

Personal Health Devices Transcoding

Bluetooth® White Paper



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Abstract:

This document describes the task of implementing a transcoder from GATT-based specifications designed for Bluetooth devices to a format compatible with IEEE 11073-20601. It provides recommendations and examples describing how a transcoding process can be done. This document is not a Bluetooth Specification as defined in the Bluetooth Patent/Copyright License Agreement between Bluetooth SIG, Inc. and its members.

Revision History

Revision Number	Date	Comments
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1 Overview

This document describes how data sent by a Bluetooth Sensor based on GATT (Generic Attribute Profile) and received by a Collector can be transcoded at the Collector into an IEEE Std. 11073-20601a [1] compatible nomenclature and model, thus enabling compatibility with the ISO/IEEE Std. 11073-104xx family of standards (both hereafter known as 11073-20601).

GATT-based Services and Profiles have been developed to support low power and low cost device implementation. Data values used in these Services and Profiles are defined as characteristics associated with a UUID accessible via the Bluetooth SIG Assigned Numbers [3].

This document covers how characteristic values can be mapped or transcoded in a consistent way to 11073-20601 nomenclature/object/attribute equivalents. This data compatibility will enable data from GATT-based Bluetooth devices to be used in the broader health ecosystem such that the transcoded measurement data will look the same as data from a Bluetooth Health Device Profile [26] device or a USB Personal Healthcare Device Class [27] device.

This data compatibility will enable data to be usable and consumable by a variety of healthcare-related organizations including the Continua Health Alliance and standards organizations related to health records such as HL7. All mandatory (as well as some optional) attributes defined for each specialization in 11073-104xx standards are supported by Bluetooth Profiles defined within this document, but support for optional attributes is not specifically required for data compatibility.

For the Bluetooth Profiles encompassed by the material in this document, all characteristics and fields that are relevant to 11073-20601 have been defined with the intent that they can be transcoded at the Collector without any loss of precision.

In order to enable such a process for a particular device, the Collector device implementing transcoding software is required to follow the general requirements in Section 2 and the device-specific requirements in Section 3. Section 3 will be expanded as new health-related Bluetooth Profiles and Services become available. Section 4 provides an end-to-end example describing how data can be mapped from a GATT-based Health Thermometer [5] to a Collector implementing a Transcoder.

While it is beyond the scope of this document to mandate or specify a specific method for transcoding Bluetooth characteristics into 11073-20601, this white paper provides requirements and guidelines to enable implementations to do so. This document does not discuss 11073-20601 concepts and details; rather, it focuses on how data from Bluetooth sensors can be transcoded for use in the 11073-20601 domain.

Although some areas of this document summarize requirements of 11073-20601 and 11073-104xx documents as a useful reference, refer to the 11073-20601 and 11073-104xx standards to ensure the most accurate information regarding 11073-20601 specifications' requirements. Similarly, refer to the relevant Bluetooth Profile specifications with their associated Service

specifications and characteristic(s) as the official sources for requirements relating to Bluetooth wireless technology.

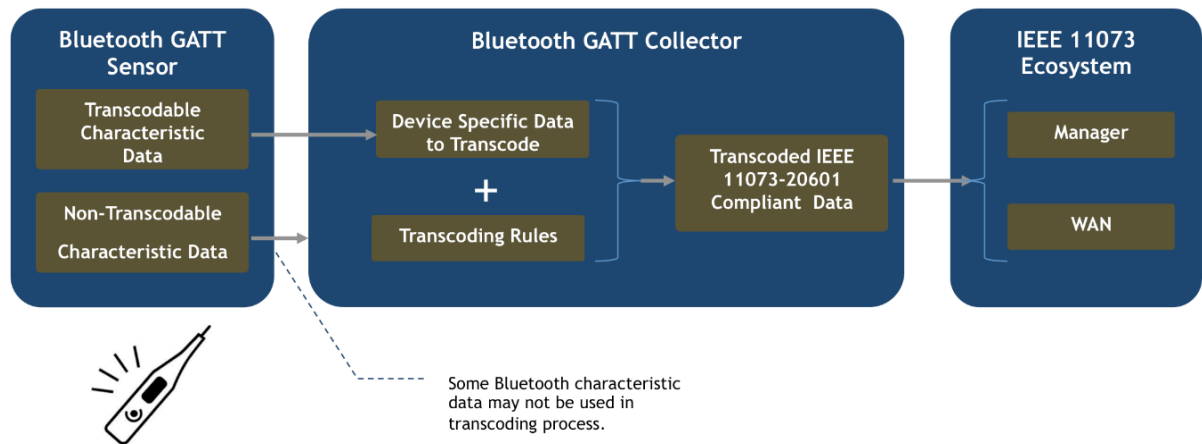


Figure 1: GATT-based Bluetooth Sensor to 11073-20601 Data Flow

The 11073-20601 DIM (Domain Information Model) of any given device type is typically more complex than, and completely different from, the related Bluetooth GATT-based health Service. This document specifies how to transcode data from GATT-based Services to DIM and nomenclature, but it is important to recognize that Collector devices are **not** actually required to create the DIM, with all its objects, attributes, or APDUs (Application Protocol Data Units, i.e. network packets) associated with 11073-20601 transactions.

The purpose of the transcoded DIMs and nomenclatures described in this white paper is just to provide a mapping. In the end, if the Collector wishes to forward data over any additional interfaces (e.g. IHE-PCD-01 [17] documents) requiring 11073-20601 nomenclature, it must do so *as if* the data had come from the DIMs as described in this white paper.

There are a number of objects that may exist in a 11073-20601 DIM that have the purpose to aid in providing more efficient transfer of data from the Sensor (Agent) device to the Collector (Manager). Scanner and PM-Store are examples of such objects. They do not affect the value and meaning of data measurements. This paper will not describe these kinds of objects and their use is at implementation's discretion.

In addition, all 11073-20601 APDUs are only of interest for 11073-20601 formatted exchanges. Transcoding the sensor device down to the APDU level, simulating a complete 11073-20601 Agent that exchanges APDUs with a 11073-20601 Manager/Collector is a valid transcoding strategy. But is not the only strategy, and it is not mandated by this paper. Any simulation of APDU transcoding is outside the purpose of this paper and is left up to the implementation.

Likewise, this paper will restrict itself to the description of those components of the DIM and nomenclature that are used to describe the *measurements* and the *device*. All additional

components of the DIM are outside the purpose of this paper and are left up to the implementation.

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2 General Data Requirements

This section describes the transcoding of general data from a Bluetooth Sensor for compatibility with the 11073-20601 ecosystem, and general data mapping requirements that are common to all devices addressed by this white paper. Device-specific data requirements are described in Section 3.

2.1 Common MDS Class Requirements

This sub-section describes general Medical Device System (MDS) class requirements from 11073-20601. The MDS is the object that describes the device and its properties. The majority of the data to populate this object's attributes comes from the Device Information Service (DIS) [2] and the Current Time Service (CTS) [14]. 11073-20601 attributes not mentioned in this section likely refer to Bluetooth device-specific data requirements and are shown in Section 3.

The Device Information Service is a general Bluetooth Service designed to describe characteristics that are often common between different sensors. The DIS includes characteristics that contain information such as the manufacturer name, model number, hardware revision, firmware revision, and software revision among others. Many characteristics in the DIS are used within the 11073-20601 and Continua Health Alliance infrastructure.

The Current Time Service provides the Collector with a means of obtaining the current time on the Sensor device. This time is entered into the Date-and-Time attribute of the MDS. The need to know the current time on the Sensor is essential if the Sensor sends measurement characteristics that contain time stamps. Knowing the Sensor's current time allows the Collector to compare its current clock with the Sensor's current clock and determine any differences. This clock information is required for the generation of e.g. HL7 data. If the Sensor provides no time stamps, the Collector uses the time of reception as the time stamp. Such devices do not need a Current Time Service and the transcoded MDS will not have a Date-and-Time attribute.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	None	N/A	N/A	HANDLE ¹	INT-U16
System-Model	Model Number String, Manufacturer Name String	DIS	UTF-8 String, UTF-8 String	SystemModel ²	(OCTET STRING, OCTET STRING)
System-Id	System ID	DIS	EUI-64	OCTET STRING	OCTET STRING
Dev-Configuration Id	None	N/A	N/A	ConfigId ³	List of (INT-U16, INT-U16)

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Attribute-Value-Map	None	N/A	N/A	AttrValMap ⁴	List of (INT-U16, INT-U16)
Production-Specification	Serial Number String, Hardware Revision String, Software Revision String, Firmware Revision String ⁵	DIS	UTF-8 String	ProductionSpec	List of (INT-U16, INT-U16, OCTET STRING)
Date-and-Time	Current Time	Current Time Service ⁶	Aggregate	AbsoluteTime	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Mds-Time-Info	None	N/A	N/A	MdsTimeInfo	(BITS-16, INT-U16, INT-U32, INT-U16, INT-U32)
Relative-Time	None	N/A	N/A	RelativeTime	INT-U32
HiRes-Relative-Time	None	N/A	N/A	HighResRelativeTime	OCTET STRING (SIZE(8))
Date-and-Time-Adjustment	None	N/A	N/A	AbsoluteTimeAdjust	OCTET STRING (SIZE(6))
Power-Status	In Development (Future updated Battery Service)	In Development (Future updated Battery Service)	N/A	PowerStatus	BITS-16
Battery-Level	Battery Level	Battery Service	UINT8	INT-U16 ⁷	INT-U16
Remaining-Battery-Time	None	N/A	N/A	BatMeasure	(FLOAT-Type, INT-U16)

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11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Reg-Cert-Data-List	IEEE 11073-20601 Regulatory Certification Data List	DIS	Aggregate	RegCertDataList	List of ((INT-U8, INT-U8), ANY)
System-Type-Spec-List	None	N/A	N/A	TypeVerList ⁸	List of (INT-U16, INT-U16)
Confirm-Timeout ⁹	None	N/A	N/A	RelativeTime	OCTET STRING (SIZE(6))

Table 1: Common MDS Class Requirements

Notes:

1. 11073-20601 requires that it is always set to 0.
2. SystemModel is described as SEQUENCE (Manufacturer Name, Model Number).
3. The device configuration id is only of use in 11073-20601 formatted exchanges. Its value is implementation specific.
4. This 11073-20601 attribute is transmission-related only. As this document is only relevant for nomenclature and model compatibility and does not mandate any way to reach the 11073-20601 domain, this attribute is implementation specific.
5. Each field is mapped into a unique entry of ProductionSpec list; for example, Serial Number String is mapped as (0x0001, INT-U16, serial_number_value). See Section 2.2.4.
6. This attribute is necessary and readable when the device timestamps measurements. See Section 2.2.4, subtopic “Date and Time”, and Section 2.2.6 for details.
7. Both Battery Level characteristic and Battery-Level attribute express battery level as an integer percentage (0 to 100). Characteristic is transcoded simply by promoting value from UINT8 to INT-U16 with no scaling.
8. For each Bluetooth Service addressed by this white paper and implemented by the device, an entry has to be added to the TypeVerList. For example, if a device implements the Health Thermometer Service [5], the following entry is required by 11073-20601 to be added to the TypeVerList which identifies the corresponding 11073-20601 Profile:

```

0x10 0x08          type = MDC_DEV_SPEC_PROFILE_TEMP
0x00 0x01          version = version 1 of the specialization

```

NOTE: The reference to “PROFILE” in the MDC_DEV_SPEC_PROFILE_TEMP refers to device specializations defined in 11073-20601 and should not be confused with Bluetooth Profiles.
9. The ConfirmTimeout is only for use in 11073-20601 formatted exchanges. It tells the Manager how long the Agent will wait for a confirmation to a confirmed event report before timing out. Its value is implementation specific.

2.2 TRANSCODING BLUETOOTH CHARACTERISTICS TO 11073-20601 ATTRIBUTES

2.2.1 32-BIT FLOATING POINT DATA TYPE (FLOAT-TYPE)

The following information is defined in ISO/IEEE Std. 11073-20601™-2008 [1].

The FLOAT-Type data type is defined to represent numeric values that are not integer in type. The FLOAT-Type is defined as a 32-bit value with a 24-bit mantissa and an 8-bit exponent. See Annex F.6 of [1] for a thorough definition of the FLOAT-Type. This data type is defined as follows:

	Exponent	Mantissa
Size	1 octet	3 octets

The 32 bits contain an 8-bit signed exponent to base 10, followed by a 24-bit signed integer (mantissa).

Special values are assigned to express the following:

- + INFINITY [exponent 0, mantissa $+(2^{23}-2) \rightarrow 0x007FFFFE$]
- NaN (Not a Number) [exponent 0, mantissa $+(2^{23}-1) \rightarrow 0x007FFFFFF$]
- NRes (Not at this Resolution) [exponent 0, mantissa $-(2^{23}) \rightarrow 0x00800000$]
- Reserved for future use [exponent 0, mantissa $-(2^{23}-1) \rightarrow 0x00800001$]
- - INFINITY [exponent 0, mantissa $-(2^{23}-2) \rightarrow 0x00800002$]

NaN is used to report an invalid result from a computation step or to indicate missing data due to the hardware's inability to provide a valid measurement, perhaps from sensor disturbances.

NRes is used to report that the value cannot be represented with the available range and resolution, possibly resulting from an overflow or underflow situation.

Example

Example for temperature measurement in 11073-20601 FLOAT-Type format:

Consider a temperature measurement of 36.4 degrees Celsius with precision of 0.1 degrees Celsius. The FLOAT-Type representation is a 32-bit value consisting of an exponent of an 8-bit signed integer followed by a mantissa of a 24-bit signed integer; here, the exponent is -1 (0xFF) and the mantissa is 364 (0x00016C). Therefore, the FLOAT-Type representation of 36.4 is 0xFF00016C.

2.2.2 16-BIT FLOATING POINT DATA TYPE (SFLOAT-TYPE)

The following information is defined in ISO/IEEE Std. 11073-20601™-2008 [1].

The SFLOAT-Type data type (a shortened version of FLOAT-Type) is defined to represent numeric values that are not integer in type. The SFLOAT-Type is defined as a 16-bit value with 12-bit mantissa and 4-bit exponent. See Annex F.8 of [1] for a thorough definition of the SFLOAT-Type. This data type is defined as follows:

	Exponent	Mantissa
Size	4 bit	12 bit

The 16-bit value contains a 4-bit exponent to base 10, followed by a 12-bit mantissa. Each is in twos-complement form.

Special values are assigned to express the following:

- NaN (Not a Number) [exponent 0, mantissa $+(2^{11}-1) \rightarrow 0x07FF$]
- NRes (Not at this Resolution) [exponent 0, mantissa $-(2^{11}) \rightarrow 0x0800$]
- + INFINITY [exponent 0, mantissa $+(2^{11}-2) \rightarrow 0x07FE$]
- – INFINITY [exponent 0, mantissa $-(2^{11}-2) \rightarrow 0x0802$]
- Reserved for future use [exponent 0, mantissa $-(2^{11}-1) \rightarrow 0x0801$]

Example

Example for blood pressure measurement in 11073-20601 SFLOAT-Type format:

Consider a systolic blood pressure measurement of 114 mmHg with a precision of 1 mmHg. The SFLOAT-Type representation is a 16-bit value consisting of an exponent of a 4-bit signed integer followed by a mantissa of a 12-bit signed integer; here, the exponent is 0 (0x0) and the mantissa is 114 (0x072). Therefore, the SFLOAT-Type representation of 114 is 0x0072.

2.2.3 STRING CONVERSION

11073-20601 variable-length string type is encoded with a field length of 2 octets followed by the specific OCTET STRING data array. 11073-20601 strings must be even length (16-bit aligned). For optimized data exchange over GATT, no such requirement exists. Bluetooth characteristic strings can be odd or even length, and the length of the string can be deciphered from the data. To transcode an odd length string, append a zero (0x00) byte to the end of the string, and increment the string length field.

Bluetooth characteristic strings are encoded as UTF-8, whereas 11073-20601 strings are encoded as ASCII printable characters (a UTF-8 subset). The transcoder shall convert non-ASCII characters in characteristic strings to ASCII in order to satisfy 11073-20601 standards.

The converted string may have a different length than the original UTF-8 string. The choice of conversion strategy is left to the implementation.

If the transcoder implementation chooses to transcode health device data directly from Bluetooth GATT string format to a higher-level protocol (e.g. PCD-01) that supports UTF-8, no string conversion is necessary.

2.2.4 MDS ATTRIBUTE CONVERSION

System-Model

The System-Model 11073-20601 attribute consists of a sequence that contains manufacturer name and model number, respectively. Its content is vendor-decided, and represented as an OCTET STRING. Therefore, it must follow the string conversion rules as described in Section 2.2.3.

All fields of the System-Model attribute are derived from the characteristics in the DIS [2]. The Bluetooth “Manufacturer Name String” and “Model Number String” characteristics of the DIS map to the Manufacturer Name and Model Number field of the System Model 11073-20601 Attribute.

System-Id

The System-Id 11073-20601 attribute has the same constraints as defined by the “System ID” Bluetooth characteristic (an EUI-64, which consists of a 24-bit Organizationally Unique Identifier followed by a 40-bit manufacturer-defined identifier). It is mapped directly from the DIS “System ID” Bluetooth characteristic value. For more information, see the DIS [2].

Production-Specification

The 11073-20601 attribute consists of a ProdSpecEntry list. Each entry may describe specific information such as serial number, hardware revision, software revision, protocol revision, firmware revision, and part numbers. Additionally, each entry in the list contains a Spec Type defining which type of specification it refers to, a vendor-specified component ID, and a vendor-specified ASCII printable string, mapped directly from the DIS characteristics as follows.

ProdSpecEntry Spec Type	Bluetooth characteristic	11073-20601 Spec Type Value
Unspecified	N/A	0x0000
Serial Number	Serial Number String (DIS)	0x0001
Part Number	N/A	0x0002
Hardware Revision	Hardware Revision String (DIS)	0x0003
Software Revision	Software Revision String (DIS)	0x0004
Firmware Revision	Firmware Revision String (DIS)	0x0005
Protocol Revision	N/A	0x0006

ProdSpecEntry Spec Type	Bluetooth characteristic	11073-20601 Spec Type Value
GMDN (Global Medical Device Nomenclature)	N/A	0x0007

Table 2: Production Specification

The conversion is done as follows for each Bluetooth characteristic (Serial Number String, Hardware Revision String, Software Revision String, and Firmware Revision String):

1. Create a new ProdSpecEntry.
2. Set the first field (spec_type) according to table above.
3. Set the second field to the vendor-specified component ID.
4. Set the third field to the corresponding Bluetooth characteristic value.

Date-and-Time

5. The transcoder shall provide this attribute if measurements report timestamps in any message (ref: [1] Section 6.3.2.3). The attribute represents the current time in Sensor's clock.
6. If the Sensor reports a timestamp in any message, the Sensor implementation should support the Current Time Service [14]. The 10-byte Current Time characteristic value is transcoded to the 8-byte Date-and-Time attribute value as specified in Section 2.2.6 and the 1-byte Day of Week and Adjust Reason fields are not part of the Date-and-Time attribute. Note that starting in v1.5 of the white paper, text in this section related to exposing the Date Time characteristic (first added in v1.3) has been removed and replaced with a recommendation to use CTS v1.1. This is due to the recent release of CTS v1.1 which added useful features and resolved limitations in CTS v1.0.
7. Since the Current Time characteristic uses absolute time, an issue may arise in cases where measurement results are time stamped with absolute time or separate base time and time offset fields. If the time is changed on the Sensor after the last measurement is stored in the Sensor's memory and before the Collector reads the current time from the Sensor, then the measurement results will not be on the same absolute time base as the Sensor's current time. This may cause the Collector to incorrectly synchronize the prior measurement results to the Collector's time base.
8. The value of 'unknown' is not permitted for year, month or day, as valid values are required for transcoding. If 'unknown' values are observed, the information shall be discarded, and handled as nonexistent.

2.2.5 IEEE 11073-20601 REGULATORY CERTIFICATION DATA LIST

Health and Medical Devices may claim adherence to various regulatory and/or certification compliance items as an informative statement.

The IEEE 11073-20601 Regulatory Certification Data List [16] enables a device to list the compliance items identifying the authorizing body and its data. IEEE, Continua, and the FDA are a few examples of authorizing bodies.

The IEEE 11073-20601 Regulatory Certification Data List is defined as an opaque structure (a “blob”) in the DIS by a regulatory body. The endianness of this data structure is as defined in the associated regulatory specification. For example, if the regulatory body is Continua, the “RegCertDataList” data structure will be in big-endian format.

Following is an example of this structure based on Continua Design Guidelines 2015 (v5.0) [6].

In this example, the *IEEE 11073-20601 Regulatory Certification Data List* characteristic is required to have the following format:

Field Name	Offset	Size	Data Type	Definition / Notes
Regulatory Certification Data List	0			
Count	0	2 octet	INT-U16	
Length	2	2 octet	INT-U16	
Authorization Body	4	1 octet	INT-U8	Code assigned by IEEE 11073-20601 identifying the authorizing body
Authorization Body Structure Type	5	1 octet	INT-U8	Identifies the data structure
Authorization Body Structure Length	6	2 octet	INT-U16	Defines authorization body data length
Authorizing Body Data	8	variable length	Opaque structure	Format defined by Authorizing Body (Continua)
Major IG version	8	1 octet	INT-U8	
Minor IG version	9	1 octet	INT-U8	
Certified device class list	10			
Count (c)	10	2 octet	INT-U16	Number of device classes
Length	12	2 octet	INT-U16	$c * \text{sizeof}(\text{INT-U16})$
Certified device class entry	$12+n*2$	2 octet	INT-U16	May be several of these entries (i.e., $c > 1$), where n is the index of device entry [1..c].
Continua Regulatory Structure	$14+c*2$	2 octet	INT-U16	
Structure length	$16+c*2$	2 octet	INT-U16	
Regulation Bit Field Type	$18+c*2$	2 octet	BITS-16	

Table 3: Format Example for IEEE 11073-20601 Regulatory Certification Data List characteristic

Regulatory Certification Data List and *Certified device class list* are types based on SEQUENCE OF, which specifies a list header with both *count* and *length*, even when the entry size is perfectly known. This allows for robust decoding, allowing the decoder to skip the sequence when it does not know the entry type.

Table 4 is an example showing the contents of this structure based on Continua Design Guidelines 2010 (v1.5) [6]. The minor and major Interoperability Guidelines (IG) version represents the current Continua Guideline being followed, and will be updated as new guidelines are adopted and followed by this document.

In this example, the Continua Health Alliance is the regulatory body and the device includes only one device specialization – the IEEE 11073-10408 Thermometer device specialization [3]. As a result, the *IEEE 11073-20601 Regulatory Certification Data List* characteristic is required to have the following format and values:

Data	Description
0x00 0x02	RegCertDataList.count = 2
0x00 0x12	RegCertDataList.length = 18
0x02 0x01	RegCertDataList{0} auth-body = auth-body-continua = 2 RegCertDataList{0}.auth-body-struct-type = continua-version-struct = 1 (<i>ContinuaBodyStruct</i>)
0x00 0x08	RegCertDataList{0}. auth-body-data.length = 8
0x01 0x05	RegCertDataList{0}. auth-body-data: ContinuaBodyStruct.major-IG-version = 5 ContinuaBodyStruct.minor-IG-version = 0
0x00 0x01	CertifiedDeviceClassList.count = 1
0x00 0x02	CertifiedDeviceClassList.length = 2
0x80 0x08	CertifiedDeviceClassList{0} = 0x8008 Based on Continua 2010 (v1.5) guidelines for a Low Power Wireless PAN Thermometer:Transport Code (TCode) = 4 (Low Power Wireless PAN) MDC_DEV_SPEC_PROFILE_TEMP = 0x10 0x08 = 4104 ₁₀ CertifiedDeviceClass = 4104-4096+4*8192 = 32776 ₁₀ -> 0x8008
0x02 0x02	RegCertDataList{1} auth-body = auth-body-continua = 2 RegCertDataList{1}.auth-body-struct-type = continua-reg-struct = 2 (<i>ContinuaRegStruct</i>)
0x00 0x02	RegCertDataList{1}. auth-body-data.length = 2
0x00 0x00	This is a regulated device

Table 4: IEEE 11073-20601 Regulatory Certification Data List Characteristic Example

In this example, the total length of the structure is 22 octets.

2.2.6 TRANSCODING TIME STAMPS AND CURRENT TIME TO IEEE 11073-20601 ABSOLUTETIME

For the Bluetooth Profiles addressed by this white paper, the measurement time stamps follow the format of the Bluetooth Date Time characteristic. This format is encoded according to the Date Time characteristic definition accessible via the Bluetooth SIG Assigned Numbers [3]. Each field is an 8-bit integer, except for “year”, which is a 16-bit integer.

For example, the time stamp for 18th December 2010, 15:23:06 is encoded as the following 7-byte sequence in the Date Time field: 0xDA 0x07 0x0C 0x12 0x0F 0x17 0x06. Note that due to the little-endian order, the first two bytes in the sequence represent the year.

The Sensor’s current time is exposed by Current Time characteristic in Current Time Service. The format is accessible via the Bluetooth SIG Assigned Numbers [3]. The Current Time characteristic has 10 bytes; the first 7 bytes are in Date Time format, and the ninth byte exposes fractions of a second, in units of 1/256th of a second. The eighth byte (day of week) and tenth byte (adjust reason) are not taken into consideration for transcoding at this time.

For example, the Sensor’s clock for 18th December 2010, 15:23:06.750 is encoded as the following 10-byte sequence in the Current Time field: 0xDA 0x07 0x0C 0x12 0x0F 0x17 0x06 0xXX 0xC0 0xXX.

IEEE 11073-20601 AbsoluteTime specifies time with a resolution of 1/100 of a second. Its data format is encoded using binary coded decimal (i.e., 4-bit nibbles) and every field has 8 bits. For example, the date/time 18th December 2010, 15:23:06:75 is encoded as 0x20 0x10 0x12 0x18 0x15 0x23 0x06 0x75.

Bluetooth Date Time characteristic format has a resolution of one second, so, when it is used for timestamps as a standalone format, the sec-fractions field must be set to zero in the transcoding process.

On the other hand, the Current Time characteristic format has a resolution of 1/256 of a second, so the sec-fractions field should be converted in the transcoding process.

Because AbsoluteTime is encoded as a Binary Coded Decimal (BCD) format, a conversion between formats is needed; however, the BCD conversion does not result in a loss of precision.

Table 5 shows mapping from the Bluetooth Time Stamp fields to the AbsoluteTime type fields:

Bluetooth Field Name (Date Time or Current Time)	AbsoluteTime Field Name
Year	century ¹
	year ²
Month	month
Day	day
Hours	hour

Bluetooth Field Name (Date Time or Current Time)	AbsoluteTime Field Name
Minutes	minute
Seconds	second
Fractions256 (only for Current Time)	sec-fractions ³

Table 5: Bluetooth Date Time characteristic format to IEEE 11073-20601 AbsoluteTime Conversion

Notes:

1. This field is set to the two most significant decimal digits of the Bluetooth Year field, when the value of the Bluetooth Year field is expressed as a 4-digit decimal value.
2. This field is set to the two least significant decimal digits of the Bluetooth Year field, when the value of the Bluetooth Year field is expressed as a 4-digit decimal value.
3. This field is transcoded by multiplying the Fractions256 value by 0.390625 (100/256), rounding down the result to the nearest integer, and then converted to BCD.

2.3 ATTRIBUTE-VALUE-MAP

Each Metric object and the MDS have a conditional Attribute-Value-Map attribute. It is mandatory if the Agent uses fixed-format data update messages. Fixed-format event reports refer to those attributes.

As this document is only relevant for nomenclature and model compatibility and does not mandate any way to reach the 11073-20601 domain, this attribute is implementation-specific.

2.4 PM STORES, SCANNERS, AND PM SEGMENTS

This set of objects and their attributes are only concerned with the 11073-20601 transfer of data.

As this document is only relevant for nomenclature and model compatibility and does not mandate any way to reach the 11073-20601 domain, the creation and use of these objects and their respective attributes is implementation-specific.

3 Device Specific Data Requirements

This section describes the mapping of device specific data from a Bluetooth environment to an 11073-20601 environment. This section will be expanded for various Bluetooth Profiles and Services in the future as they become available.

The table below shows the transport(s) supported by each GATT-based service referenced in this document.

GATT Based Specification	Supported Over Bluetooth LE	Supported Over Bluetooth BR/EDR
Health Thermometer Service v1.0	Yes	Not in this version.
Heart Rate Service v1.0	Yes	Not in this version.
Blood Pressure Service v1.0	Yes	Not in this version.
Glucose Service v1.0	Yes	Not in this version.
Weight Scale Service v1.0	Yes	Yes
Body Composition Service v1.0	Yes	Yes
Current Time Service v1.1	Yes	Yes
Device Information Service v1.1	Yes	Yes
Pulse Oximeter Service v1.0	Yes	Yes
Continuous Glucose Monitoring Service v1.0	Yes	Yes

Table 6: Transport Support for GATT-based Services

3.1 HEALTH THERMOMETER

This sub-section defines transcoding the thermometer device specific data into IEEE 11073-10408 Thermometer device specialization [3] class attributes.

3.1.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 7 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE ¹	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVer List ²	List of (INT-U16, INT-U16)

Table 7: Device-specific MDS Class Requirements

Notes:

1. Value not present since System-Type-Spec-List exists.
2. Since the “Health Thermometer Service” [5] is a “Primary Service”, an entry is required to be added to the TypeVerList as follows:

0x10 0x08	type = MDC_DEV_SPEC_PROFILE_TEMP
0x00 0x01	version = version 1 of the 11073-10408 device specialization

3.1.2 11073-10408 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10408 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Thermometer device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Metric-Id	Temperature Measurement	Health Thermometer	Aggregate	OID-Type ⁴	INT-U16
Unit-Code	Temperature Type and Temperature Measurement	Health Thermometer	Aggregate	OID-Type ⁵	INT-U16
Absolute-Time-Stamp	Temperature Measurement	Health Thermometer	Aggregate	AbsoluteTime ⁶	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Temperature Measurement	Health Thermometer	Aggregate	SimpleNuObsValue ⁷	FLOAT-Type

Table 8: 11073-10408 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_TEMP_BODY}.

3. When the Measurement Interval characteristic is not present or when it is present and its value is zero (aperiodic mode) then this is set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated). When the Measurement Interval characteristic is present and its value is non-zero (periodic mode) this is set to 0x4040 (mss-avail-stored-data, mss- acc-agent-initiated).
4. The value is inferred either based on the non-static Temperature Type field of Temperature Measurement when it is present (presence indicated by bit 2 of Flags field) or the static Temperature Type characteristic. If both are absent, Metric-Id shall be set to MDC_TEMP_BODY.

11073-10408 Temperature Metric-Id code	Bluetooth Temperature Type Description	Bluetooth Value
MDC_TEMP_AXILLA	Armpit	0x01
MDC_TEMP_BODY	Body (general)	0x02
MDC_TEMP_EAR	Ear (usually ear lobe)	0x03
MDC_TEMP_FINGER	Finger	0x04
MDC_TEMP_GIT	Gastro-intestinal Tract	0x05
MDC_TEMP_ORAL	Mouth	0x06
MDC_TEMP_RECT	Rectum	0x07
MDC_TEMP_TOE	Toe	0x08
MDC_TEMP_TYMP	Tympanum (ear drum)	0x09
	Reserved	All other values

Table 9: Temperature Metric-Id Description Conversion

5. This value is mapped from Bit 0 of the least significant octet of the Temperature Measurement characteristic. The mapping is as follows in [Table 10](#):

11073-10408 Temperature Unit Value	Bluetooth Temperature Unit Value	Temperature Unit Description
MDC_DIM_DEGC	0	Celsius
MDC_DIM_FAHR	1	Fahrenheit

Table 10: Temperature Type Description Conversion

6. When supported, this value is derived from the Time Stamp field of Temperature Measurement characteristic. See Section [2.2.6](#).
7. This value is derived from the Temperature Measurement Value field of the Temperature Measurement characteristic.

3.2 HEART RATE SENSOR

This section defines transcoding the heart rate Sensor device specific data into IEEE 11073-10406 Basic Electrocardiograph (ECG) device specialization [\[7\]](#) class attributes and the energy expended object of the IEEE 11073-10441 Cardiovascular Fitness and Activity Monitor device specialization [\[15\]](#).

3.2.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 11 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE ¹	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList ³	List of (INT-U16, INT-U16)
Tick-resolution ²	N/A	N/A	N/A	FLOAT-Type	FLOAT-Type

Table 11: Device-specific MDS Class Requirements

Notes:

- Value not present since System-Type-Spec-List exists.
- Defined as $2^{-(10)}=1/1024$. Matches [8] RR-Interval unit, and can be represented exactly by FLOAT-Type.
- Since the “Heart Rate Service” [8] is a “Primary Service”, the following entries are required to be added to the TypeVerList (the cardiovascular device specialization may be excluded if the device does not contain the Energy Expended field in the Heart Rate Measurement characteristic; since its absence can only be ascertained when the measurement sequence is completed, in practice its omission would happen if, for example, creating upstream data from the measurement sequence):

0x10 0x06	Specialization value = MDC_DEV_SPEC_PROFILE_ECG
0x00 0x01	version = version 1 of the 11073-10406 device specialization
0x10 0x29	Specialization value = MDC_DEV_SPEC_PROFILE_HF_CARDIO
0x00 0x01	version = version 1 of the 11073-10441 device specialization
0x10 0x8D	Profile value = MDC_DEV_SUB_SPEC_PROFILE_HR
0x00 0x01	version = version 1 of the 11073-10406 device specialization

Note that there should be no Date-and-Time attribute since this Service does not support time stamps in its measurements. The Manager shall enter a time stamp at the time of reception of the data.

3.2.2 11073-10406 AND 11073-10441 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10406 and 11073-10441 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Basic Electrocardiograph device and the Cardiovascular Fitness and Activity Monitor device.

3.2.2.1 HEART RATE MEASUREMENT

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16
Simple-Nu-Observed-Value	Heart Rate Measurement (Heart Rate Measurement Value field)	Heart Rate	Aggregate	SimpleNuObs Value ⁵	FLOAT-Type

Table 12: 11073-10406 Numeric Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value is set to {MDC_PART_SCADA | MDC_ECG_HEART_RATE_INSTANT}.
- Set to 0x4040 (mss-avail-stored-data, mss-acc-agent-initiated).
- Unit is MDC_DIM_BEAT_PER_MIN.
- This value is derived from the Heart Rate Measurement Value field of the Heart Rate Measurement characteristic, which is either an 8-bit or 16-bit unsigned integer depending upon bit 0 of the Flags field. This value is converted to FLOAT-Type for transcoding using an exponent of 0.

3.2.2.2 RR-INTERVAL

This data is optionally transcoded when Heart Rate Measurement contains RR-Interval data.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Simple-Nu-Observed-Value	Heart Rate Measurement (RR-Interval field)	Heart Rate	Aggregate	SimpleNuObsValue ⁵	FLOAT-Type

Table 13: 11073-10406 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_SCADA | MDC_ECG_TIME_PD_RR_GL.
3. Set to 0x5440 (mss-avail-stored-data, mss-acc-agent-initiated, mss-msmt-btb-metric, mss-msmt-aperiodic).
4. Unit is MDC_DIM_TICK (1/1024s).
5. One or more values are derived from the variable-size RR-Interval field of the Heart Rate Measurement characteristic. In 11073-10406 the sequence of heart rate measurements would occur in independent scan event reports since the event is episodic.

3.2.2.3 ENERGY EXPENDED

This data is optionally transcoded when Heart Rate Measurement contains Energy Expended field.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16
Simple-Nu-Observed-Value	Heart Rate Measurement (Energy Expended field)	Heart Rate	Aggregate	SimpleNuObsValue ⁵	FLOAT-Type

Table 14: 11073-10441 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.

2. Value set to {MDC_PART_PHD_HF | MDC_HF_ENERGY}.
3. Set to 0xf040 (mss-avail-intermittent, mss-avail-stored-data, mss-updt-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. Unit is MDC_DIM_JOULES.
5. This value is derived from the Energy Expended field of the Heart Rate Measurement characteristic by converting from an unsigned 16-bit integer to a FLOAT using an exponent of 3, and attributing the same numeric value of the field to the mantissa. For example, an Energy Expended of 123 is transcoded to a FLOAT with mantissa=123 and exponent=3. The transcoded value is equal to 123000J, which is equivalent to the original field value of 123kJ. This procedure compensates for the change of unit, without loss of precision.

3.3 BLOOD PRESSURE MONITOR

This section defines transcoding the blood pressure monitor device specific data into IEEE 11073-10407 Blood Pressure Monitor device specialization [10] class attributes.

3.3.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 15 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE ¹	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList ²	List of (INT-U16, INT-U16)

Table 15: Device-specific MDS Class Requirements

Notes:

1. Value not present since System-Type-Spec-List exists.
2. Since the “Blood Pressure Service” [9] is a “Primary Service,” the following entries are required to be added to the TypeVerList:

0x10 0x07	Specialization value = MDC_DEV_SPEC_PROFILE_BP
0x00 0x01	version = version 1 of the 11073-10407 device specialization

3.3.2 11073-10407 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10407 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Blood Pressure Monitor device.

3.3.2.1 SYSTOLIC/DIASTOLIC/MAP COMPOUND NUMERIC OBJECT (BLOOD PRESSURE)

11073-20601 Attribute	Bluetooth equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Measurement-Status	Blood Pressure Measurement	Blood Pressure	Aggregate	MeasurementStatus ⁴	BITS-16
Metric-Structure-Small	N/A	N/A	N/A	MetricStructureSmall ⁵	(INT-U8, INT-U8)
Metric-Id-List	N/A	N/A	N/A	MetricIdList ⁶	List of (INT-U16)
Unit-Code	Blood Pressure Measurement	Blood Pressure	Aggregate	OID-Type ⁷	INT-U16
Absolute-Time-Stamp	Blood Pressure Measurement	Blood Pressure	Aggregate	AbsoluteTime ⁸	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Compound-Basic-Nu-Observed-Value	Blood Pressure Measurement	Blood Pressure	Aggregate	Compound-BasicNuObservedValue ⁹	List of SFLOAT-Type

Table 16: 11073-10407 Numeric Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value is set to {MDC_PART_SCADA | MDC_PRESS_BLD_NONINV}.
- Set to 0xF040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-a-periodic | mss-msmt-a-periodic | mss-acc-agent-initiated).
- Omitted if measurement is ok or Measurement Status field is not present; set to 0x4000 (measurement questionable) if any bit of Measurement Status field is set and the Measurement Status feature is supported.
- Set to (0x03, 0x03) {ms-struct-compound-fix, 3}.
- List set to {MDC_PRESS_BLD_NONINV_SYS, MDC_PRESS_BLD_NONINV_DIA, MDC_PRESS_BLD_NONINV_MEAN}.
- This value is mapped from Bit 0 of the least significant octet of the Blood Pressure Measurement characteristic. The mapping is as follows in [Table 17](#):

11073-10407 Pressure Unit Value	Bluetooth Pressure Unit Value	Unit Description
MDC_DIM_MMHG	0	mmHg
MDC_DIM_KILO_PASCAL	1	kPa

Table 17: Pressure Type Description Conversion

- When supported, this value is derived from the Time Stamp field of Blood Pressure Measurement characteristic. See Section 2.2.6.
- This is a list of exactly three values derived from Blood Pressure Measurement characteristic: Systolic pressure, Diastolic Pressure and MAP: If any of these measurements are temporarily unavailable, this condition is signaled with NaN special value.

3.3.2.2 Pulse Rate

This data is optionally transcoded when Blood Pressure Measurement contains Pulse Rate data.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Measurement-Status	Blood Pressure Measurement (Measurement Status)	Blood Pressure	Aggregate	MeasurementStatus ⁴	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁵	INT-U16
Absolute-Time-Stamp	Blood Pressure Measurement (Time Stamp field)	Blood Pressure	Aggregate	AbsoluteTime ⁶	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Blood Pressure Measurement (Pulse Rate field)	Blood Pressure	Aggregate	BasicNuObserved Value ⁷	SFLOAT-Type

Table 18: 11073-10407 Numeric Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.

2. Value set to MDC_PART_SCADA | MDC_PULS_RATE_NON_INV.
3. Set to 0xf040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated).
4. Absent if the measurement is good or Measurement Status field is not present; set to 0x4000 (measurement questionable) if any bit of Measurement Status field is set and the Measurement Status feature is supported. The IEEE Measurement-Status attribute is an *observational* attribute and only has meaning for the observation in which it is sent. The absence of the attribute implies a good measurement.
5. Unit is MDC_DIM_BEAT_PER_MIN.
6. When supported, this value is derived from the Time Stamp field of Blood Pressure Measurement characteristic. See Section 2.2.6.
7. This value is derived from Pulse Rate field of Blood Pressure Measurement characteristic, if available.

3.3.2.3 USER ID

The 11073-20601 Person-ID is of type INT-U16, while the User ID from the characteristic is one octet, unsigned. When the User ID is in range 0x00 to 0xFE, conversion shall keep the numeric value. For example, User ID 0x02 would be transcoded to Person-ID 0x0002, and 0x85 would be transcoded to 0x0085.

When the User ID is 0xFF (unknown or guest user) it shall be transcoded to 0xFFFF (unknown-person-id).

The use of the Person ID is unspecified in 11073-20601 and is implementation specific. Depending upon the implementation, if the User-ID is absent in the characteristic value it may be ignored or transcoded to the unknown-person-id (0xFFFF).

3.3.2.4 MEASUREMENT STATUS

The Measurement Status data field in the Blood Pressure Measurement characteristic is transcoded in a lossy fashion to 11073-20601 Measurement-Status. There are several bits in Measurement Status field that indicate potential measurement problems. If any of these bits is set, the 11073-20601 Measurement-Status is set as “questionable” (0x4000).

If all these measurement status bits are zero, or if measurement status is not present, the 11073-20601 Measurement-Status is absent. The Blood Pressure Feature characteristic is needed in order to ascertain whether the Measurement Status data field is valid.

Measurement Status field bit (LSB)	11073-20601 Measurement-Status
0 (body movement)	0x4000 (questionable)
1 (cuff fit)	0x4000 (questionable)
2 (irregular pulse)	0x4000 (questionable)
3 (pulse rate range)	0x4000 (questionable)

Measurement Status field bit (LSB)	11073-20601 Measurement-Status
5 (measurement position)	0x4000 (questionable)
Other bits	Reserved for future use

Table 19: Measurement Status bit field relationship with Measurement-Status

3.3.2.5 Blood Pressure feature

The Blood Pressure Feature characteristic of the Blood Pressure Service is used to assist in the generation of the 11073-20601 Measurement-Status attribute. If the Blood Pressure Feature characteristic indicates no support for reporting measurement status error conditions, the measurement status field in the Blood Pressure Measurement characteristic shall be ignored. In this case the transcoded objects from the Blood Pressure Measurement characteristic shall have no Measurement-Status attribute.

3.4 Glucose Meter

This section defines transcoding of the glucose meter device-specific data into IEEE 11073-10417 Glucose Meter device specialization [11] class attributes.

The Glucose Meter device specialization specifies two ways to transmit data to Manager: event reports or having a PM-Store. They are mutually exclusive; that is, if the configuration has a PM-Store, it shall not send real time agent-init measurement events. The Bluetooth Glucose Service supports only the concept of stored data. The stored data is accessed by the Collector using Record Access Control Point (RACP) procedures. The result is that the Collector receives one or more Glucose Measurement characteristics. *This paper is only concerned with the transcoding of these Glucose Measurement characteristics into their respective 11073-10417 metric objects.* Any mapping of the set of PM Store and PM Segment objects and their respective APDU sequences to the Bluetooth Glucose Service RACP procedures is implementation specific.

3.4.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 20 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE ¹	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList ²	List of (INT-U16, INT-U16)

Table 20: Device-specific MDS Class Requirements

Notes:

1. Value is not present since System-Type-Spec-List exists.
2. Since the “Glucose Service” [12] is a “Primary Service”, the following entries are required to be added to the TypeVerList:

0x10 0x11	Specialization value = MDC_DEV_SPEC_PROFILE_GLUCOSE
0x00 0x02	version = version 2 of the 11073-10417 device specialization

The Date-and-Time attribute (specified in Section 2.1 and described in detail in Sections 2.2.4 and 2.2.6) is required since the Glucose Sensor has stored data.

3.4.2 11073-10417 Numeric CLASS Requirements

This section describes the 11073-10417 numeric class requirements. It is restricted to those 11073-10417 attributes that are used on the Glucose Sensor device.

3.4.2.1 Derivation of absolute time stamp

The Absolute Time Stamp of each observation is derived from the mandatory Base Time field of the Glucose Measurement characteristic, together with a potential adjustment due to the Time Offset value. The measurement characteristic may contain the optional Time Offset which is analogous to the Date-and-Time-Adjustment attribute in 11073-20601 (though Time Offset is expressed in minutes).

While there are similarities between the Time Offset field and the Date-and-Time-Adjustment attribute of 11073-20601 in the Glucose meter, there are differences. Specifically, the Date-and-Time-Adjustment contains individual adjustments, whereas each Time Offset is the *total* time adjustment applied on Base Time, up to the moment of the respective measurement.

The Date-and-Time-Adjustment is thus the difference between a given offset and the first offset received. Thus the Base Time plus first offset received in an RACP transaction (the first packet received in an RACP transaction *a/ways* contains an offset) transcodes to the Absolute Time stamp and the difference between any subsequent offset and the first offset is equivalent to the cumulative date time adjustment.

3.4.2.2 Blood Glucose Objects

Each 11073-10417 object has a static TYPE related to the type of blood sample (capillary plasma, control solution etc.). The 11073-20601 Manager (Collector) obtains all the types supported by the device during configuration and creates its DIM objects based upon this information. A GATT-based Bluetooth device does not provide such information and to follow the 11073-20601 model a generic transcoder would need to populate its DIM with a numeric metric object for each of the possible supported TYPES (a total of ten) even though only one may be used. In practice an implementation would likely create the numeric metric object on the

fly as needed or obtain the information from the RACP procedures (replacing the configuration procedure of 11073-20601) and creating the DIM prior to invoking the actual data transfer.

Table 21 is the template structure for each of the ten blood glucose objects. Each object has a different TYPE.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	Glucose Measurement	Glucose	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Glucose Measurement	Glucose	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement	Glucose	Aggregate	BasicNuObserved Value ⁶	SFLOAT-Type

Table 21: 11073-10417 Blood Glucose Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Each object has a different TYPE, of the ten types specified in [11]. They are related to measurements according to Table 22:

Type Nibble in Glucose Measurement	11073-10417 Type
0x1 (capillary wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_CAPILLARY_WHOLEBLOOD}
0x2 (capillary plasma)	{MDC_PART_SCADA MDC_CONC_GLU_CAPILLARY_PLASMA}
0x3 (venous wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_VENOUS_WHOLEBLOOD}
0x4 (venous plasma)	{MDC_PART_SCADA MDC_CONC_GLU_VENOUS_PLASMA}
0x5 (arterial wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_ARTERIAL_WHOLEBLOOD}
0x6 (arterial plasma)	{MDC_PART_SCADA MDC_CONC_GLU_ARTERIAL_PLASMA}

Type Nibble in Glucose Measurement	11073-10417 Type
0x7 (undetermined wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD}
0x8 (undetermined plasma)	{MDC_PART_SCADA MDC_CONC_GLU_UNDETERMINED_PLASMA}
0x9 (interstitial fluid – ISF)	{MDC_PART_SCADA MDC_CONC_GLU_ISF}
0xA (control solution)	{MDC_PART_SCADA MDC_CONC_GLU_CONTROL}
0xF (type not available)	N/A

Table 22: Object Type relationship with measurement type

- Set to 0xF040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated).
- This value is mapped from Bit 1 of the Flags field of the Glucose Measurement characteristic. The characteristic unit is kg/L (when flag is 0) or mol/L (when flag is 1). The transcoded units are not the same as the characteristic units, but the selection of unit codes allow conversion of measurement values by simple scaling. The mapping is as follows:

11073-10417 Glucose Unit Value	Bluetooth Glucose Unit Value	Unit Description
MDC_DIM_MILLI_G_PER_DL	0	mg/dL
MDC_DIM_MILLI_MOLE_PER_L	1	mmol/L

Table 23: Glucose: Glucose Unit Conversion

- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from Glucose Concentration value of Glucose Measurement characteristic. The value shall be converted to match the selected Unit-Code. If the characteristic unit is kg/L, the transcoded unit shall be mg/dL and the units are different by a factor of 10^5 . If the characteristic unit is mol/L, the transcoded unit shall be mmol/L and the units are different by a factor of 10^3 . Both conversions are implemented by adding 5 and 3 to SFLOAT exponent, respectively, without changing the mantissa.

If measurement value is above device capabilities, value shall be +INFINITY. Symmetrically, if measurement is below device capabilities, value shall be –INFINITY. Both conditions can be detected in Sensor Status Annunciation Value Field of Glucose Measurement characteristic, bits 5 and 6 respectively. Device may report a NaN or NRes value as well to signal some problem during measurement, which shall be transcoded as is.

The Sequence Number of the Glucose Measurement characteristic is equivalent to the scan-report number in scan event reports. It assures the Manager that a measurement is not lost or dropped. Its use is implementation specific. It has no influence on the measurement itself.

3.4.2.3 HEMOGLOBIN BOUND TO GLUCOSE A1C FORM

This data is optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 6) that HbA1c value is present.

Note that a measurement may lack glucose concentration and still contain an HbA1c value.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value ⁶	SFLOAT-Type

Table 24: 11073-10417 HbA1c Numeric Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_SCADA | MDC_CONC_HBA1C.
- Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
- Unit is MDC_DIM_PERCENT.
- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from HbA1c value of Glucose Measurement Context characteristic.

3.4.2.4 CONTEXT EXERCISE

This data is optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 3) that exercise value is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth data type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Measure-Active-Period	Glucose Measurement Context	Glucose	Aggregate	FLOAT-Type ⁶	FLOAT-Type
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value ⁷	SFLOAT-Type

Table 25: 11073-10417 Context Exercise Numeric Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_EXERCISE.
- Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
- Unit is MDC_DIM_PERCENT.
- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from Exercise Duration value of Glucose Measurement Context characteristic. Value is converted to FLOAT with an exponent of 0.
- This value is derived from Exercise Intensity value of Glucose Measurement Context characteristic. Value is converted to SFLOAT with an exponent of 0.

3.4.2.5 CONTEXT MEDICATION

This data is optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 4) that medication value is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Metric-Id	Glucose Measurement Context	Glucose	Aggregate	OID-Type ⁴	INT-U16
Unit-Code	Glucose Measurement Context	Glucose	Aggregate	OID-Type ⁵	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁶	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value ⁷	SFLOAT-Type

Table 26: 11073-10417 Context Medication Numeric Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value is set to MDC_PART_PHD_DM | MDC_CTXT_MEDICATION.
- Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
- Value is set based on Medication ID Value field of Glucose Measurement Context characteristic, according to the following table:

Medication ID	11073-10417 Value
0x1 (rapid action insulin)	MDC_CTXT_MEDICATION_RAPIDACTING
0x2 (short acting insulin)	MDC_CTXT_MEDICATION_SHORTACTING
0x3 (intermediate acting insulin)	MDC_CTXT_MEDICATION_INTERMEDIATEACTING
0x4 (long acting insulin)	MDC_CTXT_MEDICATION_LONGACTING
0x5 (pre-mixed insulin)	MDC_CTXT_MEDICATION_PREMIX

Table 27: Medication ID and Metric ID relationship

- Unit is set based on Medication Units Flag (bit 5 of Flags of the Glucose Measurement Context characteristic), according to the following table:

Medication Units Flag	11073-10417 Value	Unit
0x0	MDC_DIM_MILLI_G	mg

Medication Units Flag	11073-10417 Value	Unit
0x1	MDC_DIM_MILLI_L	ml

Table 28: Medication Units Flag and Unit relationship

Note that characteristic value has unit of kilogram (kg) or liter (L), while the transcoded unit code is milligram (mg) or milliliter (mL) respectively, so the medication value needs to be converted.

- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from Medication Value of Glucose Measurement Context characteristic. The value shall be converted to match the selected Unit-Code. If the characteristic medication unit is kg, the transcoded unit shall be mg, and the units are different by a factor of 10^6 . If the characteristic medication unit is L, the transcoded unit shall be mL and the units are different by a factor of 10^3 . Both conversions are implemented by adding 6 and 3 to SFLOAT exponent, respectively, without changing the mantissa.

3.4.2.6 CONTEXT CARBOHYDRATES

This data is optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 0) that carbohydrates value is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Metric-Id	Glucose Measurement Context	Glucose	Aggregate	OID-Type ⁴	INT-U16
Unit-Code	N/A	N/A	N/A	OID-Type ⁵	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁶	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value ⁷	SFLOAT-Type

Table 29: 11073-10417 Context Carbohydrates Numeric Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_CARB.

3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. Value is set based on Carbohydrate ID Value field of Glucose Measurement Context characteristic, according to the following table:

Carbohydrate ID	11073-10417 Value
0x1 (breakfast)	MDC_CTXT_GLU_CARB_BREAKFAST
0x2 (lunch)	MDC_CTXT_GLU_CARB_LUNCH
0x3 (dinner)	MDC_CTXT_GLU_CARB_DINNER
0x4 (snack)	MDC_CTXT_GLU_CARB_SNACK
0x5 (drink)	MDC_CTXT_GLU_CARB_DRINK
0x6 (supper)	MDC_CTXT_GLU_CARB_SUPPER
0x7 (brunch)	MDC_CTXT_GLU_CARB_BRUNCH

Table 30: Carbohydrate ID and Metric Id relationship

5. Unit is MDC_DIM_X_G. Note that characteristic value has unit of kilogram, while this transcoded unit code is gram, so the carbohydrate value needs to be converted.
6. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
7. This value is derived from Carbohydrate Value of Glucose Measurement Context characteristic. The characteristic unit is kg, transcoded unit is g, and the units are different by a factor of 10³. Conversion is achieved by adding 3 to SFLOAT exponent, without changing the mantissa.

3.4.3 Enumeration Objects

This section describes the 11073-10417 enumeration class requirements. It is restricted to those 11073 attributes that are used on the Glucose Sensor device.

3.4.3.1 Device and sensor annunciation

This data is optionally transcoded when Glucose Measurement characteristic contains the Sensor Status Annunciation Value field.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁴	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Enum-Observed-Value-Basic-Bit-Str	Glucose Measurement	Glucose	Aggregate	BITS-16 ⁵	BITS-16

Table 31: 11073-10417 Device and Sensor Annunciation Enumeration Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_GLU_METER_DEV_STATUS
- Set to 0xF040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated).
- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from Sensor Status Annunciation Value Field of the Glucose Measurement characteristic. Bits with value 1 mean that the respective failure mode has happened at measurement time. The bitmap is composed according to Table 32:

11073-10417 Device Or Sensor Condition Bit (GlucoseDevStat) Bit 0 is MSB	Bluetooth Sensor Status Annunciation Bit Bit 0 is LSB
device-battery-low (0)	0 (device battery low)
sensor-malfunction (1)	1 (sensor malfunction)
sensor-sample-size-insufficient (2)	2 (sample size insufficient, not enough blood or control solution)
sensor-strip-insertion (3)	3 (strip insertion error)
sensor-strip-type-incorrect (4)	4 (strip type is incorrect)
sensor-result-too-high (5)	5 (sensor result higher than device can process)
sensor-result-too-low (6)	6 (sensor result lower than device can process)
sensor-temp-too-high (7)	7 (ambient temperature too high for a valid test/result)
sensor-temp-too-low (8)	8 (ambient temperature too low for a valid test/result)
sensor-read-interrupt (9)	9 (reading was interrupted and/or strip was pulled too soon)
device-gen-fault (10)	10 (general device fault)
No correspondence	11 (time fault)

Table 32: Relationship between Sensor Status Annunciation and 11073-10417 sensor condition

For example, if the battery was low and on top of that the user pulled the strip too soon, the Sensor status value would be 0x0201 (bits 0 and 9 LSB set), and the 11073-20601 transcoded value would be 0x8040 (bits 0 and 9 MSB set).

3.4.3.2 Context meal

This data is optionally transcoded when Glucose Measurement Context characteristic is present and the respective Flags field indicates that Meal Value field is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁴	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement Context	Glucose	Aggregate	OID-Type ⁵	INT-U16

Table 33: 11073-10417 Context Meal Enumeration Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_MEAL.
- Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from Meal Value Field of the Glucose Measurement Context characteristic, according to Table 34:

11073-10417 Nomenclature Value	Bluetooth Meal Value
MDC_CTXT_GLU_MEAL_PREPRANDIAL	0x1 (preprandial – before meal)
MDC_CTXT_GLU_MEAL_POSTPRANDIAL	0x2 (postprandial – after meal)
MDC_CTXT_GLU_MEAL_FASTING	0x3 (fasting)
MDC_CTXT_GLU_MEAL_CASUAL	0x4 (casual – snacks, drinks etc.)
MDC_CTXT_GLU_MEAL_BEDTIME	0x5 (bedtime)

Table 34: Relationship between Bluetooth Meal value and context meal enumeration

3.4.3.3 Context sample location

This data is optionally transcoded when Glucose Measurement characteristic contains the Type/Sample Location Value field, and the Sample nibble value of this field is different from 0xF (0xF means sample location not available).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁴	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement	Glucose	Aggregate	OID-Type ⁵	INT-U16

Table 35: 11073-10417 Context Sample Location Enumeration Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_SAMPLELOCATION
- Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from Sample Location nibble in Type/Sample Location Value Field of the Glucose Measurement characteristic, according to Table 36:

11073-10417 Nomenclature Value	Bluetooth Sample Location Nibble Value
MDC_CTXT_GLU_SAMPLELOCATION_FINGER	0x1 (finger)
MDC_CTXT_GLU_SAMPLELOCATION_AST	0x2 (alternate site test)
MDC_CTXT_GLU_SAMPLELOCATION_EARLOBE	0x3 (earlobe)
MDC_CTXT_GLU_SAMPLELOCATION_CTRLsolution	0x4 (control solution)

Table 36: Relationship between Bluetooth Sample Location and location nomenclature

3.4.3.4 Context tester

This data is optionally transcoded when Glucose Measurement Context characteristic is present, the respective Flags field indicates that Tester/Health field is present, and Tester nibble value of this field is different from 0xF (0xF means health value not available).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁴	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement Context	Glucose	Aggregate	OID-Type ⁵	INT-U16

Table 37: 11073-10417 Context Tester Enumeration Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_TESTER.
- Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-a-periodic | mss-msmt-a-periodic | mss-acc-agent-initiated | mss-cat-manual).
- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- This value is derived from Tester nibble in Tester/Health Value Field of the Glucose Measurement Context characteristic, according to Table 38:

11073-10417 Nomenclature Value	Bluetooth Tester Nibble Value
MDC_CTXT_GLU_TESTER_SELF	0x1 (self)
MDC_CTXT_GLU_TESTER_HCP	0x2 (health care professional)
MDC_CTXT_GLU_TESTER_LAB	0x3 (lab test)

Table 38: Relationship between Bluetooth Tester value and tester nomenclature value

3.4.3.5 Context health

This data is optionally transcoded when Glucose Measurement Context characteristic is present, the respective Flags field indicates that Tester/Health field is present, and Health nibble value of this field is different from 0xF (0xF means health value not available).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime ⁴	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement Context	Glucose	Aggregate	OID-Type ⁵	INT-U16

Table 39: 11073-10417 Context Health Enumeration Class Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_HEALTH.
- Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
- This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See Section 3.4.2.1 for details.
- Derived from Health nibble in Tester/Health Value Field of the Glucose Measurement Context characteristic, according to Table 40:

11073-10417 Nomenclature Value	Bluetooth Health Nibble Value
MDC_CTXT_GLU_HEALTH_MINOR	0x1 (minor health issues)
MDC_CTXT_GLU_HEALTH_MAJOR	0x2 (major health issues)
MDC_CTXT_GLU_HEALTH_MENSES	0x3 (menses)
MDC_CTXT_GLU_HEALTH_STRESS	0x4 (under stress)
MDC_CTXT_GLU_HEALTH_NONE	0x5 (no health issues)

Table 40: Relationship between Bluetooth Health nibble in Tester/Health Value Field and Context Health nomenclature

3.5 Weight Scale

This section defines transcoding the weight scale device-specific data into IEEE 11073-10415 Weighing Scale [20] and IEEE 11073-10420 Body Composition [21] device specialization class attributes.

3.5.1 Device-Specific MDS class Requirements

In addition to the MDS class requirements shown in Section 2.1, Table 41 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE ¹	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList ²	List of (INT-U16, INT-U16)

Table 41: Device-specific MDS Class Requirements

Notes:

- Value not present since System-Type-Spec-List exists.
- If the Sensor exposes only the Weight Scale Service [18] the following entry is required to be added to the TypeVerList:

0x10 0x0F Specialization value = MDC_DEV_SPEC_PROFILE_SCALE
 0x00 0x01 version = version 1 of the 11073-10415 device specialization

If the Sensor exposes both the Weight Scale Service [18] and the Body Composition Service [19] the following entry is required to be added to the TypeVerList:

0x10 0x14 Specialization value = MDC_DEV_SPEC_PROFILE_BCA
 0x00 0x01 version = version 1 of the 11073-10420 device specialization

3.5.2 Weight Scale feature

The Weight Scale Feature characteristic of the Weight Scale Service contains the weight and height measurement resolutions.

Weight measurement resolution is specified by bits 3 to 6, according to Table 42. Note that resolution value is little-endian, so the LSB is bit 3 and MSB is bit 6.

Height measurement resolution is specified by bits 7 to 9, according to Table 43. Note that this resolution value is little endian as well.

Other than these resolution bits, the Weight Scale Feature characteristic of the Weight Scale Service does not contain additional information for transcoding, since it merely describes which optional features may appear in the measurement.

Weight Scale Feature Weight Measurement Resolution (bits 6, 5, 4, 3)	Resolution	Exponent for kg	Exponent for lb
0b0000	Not specified	-3	-2
0b0001	0.5kg/1lb	-1	0
0b0010	0.2kg/0.5lb	-1	-1
0b0011	0.1kg/0.2lb	-1	-1
0b0100	0.05kg/0.1lb	-2	-1
0b0101	0.02kg/0.05lb	-2	-2
0b0110	0.01kg/0.02lb	-2	-2
0b0111	0.005kg/0.01lb	-3	-2
0b1000 to 0b1111	Reserved for future use	N/A	N/A

Table 42: Weight Scale Feature: Weight Measurement Resolution

The exponent for the transcoded Weight value (Section 3.5.4.1) should be chosen according to the value of Weight Measurement Resolution bits and the measurement unit (SI or Imperial).

Weight Scale Feature Height Measurement Resolution (bits 9, 8, 7)	Resolution	Exponent for m	Exponent for in
0b000	Not specified	-3	-1
0b001	0.01m/1in	-2	0
0b010	0.005m/0.5in	-3	-1
0b011	0.001m/0.1in	-3	-1
0b100 to 0b111	Reserved for future use	N/A	N/A

Table 43: Weight Scale Feature: Height Measurement Resolution

The exponent for the transcoded Height value (Section 3.5.4.2) should be chosen according to the value of Height Measurement Resolution bits and the measurement unit (SI or Imperial).

3.5.3 Body Composition feature

The Body Composition Feature characteristic of the Body Composition Service contains the Body Mass and Height measurement resolutions.

The Mass Measurement Resolution is specified by bits 11, 12, 13 and 14, according to Table 44. Note that resolution value is little-endian, so the LSB is bit 11 and MSB is bit 14.

The Height resolution is specified by bits 15, 16 and 17, according to [Table 45](#). The resolution value is little-endian as the Mass resolution.

Note that, in the context of Weight Scale Profile, the Body Composition Service shall not include the Height and Weight fields in measurements. In the absence of Height, the Height Resolution bits of Body Composition Feature are meaningless and shall be zero.

Other than these resolution bits, the Body Composition Feature characteristic of the Body Composition Service does not contain additional information for transcoding, since it merely describes which optional features may appear in the measurement.

Body Composition Feature Mass Measurement Resolution (bits 14, 13, 12, 11)	Resolution	Exponent for kg	Exponent for lb
0b0000	Not specified	-3	-2
0b0001	0.5kg/1lb	-1	0
0b0010	0.2kg/0.5lb	-1	-1
0b0011	0.1kg/0.2lb	-1	-1
0b0100	0.05kg/0.1lb	-2	-1
0b0101	0.02kg/0.05lb	-2	-2
0b0110	0.01kg/0.02lb	-2	-2
0b0111	0.005kg/0.01lb	-3	-2
0b1000 to 0b1111	Reserved for future use	N/A	N/A

Table 44: Body Composition Feature: Mass Measurement Resolution

The exponent for the transcoded mass values (Sections [3.5.5.2](#), [3.5.5.3](#), [3.5.5.4](#), and [3.5.5.10](#)) shall be set according to the value of the resolution bits and the mass measurement unit (kg or lb).

Body Composition Feature Height Measurement Resolution (bits 17, 16, 15)	Resolution	Exponent for m	Exponent for in
0b000	Not specified	-3	-1
0b001	0.01m/1in	-2	0
0b010	0.005m/0.5in	-3	-1
0b011	0.001m/0.1in	-3	-1
0b100 to 0b111	Reserved for future use	N/A	N/A

Table 45: Body Composition Feature: Height Measurement Resolution

Table 45 is supplied only for completeness. The Height Resolution bits are not transcoded in the context of Weight Scale transcoding, as Body Composition Service does not include the Height field in this context.

3.5.4 11073-10415 Numeric CLASS Requirements

This section describes the 11073-10415 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Weight Scale device.

3.5.4.1 Weight

Mandatory object, transcoded from Weight Measurement data. Attributes are defined in Table 46.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Weight Measurement	Weight Scale	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Weight Measurement	Weight Scale	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Weight Measurement	Weight Scale	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 46: 11073-10415 Numeric Class Requirements: Weight

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, MDC_MASS_BODY_ACTUAL}.
- Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated).
- This value is mapped from Bit 0 LSB of Flags field of the Weight Measurement characteristic. The mapping is as follows in Table 47:

11073-10415 Weight Unit Value	Bluetooth Measurement Units bit value	Weight Unit Description
MDC_DIM_KILO_G	0	Kilogram

11073-10415 Weight Unit Value	Bluetooth Measurement Units bit value	Weight Unit Description
MDC_DIM_LB	1	Pound

Table 47: Weight Unit Type

- When supported, this value is derived from the Time Stamp field of Weight Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section 2.2.6.
- The Weight field of the Weight Measurement characteristic has a UINT16 format where the least significant bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a weight of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a weight of 160.00lb (16000 x 0.01).

To convert this to a FLOAT, the exponent is selected according to the value of the Weight Measurement Resolution bits (see Section 3.5.2 for details) and the weight measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x 10⁽⁻²⁾).

In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x 10⁽⁻¹⁾).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

This procedure does not result in loss of precision in the equivalent representation regardless of the selected unit.

3.5.4.2 Height

This data is optionally transcoded when Weight Measurement characteristic contains the Height field (i.e. when bit 3 of Flags field equal to 1). Attributes are defined in Table 48.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Weight Measurement	Weight Scale	Aggregate	OID-Type ⁴	INT-U16

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Absolute-Time-Stamp	Weight Measurement	Weight Scale	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Weight Measurement	Weight Scale	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 48: 11073-10415 Numeric Class Requirements: Height

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, MDC_LEN_BODY_ACTUAL}.
- Set to 0xF048 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated, mss-cat-manual).
- This value is mapped from Bit 0 LSB of Flags field of the Weight Measurement characteristic. The mapping is as follows in [Table 49](#):

11073-10415 Height Unit Value	Bluetooth Measurement Units bit value	Height Unit Description
MDC_DIM_CENTI_M	0	Centimeter
MDC_DIM_INCH	1	Inch

Table 49: Height Type Description Conversion

- When supported, this value is derived from the Time Stamp field of Weight Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section [Error! Reference source not found.2.2.6](#).
- The Height field of the Weight Measurement characteristic has a UINT16 format where each bit represents a value of 0.001m when the unit is set to meters, and 0.1in when the unit is set to inches. Therefore if the unit is set to meters and the field value is e.g. 1715, this equates to a height of 1.715m (1715 x 0.001). Similarly, if the unit is set to inches and the field value is e.g. 677, this equates to a height of 67.7in or 5' 7.7". (These are examples for scale resolutions of 0.1cm and 0.1in, respectively.)

To convert this to a FLOAT, the exponent is selected according to the value of the Height Measurement Resolution bits (see Section [3.5.2](#) for details) and the height measurement unit (i.e. cm or in). The mantissa is scaled according to the exponent. For example, if unit is m and the measurement is 1.720m (field value of 1720), and scale resolution is 0.01m, the exponent is set to -2 and the mantissa is set to 172 (1720 x 0.001 x 10⁽⁻²⁾).

In another example, if unit is in and measurement is 68.0in (field value of 680) and scale resolution is 1in, the exponent is set to 0 and the mantissa is set to 68 ($68 \times 0.1 \times 10^{(0)}$).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.4.3 Body Mass Index (BMI)

This data is optionally transcoded when Weight Measurement characteristic contains the BMI field (i.e. when bit 3 of Flags field equal to 1). Attributes are defined in [Table 50](#).

In 11073-10415, the Height object is mandatory when the BMI object is present. In the Weight Measurement, either both Height and BMI are present or both are absent, as the presence of both is announced by the same bit of Flags field (bit 3: “BMI and Height present”).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Weight Measurement	Weight Scale	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Weight Measurement	Weight Scale	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Weight Measurement	Weight Scale	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 50: 11073-10415 Numeric Class Requirements: BMI

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_RATIO_MASS_BODY_LEN_SQ}.
3. Set to 0xF042 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated, mss-cat-calculation).
4. Set to MDC_DIM_KG_PER_M_SQ. It does not change, regardless of bit 0 in Flags field.

5. When supported, this value is derived from the Time Stamp field of Weight Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section 2.2.6.
6. This value is derived from the BMI field of the Weight measurement characteristic by converting from an unsigned 16-bit integer to a FLOAT using an exponent of -1, and attributing the same numeric value of the field to the mantissa. For example, a BMI of 275 is transcoded to a FLOAT with mantissa=275 and exponent=-1. The transcoded value is equal to 27.5. This procedure does not result in loss of precision.

3.5.4.4 User ID

Weight Measurement contains a User ID field when the bit 2 LSB of Flags field of the characteristic is set to 1.

The 11073-20601 Person-ID is of type INT-U16, while the User ID from the Weight Measurement characteristic is one octet, unsigned. When the User ID is in range 0x00 to 0xFE, conversion shall keep the numeric value. For example, User ID 0x02 would be transcoded to Person-ID 0x0002, and 0x85 would be transcoded to 0x0085.

When the User ID is 0xFF (unknown or guest user) it shall be transcoded to 0xFFFF (unknown-person-id).

The use of the Person ID is unspecified in 11073-20601 and is implementation specific. Depending upon the implementation, if the User-ID is absent in the characteristic value it may be ignored or transcoded to the unknown-person-id (0xFFFF).

3.5.5 11073-10420 Numeric CLASS Requirements

This section describes the 11073-10420 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Body Composition Analyzer features of the Weight Scale device.

The 11073-10420 specialization has three mandatory numeric objects: Weight, Height and Body Fat. Since Weight is also mandatory for 11073-10415 (Weight Scale), it is already satisfied by Section 3.5.4.1. In the other hand, Height is optional for Weight Scale.

Body Composition measurements depend on two conditions to be transcodable:

- Height and BMI are exposed by Weight Scale Service;
- At least the Height object (Section 3.5.4.2) is implemented by the transcoder.

The class definitions for Weight and Height objects are exactly the same in 11073-10415 and 11073-10420. They are specified in Sections 3.5.4.1 and 3.5.4.2.

Likewise, the optional Body Mass Index object has the same class definition in both specializations and is specified in Section 3.5.4.3.

In the context of Weight Scale devices, Weight and Height can only be exposed by the Weight Scale Service, not by the Body Composition Service. Therefore, the data source for Weight and Height is always the Weight Scale Service.

Any given measurement may be transmitted (indicated) in two pieces, to cover the situation when data would not fit in a single indication packet (case of e.g. Low Energy transport when the default ATT_MTU is used). The transcoder should handle the two-part measurement as if it were single-part. See Section 3.5.5.12 for details.

3.5.5.1 Body Fat Percentage

This mandatory object is transcoded from Body Composition Measurement. While 11073-10420 allows body fat to be expressed either in percentage or absolute weight units, the Body Composition Service always uses percentage.

Attributes are defined in Table 51.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 51: 11073-10420 Numeric Class Requirements: Body Fat

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, MDC_BODY_FAT}.
- Set to 0xF042 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated, mss-cat-calculation).
- Set to MDC_DIM_PERCENT.

5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section 2.2.6.
6. This value is derived from the Body Fat Percentage field of the Body Composition Measurement characteristic by converting from an unsigned 16-bit integer to a FLOAT using an exponent of -1, and attributing the same numeric value of the field to the mantissa. For example, a Body Fat Percentage of 275 is transcoded to a FLOAT with mantissa=275 and exponent=-1. The transcoded value is equal to 27.5. This procedure does not result in loss of precision.

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful, and it should be transcoded as a FLOAT NaN. This indicates that the measurement is invalid.

3.5.5.2 Fat Free Mass

This data is optionally transcoded when bit 6 of Flags field in Body Composition Measurement is set to 1. Attributes are defined in Table 52.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 52: 11073-10420 Numeric Class Requirements: Fat Free Mass

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_MASS_BODY_FAT_FREE}.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).

- This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in [Table 53](#):

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 53: Mass Type Description Conversion

- When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section [2.2.6](#).
- The Fat Free Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a mass of 160.00lb (16000 x 0.01).

To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see Section [3.5.3](#) for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x 10⁽⁻²⁾).

In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x 10⁽⁻¹⁾).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.3 Soft Lean Mass

This data is optionally transcoded when bit 7 of Flags field in Body Composition Measurement is set to 1. Attributes are defined in [Table 54](#).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 54: 11073-10420 Numeric Class Requirements: Soft Lean Mass

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, MDC_MASS_BODY_SOFT_LEAN}.
- Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated).
- This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in [Table 55](#):

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 55: Mass Type Description Conversion

- When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section [2.2.6](#).
- The Soft Lean Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a mass of 160.00lb (16000 x 0.01).

To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see Section [3.5.3](#) for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to

-2 and the mantissa is set to 8000 ($16000 \times 0.005 \times 10^{-(-2)}$).

In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 ($16000 \times 0.01 \times 10^{-(-1)}$).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.4 Body Water Mass

This data is optionally transcoded when bit 8 of Flags field in Body Composition Measurement is set to 1. Attributes are defined in [Table 56](#).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 56: 11073-10420 Numeric Class Requirements: Body Water Mass

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, MDC_MASS_BODY_WATER}.
- Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated).
- This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in [Table 57](#):

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 57: Mass Type Description Conversion

- When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section 2.2.6.
- The Body Water Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a mass of 160.00lb (16000 x 0.01).

To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see Section 3.5.3 for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x 10⁻²).

In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x 10⁻¹).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.5 WEIGHT

This value in Body Composition Measurement (present when bit 10 of Flags field is equal to 1) is not used in the Body Composition Service in the context of the Weight Scale Profile, since the weight information comes from the Weight Measurement characteristic (see Section 3.5.4.1).

3.5.5.6 HEIGHT

This value in Body Composition Measurement (present when bit 11 of Flags field is equal to 1) is not used in the Body Composition Service in the context of the Weight Scale Profile, since the height information comes from the Weight Measurement characteristic (see Section 3.5.4.2).

3.5.5.7 Impedance

This value is optionally transcoded when bit 9 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in Table 58.

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 58: Numeric Class: Impedance

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to “Body electrical impedance” {MDC_PART_SCADA, 57708}. This unit code has been reserved but does not have a Ref ID yet.
- Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated).
- Set to MDC_DIM_X_OHM.
- When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section 2.2.6.
- The Impedance field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.1 ohm. It is transcoded to FLOAT by setting the exponent to -1 and attributing the unchanged numeric value from the Impedance field to the mantissa.

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.8 Basal Metabolism

This value is optionally transcoded when bit 3 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in Table 59.

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 59: Numeric Class: Basal Metabolism

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, 57696}. This unit code has been reserved but does not have a Ref ID yet.
- Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-a-periodic, mss-msmt-a-periodic, mss-acc-agent-initiated).
- Set to MDC_DIM_JOULES.
- When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section 2.2.6.
- The Basal Metabolism field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 1kJ. It is transcoded to FLOAT, by setting the exponent to +3 and attributing the unchanged numeric value from the field to the mantissa.

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.9 Muscle Percentage

This value is optionally transcoded when bit 4 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in [Table 60](#).

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 60: Numeric Class: Muscle Percentage

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, 57700}. This unit code has been reserved but does not have a Ref ID yet.
- Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
- Set to MDC_DIM_PERCENT.
- When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section [2.2.6](#).
- The Muscle Percentage field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value 0.1%. It is converted to FLOAT by setting the exponent to -1 and attributing the unchanged numeric value from the field to the mantissa.

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.10 Muscle Mass

This value is optionally transcoded when bit 5 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in [Table 61](#).

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type ⁴	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime ⁵	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 61: Numeric Class: Muscle Mass

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Set to {MDC_PART_SCADA, 57704}. This unit code has been reserved but does not have a Ref ID yet.
- Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
- This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in [Table 62](#):

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 62: Mass Type Description Conversion

- When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to 1. See Section 2.2.6.
- The Muscle Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a mass of 160.00lb (16000 x 0.01).

To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see Section 3.5.3 for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x 10⁻⁽⁻²⁾).

In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x 10⁻⁽⁻¹⁾).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.11 User ID

User ID is present in Body Composition Measurement when bit 1 of Flag fields is equal to 1.

The 11073-20601 Person-ID is of type INT-U16, while the User ID from the Body Composition Measurement characteristic is one octet, unsigned. When the User ID is in range 0x00 to 0xFE, conversion shall keep the numeric value. For example, User ID 0x02 would be transcoded to Person-ID 0x0002, and 0x85 would be transcoded to 0x0085.

When the User ID is 0xFF (unknown or guest user) it shall be transcoded to 0xFFFF (unknown-person-id).

The use and interpretation of the Person ID in 11073-20601 is implementation-specific. Depending upon the implementation, if the User-ID is absent in the characteristic value it may be ignored or transcoded to the unknown-person-id (0xFFFF).

3.5.5.12 Multiple Packet Measurement flag

The bit 12 in Flags field in Body Composition Measurement, when is equal to 1, informs that the measurement data is being sent in two pieces (i.e. two consecutive indications).

- Both first and second indications have the bit 12 equal to 1;
- The second indication contains the optional fields that did not fit in the first indication but belong to the same measurement. The respective bits in Fields flag are set accordingly;
- If the service supports Time Stamp and/or User ID, these fields are present only in the first indication;
- The mandatory Body Fat Percentage field is present in both indications, containing the same value.

The transcoder should detect the multiple-packet flag, wait for the second indication and handle the pair of indications as if it were a single-packet measurement.

3.6 Continuous Glucose Monitoring

This section defines transcoding of the continuous glucose monitoring device-specific data into IEEE 11073-10425 Continuous Glucose Monitor device specialization [22] class attributes.

The Continuous Glucose Monitoring Service communicates observations using notification and indications, which will be transcoded as agent-init events. In addition, stored observations retrieved using the Record Access Control Point (RACP) will be transcoded to agent-init events.

3.6.1 Device-Specific MDS class Requirements

In addition to the MDS class requirements shown in Section 2.1, Table 63 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE ¹	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList ²	List of (INT-U16, INT-U16)

Table 63: Device-specific MDS Class Requirements

Notes:

1. Value is not present since System-Type-Spec-List exists.
2. Since the “Continuous Glucose Monitoring Service” [23] is a “Primary Service”, the following entries are required to be added to the TypeVerList:

0x10 0x1A Specialization value = MDC_DEV_SPEC_PROFILE_CGM

0x00 0x01 version = version 1 of the 11073-10425 device specialization

The Date-and-Time attribute (specified in Section 2.1 and described in detail in Sections 2.2.4 and 2.2.6) is required since the Continuous Glucose Monitoring (CGM) Service has stored data.

3.6.2 11073-10425 Numeric CLASS Requirements

This section describes the 11073-10425 numeric class requirements. It is restricted to those 11073-10425 attributes that are used on the Continuous Glucose Monitoring device.

3.6.2.1 Derivation of Base-Offset time stamp

The Base-Offset-Time-Stamp attribute of each observation is derived either from the collector's time or from the mandatory CGM Session Start Time characteristic's Session Start Time, Time Zone, DST - Offset fields plus the observation's Time Offset field value. The observation's Time Offset field is the relative time difference in minutes for that observation from the Session Start Time field.

In the case of the CGM Specific Ops Control Point procedures where the observation response does not have a Time Offset field, the Base-Offset-Time-Stamp attribute will be derived from the collector's time at the time of collection. In the case of the CGM Session Run Time field in the CGM Session Run Time characteristic, the Base-Offset-Time-Stamp attribute will be derived from CGM Session Start Time characteristic's Session Start Time, Time Zone, DST - Offset fields. In all other cases, the Base-Offset-Time-Stamp attribute will be derived from the Session Start Time, Time Zone, DST - Offset fields with the addition of the observation's Time Offset field.

3.6.2.2 Glucose Numeric Object

This is a mandatory object to be transcoded from a continuous glucose monitor. The Glucose numeric object of 11073-10425 has a static TYPE related to the type of fluid being sampled (interstitial fluid, capillary plasma, etc.). The 11073-20601 Manager (Collector) obtains the types supported by the device during configuration and creates its domain information model (DIM) objects based upon this information. A GATT-based Bluetooth device does not provide such information and to follow the 11073-20601 model a generic transcoder may choose to populate its DIM with a numeric metric object for each of the possible supported TYPES even though only one type may be used. Alternatively, an implementation could create the glucose objects as needed at run-time after obtaining the TYPE from the CGM Feature Characteristic as described in Table 65.

The CGM Quality field of the CGM Measurement characteristic is not transcodable.

Table 64 is the template structure for the Glucose numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
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Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	CGM Feature	CGM	Aggregate	TYPE ²	(INT-U16, INT-U16)
Supplement-Types	CGM Feature	CGM	Aggregate	SupplementalTypeList ³	List of (INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ⁴	BITS-16
Measurement-Status	CGM Measurement	CGM	Aggregate	MeasurementStatus ⁵	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁶	INT-U16
Base-Offset-Time-Stamp	CGM Measurement & CGM Session Start Time	CGM	Aggregate	BaseOffsetTime ⁷	(INT-U32, INT-U16, INT-U16)
Basic-Nu-Observed-Value	CGM Measurement	CGM	Aggregate	BasicNuObsValue ⁸	SFLOAT-Type
Threshold-Notification-Text-String	CGM Measurement	CGM	Aggregate	OCTET STRING ⁹	OCTET STRING

Table 64: 11073-10425 Glucose Numeric Object Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Each object has a different TYPE, of the types specified in [22]. They are related to measurements according to Table 65:

Type Nibble in CGM Feature	11073-10425 Glucose Numeric Type
0x1 (capillary wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_CAPILLARY_WHOLEBLOOD}
0x2 (capillary plasma)	{MDC_PART_SCADA MDC_CONC_GLU_CAPILLARY_PLASMA}
0x3 (venous wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_VENOUS_WHOLEBLOOD}
0x4 (venous plasma)	{MDC_PART_SCADA MDC_CONC_GLU_VENOUS_PLASMA}
0x5 (arterial wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_ARTERIAL_WHOLEBLOOD}
0x6 (arterial plasma)	{MDC_PART_SCADA MDC_CONC_GLU_ARTERIAL_PLASMA}
0x7 (undetermined wholeblood)	{MDC_PART_SCADA MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD}

Type Nibble in CGM Feature	11073-10425 Glucose Numeric Type
0x8 (undetermined plasma)	{MDC_PART_SCADA MDC_CONC_GLU_UNDETERMINED_PLASMA}
0x9 (interstitial fluid – ISF)	{MDC_PART_SCADA MDC_CONC_GLU_ISF}
0xA (control solution)	{MDC_PART_SCADA MDC_CONC_GLU_CONTROL}

Table 65: Object Type relationship with measurement type

- Each object may have a different supplemental type, which indicates the sample location and is specified in [22]. They are related to glucose measurement sample locations according to Table 66:

Sample location Nibble in CGM Feature	11073-10425 Glucose Numeric Supplemental-Types
0x1 (finger)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_FINGER}
0x2 (alternative site test)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_AST}
0x3 (earlobe)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_EARLOBE}
0x4 (control solution)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_CTRLsolution}
0x5 (subcutaneous tissue)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_SUBCUTANEOUS}
0xF (sample location value not available)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_UNDETERMINED}

Table 66: Object supplemental type relationship with sample location

- Set to 0xC042 (mss-avail-intermittent | mss-avail-stored-data | mss-acc-agent-initiated | mss-cat-calculation).
- Each Glucose object may have a different measurement status and the Measurement-Status attribute value can be determined from the Sensor Status Annunciation Field. The IEEE Measurement-Status attribute is an observational attribute and only has meaning for the observation in which it is sent. The absence of the Measurement-Status attribute or setting bit 8 (validated-data) implies a good measurement. Setting bit 1 (questionable) shall indicate that the measurement is not reliable. Table 67 relates the Sensor Status Annunciation Field to the Measurement-Status attribute.

Sensor Status Annunciation bit (LSB) in CGM Measurement	11073-10425 Glucose Numeric Measurement-Status
11 (calibration required)	Set bit 1 (questionable)
12 (sensor temperature too high for valid test/result at time of measurement)	Set bit 0 (invalid)

Sensor Status Annunciation bit (LSB) in CGM Measurement	11073-10425 Glucose Numeric Measurement-Status
13 (sensor temperature too low for valid test/result at time of measurement)	Set bit 0 (invalid)
16 (Sensor result lower than the Patient Low level)	Set bit 14 (measurement outside threshold boundaries)
17 (Sensor result higher than the Patient Low level)	Set bit 14 (measurement outside threshold boundaries)
18 (Sensor result lower than the Hypo level)	Set bit 14 (measurement outside threshold boundaries)
19 (Sensor result higher than the Hyper level)	Set bit 14 (measurement outside threshold boundaries)
22 (sensor result lower than the device can process)	Set bit 0 (invalid)
23 (sensor result higher than the device can process)	Set bit 0 (invalid)

Table 67: Glucose numeric object Measurement-Status relationship with Sensor Status Annunciation

- The Continuous Glucose Monitoring Service only supports units of mg/dL and as such, the Unit-Code attribute shall be transcoded to MDC_DIM_MILLI_G_PER_DL.
- Base-Offset-Time-Stamp attribute value is derived from the mandatory CGM Session Start Time characteristic, added by the Time Offset field of the CGM measurement characteristic. See Section 3.6.2.1 for details.
- The Basic-Nu-Observed-Value attribute value is the CGM Glucose Concentration value of the CGM Measurement characteristic.
If the measurement is below device capabilities, value shall be -INFINITY. Symmetrically, if measurement is above device capabilities, value shall be +INFINITY. Both conditions can be detected in Sensor Status Annunciation Field of CGM Measurement characteristic, bits 22 and 23 respectively. Device may report a NaN or NRes value as well to signal some problem during measurement, which shall be transcoded as is.
- The Threshold-Notification-Text-String attribute provides a user readable description of the threshold notification and can be determined from bits 16 through 19 of the Sensor Status Annunciation Field in the CGM measurement.

3.6.2.3 Sensor Calibration Numeric Object

If calibration support is indicated in the CGM Feature characteristic (bit 0), the Sensor Calibration numeric object of 11073-10425 shall be reported when the Glucose Calibration procedure has been executed using the CGM Specific Ops Control Point Characteristic or the calibration bit is set in the sensor status field.

Table 68 is the template structure for the Sensor Calibration numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Supplement-Types	CGM Specific Ops Control Point	CGM	Aggregate	SupplementalTypeList ³	List of (INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ⁴	BITS-16
Measurement-Status	CGM Specific Ops Control Point	CGM	Aggregate	MeasurementStatus ⁵	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁶	INT-U16
Base-Offset-Time-Stamp	CGM Specific Ops Control Point & CGM Session Start Time	CGM	Aggregate	BaseOffsetTime ⁷	(INT-U32, INT-U16, INT-U16)
Basic-Nu-Observed-Value	CGM Specific Ops Control Point	CGM	Aggregate	BasicNuObsValue ⁸	SFLOAT-Type

Table 68: 11073-10425 Sensor Calibration Numeric Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CGM_SENSOR_CALIBRATION.
- Each object may have a different supplemental type, which indicates the sample location and are specified in [22]. They are related to glucose measurement sample locations according to Table 69:

Sample location Nibble in Calibration Data Record	11073-10425 Sensor Calibration Numeric Supplemental-Types
0x1 (finger)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_FINGER}
0x2 (alternative site test)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_AST}
0x3 (earlobe)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_EARLOBE}

Sample location Nibble in Calibration Data Record	11073-10425 Sensor Calibration Numeric Supplemental-Types
0x4 (control solution)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_CTRLsolution}
0x5 (subcutaneous tissue)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_SUBCUTANEOUS}
0xF (sample location value not available)	{MDC_PART_PHD_DM MDC_CTXT_GLU_SAMPLELOCATION_UNDERTERMINED}

Table 69: Object supplemental type relationship with sample location

- Set to 0x6044 (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-setting) when the Glucose Calibration procedure has been executed. Otherwise set to 0x604C (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-manual | mss-cat-setting) when the calibration was updated manually by the user.
- Set to 0x8000 (invalid) when setting the calibration value was not successful, which can be determined if either bit 0 (calibration data rejected) or bit 1 (calibration data out-of-range) of the Calibration Status field in the Calibration Data Record is true. Set to 0x1000 (calibration-ongoing) when bit 2 (calibration process pending) of the Calibration Status field is true. The absence of the Measurement-Status attribute or a value of 0x0080 (validated-data) implies a calibration was set successfully.
- The Continuous Glucose Monitoring Service only supports units of mg/dL and as such, the Unit-Code attribute shall be transcoded to MDC_DIM_MILLI_G_PER_DL.
- Base-Offset-Time-Stamp attribute value is derived from the mandatory CGM Session Start Time characteristic, added by the Calibration Time field of the Calibration Data Record. See Section 3.6.2.1 for details.
- The Basic-Nu-Observed-Value attribute value is the Glucose Concentration of Calibration field value of the Calibration Data Record.

3.6.2.4 Sensor Run-time Numeric Object

The CGM Session Run-time is a mandatory characteristic for the CGM service and shall be transcoded to the Sensor Run-time numeric object. Both values indicate the run-time of the sensor in hours from a reference time. The reference time for the CGM Session Run-Time is the CGM Session Start Time. The reference time for the Sensor Run-time numeric object is its Base-Offset-Time-Stamp attribute.

Table 70 is the template structure for the Sensor run-time numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16
Base-Offset-Time-Stamp	CGM Session Start Time	CGM	Aggregate	BaseOffsetTime ⁵	(INT-U32, INT-U16, INT-U16)
Simple-Nu-Observed-Value	CGM Session Run-time	CGM	Aggregate	SimpleNuObsValue ⁶	FLOAT-Type

Table 70: 11073-10425 Sensor Run-time Numeric Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CGM_SENSOR_RUN_TIME.
- Set to 0x7046 (mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-calculation | mss-avail-stored-data | mss-cat-setting).
- Value set MDC_DIM_HR.
- Base-Offset-Time-Stamp attribute value is the CGM Session Start Time characteristic. See Section 3.6.2.1 for details.
- The Simple-Nu-Observed-Value attribute value is derived from the CGM Session Run-time field, which reports a 16-bit unsigned integer. This value is converted to FLOAT-Type for transcoding using an exponent of 0.

3.6.2.5 Glucose Sampling Interval Numeric Object

The Glucose Sampling Interval numeric object of 11073-10425 shall be reported when the CGM Communication Interval procedure is executed using the CGM Specific Ops Control Point Characteristic. Both the Glucose Sampling Interval numeric object and CGM Communication Interval procedure report the interval in minutes.

Table 71 is the template structure for the Glucose Sampling Interval numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16
Base-Offset-Time-Stamp	N/A	N/A	N/A	BaseOffsetTime ⁵	(INT-U32, INT-U16, INT-U16)
Basic-Nu-Observed-Value	CGM Specific Ops Control Point	CGM	Aggregate	BasicNuObsValue ⁶	SFLOAT-Type

Table 71: 11073-10425 Sensor Run-time Numeric Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CGM_SENSOR_SAMPLE_INTERVAL.
- Set to 0x6044 (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-setting) when the CGM Communication Interval procedure has been executed. Otherwise set to 0x604C (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-manual | mss-cat-setting) when the communication interval was updated manually by the user.
- Value set MDC_DIM_MIN.
- Base-Offset-Time-Stamp attribute value is determined at the time of collection by the collector's time. See Section 3.6.2.1 for details.
- The Basic-Nu-Observed-Value attribute value is derived from the CGM Communication Interval procedure, which reports an 8-bit unsigned integer. This value is converted to SFLOAT-Type for transcoding using an exponent of 0.

3.6.2.6 Glucose trend Numeric Object

If CGM trend information support is indicated in the CGM Feature characteristic (bit 15), the Glucose Trend numeric object of 11073-10425 shall be reported.

Table 72 is the template structure for the Glucose Trend numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Measurement-Status	CGM Measurement	CGM	Aggregate	MeasurementStatus ⁴	BITS-16

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Unit-Code	N/A	N/A	N/A	OID-Type ⁵	INT-U16
Base-Offset-Time-Stamp	CGM Measurement & CGM Session Start Time	N/A	Aggregate	BaseOffsetTime ⁶	(INT-U32, INT-U16, INT-U16)
Basic-Nu-Observed-Value	CGM Measurement	CGM	Aggregate	BasicNuObsValue ⁷	SFLOAT-Type
Threshold-Notification-Text-String	CGM Measurement	CGM	Aggregate	OCTET STRING ⁸	OCTET STRING

Table 72: 11073-10425 Glucose Sampling Interval Numeric Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CONC_GLU_TREND.
- Set to 0xF042 (mss-avail-intermittent | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-calculation | mss-avail-stored-data).
- Each Glucose Trend numeric object may have a different measurement status and the Measurement-Status attribute value can be determined from the Sensor Status Annunciation Field. The IEEE Measurement-Status attribute is an observational attribute and only has meaning for the observation in which it is sent. [Table 73](#) relates the Sensor Status Annunciation Field to the Measurement-Status attribute.

Sensor Status Annunciation bit (LSB) in CGM Measurement	11073-10425 Glucose Trend Numeric Measurement-Status
20 (Sensor Rate of Decrease exceeded)	Set bit 14 (measurement outside threshold boundaries)
21 (Sensor Rate of Decrease exceeded)	Set bit 14 (measurement outside threshold boundaries)

Table 73: Glucose Trend numeric object Measurement-Status relationship with Sensor Status Annunciation

- Value set MDC_DIM_MILLI_G_PER_DL_PER_MIN.
- Base-Offset-Time-Stamp attribute value is derived from the mandatory CGM Session Start Time characteristic, added by the Time Offset field of the CGM measurement characteristic. See [Section 3.6.2.1](#) for details.
- The Basic-Nu-Observed-Value attribute value is the CGM Trend Information Field value of the CGM Measurement characteristic.

8. The Threshold-Notification-Text-String attribute provides a user readable description of the threshold notification and can be determined from bits 20 and 21 of the Sensor Status Annunciation Field in the CGM measurement.

3.6.2.7 Patient low/high thresholds Compound Numeric Object

If Patient High/Low Alerts support is indicated in the CGM Feature characteristic (bit 1), the Patient Low/High Thresholds compound numeric object of 11073-10425 shall be reported when the Patient High/Low Alert Level procedure has been executed using the CGM Specific Ops Control Point Characteristic.

Table 74 is the template structure for the Patient Low/High Thresholds compound numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Metric-Structure-Small	N/A	N/A	N/A	MetricStructureSmall ⁴	(INT-U8, INT-U8)
Metric-Id-List	N/A	N/A	N/A	MetricIdList ⁵	(INT-U16, INT-U16, list of (INT-U16))
Unit-Code	N/A	N/A	N/A	OID-Type ⁶	INT-U16
Base-Offset-Time-Stamp	CGM Specific Ops Control Point & CGM Session Start Time	CGM	Aggregate	BaseOffsetTime ⁷	(INT-U32, INT-U16, INT-U16)
Compound-Basic-Nu-Observed-Value	CGM Specific Ops Control Point	CGM	Aggregate	BasicNuObsValueCmp ⁸	(INT-U16, INT-U16, List of (SFLOAT-Type))

Table 74: 11073-10425 Patient Low/High Thresholds Compound Numeric Object Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_CONC_GLU_PATIENT_THRESHOLDS_LOW_HIGH.
3. Set to 0x6044 (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-setting) when the Patient High/Low Alert Level procedure has been executed. Otherwise set to 0x604C (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-manual | mss-cat-setting) when the patient low/high thresholds were updated manually by the user.
4. Set to 0x40 (ms-struct-compound), 0x02 (number of components is 2).

5. Set to 0x0002 (count of metric ids is 2), 0x0004 (list length is 4 octets),
MDC_CONC_GLU_PATIENT_THRESHOLD_LOW,
MDC_CONC_GLU_PATIENT_THRESHOLD_HIGH.
6. The Continuous Glucose Monitoring Service only supports units of mg/dL and as such, the Unit-Code attribute shall be transcoded to MDC_DIM_MILLI_G_PER_DL.
7. Base-Offset-Time-Stamp attribute value is determined at the time of collection by the collector's time. See Section 3.6.2.1 for details.
8. The Compound-Basic-Nu-Observed-Value attribute value is 0x0002 (count of components is 2), 0x0004 (component list length is 4 octets), the Patient Low Alert Level Response Operand followed by the Patient High Alert Level Response Operand, as indicated in Table 75.

Compound-Basic-Nu-Observed-Value attribute structure	Value
Component count (INT-U16)	0x0002
Length in octets (INT-U16)	0x0004
First value (SFLOAT-Type)	Patient Low Alert Level Response Operand
Second value (SFLOAT-Type)	Patient High Alert Level Response Operand

Table 75: Values for the Compound-Basic-Nu-Observed-Value attribute structure

3.6.2.8 Device hypo/hyper Thresholds Compound Numeric Object

If Hypo Alerts and/or Hyper Alerts support is indicated in the CGM Feature characteristic (bits 2 and 3), the Device Hypo/Hyper Thresholds compound numeric object of 11073-10425 shall be reported when either the Hypo Alert or Hyper Alert procedure has been executed using the CGM Specific Ops Control Point Characteristic.

Table 76 is the template structure for the Device Hypo/Hyper Thresholds compound numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Metric-Structure-Small	N/A	N/A	N/A	MetricStructureSmall ⁴	(INT-U8, INT-U8)
Metric-Id-List	N/A	N/A	N/A	MetricIdList ⁵	(INT-U16, INT-U16, list of (INT-U16))

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Unit-Code	N/A	N/A	N/A	OID-Type ⁶	INT-U16
Base-Offset-Time-Stamp	CGM Specific Ops Control Point & CGM Session Start Time	N/A	Aggregate	BaseOffsetTime ⁷	(INT-U32, INT-U16, INT-U16)
Compound-Basic-Nu-Observed-Value	CGM Specific Ops Control Point	CGM	Aggregate	BasicNuObsValueCmp ₈	(INT-U16, INT-U16, List of (SFLOAT-Type))

Table 76: 11073-10425 Device Hypo/Hyper Thresholds Compound Numeric Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CONC_GLU_THRESHOLDS_HYPO_HYPER.
- Set to 0x6044 (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-setting) when either the Hypo Alert or Hyper Alert procedure has been executed. Otherwise set to 0x604C (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-manual | mss-cat-setting) when the hypo/hyper thresholds were updated manually by the user.
- Set to 0x40 (ms-struct-compound), 0x02 (number of components is 2).
- Set to 0x0002 (count of metric ids is 2), 0x0004 (list length is 4 octets), MDC_CONC_GLU_THRESHOLD_HYPO, MDC_CONC_GLU_THRESHOLD_HYPER.
- The Continuous Glucose Monitoring Service only supports units of mg/dL and as such, the Unit-Code attribute shall be transcoded to MDC_DIM_MILLI_G_PER_DL.
- Base-Offset-Time-Stamp attribute value is determined at the time of collection by the collector's time. See Section 3.6.2.1 for details.
- The Compound-Basic-Nu-Observed-Value attribute value is 0x0002 (count of components is 2), 0x0004 (component list length is 4 octets), the Hypo Alert Level Response Operand followed by the Hyper Alert Level Response Operand, as indicated in Table 77. If only one of the Hypo Alert or the Hyper Alert support is indicated in the CGM Feature characteristic, NaN will be used for the component of the Compound-Basic-Nu-Observed-Value that corresponds with the unsupported alert.

Compound-Basic-Nu-Observed-Value attribute structure	Value
Component count (INT-U16)	0x0002
Length in octets (INT-U16)	0x0004

Compound-Basic-Nu-Observed-Value attribute structure	Value
First value (SFLOAT-Type)	Hypo Alert Level Response Operand
Second value (SFLOAT-Type)	Hyper Alert Level Response Operand

Table 77: Values for the Compound-Basic-Nu-Observed-Value attribute structure

3.6.2.9 Glucose rate of change thresholds Compound Numeric Object

If Rate of Increase/Decrease Alerts support is indicated in the CGM Feature characteristic (bit 4), the Glucose Rate of Change Thresholds compound numeric object of 11073-10425 shall be reported when the Rate of Increase/Decrease Alert Level procedure has been executed using the CGM Specific Ops Control Point Characteristic.

Table 78 is the template structure for the Glucose Rate of Change Thresholds compound numeric object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Metric-Structure-Small	N/A	N/A	N/A	MetricStructureSmall ⁴	(INT-U8, INT-U8)
Metric-Id-List	N/A	N/A	N/A	MetricIdList ⁵	(INT-U16, INT-U16, list of (INT-U16))
Unit-Code	N/A	N/A	N/A	OID-Type ⁶	INT-U16
Base-Offset-Time-Stamp	CGM Specific Ops Control Point & CGM Session Start Time	N/A	Aggregate	BaseOffsetTime ⁷	(INT-U32, INT-U16, INT-U16)
Compound-Basic-Nu-Observed-Value	CGM Specific Ops Control Point	CGM	Aggregate	BasicNuObsValueCmp ⁸	(INT-U16, INT-U16, List of (SFLOAT-Type))

Table 78: 11073-10425 Glucose Rate of Change Thresholds Compound Numeric Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CONC_GLU_RATE_THRESHOLDS.

3. Set to 0x6044 (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-setting) when the Rate of Increase/Decrease Alert Level procedure has been executed. Otherwise set to 0x604C (mss-avail-stored-data | mss-upd-aperiodic | mss-acc-agent-initiated | mss-cat-manual | mss-cat-setting) when the rate of change thresholds were updated manually by the user.
4. Set to 0x40 (ms-struct-compound), 0x02 (number of components is 2).
5. Set to 0x0002 (count of metric ids is 2), 0x0004 (list length is 4 octets), MDC_CONC_GLU_RATE_THRESHOLD_INCREASE, MDC_CONC_GLU_RATE_THRESHOLD_DECREASE.
6. The Continuous Glucose Monitoring Service only supports units of mg/dL and as such, the Unit-Code attribute shall be transcoded to MDC_DIM_MILLI_G_PER_DL_PER_MIN.
7. Base-Offset-Time-Stamp attribute value is determined at the time of collection by the collector's time. See Section 3.6.2.1
8. for details.
9. The Compound-Basic-Nu-Observed-Value attribute value is 0x0002 (count of components is 2), 0x0004 (component list length is 4 octets), the Rate of Increase Alert Level Response Operand followed by the Rate of Decrease Alert Level Response Operand, as indicated in Table 79.

Compound-Basic-Nu-Observed-Value attribute structure	Value
Component count (INT-U16)	0x0002
Length in octets (INT-U16)	0x0004
First value (SFLOAT-Type)	Rate of Increase Alert Level Response Operand
Second value (SFLOAT-Type)	Rate of Decrease Alert Level Response Operand

Table 79: Values for the Compound-Basic-Nu-Observed-Value attribute structure

3.6.3 Enumeration Objects

This section describes the 11073-10425 enumeration class requirements. It is restricted to those 11073 attributes that are used on the Continuous Glucose Monitoring device.

3.6.3.1 PHD DM Status Enumeration Object

Both the CGM Status and CGM Measurement are mandatory characteristics for the CGM service and shall be transcoded to the PHD DM Status enumeration object as needed. There are optional status features where support can be determined from the CGM Feature characteristic (bits 9 and 11).

Table 80 is the template structure for the PHD DM Status enumeration object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Supplement-Types	N/A	N/A	N/A	SupplementalTypeList ³	List of (INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ⁴	BITS-16
Base-Offset-Time-Stamp	(CGM Status CGM Measurement) & CGM Session Start Time	CGM	Aggregate	BaseOffsetTime ⁵	(INT-U32, INT-U16, INT-U16)
Enum-Observed-Value-Simple-Bit-Str	CGM Status CGM Measurement	CGM	Aggregate	BITS-32 ⁶	BITS-32

Table 80: 11073-10425 PHD DM Status Enumeration Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_PHD_DM_DEV_STAT.
- There may be multiple instances of the PHD DM Status enumeration object, which is dependent on the physical component architecture of the Continuous Glucose Monitoring device. When it is possible to assign the status to a specific physical component, the Supplement-Types attribute should be reported. Otherwise it may be omitted. Possible values for the Supplement-Types attribute are limited to MDC_CGM_DEV_TYPE_SENSOR, MDC_CGM_DEV_TYPE_TRANSMITTER, MDC_CGM_DEV_TYPE_RECEIVER, or MDC_CGM_DEV_TYPE_OTHER. There shall be only one instance of the PHD DM status object for each physical component.
- Set to 0xF040 (mss-avail-intermittent | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-avail-stored-data).
- If the status is coming from the CGM Status Characteristic, the Base-Offset-Time-Stamp attribute value is derived from the mandatory CGM Session Start Time characteristic, added by the Time Offset field of the CGM Status characteristic. If the status is coming from the CGM Measurement Characteristic, the Base-Offset-Time-Stamp attribute value is derived from the mandatory CGM Session Start Time characteristic, added by the Time Offset field of the CGM Measurement characteristic. See Section 3.6.2.1 for details.
- The Enum-Observed-Value-Simple-Bit-Str attribute value is derived from either the CGM Status field of the CGM Status characteristic or Sensor Status Annunciation field of the CGM Measurement. The bit definition and ordering for both the CGM Status field and Sensor Status

Annunciation field are identical. [Table 81](#) relates those bits to the Enum-Observed-Value-Simple-Bit-Str attribute value.

Status bit (LSB)	11073-10425 PHD DM Status Enumeration Enum-Observed-Value-Simple-Bit-Str
1 (device battery low)	Set bit 25 (device-status-battery-low)
5 (general device fault has occurred in the sensor)	Set bit 5 (device-status-error)
8 (time synchronization between sensor and collector required)	Set bit 16 (device-status-service-time-sync-required)

Table 81: PHD DM Status enumeration object Enum-Observed-Value-Simple-Bit-Str relationship with CGM Status

3.6.3.2 CGM Status Enumeration Object

Both the CGM Status and CGM Measurement are mandatory characteristics for the CGM service and shall be transcoded to the CGM Status enumeration object as needed. There are optional status features where support can be determined from the CGM Feature characteristic (bits 0-8 and 10).

[Table 82](#) is the template structure for the CGM Status enumeration object.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Base-Offset-Time-Stamp	(CGM Status CGM Measurement) & CGM Session Start Time	CGM	Aggregate	BaseOffsetTime ⁴	(INT-U32, INT-U16, INT-U16)
Enum-Observed-Value-Simple-Bit-Str	CGM Status CGM Measurement	CGM	Aggregate	BITS-32 ⁵	BITS-32

Table 82: 11073-10425 CGM Status Enumeration Object Requirements

Notes:

- Each metric object is required to have a unique non-zero ID assigned by the implementation.
- Value set to MDC_PART_PHD_DM | MDC_CGM_DEV_STAT.
- Set to 0xF040 (mss-avail-intermittent | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-avail-stored-data).

4. If the status is coming from the CGM Status Characteristic, the Base-Offset-Time-Stamp attribute value is derived from the mandatory CGM Session Start Time characteristic, added by the Time Offset field of the CGM Status characteristic. If the status is coming from the CGM Measurement Characteristic, the Base-Offset-Time-Stamp attribute value is derived from the mandatory CGM Session Start Time characteristic, added by the Time Offset field of the CGM Measurement characteristic. See Section 3.6.2.1 for details.
5. The Enum-Observed-Value-Simple-Bit-Str attribute value is derived from either the CGM Status field of the CGM Status characteristic or Sensor Status Annunciation field of the CGM Measurement. The bit definition and ordering for both the CGM Status field and Sensor Status Annunciation field are identical. Table 83 relates those bits to the Enum-Observed-Value-Simple-Bit-Str attribute value.

Status bit (LSB)	11073-10425 CGM Status Enumeration Enum-Observed-Value-Simple-Bit-Str
0 (session stopped)	Set bit 0 (sensor-session-stopped)
2 (sensor type incorrect for device)	Set bit 2 (sensor-type-incorrect)
3 (time synchronization between sensor and collector required)	Set bit 3 (sensor-malfunction)
4 (device specific alert)	Set bit 4 (device-specific-alert)
9 (calibration not allowed)	Set bit 7 (sensor-calibration-not-allowed)
10 (calibration recommended)	Set bit 8 (sensor-calibration-recommended)
11 (calibration required)	Set bit 9 (sensor-calibration-required)
12 (sensor temperature too high for valid test/result at time of measurement)	Set bit 10 (sensor-temp-too-high)
13 (sensor temperature too low for valid test/result at time of measurement)	Set bit 11 (sensor-temp-too-low)
16 (sensor result lower than the patient low level)	Set bit 12 (sensor-result-below-patient-low)
17 (sensor result higher than the patient low level)	Set bit 13 (sensor-result-above-patient-low)
18 (sensor result lower than the hypo level)	Set bit 14 (sensor-low-hypo)
19 (sensor result lower than the hyper level)	Set bit 15 (sensor-high-hyper)
20 (sensor rate of decrease exceeded)	Set bit 16 (sensor-rate-decrease-exceeded)
21 (sensor rate of increase exceeded)	Set bit 17 (sensor-rate-increase-exceeded)
22 (sensor result lower than the device can process)	Set bit 18 (sensor-result-too-low)
23 (sensor result higher than the device can process)	Set bit 19 (sensor-result-too-high)

Table 83: CGM Status enumeration object Enum-Observed-Value-Simple-Bit-Str relationship with CGM Status

3.7 Pulse Oximeter

This section defines transcoding the pulse oximeter sensor device specific data into IEEE 11073-10404 Pulse Oximeter device specialization [25] class attributes.

The Pulse Oximeter Service communicates measurements using notifications and indications of characteristics. For the purposes of transcoding it is not important how those characteristics are obtained. The values in these received characteristics are composed of measurements and various status settings. These fields are subsequently transcribed into the respective metric objects and attributes of the IEEE 11073-10404 Pulse Oximeter specialization.

In the Pulse Oximeter Service, a pulse rate measurement always accompanies a SpO2 measurement. Therefore, whenever a measurement is transcribed, both the SpO2 and pulse rate objects will be transcribed into. If a measurement status field accompanies the measurement, it will be transcribed into both the SpO2 and pulse rate numeric objects.

The measurement fields are transcribed into a set of numeric metric objects whose TYPE attribute is MDC_PULS_OXIM_SAT_O2 for oxygen saturations, MDC_PULS_OXIM_PULS_RATE for pulse rates, and MDC_SAT_O2_QUAL for the amplitude index measurements. The saturation and pulse rate measurements may be further qualified by a Supplemental types attribute describing the modality of the measurement (if the measurement has a modality), in this case one of MDC_MODALITY_SPOT (when transcribed from the PLX Spot-check Measurement characteristic value), MDC_MODALITY_FAST, or MDC_MODALITY_SLOW (when transcribed from the PLX Continuous Measurement characteristic value's SpO2PR-Fast and SpO2PR-Slow fields). No supplemental type attribute is present when the measurement is being transcribed from the SpO2PR-Normal field in the PLX Continuous Measurement characteristic. The measurement status fields are transcribed into the IEEE 11073-20601 measurement status attribute of the appropriate numeric metric object whereas the device status field is transcribed into an enumeration metric object whose TYPE attribute is given by MDC_PULS_OXIM_DEV_STATUS. This enumeration metric does NOT contain a supplemental types attribute.

The attributes of the IEEE 11073-20601 MDS object are populated by reading the characteristics of the Device Information Service, or the Current Time Service, and optionally the Battery Service Battery Level Characteristic should the sensor support a Battery service. If the battery level characteristic is updated by notification, the collector will need to update its MDS Battery Level attribute with the notified characteristic value if the collector is supporting the Battery Level attribute. It should be noted that Continua-compliant Bluetooth pulse oximeters are required to expose a RegCertData characteristic in its Device Information Service. Exposing this characteristic is optional in the Pulse Oximeter Profile. It should also be noted that a Continua-compliant Bluetooth pulse oximeter that reports time stamps in any of its measurements (stored or otherwise) are required to support some source of sensor current time. Exposing a source of current time is optional in the Pulse Oximeter Profile.

3.7.1 Device Specific MDS class Requirements

In addition to the MDS class requirements shown in Section 2.1, Table 84 shows incremental MDS class requirements specific to this device. The Battery-Level is optional but recommended if the device exposes it.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE ¹	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList ²	List of (INT-U16, INT-U16)

Table 84: Device-specific MDS Class Requirements

Notes:

- Value is not present since System-Type-Spec-List exists.
- Since the “Pulse Oximeter Service” [24] is a “Primary Service”, the following entries are required to be added to the TypeVerList:

0x10 0x04	Specialization value = MDC_DEV_SPEC_PROFILE_PULS_OXIM
0x00 0x01	version = version 1 of the 11073-10404 device specialization

3.7.2 11073-10404 Numeric CLASS Requirements

This section describes the 11073 numeric class requirements. It is restricted to those 11073 attributes that are used on the Pulse Oximeter. All unmentioned attributes defined in [1] are not applicable to this device.

3.7.2.1 SpO2

Mandatory object transcoded from a pulse oximeter. The device will have at least one, and up to four, SpO2 numeric objects, belonging to the following measurement modes: spot-check, continuous measurement normal, continuous measurement fast response, and continuous measurement slow response.

The fast and slow response measurement types are supported by a pulse oximeter if the Supported Features field of the PLX Features characteristic indicates they are supported, as follows:

- If bit 4 (LSB) is set to 1, the fast response mode is supported
- If bit 5 (LSB) is set to 1, the slow response mode is supported

Both in the Pulse Oximetry Spot-check Measurement and in the Pulse Oximetry Continuous Measurement Characteristic, every SpO₂ value is always accompanied by a pulse rate. For transcoding purposes, this means that, for every measurement received from the device, there should be a pair of objects: a SpO₂ object and a related Pulse Rate object. They are both present or both absent from configuration, as the related measurement characteristic is supported or not.

If a measurement could not determine the SpO₂, the special value NaN will be used (the field is not omitted from the measurement).

The Pulse Amplitude Index field of the spot-check and continuous characteristics measures the quality of the signal being handled by the device. This field is transcoded into the Pulsatile Quality object in IEEE 11073-10404 and is addressed in Section 3.7.2.3.

The device and sensor status field of the spot-check and continuous characteristics is handled by the enumeration object in Section 3.7.3.1.

11073 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Supplemental-Types	N/A	N/A	N/A	Supplemental TypeList ³	List of (INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ⁴	BITS-16
Measurement-Status ⁵	Spot-Check Measurement or Continuous Measurement	Pulse Oximeter	Aggregate	Measurement Status ⁶	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁷	INT-U16
Absolute-Time-Stamp ⁸	Spot-Check Measurement	Pulse Oximeter	Aggregate	AbsoluteTime ⁹	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Spot-Check Measurement or Continuous Measurement	Pulse Oximeter	Aggregate	BasicNuObs Value ¹⁰	SFLOAT-Type

Table 85: SpO₂ 11073 Numeric Class Requirements

Notes:

1. Each object is required to have a unique non-zero ID assigned by the implementation.
2. Value is set to {MDC_PART_SCADA, MDC_PULS_OXIM_SAT_O2}.
3. For the spot-check object, value is set to {MDC_PART_SCADA, MDC_MODALITY_SPOT}. For the continuous measurement object (normal), value is set to empty. For the continuous measurement/fast mode object, value is set to {MDC_PART_SCADA, MDC_MODALITY_FAST}. For the continuous measurement/slow mode, value is set to {MDC_PART_SCADA, MDC_MODALITY_SLOW}.
4. Value is set to one of the following three possibilities:
 - a) 0x5040 (mss-avail-stored-data, mss-msmt-aperiodic, mss-acc-agent-initiated) for the spot-check object when device supports measurement storage (which is signaled by bit 2 of the Supported Features field in Pulse Oximetry Features characteristic).
 - b) 0x1040 (mss-msmt-aperiodic, mss-acc-agent-initiated) for the spot-check object when device does not support measurement storage.
 - c) 0x0040 (mss-acc-agent-initiated) for continuous-measurement objects.
5. This attribute is present when Measurement Status support is present (signaled by bit 0 of the Supported Features field in PLX Features characteristic being equal to 1).
6. This value is derived from Measurement Status field of the PLX Spot-Check Measurement or Continuous Measurement characteristic. The bitmap is composed according to [Table 86](#):

11073 MeasurementStatus Bit 0 is MSB	Bluetooth Measurement Status Bit Bit 0 is LSB
invalid (0)	15 (Invalid measurement detected)
questionable (1)	14 (Questionable measurement detected)
not-available (2)	13 (Measurement not available)
calibration-ongoing (3)	12 (Calibration ongoing)
test-data (4)	11 (Data for testing)
demo-data (5)	10 (Data for demonstration)
validated-data (8)	7 (Fully qualified data)
early-indication (9)	6 (Early estimated data)
msmt-ongoing (10)	5 (Measurement ongoing)

Table 86: Relationship between Measurement Status and 11073 MeasurementStatus

7. Unit is MDC_DIM_PERCENT.
8. Only the PLX Spot-Check Measurement Characteristic has a timestamp, so this attribute is only present in the spot-check object (and not in the continuous measurement objects).
9. This value is derived from the Timestamp field of PLX Spot-Check Measurement characteristic. See also [Section 2.2.6](#).

10. For the spot-check object, this value is derived from the SpO₂ value of the SpO₂PR field in PLX Spot-Check Measurement characteristic. For continuous measurement objects, value is derived from the SpO₂ value of the SpO₂PR - Normal, SpO₂PR -Fast (if supported) or SpO₂PR -Slow (if supported) of the PLX Continuous Measurement characteristic, accordingly to object's Supplemental Type.

3.7.2.2 Pulse Rate

Configuration has at least one, and up to four, pulse rate numeric objects, belonging to the following measurement modes: spot-check, continuous measurement normal, continuous measurement fast response and continuous measurement slow response.

Each pulse rate object is paired to a SpO₂ object and its presence or absence follows exactly the same requirements for SpO₂ (Section 3.7.2.1).

Both in Pulse Oximetry Spot-check Measurement and in Pulse Oximetry Continuous Measurement Characteristic, every Pulse Rate value is always accompanied by a SpO₂. For transcoding purposes, this means that, for every measurement received from the device, there should be a pair of objects: a SpO₂ object and a related Pulse Rate object. They are both present or both absent from configuration, as the related measurement mode is supported or not.

If a measurement could not determine the Pulse Rate, the special value NaN will be used (the field is not omitted from the measurement).

The Pulse Amplitude Index field of the spot-check and continuous characteristics measures the quality of the signal being handled by the device. This field is transcoded into the Pulsatile Quality object in IEEE 11073-10404 and is addressed in Section 3.7.2.3.

The device and sensor status field of the spot-check and continuous characteristics is handled by the enumeration object in Section 3.7.3.1.

11073 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Supplemental-Types	N/A	N/A	N/A	Supplemental TypeList ³	List of (INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ⁴	BITS-16

11073 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073 Data Type (informative)
Measurement-Status ⁵	Spot-Check Measurement or Continuous Measurement	Pulse Oximeter	Aggregate	Measurement Status ⁶	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁷	INT-U16
Absolute-Time-Stamp ⁸	Spot-Check Measurement	Pulse Oximeter	Aggregate	AbsoluteTime ⁹	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Spot-Check Measurement or Continuous Measurement	Pulse Oximeter	Aggregate	BasicNuObs Value ¹⁰	SFLOAT-Type

Table 87: Pulse Rate 11073 Numeric Class Requirements

Notes:

- Each object is required to have a unique non-zero ID assigned by the implementation.
- Value is set to {MDC_PART_SCADA, MDC_PULS_OXIM_PULS_RATE}.
- For the spot-check object, value is set to {MDC_PART_SCADA, MDC_MODALITY_SPOT}. For the continuous measurement object (normal), value is set to empty. For the continuous measurement/fast mode object, value is set to {MDC_PART_SCADA, MDC_MODALITY_FAST}. For the continuous measurement/slow mode, value is set to {MDC_PART_SCADA, MDC_MODALITY_SLOW}.
- Value is set to one of the following three possibilities:
 - 0x5040 (mss-avail-stored-data, mss-msmt-aperiodic, mss-acc-agent-initiated) for the spot-check object when device supports measurement storage (which is signaled by bit 2 of the Supported Features field in Pulse Oximetry Features characteristic).
 - 0x1040 (mss-msmt-aperiodic, mss-acc-agent-initiated) for the spot-check object when device does not support measurement storage.
 - 0x0040 (mss-acc-agent-initiated) for continuous-measurement objects.
- This attribute is present when Measurement Status support is present (signaled by bit 0 of the Supported Features field in PLX Features characteristic being equal to 1).
- This value is derived from Measurement Status field of the Pulse Oximetry Spot-Check Measurement or Continuous Measurement characteristic. The bitmap is composed according to [Table 96](#):

11073 MeasurementStatus Bit 0 is MSB	Bluetooth Measurement Status Bit Bit 0 is LSB
invalid (0)	15 (Invalid measurement detected)
questionable (1)	14 (Questionable measurement detected)
not-available (2)	13 (Measurement not available)
calibration-ongoing (3)	12 (Calibration ongoing)
test-data (4)	11 (Data for testing)
demo-data (5)	10 (Data for demonstration)
validated-data (8)	7 (Fully qualified data)
early-indication (9)	6 (Early estimated data)
msmt-ongoing (10)	5 (Measurement ongoing)

Table 88: Relationship between Measurement Status and 11073 MeasurementStatus

7. Unit is MDC_DIM_BEAT_PER_MIN.
8. Only the PLX Spot-Check Measurement Characteristic has a timestamp, so this attribute is only mandatory in the spot-check object (and not in the continuous measurement objects).
9. This value is derived from the Timestamp field of PLX Spot-Check Measurement characteristic. See also Section 2.2.6.
10. For the spot-check object, this value is derived from the PR value of the SpO2PR field in PLX Spot-Check Measurement characteristic. For continuous measurement objects, value is derived from the PR value of the SpO2PR -Normal, SpO2PR -Fast (if supported) or SpO2PR -Slow (if supported) of the PLX Continuous Measurement characteristic, accordingly to object's Supplemental Type.

3.7.2.3 Pulsatile Quality (Pulse Amplitude Index)

The Pulse Amplitude index represents the quality of the signal and is transcoded to the IEEE 11073-10404 Pulsatile Quality numeric metric object. The IEEE specialization offers several alternatives but the option applicable to this case is the measure expressed as a percentage.

The device and sensor status field of the spot-check and continuous characteristics is handled by the enumeration object in Section 3.7.3.1.

11073 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)

11073 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073 Data Type (informative)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type ⁴	INT-U16
Label-String	N/A	N/A	N/A	OctetString ⁵	OctetString
Absolute-Time-Stamp ⁶	Spot-Check Measurement	Pulse Oximeter	Aggregate	AbsoluteTime ⁷	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Amplitude Index	Pulse Oximeter	Aggregate	BasicNuObs Value ⁸	SFLOAT-Type

Table 89: Pulsatile Quality 11073 Numeric Class Requirements

- Each object is required to have a unique non-zero ID assigned by the implementation.
- Value is set to {MDC_PART_SCADA, MDC_SAT_O2_QUAL}.
- Value is set to one of the following three possibilities:
 - 0x5040 (mss-avail-stored-data, mss-msmt-aperiodic, mss-acc-agent-initiated) for the spot-check object when device supports measurement storage (which is signaled by bit 2 of the Supported Features field in Pulse Oximetry Features characteristic).
 - 0x1040 (mss-msmt-aperiodic, mss-acc-agent-initiated) for the spot-check object when device does not support measurement storage.
 - 0x0040 (mss-acc-agent-initiated) for continuous-measurement objects.
- Unit is MDC_DIM_PERCENT.
- This optional attribute provides a human readable string which further clarifies the meaning of the TYPE. In this case it could state "This measure is the ratio of the AC to DC signal of the Pleth Waveform".
- Only the PLX Spot-Check Measurement Characteristic has a timestamp, so this attribute is only mandatory if it appears in the Spot check measurements (and not in the continuous measurement objects).
- This value is derived from the Timestamp field of PLX Spot-Check Measurement characteristic. See also Section 2.2.6.
- This value is derived from the Pulse Amplitude Index field of the PLX Spot-check Measurement or PLX Continuous Measurement characteristic.

3.7.3 Enumeration Objects

This section describes the 11073 enumeration class requirements. It is restricted to those 11073 attributes that are used on the Pulse Oximeter device. All unmentioned attributes defined in [1] are not applicable to those devices.

3.7.3.1 Device and Sensor Status

This data is optionally transcoded when device supports reporting Device and Sensor Status (bit 1 (LSB) of Supported Features field in Pulse Oximetry Features Characteristic is equal to 1).

If it is supported, Device and Sensor Status field is always present in both Spot-Check Measurement and Continuous Measurement characteristics.

11073 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE ¹	INT-U16
Type	N/A	N/A	N/A	TYPE ²	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall ³	BITS-16
Enum-Observed-Value-Basic-Bit-Str	Spot-Check Measurement and Continuous Measurement	Pulse Oximeter	Aggregate	BITS-16 ⁴	BITS-16

Table 90: 11073 Device and Sensor Annunciation Enumeration Class Requirements

Notes:

- Each object is required to have a unique non-zero ID assigned by the implementation.
- Value set to {MDC_PART_SCADA, MDC_PULS_OXIM_DEV_STATUS}.
- Set to 0x0040 (mss-acc-agent-initiated).
- This value is derived from Device and Sensor Status Field of the Pulse Oximetry Spot-Check Measurement and Continuous Measurement characteristics. Bits with value 1 mean that the respective condition is present at measurement time. The bitmap is composed accordingly to [Table 91](#):

11073 Device and Sensor Status Bit (PulseOxDevStat) Bit 0 is MSB	Bluetooth Device and Sensor Status Bit Bit 0 is LSB
device-extended-update (15)	0 (extended display update ongoing)
device-equipment-malfunction (14)	1 (equipment malfunction)
signal-processing-irregularity (13)	2 (signal processing irregularity detected)

11073 Device and Sensor Status Bit (PulseOxDevStat) Bit 0 is MSB	Bluetooth Device and Sensor Status Bit Bit 0 is LSB
signal-inadequate (12)	3 (inadequate signal detected)
signal-poor (11)	4 (poor signal detected)
signal-low-perfusion (10)	5 (low perfusion detected)
signal-erratic (9)	6 (erratic signal detected)
signal-non-pulsatile (8)	7 (non-pulsatile signal detected)
signal-pulse-questionable (7)	8 (questionable pulse detected)
signal-searching (6)	9 (signal analysis ongoing)
signal-interference (5)	10 (sensor interference detected)
sensor-off (4)	11 (sensor unconnected to user)
sensor-unsupported (3)	12 (unknown sensor connected)
sensor-displaced (2)	13 (sensor displaced)
sensor-malfunction (1)	14 (sensor malfunctioning)
sensor-disconnected (0)	15 (sensor disconnected)
Not Transcodable	16-23 RFU

Table 91: Relationship between Sensor Status Annunciation and 11073 sensor condition

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4 End-To-End Example

This section provides an example of an end-to-end communication between a GATT-based Bluetooth Health Thermometer and a Collector (e.g., phone) implementing an 11073-20601 Manager and a transcoder. This section also describes how Bluetooth characteristic data can be mapped to 11073-20601 nomenclature and modeling. This example illustrates the steps required to use the mappings so that the transcoder can generate 11073-20601 DIM objects based on the received data.

Hypothetical Health Thermometer data is used in Section 4.1 as an input. Section 4.3 discusses how this data could be mapped into 11073-20601 objects.

4.1 Health Thermometer Data

Table 92 and Table 93 describe the Health Thermometer data being sent to the Collector, which implements a Transcoder. The Health Thermometer Bluetooth Address is 00:23:6C:AF:BD:F4.

Health Thermometer Service Data

This data refers to a previous time-stamped measurement taken from a general body location. The values shown represent the sequence of bytes as transmitted on the wire (over the air).

Bluetooth Characteristic	Bluetooth Value
Temperature Measurement	37.0 degrees Celsius with Timestamp of 18th December 2010 15:00:00: 0x02 0x72 0x01 0x00 0xFF 0xDA 0x07 0x0C 0x12 0x0F 0x00 0x00
Temperature Type	Body: 0x02
Intermediate Temperature	Not transcoded to 11073-20601. (Could be if one wanted to use the Measurement-Status attribute and set the status to measurement in progress or something else appropriate)
Measurement Interval	Not transcoded to 11073-20601. (This behavior is implicit in the time stamp)
Valid Range descriptor	Not transcoded to 11073-20601. (In 11073-20601 values exceeding this descriptor would be reported using the 'not at this resolution' or via the Measurement-Status attribute.)

Table 92: Health Thermometer Service Data

Note that GATT employs little-endian representation of integers, and the year 2010 (0x07DA in hex) is encoded as 0xDA 0x07 in the Temperature Measurement characteristic, because the year is a 16-bit unsigned integer field. The other date and time fields (month, day, hour, etc.) are all 8-bit values and not affected by endianness.

Also, the FLOAT representation of temperature is affected by endianness. The temperature measurement (37.0 degrees, raw FLOAT value is 0xFF000172) is encoded as 0x72 0x01 0x00 0xFF in the Temperature Measurement characteristic.

Device Information Service Data

This data refers to a Health Thermometer that has its System ID filled in based on its Bluetooth address as described in the characteristic definition accessible via the Bluetooth SIG Assigned Numbers [3].

Bluetooth Characteristic	Bluetooth Value
System ID	0xF4 0xBD 0xAF 0xFE 0xFF 0x6C 0x23 0x00
Model Number String	"TS-1017"
Manufacturer Name String	"ACME"
Serial Number String	"237495-3282-A"
Firmware Revision String	"1.23"
Hardware Revision String	"1.0"
Software Revision String	"1.2"
IEEE 11073-20601 Regulatory Certification Data List	For an example on how to populate this structure, refer to Section 2.2.5.

Table 93: Device Information Service data

System ID is another field affected by the little-endian format of GATT. The actual System ID of this example is 00:23:6C:FF:FE:AF:BD:F4. The System ID characteristic format is (uint40, uint24), for manufacturer identifier and OUI, respectively.

Since the Thermometer of this example attributes timestamps to measurements, it has to expose the internal clock as the Current Time characteristic in Current Time Service (see Section 2.2.4, subtopic "Date and Time", and Section 2.2.6 for details). The characteristic has 10 bytes but only the first 7 are of interest for transcoding.

Bluetooth Characteristic	Bluetooth Value
Current Time characteristic	18th December 2010 15:23:06 encoded as 0xDA 0x07 0x0C 0x12 0x0F 0x17 0x06 0xFF 0xFF 0xFF

4.2 Health thermometer Service ReCord

Table 94 shows the Health Thermometer Service record and the attributes contained on the Sensor.

Bluetooth Attribute	Bluetooth Attribute Value	Description
Primary Service (0x2800)	0x180A	Device Information Service
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A23}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "System ID"

Bluetooth Attribute		Bluetooth Attribute Value	Description
	System ID (0x2A23)	{0x00236CFFFEAFBDF4}	System ID
	Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A29}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Manufacturer Name String"
	Manufacturer Name String (0x2A29)	{0x41, 0x43, 0x4D, 0x45}	Manufacturer Name String = UTF-8 String "ACME"
	Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A24}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Model Number String"
	Model Number String (0x2A24)	{0x54, 0x53, 0x2D, 0x31, 0x30, 0x31, 0x37}	Model Number String = UTF-8 String "TS-1017"
	Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A25}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Serial Number String"
	Serial Number String (0x2A25)	{0x32, 0x33, 0x37, 0x34, 0x39, 0x35, 0x2D, 0x33, 0x32, 0x38, 0x32, 0x2D, 0x41}	Serial Number String = UTF-8 String "237495-3282-A"
	Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A26}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Firmware Revision String"
	Firmware Revision String (0x2A26)	{0x31, 0x2E, 0x32, 0x33}	Firmware Revision String = UTF-8 String "1.23"
	Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A27}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Hardware Revision"
	Hardware Revision String (0x2A27)	{0x31, 0x2E, 0x30}	Hardware Revision String = UTF-8 String "1.0"
	Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A28}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Software Revision String"
	Serial Number String (0x2A28)	{0x31, 0x2E, 0x32}	Software Revision String = UTF-8 String "1.2"
Primary Service (0x2800)		0x1809	Health Thermometer Service
	Characteristic (0x2803)	0x20, 0xhhhh, 0x2A1C	Characteristic value is Indicated, Value Handle reference is 0xhhhh and

Bluetooth Attribute		Bluetooth Attribute Value	Description
			characteristic is "Temperature Measurement"
	Temperature Measurement (0x2A1C)	{0x02, 0xFF000172, 0x07DA 0x0C 0x12 0x0F 0x00 0x00}	Timestamp [18th December 2010 15:23:06] Temperature Measurement of 37.0 degrees in Celsius

Table 94: Health Thermometer Service Record

4.3 11073-20601 Objects

Table 95 and Table 96 describe how data are represented as 11073-20601 objects.

MDS Object

11073-20601 Attribute	Bluetooth Equivalent Characteristic	11073-20601 Value	Reference
Handle	None	0	
System-Model	Model Number String	"TS-1017" ¹	Section 2.2.4 – System Model
	Manufacturer Name String	"ACME"	
System-Id	System ID	0x00 0x23 0x6C 0xFF 0xFE 0xAF 0xBD 0xF4	Section 2.2.4 – System Id
Dev-Configuration-Id	None	MDC_TEMP_BODY = 0x4002	Section 3.1.1
Production-Specification	Serial Number String	"237495-3282-A" ¹	Section 2.2.4 – Prod. Specification
	Hardware Revision String	"1.0" ¹	
	Software Revision String	"1.2" ¹	
	Firmware Revision String	"1.23"	
Date-and-Time	Current Time	0x20 0x10 0x12 0x18 0x15 0x23 0x06 0x00	Section 2.2.6

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11073-20601 Attribute	Bluetooth Equivalent Characteristic	11073-20601 Value	Reference
Reg-Cert-Data-List	IEEE 11073-20601 Regulatory Certification Data List	For an example on how to populate this structure, refer to Section 2.2.5 .	Section 2.2.4 – Reg-Cert-Data-List
System-Type-Spec-List	None	{MDC_DEV_SPEC_PROFILE_TEMP, 1}	

Table 95: MDS Object for Health Thermometer

Notes:

1. Because this is an odd-sized string, a zero (0x00) byte must be appended to its end and its length field must be incremented. See Section [2.2.3](#) for more information.

Numeric Object

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Value	Reference
Handle	None	1	
Type	None	MDC_PART_SCADA	Section 3.1.1
	None	MDC_TEMP_BODY	
Metric-Spec-Small	None		
Measurement-Status	None	relevant data, 0x10 (optional)	
Metric-Id	None	MDC_TEMP_BODY = 0x4002	Section 3.1.2
Metric-Id-List	None		
Metric-Id-Partition	None		
Unit-Code	Temperature Measurement	MDC_DIM_DEGC	Section 3.1.2
Attribute-Value-Map	None		
Absolute-Time-Stamp	Temperature Measurement	0x20 0x10 0x12 0x18 0x15 0x00 0x00	Section 3.1.2
Measure-Active-Period	None		
Simple-Nu-Observed-Value	None	0xFF000172 (37.0)	Section 3.1.2 and Annex F.8 of [1]
Compound-Simple-Nu-Observed-Value	None		
Basic-Nu-Observed-Value	None		
Compound-Basic-Nu-Observed-Value	None		
Nu-Observed-Value	Temperature Measurement		
Compound-Nu-Observed-Value	None		
Accuracy	None		

Table 96: Numeric Object for Health Thermometer

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5 Acronyms and Abbreviations

Acronyms and Abbreviations	Meaning
11073-20601	The ISO/IEEE 11073-20601 standard [1]
APDU	Application Protocol Data Unit
ASCII	American Standard Code for Information Interchange as defined in ISO/IEC 646 (1991)
ASN.1	Abstract Syntax Notation One
BCD	Binary-Coded Decimal
BMI	Body Mass Index
CTS	Current Time Service
DIM	Domain Information Model
DIS	Device Information Service
EUI	Extended Unique Identifier
FDA	Food and Drug Administration
GATT	Generic Attribute Profile
ID	Identifier
IEC	International Electrotechnical Commission
IEEE	Worldwide technical society which generated the IEEE 11073 series standards, www.ieee.org
IG	Interoperability Guidelines
ISO	International Organization for Standardization
LE	Low Energy
LSB	Least Significant Bit
MAP	Mean Arterial Pressure
MDS	Medical Device System
MSB	Most Significant Bit
OID	Object Identifier
OUI	Organizationally Unique Identifier
RACP	Record Access Control Point
USB	Universal Serial Bus
UTF-8	Unicode Transformation Format-8
UUID	Universally Unique Identifier

Table 97: Acronyms and Abbreviations

6 References

- [1] ISO/IEEE Std 11073-20601TM- 2008 Health Informatics - Personal Health Device Communication - Application Profile - Optimized Exchange Protocol - version 1.0. This also includes ISO/IEEE Std 11073-20601aTM-2010 – Amendment 1
- [2] Device Information Service v1.1 or later
- [3] [Bluetooth SIG Assigned Numbers](#)
- [4] ISO/IEEE Std 11073-10408TM-2008 Standard for Health informatics - Personal health device communication - Device specialization - Thermometer
- [5] Health Thermometer Service (v1.0 or later)
- [6] Continua Design Guidelines 2015 (version 5.0)
- [7] IEEE Std 11073-10406TM-2011 Standard for Health informatics - Personal health device communication - Device specialization - Basic Electrocardiograph (ECG) (1 to 3-lead ECG)
- [8] Heart Rate Service v1.0 or later
- [9] Blood Pressure Service v1.0 or later
- [10] IEEE Std 11073-10407TM-2008 Standard for Health informatics – Personal health device communication – Device specialization – Blood Pressure Monitor
- [11] IEEE Std 11073-10417TM-2011 Standard for Health informatics – Personal health device communication – Device specialization – Glucose meter
- [12] Glucose Service v1.0 or later
- [13] Bluetooth Core Specification v4.0 or later
- [14] Current Time Service v1.1 or later
- [15] ISO/IEEE Std 11073-10441TM-2008 Standard for Health Informatics – Personal health device communication – Device specialization – Cardiovascular fitness and activity monitor
- [16] Specification of Regulatory Certification Data List at ISO/IEEE Std 11073-20601a-2010, sections 6.3.2.3 (MDS class attributes) and A.11.2 (MDS-related data types).
- [17] Patient Care Device (PCD) Technical Framework [at the IHE site](#).
- [18] Weight Scale Service v1.0 or later
- [19] Body Composition Service v1.0 or later
- [20] ISO/IEEE Std 11073-10415TM-2010 Standard for Health Informatics – Personal health device communication – Device specialization – Weighing Scale
- [21] ISO/IEEE Std 11073-10420TM-2010 Standard for Health Informatics – Personal health device communication – Device specialization – Body Composition Analyzer
- [22] IEEE Std 11073-10425TM-2011 Standard for Health informatics – Personal health device communication – Device specialization – Continuous Glucose Monitor
- [23] Continuous Glucose Monitoring Service v1.0 or later

- [24] Pulse Oximeter Service v1.0 or later
- [25] IEEE Std 11073-10404[™]-2008 Standard for Health informatics – Personal health device communication – Device specialization – Pulse Oximeter
- [26] Health Device Profile v1.0 or later
- [27] Personal Health Care Device Class, available at USB.org