams schema.

3695 SeePartCountDiscrete element inMTConnectStreams schema.

3696 SeeVariableDataSet element inMTConnectStreams schema.

3697 SeeEntry element inMTConnectStreams schema.

3698 SeeWorkOffsetTable element inMTConnectStreams schema.

## 3699 C XML Examples

### 3700 C.1 DeviceStream Example

#### Example 1: DeviceStream Example

```

3701 1 <Streams>
3702 2   <DeviceStream name="M12346" uuid="M8010W4194N" >
3703 3     <ComponentStream component="Device" name="M12346" componentId="
3704     d1" >
3705 4       <Events>
3706 5         <Availability dataItemId="avail" sequence="156" timestamp="
3707         2021-10-01T14:26:38.668505Z" >AVAILABLE</Availability>

```

```

3708 6      <AssetChanged assetType="CuttingTool" dataItemId="d1\
3709          textunderscore_asset\textunderscore_chg" sequence="75570"
3710          timestamp="2021-10-07T05:08:53.870206Z">M8010W4194N1
3711          .120</AssetChanged>
3712 7      <AssetRemoved assetType="CuttingTool" dataItemId="d1\
3713          textunderscore_asset\textunderscore_rem" sequence="140"
3714          timestamp="2021-10-01T11:40:08.101461Z">UNAVAI LABEL</
3715          AssetRemoved>
3716 8      </Events>
3717 9      </ComponentStream>
3718 10     <ComponentStream component="Controller" name="controller"
3719          componentId="cont">
3720 11     <Events>
3721 12         <EmergencyStop dataItemId="estop" sequence="159" timestamp="
3722         2021-10-01T14:26:38.66869Z">ARMED</EmergencyStop>
3723 13         </Events>
3724 14     <Samples>
3725 15         <AccumulatedTime dataItemId="cut\textunderscore_time"
3726         sequence="75437" timestamp="2021-10-07T05:08:28.221704Z">
3727         1763070.0</AccumulatedTime>
3728 16         </Samples>
3729 17     <Condition>
3730 18         <Unavailable dataItemId="cont\textunderscore_system"
3731         sequence="72" timestamp="2021-10-11T21:04:03.251999Z" type="
3732         SYSTEM"/>
3733 19         <Warning dataItemId="cont\textunderscore_system" nativecode=
3734         "313" nativeSeverity="50" sequence="75573" timestamp="
3735         2021-10-07T05:08:58.518317Z" type="LOGIC\textunderscore_
3736         PROGRAM">PALLET ARM DOWN RS. MALF.</Warning>
3737 20     </Condition>
3738 21     </ComponentStream>
3739 22     <ComponentStream component="Path" name="path" componentId="path1
3740         ">
3741 23     <Events>
3742 24         <Execution dataItemId="execution" name="execution" sequence=
3743         "222623" timestamp="2021-10-12T06:04:32.761198Z">INTERRUPTED</
3744         Execution>
3745 25         <VariableDataSet count="2" dataItemId="cvars" sequence="
3746         126513" timestamp="2021-10-12T03:57:31.106559Z">
3747 26             <Entry key="100">66.3314</Entry>
3748 27             <Entry key="101">167.2</Entry>
3749 28         </VariableDataSet>
3750 29         <WorkOffsetTable count="2" dataItemId="woffset" sequence="
3751         222101" timestamp="2021-10-12T06:04:11.990531Z">
3752 30             <Entry key="G53.1">
3753 31                 <Cell key="X">1</Cell>
3754 32                 <Cell key="Y">2</Cell>
3755 33                 <Cell key="Z">3</Cell>
3756 34             </Entry>
3757 35             <Entry key="G53.2">
3758 36                 <Cell key="X">4</Cell>

```

```

3759 37         <Cell key="Y">5</Cell >
3760 38         <Cell key="Z">6</Cell >
3761 39     </Entry>
3762 40 </WorkOffsetTable>
3763 41 </Events>
3764 42 <Samples>
3765 43     <CuttingSpeed dataItemId="cspeed" sequence="112" timestamp="
3766 2021-10-07T05:08:28.221704Z" subType="ACTUAL">UNAVAILABLE</
3767 CuttingSpeed>
3768 44 </Samples>
3769 45 <Condition>
3770 46     <Normal dataItemId="path\textunderscore_system" sequence="
3771 153" timestamp="2021-10-11T21:04:03.262845Z" type="SYSTEM"/>
3772 47 </Condition>
3773 48 </ComponentStream>
3774 49 </DeviceStream>
3775 50 </Streams>

```

## 3776 C.2 Observations made for DataItem Example

### Example 2: MTConnectDevices Response Document

```

3777 1 <Components>
3778 2   <Controller id="cont" name="controller">
3779 3     <DataItems>
3780 4       <DataItem category="EVENT" id="estop" name="estop" type="
3781 EMERGENCY\textunderscore_STOP"/>
3782 5     </DataItems>
3783 6   </Controller>
3784 7 </Components>

```

### Example 3: MTConnectStreams Response Document

```

3785 1 <ComponentStream component="Controller" name="controller"
3786   componentId="cont">
3787 2   <Events>
3788 3     <EmergencyStop dataItemId="estop" sequence="159" timestamp="
3789 2021-10-01T14:26:38.66869Z">ARMED</EmergencyStop>
3790 4   </Events>
3791 5 </ComponentStream>

```

## 3792 C.3 Sample Example

### Example 4: Sample Example

```

3793 1 <Samples>

```

```

3794 2 <Accumul atedTi me dataItemId="cut\textunderscore_time" sequence="
3795 75437" timestamp="2021-10-07T05:08:28.221704Z">1763070.0</
3796 Accumul atedTi me>
3797 3 <CuttingSpeed dataItemId="cspeed" sequence="112" timestamp="
3798 2021-10-07T05:08:28.221704Z" subType="ACTUAL">UNAVAI LABLE</
3799 Cutti ngSpeed>
3800 4 </Sampl es>

```

## 3801 C.4 Event Example

### Example 5: Event Example

```

3802 1 <Events>
3803 2 <Avai lability dataItemId="avail" sequence="156" timestamp="
3804 2021-10-01T14:26:38.668505Z">AVAI LABLE</Avai lability>
3805 3 <AssetRemoved assetType="CuttingTool" dataItemId="d1\
3806 textunderscore_asset\textunderscore_rem" sequence="140"
3807 timestamp="2021-10-01T11:40:08.101461Z">UNAVAI LABLE</
3808 AssetRemoved>
3809 4 </Events>

```

## 3810 C.5 Condition Example

3811 Condition types are represented differently in XML when compared to Sample and  
3812 Event types. The element name is the condition state of the Condition type in Pascal  
3813 Case. The name of the Condition type is represented by the attribute type.

3814 If the condition state is unavailable then the element name is represented by Unavail-  
3815 able.

### Example 6: Condition Example

```

3816 1 <Condi ti on>
3817 2 <Unavai lable dataItemId="cont\textunderscore_system" sequence="72"
3818 timestamp="2021-10-11T21:04:03.251999Z" type="SYSTEM"/>
3819 3 <Normal dataItemId="path\textunderscore_system" sequence="153"
3820 timestamp="2021-10-11T21:04:03.262845Z" type="SYSTEM"/>
3821 4 <Warni ng dataItemId="cont\textunderscore_system" nativecode="313"
3822 nativeSeverity="50" sequence="75573" timestamp="2021-10-07T05
3823 :08:58.518317Z" type="LOGIC\textunderscore_PROGRAM">PALLET ARM
3824 DOWN RS. MALF. </Warni ng>
3825 5 </Condi ti on>

```

## 3826 C.6 DataSet Example

### Example 7: DataSet Example

```

3827 1 <Events>
3828 2   <VariableDataSet count="2" dataItemId="cvars" sequence="126513"
3829   timestamp="2021-10-12T03:57:31.106559Z">
3830 3     <Entry key="100">66.3314</Entry>
3831 4     <Entry key="101">167.2</Entry>
3832 5   </VariableDataSet>
3833 6 </Events>

```

## 3834 C.7 Table Example

### Example 8: Table Example

```

3835 1 <Events>
3836 2   <WorkOffsetTable count="2" dataItemId="woffset" sequence="222101"
3837   timestamp="2021-10-12T06:04:11.990531Z">
3838 3     <Entry key="G53.1">
3839 4       <Cell key="X">1</Cell>
3840 5       <Cell key="Y">2</Cell>
3841 6       <Cell key="Z">3</Cell>
3842 7     </Entry>
3843 8     <Entry key="G53.2">
3844 9       <Cell key="X">4</Cell>
3845 10      <Cell key="Y">5</Cell>
3846 11      <Cell key="Z">6</Cell>
3847 12     </Entry>
3848 13   </WorkOffsetTable>
3849 14 </Events>

```