



Health Informatics—Device Interoperability

Part 10441: Personal Health Device Communication—Device Specialization—Cardiovascular Fitness and Activity Monitor

IEEE Engineering in Medicine and Biology Society

Developed by the
IEEE 11073™ Standards Committee

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STANDARDS

Health Informatics—Device Interoperability

Part 10441: Personal Health Device Communication—Device Specialization—Cardiovascular Fitness and Activity Monitor

Developed by the

IEEE 11073 Standards Committee

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IEEE Engineering in Medicine and Biology Society

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IEEE SA Standards Board

Abstract: Within the context of the ISO/IEEE 11073 family of standards for device communication, a normative definition of communication between personal telehealth cardiovascular fitness and activity monitor devices and managers (e.g., cell phones, personal computers, personal health appliances, and set top boxes) in a manner that enables plug-and-play interoperability is established in this standard. Appropriate portions of existing standards are leveraged including ISO/IEEE 11073 terminology, information models, application profile standards, and transport standards. The use of specific term codes, formats, and behaviors in telehealth environments restricting optionality in base frameworks in favor of interoperability is specified. A common core of communication functionality for personal telehealth cardiovascular fitness and activity monitor devices is defined in this standard.

Keywords: activity monitor, cardiovascular fitness, IEEE 11073-10441™, medical device communication, personal health devices

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Introduction

This introduction is not part of IEEE Std 11073-10441-2025, Health Informatics—Device Interoperability—Part 10441: Personal Health Device Communication—Device Specialization—Cardiovascular Fitness and Activity Monitor.

Within the context of the ISO/IEEE 11073 family of standards for device communication, a normative definition of communication between personal telehealth cardiovascular fitness and activity monitor devices and managers (e.g., cell phones, personal computers, personal health appliances, and set top boxes) is established in this standard in a manner that enables plug-and-play interoperability. Appropriate portions of existing standards are leveraged including ISO/IEEE 11073 terminology, information models, application profile standards, and transport standards. The use of specific term codes, formats, and behaviors in telehealth environments restricting optionality in base frameworks in favor of interoperability is specified. A common core of communication functionality for personal telehealth cardiovascular fitness and activity monitor devices is defined in this standard.

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Part 10441: Personal Health Device Communication—Device Specialization—Cardiovascular Fitness and Activity Monitor

1. Overview

1.1 Scope

Within the context of the ISO/IEEE 11073 family of standards for device communication, this standard establishes a normative definition of the communication between personal cardiovascular fitness and activity monitoring devices and managers (e.g., cell phones, personal computers, personal health appliances, and set top boxes) in a manner that enables plug-and-play interoperability. It leverages appropriate portions of existing standards including ISO/IEEE 11073 terminology and information models. It specifies the use of specific term codes, formats, and behaviors in telehealth environments, restricting optionality in base frameworks in favor of interoperability. This standard defines a common core of communication functionality for personal telehealth, cardiovascular fitness, and activity monitor devices. In this context, cardiovascular fitness and activity monitor devices are being used broadly to cover cardiovascular fitness and activity monitor devices that measure physical actions and the body's various physiological responses to that activity.

1.2 Purpose

This standard addresses a need for an openly defined, independent standard for controlling information exchange to and from personal health devices and managers (e.g., cell phones, personal computers, personal health appliances, and set top boxes). Interoperability is the key to growing the potential market for these devices and to enabling people to be better informed participants in the management of their health.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).^{6, 7}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

1.4 Context

See ISO/IEEE 11073-20601⁸ for an overview of the environment within which this standard is written.

This document defines the device specialization for the cardiovascular fitness and activity monitor being a specific agent type, and it provides a description of the device concepts, its capabilities, and its implementation according to this standard.

This standard is based on ISO/IEEE 11073-20601, which in turn draws information from both ISO/IEEE 11073-10201 [B1]⁹ and ISO/IEEE 11073-20101 [B2]. The medical device encoding rules (MDERs) used within this standard are fully described in ISO/IEEE 11073-20601.

The object classes and attributes in this standard are identified by nomenclature codes. Each code consists of a reference identifier (RefID) string and an integer code value. By using a consistent nomenclature, interoperability is enhanced as all implementations maintain the same semantic meaning for the numeric codes. This standard leverages the existing nomenclature codes in ISO/IEEE 11073-10101. Between this standard, ISO/IEEE 11073-10101, ISO/IEEE 11073-20601, and other ISO/IEEE Std 11073-104zz, all required nomenclature codes for implementation are documented. New codes may be defined in newer versions/revisions of each of these documents. In the case of a conflict, when one term code has been assigned to two separate semantic concepts with different RefIDs, in general the oldest definition in actual use should take precedence. The same policy applies when one RefID has two different code values assigned in different specifications. The resolution of such conflicts shall be determined through joint action by the responsible working groups and other stakeholders, and any corrective action shall be published as corrigenda.

NOTE—In this standard ISO/IEEE P11073-104zz is used to refer to the collection of device specialization standards that utilize ISO/IEEE 11073-20601, where zz can be any number from 01 to 99, inclusive.¹⁰

⁶ The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

⁷ The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

⁸ Information on references can be found in Clause 2.

⁹ The numbers in brackets correspond to those of the bibliography in Annex A.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so that each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ISO/IEEE 11073-20601, Health informatics—Personal health device communication—Application profile—Optimized Exchange Protocol.^{11, 12, 13}

ISO/IEEE 11073-10101, Health informatics—Point-of-care medical device communication—Part 10101: Nomenclature.

See Annex A for all informative material referenced by this standard.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.¹⁴

agent: A node that collects and transmits personal health data to an associated manager.

class: In object-oriented modeling, a class describes the attributes, methods, and events that objects instantiated from the class utilize.

device: A physical apparatus implementing either an agent or a manager role.

handle: An unsigned 16-bit number that is locally unique and identifies one of the object instances within an agent.

manager: A node receiving data from one or more agent systems. Some examples of managers include cellular phones, health appliances, set top boxes, or computer systems.

mass: An intrinsic property of matter that can be measured using the effect of the gravitational field on an object.

obj-handle: *See:* **handle**.

object: In object-oriented modeling, a particular instantiation of a class. The instantiation realizes attributes, methods, and events from the class.

personal health device (PHD): A device used in personal health applications.

personal telehealth device: *See:* **personal health device**.

¹¹ The IEEE standards or products referred to in this clause are trademarks of The Institute of Electrical and Electronics Engineers, Inc.

¹² This publication is available from The Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).

¹³ ISO/IEC publications are available from the ISO Central Secretariat (<http://www.iso.org/>). ISO publications are also available in the United States from the American National Standards Institute (<http://www.ansi.org/>).

¹⁴ *IEEE Standards Dictionary Online* is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

proportional integral mode (PIM): This mode is defined as the integral of a variable with respect to one of its axes over the duration of the session or subsession. It is used in actigraphy to provide an activity measurement.

root mean square (RMS): The square root of the average of the squares of a variable over the duration of the session or subsession.

time above threshold (TAT): This is defined as the total time that an input variable exceeds a given threshold value over the duration of the session or subsession. It is used in actigraphy to provide an activity measurement.

weight: The force that results from the exertion of gravity on an object. The weight is directly proportional to the mass of the object. However, in the healthcare domain, the term *body weight* is typically used to denote the body mass of a person. This notation applies also to this standard.

3.2 Acronyms and abbreviations

2D	two-dimensional
3D	three-dimensional
APDU	application protocol data unit
ASN.1	Abstract Syntax Notation One
DIM	domain information model
ICS	implementation conformance statement
MDC	medical device communication
MDS	medical device system
MOC	managed object class
PHD	personal health device
PIM	proportional integral mode
RPM	revolutions per minute
RMS	root mean square
RT-SA	real-time sample array
TAT	time above threshold
VMO	virtual medical object
VMS	virtual medical system

4. Introduction to ISO/IEEE 11073 personal health devices

4.1 General

This standard and the remainder of the series of ISO/IEEE 11073 personal health device (PHD) standards fit in the larger context of the ISO/IEEE 11073 series of standards. The full suite of standards enables agents to interconnect and interoperate with managers and with computerized healthcare information systems. See ISO/IEEE 11073-20601 for a description of the guiding principles for this series of ISO/IEEE 11073 personal health device standards.

ISO/IEEE 11073-20601 supports the modeling and implementation of an extensive set of personal health devices (PHDs). This standard defines aspects of the cardiovascular fitness and activity monitor device. It describes all aspects necessary to implement the application layer services and data exchange protocol between an ISO/IEEE 11073 PHD cardiovascular fitness and activity monitor agent and a manager. This standard defines a subset of the objects and functionality contained in ISO/IEEE 11073-20601 and extends and adds definitions where appropriate. All new definitions are given in Annex B in Abstract Syntax Notation One (ASN.1) [B3]. All nomenclature codes referenced in this standard are collected in Annex C.

4.2 Introduction to ISO/IEEE 11073-20601 modeling constructs

4.2.1 General

The ISO/IEEE 11073 series of standards, and in particular ISO/IEEE 11073-20601, is based on an object-oriented systems management paradigm. The overall system model is divided into three principal components: the domain information model (DIM), the service model, and the communication model. See ISO/IEEE 11073-20601 for a detailed description of the modeling constructs.

4.2.2 Domain information model

The DIM is a hierarchical model that describes an agent as a set of objects. These objects and their attributes represent the elements that control behavior and report on the status of the agent and data that an agent can communicate to a manager. Communication between the agent and the manager is defined by the application protocol in ISO/IEEE 11073-20601.

4.2.3 Service model

The service model defines the conceptual mechanisms for the data exchange services. Such services are mapped to messages that are exchanged between the agent and the manager. Protocol messages within the ISO/IEEE 11073 series of standards are defined in ASN.1. The messages defined in ISO/IEEE 11073-20601 can coexist with messages defined in other standard application profiles defined in the ISO/IEEE 11073 series of standards.

4.2.4 Communication model

In general, the communication model supports the topology of one or more agents communicating over logical point-to-point connections to a single manager. For each logical point-to-point connection, the dynamic system behavior is defined by a connection state machine as specified in ISO/IEEE 11073-20601.

4.2.5 Implementing the models

An agent implementing this standard shall implement all mandatory elements of the information, service, and communication models as well as all conditional elements where the condition is met. The agent should implement the recommended elements, and it may implement any combination of the optional elements. A manager implementing this standard shall utilize at least one of the mandatory, conditional, recommended,

or optional elements. In this context, *utilize* means to use the element as part of the primary function of the manager device. For example, a manager whose primary function is to display data would need to display a piece of data in the element in order to utilize it.

4.3 Compliance with other standards

Devices that comply with this standard may also be required to comply with other domain and device specific standards that supersede the requirements of this standard with respect to issues including safety, reliability, and risk management. A user of this standard is expected to be familiar with all other such standards that apply and to comply with any higher specifications thus imposed.

Typically, medical devices should comply with the IEC 60601-1 [B4] base standards with respect to electrical and mechanical safety and any device-specific standard as might be defined in the IEC 60601-2 [B5] series of standards. Software aspects may apply through standards such as IEC 62304 [B6]. Devices that comply with this standard implement higher layers of network software and utilize lower layers as appropriate to the application. The requirements on performance of such applications and conformance are defined elsewhere and are outside the scope of this standard. Moreover, the use of any medical equipment is subject to risk assessment and risk management appropriate to the application. Relevant examples include ISO 14971 [B7] and IEC 80001-1 [B8]. The requirements of such risk assessment, risk management, and conformance are outside the scope of this standard. The applicable versions of the referenced safety related standards may differ by country.

5. Cardiovascular fitness and activity monitor device concepts and modalities

5.1 General concepts

Cardiovascular fitness and activity monitor agents measure the physical activity of an individual and report the physiological response to that activity. Agents include treadmills, exercise bikes, heart rate monitors, bike computers, pedometers, and overall activity/lifestyle monitors in the form of watches, bracelets, and rings. Although there is great variety in the forms of these agents, there is significant commonality and overlap in the measurements they make.

Agents of this type may generally report measures, such as steps during the day, or may be used to measure activity during an episode of a specific activity, called a *session* (see 6.9.3 for details), or a set of activities within a session, called *subsessions*.

One mode of operation is to report summaries of a session once the session is completed. The data associated with a session may vary greatly from agent to agent. Minimally, the session shall include the date and time of the session, as well as the duration of the session and the activity that was being performed during the session. In addition, a number of statistical metrics may be reported for the entire session, such as the total distance and mean speed.

Subsessions provide a mechanism to report periods of specific activity within the session, such as reporting information on individual laps, or separate phases of an activity. Subsessions may report a variety of statistical metrics for the entire subsession; such as the mean, maximum, or minimum values for the subsession (e.g., total distance and mean speed).

A second mode of operation is to report measures during the session and subsessions; either episodically with their timestamps and/or periodically at a given sampling period. This allows applications to display measures during sessions and subsessions. Statistical metrics may also be reported for the entire session and subsession, such as the total distance and mean speed.

Raw data that are generated at much higher frequencies (maybe hundreds of times per second) can also be collected during continuous monitoring sessions and transmitted to the manager. This type of data should use the ISO/IEEE 20601 real-time sample array (RT-SA) metric object, which is restricted to periodic sampling.

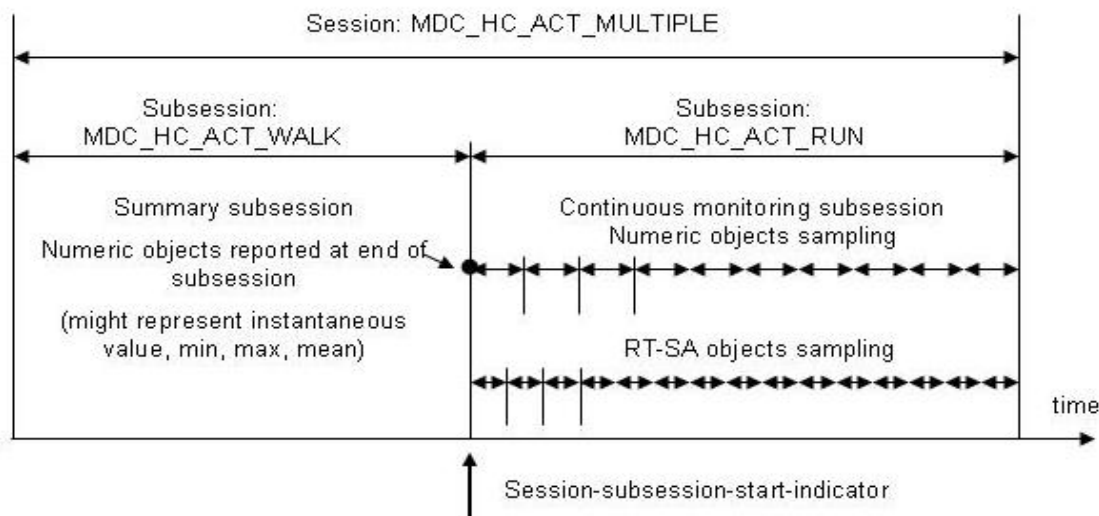


Figure 1—Sessions, subsessions, and reporting

Figure 1 provides an illustration of the session, subsessions, and their different methods of reporting data. In this example, a session with multiple subsessions comprises a walking subsession followed by a running subsession. The first subsession is a summary subsession and only provides a single measurement at the end of the subsession. This data point might represent the instantaneous value, the minimum, the maximum, or the average value of the subsession. The second subsession is started with the session-subsession-start-indicator marking a continuously monitoring subsession where data are reported periodically. As such, one set of measurements (such as the heart rate) is sampled at a given frequency using ISO/IEEE 20601 numeric metric objects, while a second set of measurements (such as accelerometer data) RT-SA objects might be sampled at another much higher frequency using ISO/IEEE 20601 RT-SA objects.

Session summaries are used in the pedometer profile (see Clause 11), whereas continuous session monitoring is mandatory for the activity monitor profile (see Clause 12).

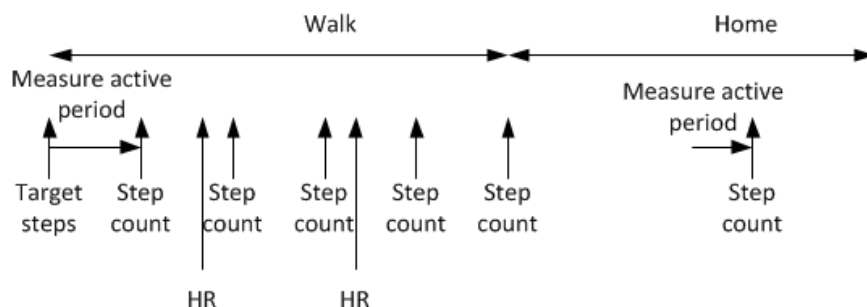


Figure 2—Simple real time reporting

Figure 2 shows how a simple agent may report observations in real time to a manager with a user interface. Note that aperiodic observations, such as a step count, shall include the period over which the observation was taken. This example shows how a target may be set in advance for the session or subsession.

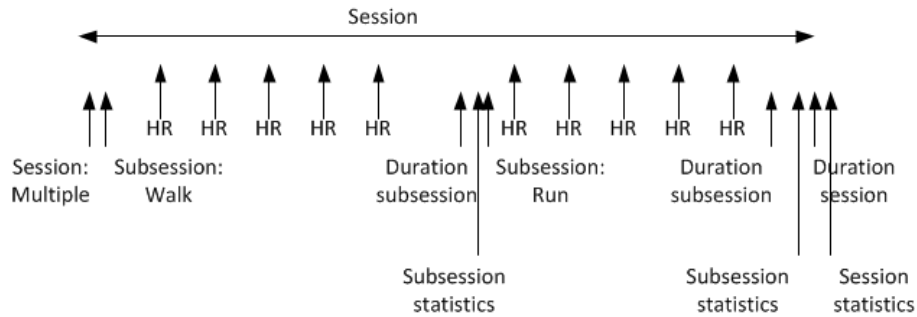


Figure 3—Reporting an activity as a session and subsessions

Figure 3 shows an example of a session of a training activity that includes a subsession of walking followed by a subsession of running. The start of the session and each subsession are denoted by the start event, and the end of the session and each subsession is denoted by reporting the duration. The heart rate is reported periodically, and statistics, such as mean and maximum heart rate, are given at the end of each subsession, and the session.

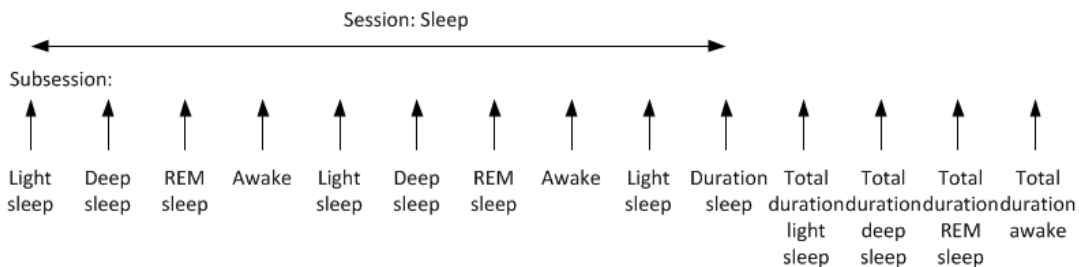


Figure 4—Sessions and subsessions to report sleep

Figure 4 shows an example of how activities during a period of sleep may be reported. This includes reporting the start time of each type of sleep during the session of sleep, and includes statistical reports of the session such as the total duration of each type of sleep.

Subclauses 5.2 through 5.55 present objects in alphabetical order for easy navigation of the document.

5.2 3D acceleration (numeric)

Three-dimensional (3D) vector components (X, Y, Z, and Z with gravity offset) of accelerometer sensor data. A vector is generated by the accelerometer and the components are reported together as a compound numeric.

5.3 3D acceleration (RT-SA)

Three-dimensional (3D) vector components (X, Y, Z, and Z with gravity offset) of accelerometer sensor data. A vector is generated at each clock sample of the accelerometer and the components are reported as separate streams of samples. These components might be used to construct a two-dimensional (2D) or 3D vector. Raw data are sometimes processed within devices like pedometers for calculation of fine trajectory, and spent energy.

5.4 3D angular acceleration (numeric)

3D vector components (X, Y, and Z), respectively, for pitch, roll, and yaw of angular accelerometer sensor (e.g., gyroscopes) data. A vector is generated by the gyroscope and the components are reported together as a compound numeric.

5.5 3D angular acceleration (RT-SA)

3D vector components (X, Y, and Z), respectively, for pitch, roll, and yaw of angular accelerometer sensor (e.g., gyroscope) data. A vector is generated at each clock sample of the gyroscope and the components are reported as separate streams of samples. These components might be used to construct a 2D or 3D vector. Raw data are sometimes processed within devices like gaming remote controls or activity monitors for fine trajectory calculation, stabilization, and so on.

5.6 Activity intensity (numeric)

This measurement reports the intensity of a certain activity. It is expected to be used as a supplement to the program identifier to describe the nature of the activity (e.g., slow running, moderate running, or fast running). The intensity of activity reports a percentage of intensity of this particular activity as compared with the top performance intensity. Calculation methods are known in the state of the art, e.g., running 70% could mean to run at 70% of the VO_2 max (maximum effort) capability, which can be approximated by the following formula:

$$\text{VO}_2 \text{ max} = \text{maximum recommended heart rate} \times 0.70$$

For calculation of the maximum recommended heart rate, see 5.29.

5.7 Age (numeric)

Age is a setting typically entered manually by the user. The age setting might be used by an agent for derived calculations (e.g., calculation of maximum recommended heart rate; see 5.29).

5.8 Altitude (numeric)

Altitude represents a point of elevation, relative to sea level.

5.9 Altitude gain (numeric)

While ascent time and distance (see 5.11) capture the distance and time spent gaining altitude, the measurement of altitude gain depicts the cumulative height gained during ascents since the start of a session or subsession.

If in Figure 5 a person traveled $a \rightarrow b \rightarrow c$, then both the altitude gain and the altitude loss would be bd . These values are equal because the start and finish for the route of travel are on the same elevation. However, if a person traveled from $a \rightarrow b$, then the altitude gain would be bd and the altitude loss would be zero.

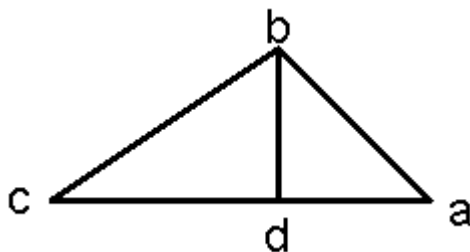


Figure 5—Distance and elevation profile

5.10 Altitude loss (numeric)

While descent time and distance (see 5.9) capture the distance and time spent losing altitude, the measurement of altitude loss depicts the cumulative height lost during descents since the start of a session or subsession.

If in Figure 5 a person traveled $a \rightarrow b \rightarrow c$, then both the altitude gain and the altitude loss would be bd . These values are equal because the start and finish for the route of travel are on the same elevation. However, if a person only traveled from $a \rightarrow b$, the altitude gain would be bd and the altitude loss would be zero.

5.11 Ascent time and distance (numeric)

The ascent time records the period spent gaining elevation since the start of a session or subsession and may be used to determine a measure of work expended. The ascent distance records the respective distances covered during those periods.

If in Figure 5 a person traveled $a \rightarrow b \rightarrow c$, then the ascent distance would be ab and the descent distance would be bc .

5.12 Body height (numeric)

Body height is a setting typically entered manually by the user. The height setting might be used by an agent for derived calculations (e.g., calculation of body mass index).

5.13 Blood oxygen (SpO_2) (numeric)

The blood oxygen level (SpO_2) is the measured hemoglobin binding sites in the bloodstream occupied by oxygen, normally given as percentage. It is measured from the plethysmogram, with the maximum value during a cardiac cycle being given. SpO_2 can be observed as an instantaneous value and the maximum, minimum, or mean values for a session or subsession.

5.14 Body weight (numeric)

Body weight is a setting typically entered manually by the user, although an agent may have the capability to measure this directly. The weight setting might be used by an agent for derived calculations (e.g., calculation of the energy expended during a jogging session).

5.15 Breathing rate (numeric)

The breathing rate can provide information on lung function in response to physical exertion. The breathing rate can either be calculated as the maximum, minimum, or mean values for a session or subsession or as an instantaneous value.

5.16 Cadence (numeric)

Cadence records the frequency of a repetitive action, such as the rate of revolution of the pedals of a bicycle or striding frequency of a runner or walker. Cadence is either recorded as the minimum, mean, or maximum values for a session or subsession or as an instantaneous value.

5.17 Calories ingested (numeric)

Calories ingested are an entry, either through manual means or through an agent having the capability to set it. This is the number of calories consumed or ingested by a person since the start of a session or subsession.

5.18 Carbohydrate calories ingested (numeric)

Carbohydrate calories ingested are an entry, either through manual means or through an agent having the capability to set it. This is the number of carbohydrate calories consumed or ingested by a person since the start of a session or subsession.

5.19 Descent time and distance (numeric)

The descent time records the period spent losing elevation since the start of a session or subsession and may be used to determine a measure of work expended. The descent distance records the respective distances covered during those periods.

If in Figure 5 a person traveled $a \rightarrow b \rightarrow c$, then the ascent distance would be ab and the descent distance would be bc .

5.20 Distance (numeric)

Distance defines the total distance covered since the start of a session and/or subsession. Distance may be specified as the actual distance such as meters or feet, or in more abstract concepts such as steps taken or flights of stairs climbed. In the latter case, the distance expressed in `MDC_DIM_STEP` is equivalent to a stride count measurement.

Using the distance and elevation profile shown in Figure 5, if a person were to travel $a \rightarrow b \rightarrow c$, the distance traveled would be $ab + bc$.

5.21 Energy expended (numeric)

This is the amount of energy expended since the start of a session or subsession.

5.22 Energy expended target range (numeric)

The energy expended target range is the value set for the energy expended during a period of physical exercise. The user should try to maintain their energy expended in this target range in order to achieve the training objective.

5.23 Estimated weight loss (numeric)

The estimated weight loss approximates the weight loss since the start of a session and/or subsession. Weight loss is a common goal for cardiovascular exercise. It is typically calculated by step counters and activity monitors as a derivation from energy expended. The state of the art reports several methods of calculation based on energy expended and weight.

5.24 Heart rate (numeric)

The heart rate is the number of beats of the heart in a period, normally given as beats per minute, and measured from the electrocardiogram (ECG). The heart rate can be observed as an instantaneous value and the maximum, minimum, or mean values for a session or subsession. The rate is a key indicator of physical exertion. In particular, the maximum observed heart rate is an important observation that might be used to calculate the VO_2 of a user.

5.25 Heart rate target (numeric)

The heart rate target is the value set as a target to control heart rate during a period of physical exercise. The user can set a single target value or an upper target, lower target, or a range. The user should try to attain the target and maintain their heart rate within the target range to achieve the training objective.

5.26 Incline (numeric)

This measurement represents the steepness of the incline being traveled either as a minimum, mean, or maximum value over a session or subsession or as an instantaneous value. A positive value means an incline and a negative one a decline. As such, the minimum incline gives the value of the steepest decline during the session or subsession.

5.27 Latitude (numeric)

This is the latitudinal (north/south) location of the person at a point in time.

5.28 Longitude (numeric)

This is the longitudinal (east/west) location of the person at a point in time.

5.29 Maximum recommended heart rate (numeric)

The maximum recommended heart rate is typically manually entered by the user (or the physician) or can be calculated. Its simplest estimation is given by the formula:

Maximum recommended heart rate = $220 - \text{Age}$

The maximum recommended heart rate can be useful in providing context for the other values like the maximum, minimum, and mean observed heart rates achieved during an exercise session.

5.30 Proportional integral mode (PIM) (numeric)

PIM is defined for a session or subsession as the integral of the absolute value of the 3D acceleration variable with respect to one of its axes over the duration of the session or subsession. It is used in actigraphy to provide an activity measurement for both sleep and activity periods.

Note that this PIM is not the one commonly defined by the IEEE in control systems as proportional integral mode.

5.31 Power (numeric)

Power is a measure of the work rate of a user. Power is measured as a minimum, mean, or maximum value over a session or subsession or as an instantaneous value.

5.32 Program identifier (enumeration)

This measurement identifies the exercise program used by the person during a session or subsession.

5.33 Pulse rate (numeric)

The pulse rate is the number of beats of the heart in a period, normally given as beats per minute and measured from the plethysmogram. The pulse rate can be observed as an instantaneous value and the maximum, minimum, or mean values for a session or subsession. The rate is a key indicator of physical exertion.

5.34 Resistance (numeric)

This measurement represents either the minimum, mean, or maximum resistance employed over a session or subsession or the instantaneous resistance. This measurement applies primarily to machines that apply variable resistance to a person doing an exercise.

5.35 Root mean square (RMS) (numeric)

RMS is defined for a session or subsession as the root mean squared of the 3D acceleration variable with respect to one of its axes over the duration of the session or subsession.

5.36 Session (enumeration)

A session defines an envelope that contains all the measurements associated with an episode of an activity/exercise. Each session reports the start date and start time of the episode and the activity in which the user has engaged during the episode.

5.37 Session duration (numeric)

The session duration reports the duration of an activity/exercise and shall be reported when a session is terminated. The session duration shall have a timestamp that denotes the end of the session. The session duration may include as the supplemental type the enumeration to identify the activity/exercise of the session that has terminated. Any statistical metrics shall be reported after the session duration has been reported.

5.38 Session duration target (numeric)

The session duration target reports the duration that is targeted for an activity/exercise and, if present, shall be reported when a session is started.

5.39 Sleep awake total duration (numeric)

The sleep awake total duration provides a summary of the total time awake during a session of sleep and shall be reported when a session of sleep is terminated. The sleep awake total duration shall have a timestamp that denotes the end of the sleep session.

5.40 Sleep deep total duration (numeric)

The sleep deep total duration provides a summary of the total time of deep sleep during a session of sleep and shall be reported when a session of sleep is terminated. The sleep deep total duration shall have a timestamp that denotes the end of the sleep session.

5.41 Sleep light total duration (numeric)

The sleep light total duration provides a summary of the total time of light sleep during a session of sleep and shall be reported when a session of sleep is terminated. The sleep light total duration shall have a timestamp that denotes the end of the sleep session.

5.42 Sleep REM total duration (numeric)

The sleep rapid eye movement (REM) total duration provides a summary of the total time of REM sleep during a session of sleep and shall be reported when a session of sleep is terminated. The sleep REM total duration shall have a timestamp that denotes the end of the sleep session.

5.43 Sleep total duration (numeric)

The sleep total duration provides a summary of the total time of sleep during a session of sleep and shall be reported when a session of sleep is terminated. The sleep total duration shall have a timestamp that denotes the end of the sleep session. Any statistical metrics shall be reported after the session duration and sleep total duration have been reported.

5.44 Slopes (numeric)

This is the number of slopes skied by a person since the start of the session or a subsession.

5.45 Speed (numeric)

Speed adds additional context to the work being done and is used to capture how fast the user moved over a distance (5.20). Speed is either reported as minimum, mean, or maximum speed for a session or subsession or as instantaneous speed.

5.46 Speed target range (numeric)

The speed target range is the value set for the speed during a period of physical exercise. The user should try to maintain their speed in this target range to achieve the training objective.

5.47 Stride length (numeric)

This is a measurement of the distance covered in a single stride/step when walking or running. It is either reported as a minimum, mean, or maximum value over a session or subsession or as an instantaneous value.

5.48 Subsession (enumeration)

The subsession defines the envelope that contains all the measurements associated with an activity/exercise that comprises a portion of the session. Each subsession defines its start date and start time; it also contains the activity in which the user has engaged during the subsession.

5.49 Subsession duration (numeric)

The subsession duration reports the duration of an activity/exercise within a session and shall be reported when a subsession is terminated. The subsession duration shall have a timestamp that denotes the end of the subsession. The subsession duration may include as the supplemental type the enumeration of the subsession that has terminated. Any statistical metrics shall be reported after the subsession duration has been reported and before any new subsession is started and the session duration is reported.

5.50 Subsession duration target (numeric)

The subsession duration target reports the duration targeted for an activity/exercise within a session, and, if present, shall be reported when a subsession is started, if present.

5.51 Subsession total duration (numeric)

The subsession total duration reports the cumulative duration of all subsessions of the same activity/exercise within a session and shall be reported when a subsession is terminated. The subsession duration shall have a timestamp that denotes the end of the session. The subsession duration shall include as the supplemental type the enumeration of the subsession being reported.

5.52 Sustained physical activity threshold (numeric)

This setting represents the amount of time a person shall be engaged in physical activity to be considered sustained physical activity, which is an important metric in determining a person's activity level.

5.53 Time above threshold (TAT) (numeric)

TAT is defined for a session or subsession as the total time that a variable exceeds a given threshold value over the duration of the session or subsession. Figure 6 shows an example for the TAT for the *z* axis for 3D acceleration.

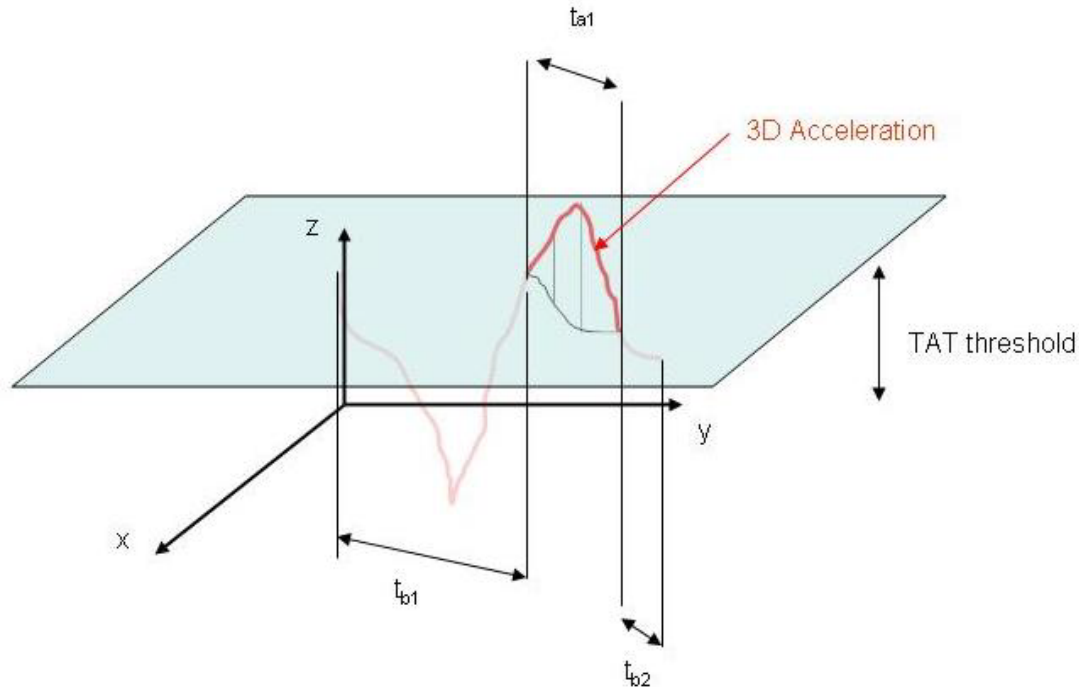


Figure 6—Time above threshold (monodimensional z)

5.54 TAT threshold (numeric)

The TAT threshold is the value applied in evaluating the corresponding TAT value. The TAT threshold may change between sessions or subsessions; in which case, the TAT threshold should be provided with every TAT value.

5.55 User exercise target and health status (enumeration)

This measurement identifies the user exercise target and health status during a session or subsession.

6. Cardiovascular fitness and activity monitor domain information model

6.1 Overview

This clause describes the domain information model of the cardiovascular fitness and activity monitor.

6.2 Class extensions

In this standard, no class extensions are defined with respect to ISO/IEEE 11073-20601.

6.3 Object instance diagram

The object instance diagram of the cardiovascular fitness and activity monitor domain information model, defined for the purposes of this standard, is shown in Figure 7.

The objects of the DIM, as shown in Figure 7 through Figure 12, are described in 6.4 through 6.13. This includes the medical device system (MDS) object (see 6.6), numeric objects (see 6.7), RT-SA objects (see 6.8), enumeration objects (see 6.9), PM-store objects (see 6.10), and scanner objects (see 6.11). See 6.12 for rules for extending the information model beyond elements as described in this standard. Each subclause that describes an object of the cardiovascular fitness and activity monitor contains the following information:

- The nomenclature code used to identify the class of the object. One example where this code is used is the configuration event, where the object class is reported for each object. This allows the manager to determine whether the class of the object being specified is a numeric, real-time sample array class, enumeration, scanner, or PM-store class.
- The attributes of the object. Each object has attributes that represent and convey information on the physical agent and its data sources. Each object has a handle attribute that identifies the object instance within an agent. Attribute values are accessed and modified using communication services such as GET and SET. Attribute types are defined using ASN.1. The ASN.1 definitions for new attribute types specific to this standard are in Annex B, and the ASN.1 definitions for existing attribute types referenced in this standard are in ISO/IEEE 11073-20601.
- The methods available on the object.
- The potential events generated by the object. The data are sent to the manager using events.
- The available services, such as getting or setting attributes.

The attributes for each class are defined in tables that specify the name of the attribute, its value, and its qualifier. The qualifiers are defined as follows:

- M—attribute is mandatory.
- C—attribute is conditional and depends on the condition stated in the Remark or Value column (if ISO/IEEE 11073-20601 is referenced, then it contains the conditions).
- R—attribute is recommended.
- NR—attribute is not recommended.
- O—attribute is optional.

Mandatory attributes shall be implemented by an agent. Conditional attributes shall be implemented if the condition applies and may be implemented otherwise. Recommended attributes should be implemented by the agent. Not recommended attributes should not be implemented by the agent. Optional attributes may be implemented by the agent. For attributes with qualifiers set to R or NR, underlying requirements stated in the Remark and Value column in ISO/IEEE 11073-20601 shall be followed. If any attribute (from the DIM of IEEE Std 11073-20601) is not included in the definition of that object in this standard, it shall not be included in that object by an implementation, unless it is a vendor-specific attribute extended according to 6.12.

An attribute is further qualified as static, dynamic, or observational. Static attributes shall not change value during the life of an association. Dynamic attributes have a value that may change during the life of an association. The dynamic attribute value should be sent at configuration time and shall be sent at or before the time when the value would be needed for interpreting a reported observation. Observational attributes have a value that may change during the life of an association. When a set of observational attribute values is received, these values are combined with the available context information (i.e., all related dynamic and static attribute values) to represent the observation at the observation time.

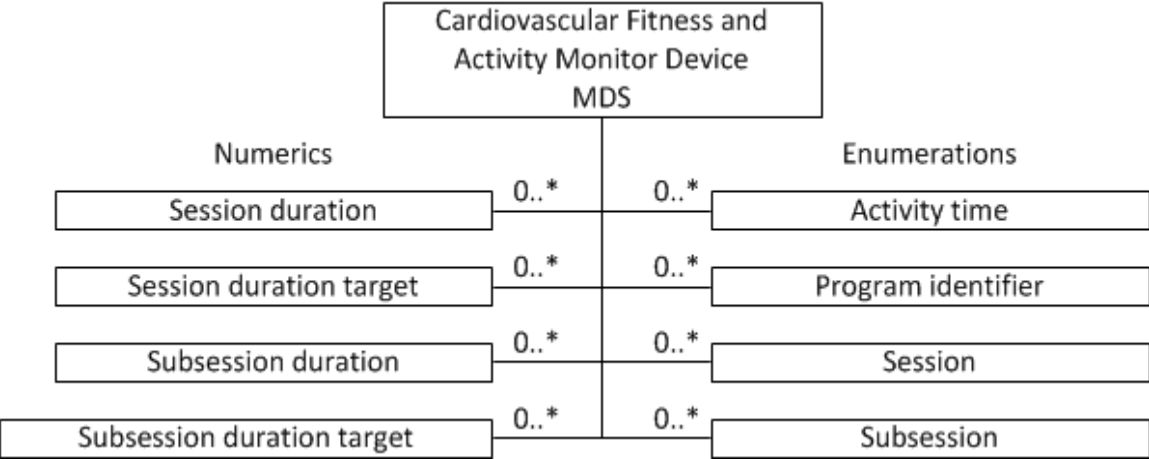


Figure 7—Instance diagram for session related objects

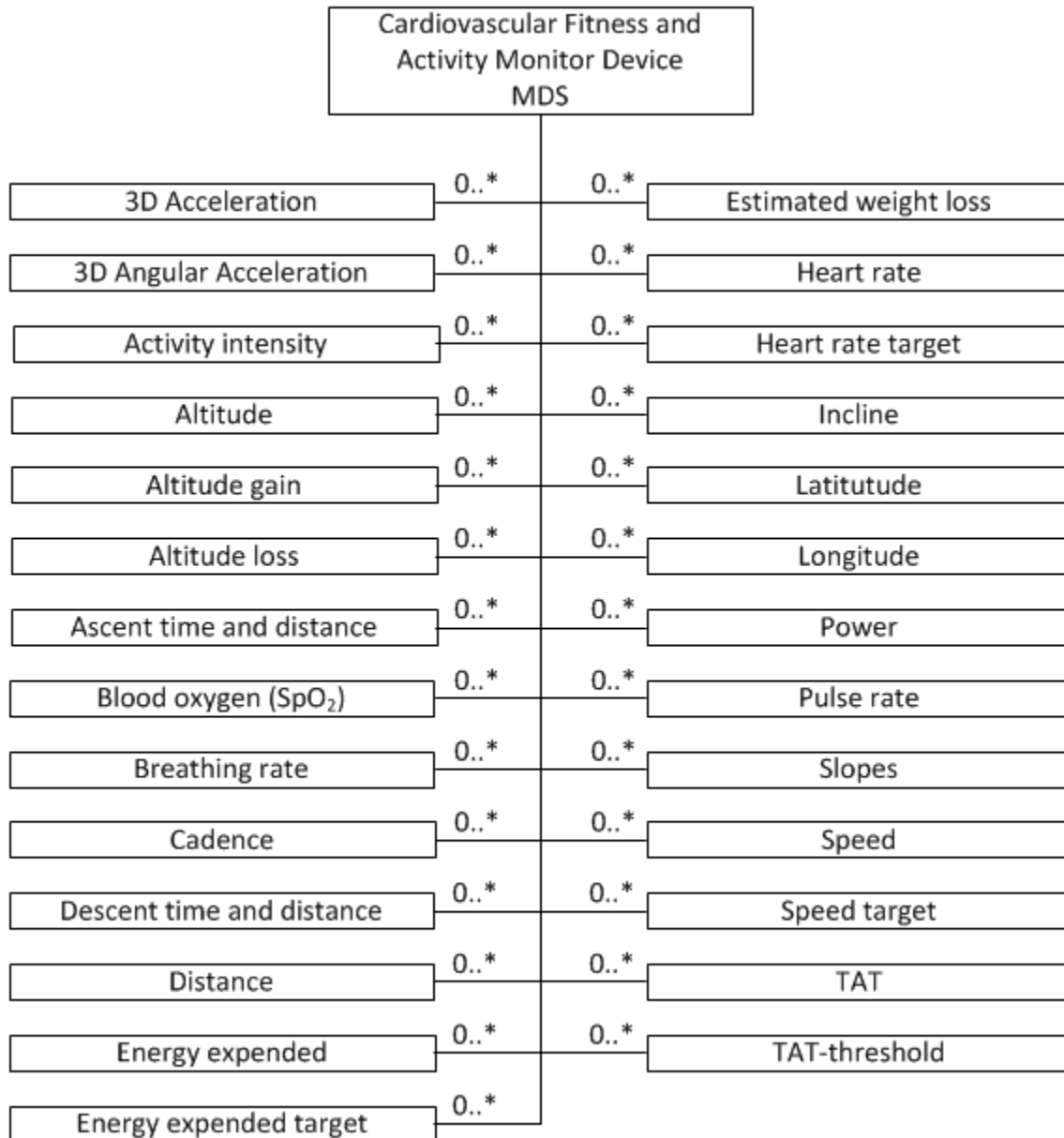


Figure 8—Instance diagram for numeric objects

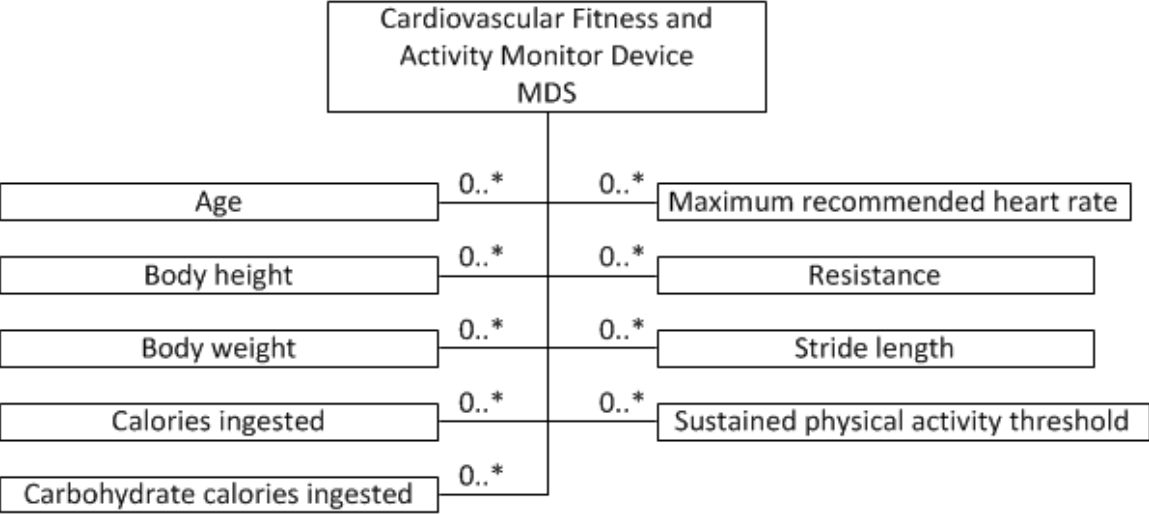


Figure 9—Instance diagram for settings related objects

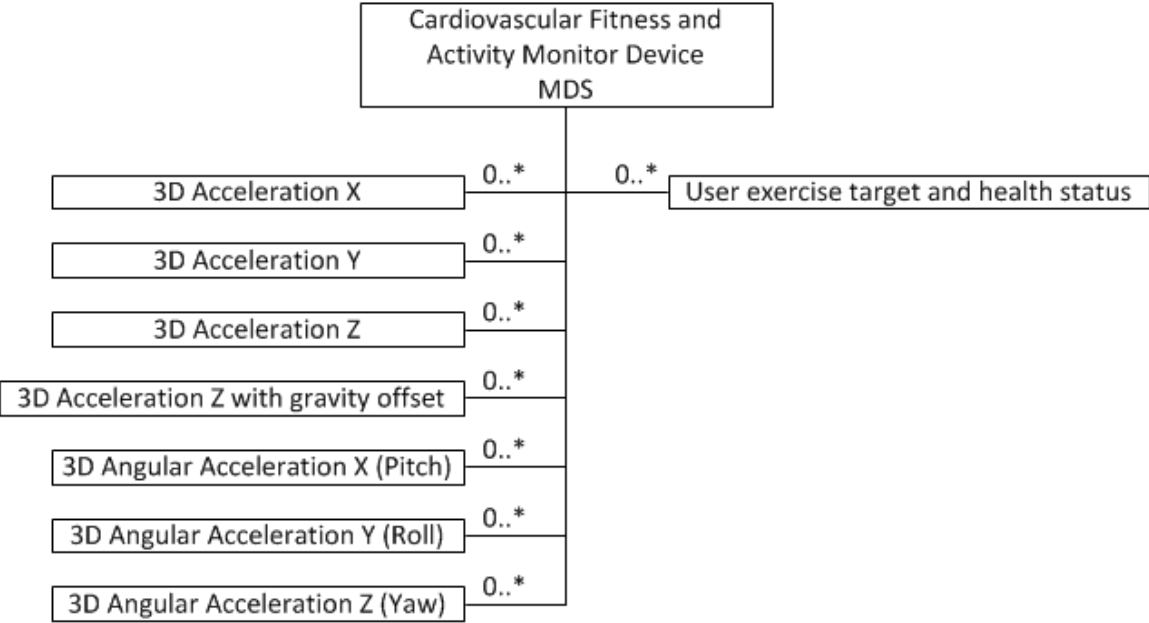


Figure 10—Instance diagram for real time and enumeration objects

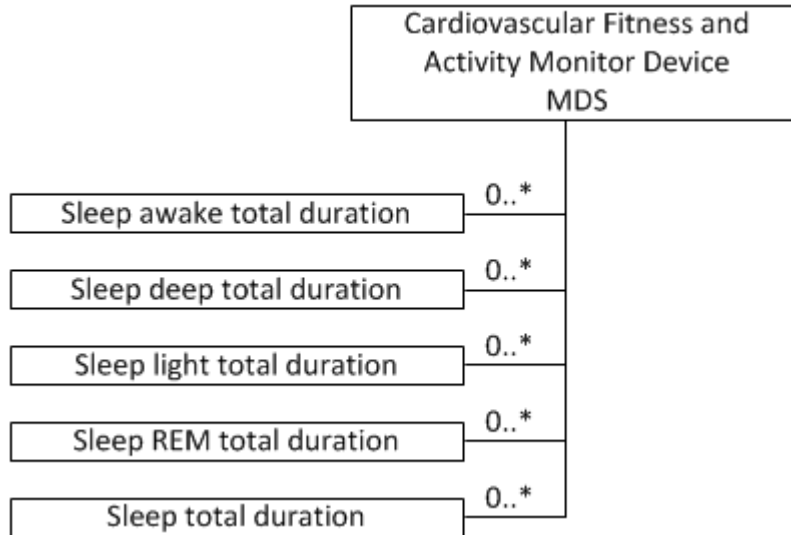


Figure 11—Instance diagram for sleep related objects

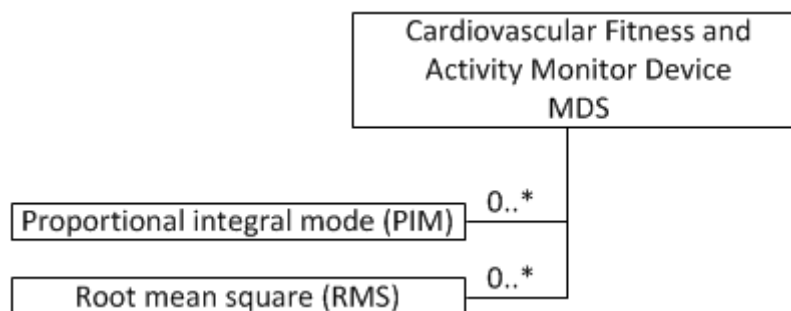


Figure 12—Instance diagram for statistical related objects

6.4 Types of configuration

6.4.1 General

As specified in ISO/IEEE 11073-20601, two styles of configuration are available. Subclauses 6.4.2 and 6.4.3 briefly introduce standard and extended configurations.

6.4.2 Standard configuration

Standard configurations are defined in the ISO/IEEE 11073-104zz specializations (such as this standard) and are assigned a well-known identifier (Dev-Configuration-Id). The usage of a standard configuration is negotiated at association time between the agent and the manager. If the manager recognizes and selects to operate using the configuration, then the agent can send measurements immediately. If the manager does not recognize the configuration, then the agent provides the configuration prior to transmitting measurement information. This standard does not support standard configurations.

6.4.3 Extended configuration

In extended configurations, the configuration of the agent is not predefined in a standard. The agent determines which objects, attributes, and values that it wants to use in a configuration and assigns a

configuration identifier. When the agent associates with a manager, it negotiates an acceptable configuration. Typically, the manager does not recognize the configuration of the agent on the first connection, so the manager responds that the agent shall send its configuration information as a configuration event report. If, however, the manager already understands the configuration, either because it was preloaded in some way or the agent had previously associated with the manager, then the manager responds that the configuration is known and no further configuration information needs to be sent.

6.5 Profiles

6.5.1 General

A profile further constrains the objects, services, and communication model of a specialization. By profiling the device specialization, the standard provides more guidance on the specific mandatory objects that shall be implemented, for that profile. This standard defines two profiles: step counter (see Clause 11) and activity monitor (see Clause 12). A cardiovascular fitness and activity monitor device may implement one of these profiles.

6.6 Medical device system object

6.6.1 MDS object attributes

Table 1 defines the attributes of the cardiovascular fitness and activity monitor MDS object. The nomenclature code to identify the MDS object class is MDC_MOC_VMS_MDS_SIMP.

Table 1—MDS object attributes

Attribute name	Value	Qual.
Handle	0	M
System-Type	Attribute not present. See ISO/IEEE 11073-20601.	C
System-Model	{“Manufacturer”, “Model”}	M
System-Id	See ISO/IEEE 11073-20601.	M
Dev-Configuration-Id	Extended configs: 0x4000-0x7FFF.	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Production-Specification	See ISO/IEEE 11073-20601.	O
Mds-Time-Info	See ISO/IEEE 11073-20601.	C
Date-and-Time	See ISO/IEEE 11073-20601.	C
Relative-Time	See ISO/IEEE 11073-20601.	C
HiRes-Relative-Time	See ISO/IEEE 11073-20601.	C
Base-Offset-Time-Stamp	See ISO/IEEE 11073-20601.	C
Date-and-Time-Adjustment	See ISO/IEEE 11073-20601.	C
Power-Status	<i>onBattery</i> or <i>onMains</i>	R
Battery-Level	See ISO/IEEE 11073-20601.	R
Remaining-Battery-Time	See ISO/IEEE 11073-20601.	R
Reg-Cert-Data-List	See ISO/IEEE 11073-20601.	O
System-Type-Spec-List	{MDC_DEV_SPEC_PROFILE_HF_CARDIO, 2} and Profile value: {MDC_DEV_SUB_SPEC_PROFILE_STEP_COUNTER, 2} or {MDC_DEV_SUB_SPEC_PROFILE_ACTIVITY, 2}	M
Confirm-Timeout	See ISO/IEEE 11073-20601.	O
Transport-Timeout	See ISO/IEEE 11073-20601.	O

In the response to a Get MDS object command, only implemented attributes and their corresponding values are returned.

See ISO/IEEE 11073-20601 for descriptive explanations of the individual attributes as well as for information on attribute ID and attribute type.

If an agent implements multiple ISO/IEEE 11073-104zz specializations, System-Type-Spec-List is a list of type/version pairs, each referencing the respective device specialization and version of that specialization. For a cardiovascular fitness and activity monitor agent, a specialization value of MDC_DEV_SPEC_PROFILE_HF_CARDIO shall be included in the System-Type-Spec-List attribute as shown in Table 1. Additionally, the value(s) for the supported profile(s) shall be included in the System-Type-Spec-List attribute.

The Dev-Configuration-Id attribute holds a locally unique 16-bit identifier that identifies the device configuration. For a cardiovascular fitness and activity monitor agent, this identifier is chosen in the range of extended-config-start to extended-config-end (see ISO/IEEE 11073-20601) as shown in Table 1. Since it is an extended configuration, the actual configuration associated with the Dev-Configuration-Id is globally unique only for a given System-Id (agent device).

The agent sends the Dev-Configuration-Id and System-Id during the Associating state (see 8.3) to identify its configuration for the duration of the association. If the manager already holds the configuration information relating to the Dev-Configuration-Id and System-Id pair, then it recognizes the Dev-Configuration-Id for that agent device. Then, the Configuration state (see 8.4) is skipped, and the agent and manager enter the Operating state. If the manager does not recognize the Dev-Configuration-Id for that System-Id, then the agent and manager enter the Configuring state.

If an agent implements multiple IEEE 11073-104zz specializations, then the System-Type-Spec-List contains a list of type/version pairs each referencing the respective device specialization and version of that specialization in addition to the entry required for this specialization as noted in Table 1.

6.6.2 MDS object methods

Table 2 defines the methods (actions) of the cardiovascular fitness and activity monitor agent's MDS object. These methods are invoked using the Action service. In Table 2, the Subservice type name column defines the name of the method; the Mode column defines whether the method is invoked as an unconfirmed action (i.e., roiv-cmip-action from ISO/IEEE 11073-20601) or a confirmed action (i.e., roiv-cmip-confirmed-action); the Subservice type (action-type) column defines the nomenclature code to use in the action-type field of an action request and response (see ISO/IEEE 11073-20601); the Parameters (action-info-args) column defines the associated ASN.1 data structure (see ISO/IEEE 11073-20601 and ASN.1 definitions) to use in the action message for the action-info-args field of the request; and the Results (action-info-args) column defines the structure to use in the action-info-args of the response.

Table 2—MDS object methods

Service	Subservice type name	Mode	Subservice type (action-type)	Parameters (action-info-args)	Results (action-info-args)
ACTION	Set-Time	Confirmed	MDC_ACT_SET_TIME	SetTimeInvoke	—
	Set-Base-Offset-Time	Confirmed	MDC_ACT_SET_BO_TIME	SetBOTimeInvoke	—

Set-Time

This method allows the manager to set a real-time clock in the agent with the absolute time. The agent indicates whether the Set-Time command is valid using the mds-time-capab-set-clock bit in the Mds-Time-Info attribute (see ISO/IEEE 11073-20601). Agents with an internal real-time clock shall indicate this capability by also setting the mds-time-capab-real-time-clock bit in the Mds-Time-Info attribute.

The Set-Time method can be supported only if the Absolute-Time-Stamp attribute is supported.

Base-Offset-Time

This method allows the manager to set a real-time clock in the agent with the base time and offset. The agent indicates whether the Set-Base-Offset-Time command is valid using the mds-time-capab-set-clock bit in the Mds-Time-Info attribute (see ISO/IEEE 11073-20601).

The Set-Base-Offset-Time method can be supported only if the Base-Offset-Time-Stamp attribute is supported.

An agent may support either absolute time or base time, but not both. The time option used is indicated by the agent in the Mds-Time-Info attribute.

Agents following this device specialization shall support the sending of any temporarily stored and real-time measurement data using the agent-initiated method of measurement data transmission. This requirement does not prevent the agent from supporting additional methods of measurement data transmission, but agents that choose to support these additional methods shall fall back to the agent-initiated method of measurement data transmission when associated with a manager that does not support these additional methods of data transmission. During the association procedure (see 8.3), DataReqModeCapab shall be set to the appropriate value for the event report style. Managers supporting this specialization are only required to support agent-initiated measurement transfers. Thus, implementation of the MDS-Data-Request method/action is not required in this standard and is not shown in Table 2.

6.6.3 MDS object events

Table 3 defines the events that can be sent by the cardiovascular fitness and activity monitor MDS object.

Table 3—MDS object events

Service	Subservice type name	Mode	Subservice type (event-type)	Parameters (event-info)	Results (event-reply-info)
EVENT REPORT	MDS-Configuration-Event	Confirmed	MDC_NOTI_CONFIG	ConfigReport	ConfigReportRsp
	MDS-Dynamic-Data-Update-Var	Confirmed	MDC_NOTI_SCAN_REPORT_VAR	ScanReportInfoVar	—
	MDS-Dynamic-Data-Update-Fixed	Confirmed	MDC_NOTI_SCAN_REPORT_FIXED	ScanReportInfoFixed	—
	MDS-Dynamic-Data-Update-MP-Var	Confirmed	MDC_NOTI_SCAN_REPORT_MP_VAR	ScanReportInfoMPVar	—
	MDS-Dynamic-Data-Update-MP-Fixed	Confirmed	MDC_NOTI_SCAN_REPORT_MP_FIXED	ScanReportInfoMPFixed	—

— **MDS-Configuration-Event:**

This event is sent by the agent during the configuring procedure if the manager does not already know the configuration of the agent from past associations. The event provides static information about the supported measurement capabilities of the agent.

— **MDS-Dynamic-Data-Update-Var:**

This event provides dynamic measurement data from the agent. These data are reported using a generic attribute list variable format. The event is sent as an unsolicited message by the agent (i.e.,

an agent-initiated measurement data transmission). See 8.5.3 for more information on unsolicited event reporting.

- **MDS-Dynamic-Data-Update-Fixed:**
This event provides dynamic measurement data from the agent. These data are reported in the fixed format defined by the Attribute-Value-Map attribute of the relevant metric objects. The event is sent as an unsolicited message by the agent (i.e., an agent-initiated measurement data transmission). See 8.5.3 for more information on unsolicited event reporting.
- **MDS-Dynamic-Data-Update-MP-Var:**
This is the same as MDS-Dynamic-Data-Update-Var but allows inclusion of data from multiple people.
- **MDS-Dynamic-Data-Update-MP-Fixed:**
This is the same as MDS-Dynamic-Data-Update-Fixed but allows inclusion of data from multiple people.

NOTE—ISO/IEEE 11073-20601 requires that managers support all of the MDS object events listed above.

6.6.4 Other MDS services

6.6.4.1 GET service

A cardiovascular fitness and activity monitor agent shall support the GET service as indicated by ISO/IEEE 11073-20601.

A cardiovascular fitness and activity monitor agent shall support the GET service, which is provided by the MDS object to retrieve the values of all implemented MDS object attributes. The GET service can be invoked only after the manager has confirmed selection of the configuration of the agent.

The manager may request the MDS object attributes of the Basic cardiovascular fitness and activity monitor agent; in which case, the manager shall send the “Remote Operation Invoke | Get” message (see roiv-cmip-get in ISO/IEEE 11073-20601) with the reserved MDS handle value of 0. The cardiovascular fitness and activity monitor agent shall report its MDS object attributes to the manager using the “Remote Operation Response | Get” message (see rors-cmip-get in ISO/IEEE 11073-20601). See Table 4 for a summary of the GET service including some message fields.

Table 4—Cardiovascular fitness and activity monitor MDS object GET service

Service	Subservice type name	Mode	Subservice type	Parameters	Results
GET	<na>	<implied confirmed>	<na>	GetArgumentSimple = (obj-handle = 0), attribute-id-list <optional>	GetResultSimple = (obj-handle = 0), attribute-list

See 8.5.2 for details on the procedure for getting the MDS object attributes.

6.6.4.2 SET service

The cardiovascular fitness and activity monitor specialization does not require an implementation to support the MDS object SET service.

6.7 Numeric objects

6.7.1 General

6.7.1.1 Definitions

The numeric objects listed in this subclause represent the numeric observations that can be produced by a cardiovascular fitness and activity monitor agent. The nomenclature code to identify a numeric object class is MDC_MOC_VMO_METRIC_NU. Each object specifies how each attribute is to be used, but there are some concepts that apply to each numeric in a general fashion that are described in 6.7.1.2 through 6.7.1.7.

6.7.1.2 Dependent attributes

Sometimes, the interpretation of one attribute value in an object depends on other attribute values in the same object. For example, Unit-Code and Unit-Label-String provide context for the observed values. Whenever a contextual attribute changes, the agent shall report these changes to the manager using an MDS object event (see 6.6.3) prior to reporting any of the dependent values.

6.7.1.3 Timestamps

All numeric object instances are associated with either a session or subsession object, defined in 6.9.3 and 6.9.4, respectively:

- In case of a session summary, only the session or subsession shall have a timestamp attribute.
- In case of a continuously monitoring session or subsession, session summary attributes are reported and in addition each numeric object instance sampled shall carry its own timestamp attribute.

6.7.1.4 Source handle reference

It is possible for a session or subsession to have associated numeric objects that represent observations that span the entire session or subsession. Therefore, the Source-Handle-Reference attribute of the numeric object shall identify whether the numeric object instance is associated with either the session or the subsession object. If the numeric object is a session-level observation, then the Source-Handle-Reference shall be equal to the value of the handle of the session object. Likewise, if the numeric object represents a subsession-level observation, then the Source-Handle-Reference attribute shall be equal to the handle of the subsession object.

6.7.1.5 Methods

The objects listed in this subclause do not support any methods.

6.7.1.6 Events

The objects listed in this subclause do not support any events.

6.7.1.7 Services

The objects listed in this subclause do not support any services.

6.7.2 3D Acceleration

Table 5 defines the attributes for the object that represents the components of 3D acceleration. This object may be supported by the agent.

The 3D compound observed value attribute shall include components from the following:

- MDC_HF_3D_ACC_X (_MAX, _MIN, _MEAN)
- MDC_HF_3D_ACC_Y (_MAX, _MIN, _MEAN)
- MDC_HF_3D_ACC_Z (_MAX, _MIN, _MEAN)
- MDC_HF_3D_ACC_Z_G_OFFSET (_MAX, _MIN, _MEAN)

Table 5—3D acceleration

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_3D_ACC	M
Metric-Spec-Small	mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-cat-manual mss-cat-setting	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Unit-Code	MDC_DIM_M_PER_SEC_SQ or MDC_DIM_CENTI_M_PER_SEC_SQ	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Compound-Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Compound-Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C

6.7.3 3D angular acceleration

Table 6 defines the attributes for the object that represents the components of 3D angular acceleration. This object may be supported by the agent.

The 3D compound observed value attribute shall include components from the following:

- MDC_HF_3D_ANG_ACC_X (_MAX, _MIN, _MEAN)
- MDC_HF_3D_ANG_ACC_Y (_MAX, _MIN, _MEAN)
- MDC_HF_3D_ANG_ACC_Z (_MAX, _MIN, _MEAN)

Table 6—3D angular acceleration

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_3D_ANG_ACC	M
Metric-Spec-Small	mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-cat-manual mss-cat-setting	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Unit-Code	MDC_DIM_M_PER_SEC_SQ or MDC_DIM_CENTI_M_PER_SEC_SQ.	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Compound-Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Compound-Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C

6.7.4 Activity intensity

Table 7 defines the attributes for the object that represents the activity intensity. This object may be supported by the agent.

Table 7—Activity intensity attributes

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_ACTIVITY_INTENSITY or MDC_HF_ACTIVITY_INTENSITY_MAX or MDC_HF_ACTIVITY_INTENSITY_MIN or MDC_HF_ACTIVITY_INTENSITY_MEAN	M
Supplemental-Types	This attribute denotes the type of measure performed for the associated session or subsession. Valid values are: MDC_HF_MEAN_NULL_INCLUDE and MDC_HF_MEAN_NULL_EXCLUDE	O
Metric-Spec-Small	mss-avail-intermittent mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-acc-agent-initiated	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Measurement-Status	See ISO/IEEE 11073-20601.	O
Metric-Id-Partition	See ISO/IEEE 11073-20601.	O
Unit-Code	MDC_DIM_PERCENT.	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Label-String	See ISO/IEEE 11073-20601.	O
Unit-LabelString	See ISO/IEEE 11073-20601.	O
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Accuracy	See ISO/IEEE 11073-20601.	O
Measure-Active-Period	See ISO/IEEE 11073-20601. By default, the measuring period is a session or a subsession.	O

The observed value reported in this object is the instantaneous percentage of maximal intensity effort or percentage of maximal intensity expended during the measurement period as defined by the associated session or subsession object.

6.7.5 Age

Table 8 defines the attributes for the object that represents age. This object may be supported by the agent.

Table 8—Age attributes

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_AGE	M
Metric-Spec-Small	mss-avail-intermittent mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-acc-agent-initiated mss-cat-setting	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Measurement-Status	See ISO/IEEE 11073-20601.	O
Metric-Id	See ISO/IEEE 11073-20601.	O
Metric-Id-Partition	See ISO/IEEE 11073-20601.	O
Unit-Code	MDC_DIM_YR	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Label-String	See ISO/IEEE 11073-20601.	O
Unit-LabelString	See ISO/IEEE 11073-20601.	O
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Accuracy	See ISO/IEEE 11073-20601.	O
Measure-Active-Period	See ISO/IEEE 11073-20601.	NR

The observed value reported in this object is the age of the user in whole years at the time of the observation. Age is a setting typically entered manually by the user.

6.7.6 Altitude

Table 9 defines the attributes for the object that represents altitude. This object may be supported by the agent.

Table 9—Altitude attributes

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_ALT or MDC_HF_ALT_MAX or MDC_HF_ALT_MIN or MDC_HF_ALT_MEAN	M
Metric-Spec-Small	mss-avail-intermittent mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-acc-agent-initiated	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Measurement-Status	See ISO/IEEE 11073-20601.	O
Metric-Id	See ISO/IEEE 11073-20601.	O
Metric-Id-Partition	See ISO/IEEE 11073-20601.	O
Unit-Code	MDC_DIM_M or MDC_DIM_FOOT	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Label-String	See ISO/IEEE 11073-20601.	O
Unit-LabelString	See ISO/IEEE 11073-20601.	O
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Accuracy	See ISO/IEEE 11073-20601.	O
Measure-Active-Period	See ISO/IEEE 11073-20601. By default, the measuring period is a sample-period-session.	O

The observed value reported in this object is the instantaneous altitude relative to sea level or maximal altitude at the end of the activity. Positive values indicate elevations above sea level, negative values indicate elevations below sea level, and zero is equal to sea level.

6.7.7 Altitude gain

Table 10 defines the attributes for the object that represents the sum of all altitude gained. This object may be supported by the agent.

Table 10—Altitude gain attributes

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_ALT_GAIN	M
Metric-Spec-Small	mss-avail-intermittent mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-acc-agent-initiated	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Measurement-Status	See ISO/IEEE 11073-20601.	O
Metric-Id	See ISO/IEEE 11073-20601.	O
Metric-Id-Partition	See ISO/IEEE 11073-20601.	O
Unit-Code	MDC_DIM_M or MDC_DIM_CENTI_M or MDC_DIM_INCH	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Label-String	See ISO/IEEE 11073-20601.	O
Unit-LabelString	See ISO/IEEE 11073-20601.	O
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Accuracy	See ISO/IEEE 11073-20601.	O
Measure-Active-Period	See ISO/IEEE 11073-20601. By default, the measuring period is a sample-period-session.	O

The observed value reported in this object is the sum of all altitude gained since the start of the measurement period, as defined by the associated session or subsession object.

6.7.8 Altitude loss

Table 11 defines the attributes for the object that represents the sum of all altitude lost. This object may be supported by the agent.

Table 11 —Altitude loss attributes

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_ALT_LOSS	M
Metric-Spec-Small	mss-avail-intermittent mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-acc-agent-initiated	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Measurement-Status	See ISO/IEEE 11073-20601.	O
Metric-Id	See ISO/IEEE 11073-20601.	O
Metric-Id-Partition	See ISO/IEEE 11073-20601.	O
Unit-Code	Valid values are MDC_DIM_M, MDC_DIM_CENTI_M, and MDC_DIM_INCH.	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Label-String	See ISO/IEEE 11073-20601.	O
Unit-LabelString	See ISO/IEEE 11073-20601.	O
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Accuracy	See ISO/IEEE 11073-20601.	O
Measure-Active-Period	See ISO/IEEE 11073-20601. By default, the measuring period is a sample-period-session.	O

The observed value reported in this object is the sum of all altitude lost since the start of the measurement period, as defined by the associated session or subsession object.

6.7.9 Ascent time and distance

Table 12 defines the attributes for the object that represents the ascent time and distance. This object may be supported by the agent.

Table 12—Ascent time and distance attributes

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_ASC_TIME_DIST or MDC_HF_ASC_TIME_DIST_MAX or MDC_HF_ASC_TIME_DIST_MIN or MDC_HF_ASC_TIME_DIST_MEAN	M
Metric-Spec-Small	mss-avail-intermittent mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-acc-agent-initiated	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Measurement-Status	See ISO/IEEE 11073-20601.	O
Metric-Id	See ISO/IEEE 11073-20601.	O
Metric-Id-Partition	See ISO/IEEE 11073-20601.	O
Unit-Code	MDC_DIM_M or MDC_DIM_CENTIM or MDC_DIM_INCH or MDC_DIM_STEP	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Label-String	See ISO/IEEE 11073-20601.	O
Unit-LabelString	See ISO/IEEE 11073-20601.	O
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Accuracy	See ISO/IEEE 11073-20601.	O
Measure-Active-Period	See ISO/IEEE 11073-20601. By default, the measuring period is a sample-period-session.	O

The observed value reported in this object is the distance covered while gaining elevation since the start of the measurement period, as defined by the associated session or subsession object. The amount of time spent gaining altitude is represented in the Measure-Active-Period attribute.

6.7.10 Body height

Table 13 defines the attributes for the object that represents height. This object may be supported by the agent.

Table 13—Body height attributes

Attribute name	Value	Qual.
Handle	See ISO/IEEE 11073-20601.	M
Type	MDC_PART_SCADA MDC_LEN_BODY_ACTUAL	M
Metric-Spec-Small	mss-avail-intermittent mss-avail-stored-data mss-updt-aperiodic mss-msmt-aperiodic mss-acc-agent-initiated mss-cat-setting	M
Metric-Structure-Small	See ISO/IEEE 11073-20601.	R
Measurement-Status	See ISO/IEEE 11073-20601.	O
Metric-Id	See ISO/IEEE 11073-20601.	O
Metric-Id-Partition	See ISO/IEEE 11073-20601.	O
Unit-Code	MDC_DIM_M or MDC_DIM_FOOT.	M
Attribute-Value-Map	See ISO/IEEE 11073-20601.	C
Source-Handle-Reference	Contains the handle of the session or subsession it is associated with. See ISO/IEEE 11073-20601.	M
Label-String	See ISO/IEEE 11073-20601.	O
Unit-LabelString	See ISO/IEEE 11073-20601.	O
Absolute-Time-Stamp	See 6.7.1.3.	C
Relative-Time-Stamp	See 6.7.1.3.	C
HiRes-Time-Stamp	See 6.7.1.3.	C
Base-Offset-Time-Stamp	See 6.7.1.3.	C
Simple-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Basic-Nu-Observed-Value	See ISO/IEEE 11073-20601.	C
Accuracy	See ISO/IEEE 11073-20601.	O
Measure-Active-Period	See ISO/IEEE 11073-20601.	NR

Body height is a setting typically entered manually by the user.